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Statistical implications of the new financial landscape

Overview of the eighth IFC conference[1]

Burcu Tunç[2] and Bruno Tissot[3]

Opening the eighth IFC conference on the "*Statistical implications of the new financial landscape,*"[4] Katherine Hennings, IFC Vice Chair and representative from the Central Bank of Brazil, underlined central bank statisticians' ongoing efforts to improve international financial statistics in response to the Great Financial Crisis (GFC) of 2007–09. Such efforts aimed, in particular, at developing better quality, more comprehensive and more flexible data sets.

In his remarks, Luiz Awazu Pereira da Silva, Deputy General Manager of the BIS, recalled the numerous actions undertaken in the area of financial statistics since the GFC, including, in particular, the Data Gaps Initiative endorsed by the G20 (see IMF and FSB (2009), and Heath and Goksu (2016)). The BIS and the various financial stability groups hosted at the BIS have concentrated their efforts on four major areas: the production of new financial statistics; the effective dissemination of these data; their adequate use, especially for policy purposes; and the anchoring of Basel-based statistical work in international initiatives. Looking ahead, one needs to be prepared for the constant emergence of new data-related issues. To this end, statisticians should further their efforts to: produce better macro statistics; collect macro-relevant, "pure" micro data; facilitate the linking of macro- and micro-financial data; better assess the distribution of aggregated indicators; ensure that the design and assessment of new financial policies are based on statistical evidence; and expand "the knowledge frontier" by developing new concepts for analysing financial stability issues (Tissot (2016a)).

In his keynote speech, Pedro Silva, President of the International Statistical Institute (ISI), emphasised the disconnection between the large data gaps revealed by the GFC and the increasing volume of statistics emanating from the digital revolution (IFC (2015b)). But having more data at one's disposal was not necessarily associated with better quality information. It was also posing new and sometimes unexpected challenges. The way forward for statisticians was to keep their existing and well known data frameworks, and to complete them with available information rather than switching to the compilation of entirely new large data sets. In any case,

[1] The views expressed here are those of the authors and do not necessarily reflect those of the Bank for International Settlements, the Central Bank of the Republic of Turkey or the Irving Fisher Committee on Central Bank Statistics.

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[4] Hosted by the BIS in Basel on 8 and 9 September 2016 and attended by about 150 participants from 63 countries.

applying statistical thinking for process analysis and having sound methodology were essential in ensuring data quality and evidence-based decision-making, especially in a world of big data.

The conference was fruitful in combining various country experiences, both from methodological and empirical perspectives, and allowing for an in-depth exploration of several specific themes. Session 1 focused on the post-GFC data frameworks that were developed to capture financial stability risks. Session 2 looked at the statistical implications of changing financial intermediation patterns. Session 3 reviewed the new data required by evolving monetary policy needs. Session 4 dealt with the assessment of vulnerabilities. Session 5 focused on micro data. Finally, Session 6 reviewed issues related to the sharing and dissemination of statistics. The Conference ended with a panel discussion on the statistical implications of the new financial landscape.

1. Data frameworks for systemic risk

The first session, chaired by Aurel Schubert, Vice Chair of the IFC and European Central Bank (ECB), discussed *data frameworks for systemic risk*. The greater focus on systemic risk analysis after the GFC had called for new types of statistics (eg financial stability indicators) and compilation practices (eg greater focus on micro data). The session was thus an opportunity to look at central banks' experiences in enhancing existing data frameworks, building up new databases and creating indicators to support systemic risk analysis.

The first presentation, by the ECB, stressed the importance of having adequate and comprehensive statistical databases to support macroprudential policies. A new "*Macroprudential Database*" was launched in the European Union (EU) in 2015 to support the activities of both the Single Supervisory Mechanism (SSM) and the European Systemic Risk Board (ESRB). In the main, it provides a framework for collecting the various statistical inputs required for macroprudential analysis within euro area countries (as members of the SSM) and also for the whole Europe Union (the ESRB being in charge of macroprudential oversight for the entire EU financial system). The database is structured around a number of domains that are key from a financial stability perspective; for instance, macroeconomics and financial markets, debt and credit, residential and commercial real estate, banking sector, non-banks and interconnections. Most of the statistics covered are in the public domain, allowing for interaction between academic researchers and the central banking community.

Such a comprehensive collection of existing information can be a cumbersome exercise, especially if one wants to integrate financial supervisory data that are usually not available in the public domain. From this perspective, the Bank of England presented a new *Historical Banking Regulatory Database*. This database provides a long-term overview of the UK banking sector and its various business models, with information at both the consolidated parent group and solo levels. The data are available since the late 1980s, a significant advantage compared with other relatively shorter databases – not least considering that financial cycles tend to have a longer time-span than more traditional business cycles.[5]

While the first two presentations had mainly dealt with existing statistics, the third presentation by the Netherlands Bank illustrated the need to collect new statistics to better analyse systemic risk. From this perspective, a key issue was to assess the role played by "pass-through funds"[6] in the Netherlands. For that purpose, and as compiler of statistics on balance of payments (BOP), the Netherlands Bank had originally defined the concept of "Special Financial Institutions (SFIs)".[7] In order to align this national concept with international standards, the focus was now on switching to those special purpose entities (SPEs) considered to be "captive financial institutions"[8] in the System of National Accounts (SNA) framework. However, to continue with being able to specifically monitor the impact of pass-through funds, the Netherlands Bank was following a combined approach to identify precisely those SPEs engaged in pass-through activities.

Independently of whether the statistics collected were old or new, the next step was to build adequate indicators to underpin systemic risk analysis. To this end, and as explained in its second presentation, the Bank of England set up a regulatory database of inter-institutional exposures which was extended to cover both financial and non-financial firms. This information allowed for the computing of a risk index that encompassed the system-wide impact of the potential failure of an institution due to its credit exposures and interactions in various market segments. This modelling allowed for the assessment of each bank's contribution to systemic risk and provided, in addition, a basis for developing regulatory responses.

The last presentation, by a researcher from Erasmus University (Rotterdam), looked at the role of statistical frameworks in globalisation, with a focus on the banking statistics collected by the BIS (2015). By providing information on multinational banks, these data help in analysing the structure of global capital markets. In particular, they allow to measure banking operations from residency and nationality perspectives, and help to differentiate among the various types of capital flow (eg domestic versus cross-border). This statistical framework thus provides a

5 See *Debt and the financial cycle: domestic and global*, in BIS (2014), Chapter IV.

6 See the 2008 System of National Accounts (European Commission et al (2009)), especially Chapter 21: ""Pass-through funds" or "funds in transit" are funds that pass through an enterprise resident in one economy to an affiliate in another economy, so that the funds do not stay in the economy of the affiliate" (#21.41).

7 SFIs are broadly defined by the Netherlands Bank as resident institutions in which non-residents hold a participating interest or exercise influence. Their business consists schematically in holdings of assets and liabilities abroad and/or transfers of royalty and licence income earned abroad to foreign group companies and/or the generation of turnover associated with reinvoicing to and from foreign group companies. All SFIs are ultimately owned by foreign parents (see *Notes to the SFI benchmark survey*, available on www.dnb.nl/home/index.jsp).

8 The 2008 SNA provides guidance on the treatment of units with no employees and no non-financial assets, units often described as SPEs or special purpose vehicles (SPVs). See 2008 SNA Chapter 4: "There is no common definition of an SPE but some of its characteristics are that it has little physical presence, is always related to another corporation, often as a subsidiary, and it is often resident in a territory other than the territory of residence of its parent" (#4.55-6 and #A3.10). A SPE can fall in the category of "captive financial institutions"; in particular, "a holding company that simply owns the assets of subsidiaries is one example of a captive financial institution" (#4.59-61).

geography of financial globalisation and related systemic risks, complementing country-based indicators. One issue, however, is that this new financial geography is shaped by multinationals' decisions to distribute activities across countries, contributing to the expansion of cross-border capital flows and questioning the traditional role of the nation-state.

2. New financial intermediation patterns

The second session, chaired by Hock Chai Toh, Central Bank of Malaysia, reviewed the *new financial intermediation patterns* that have emerged since the GFC and their statistical implications. A key issue was to deal with the increasing importance and variety of financial intermediaries – such as SPVs/SPEs and other "shadow banks" – and the associated emergence of new "data gaps" as well as the implications for traditional banking activities.

A first example was the presentation by the Central Bank of Ireland of a new data collection on SPVs located in Ireland to better assess the diverse range of their activities as well as their linkages to other institutions. The aim was to support financial stability analysis by: (i) enhancing the measurement of the shadow banking sector itself; (ii) capturing the associated geographical and sectoral linkages; and (iii) assessing the potential spillover risks stemming from the SPV sector. This experience underlined the role of data-sharing to better measure cross-sector and cross-border systemic interactions.

A second example was provided by the Netherlands Bank whose presentation emphasised the importance of a better monitoring of financial flows across sectors. Enhanced cooperation with Statistics Netherlands had helped to develop a new and consistent data set covering the financial and non-financial sectors. This data set provided balance sheet information, including counterparty information, for all the reporting units. A key lesson was that expanding this type of data collection required greater powers for national statistical authorities, including central banks.

A third example, provided by the ECB, related to the securitisation of bank loans. This financial innovation played an important role in the GFC in that it disrupted the assessment of banks' balance sheets, with major implications for monetary and financial stability. Addressing this issue required significant adjustments to European statistics on loans to the private sector. One was to correct balance sheet measures for the impact of loan transfers between banks and non-banks. A second, and more recent initiative, was to collect information on all the loans originated by banks (whether on- or off-balance sheet) so as to get a more comprehensive assessment of the credit provided to the real economy.

New data collections, such as the examples referred to above, could be instrumental in better assessing the nature and size of new financial intermediaries, and the implications that this had for financial stability and systemic risk analysis. Yet, an understanding of the factors driving the development of shadow banks remained a challenge, not least because of the difficulty of assessing the impact of regulatory arbitrage. The paper from the Bank of Korea attempted to fill this gap, using the data regularly collected by the Financial Stability Board (FSB (2015)). This exercise showed that the development of long-term institutional investors, such as pension funds and insurance companies, was an important element driving shadow banking. It also found that the expansion of new financial intermediaries was not associated with a reduction in traditional banking, as the two forms of intermediation were often developing together.

Another paper, by the Bank of England, focused on the role of competition in UK banking. This was assessed by using the new regulatory database set up by the Bank of England which pointed to a general decline in the intensity of competition in the deposit-taking sector since the late 1980s. In particular, the ability of UK banks to extract market rents from customers had risen significantly in the years preceding the GFC. However, this general picture covered differences across market segments (eg mortgage and retail banking), underlying the complexity of the relationships that could exist between competition intensity and financial stability.

3. New statistics for new monetary policy needs?

Monetary policy frameworks have faced a number of changes in the aftermath of the GFC with, in particular, a stronger focus on unconventional policy tools in a context of very low interest rates. The third session, chaired by Katherine Hennings, discussed the *statistical implications of these monetary developments*, in particular as regards the need for new data collections and for a better understanding of the transmission channels of policy actions (both conventional and non-conventional).

A first objective, highlighted by Bank Indonesia's presentation, was to expand the collection of statistics that could be useful in times of financial stress. In that case, it was important to better capture agents' expectations, which could have a destabilising role. An *Inflation Expectations Survey* pilot project was accordingly launched to collect information on inflation expectations following the implementation of the Inflation Targeting Framework in Indonesia in 2005. Another initiative to complement existing data was the conduct of a banking survey to assess financial institutions' practices with respect to the taking of deposits, the provision of loans, the placement of excess liquidity and the determination of lending and deposit rates.

A second objective was to improve the understanding of the transmission channel of "conventional" monetary policy actions, as highlighted by three country presentations. First, the contribution of the Central Bank of Malaysia[9] showed how to assess commercial banks' risk-taking in a situation of low interest rates. To this end, it proposed to use firm-level information from the credit register database administered by the Central Bank of Malaysia to assess the lending standards faced by borrowers. Second, the South African Reserve Bank's presentation focused on the link between the policy rate and alternative interest rates in order to better assess the stance of monetary policy. A key lesson was that in the post-crisis period the policy rate did not properly reflect the real burden faced by borrowers. To obtain a comprehensive picture of the monetary policy stance, various indicators had thus to be looked at – including, for example, the rates observed for baskets of loans as well as quantity-based indicators such as banks' liquidity, credit extension

[9] The related paper "*Measuring bank risk-taking behaviour: the risk-taking channel of monetary policy in Malaysia*", by Teh Tian Huey and Daniel Chin Shen Li (Central Bank Malaysia), received the IFC award for the best paper by a young statistician on the occasion of the Conference.

and loan rejection rates. The third presentation, by the National Bank of the Republic of Macedonia, underlined the need to consider the presence and degree of nominal rigidities. Using firm-level survey data, it found that monetary policy effectiveness was significantly influenced by price and wage adjustment patterns.

Beside these relatively traditional issues, specific data needs were also triggered by the wide range of non-standard monetary policy actions taken in response to the GFC. Two presentations focused on this area. The first, by the ECB, underlined the importance of having quantitative indicators for the design of new monetary policy tools, their implementation and the analysis of their impact. To this end, new data had to be collected, including on bank loans and money market transactions. For instance, the implementation of the Targeted Longer-Term Refinancing Operations (TLTRO)[10] had led to the setting up of a fully dedicated statistical reporting framework at the ECB. In addition, analysing the impact of unconventional policy tools had required a close monitoring of financial market participants, putting a premium on the granularity and timeliness of the statistics collected; for instance, balance sheet and interest rate information at the level of individual financial institutions.

This point was emphasised in the second presentation on data needs relating to unconventional monetary tools, by the Bank of Portugal. The issue was that aggregated data could be misleading when assessing the impact of these tools. For instance, aggregated interest rate statistics would provide information on the average cost of funding in the economy. However, it might not be sufficient to assess the impact on the potential borrowers targeted by the unconventional tools; for instance, small and medium-size enterprises (SMEs), mortgage borrowers etc. The Bank of Portugal had consequently started collecting individual data on loans provided to non-financial corporations and their respective interest rates. More precise statistics were also in demand for the households sector; for instance, to capture the impact of variables such as age and education. Another important goal was to compute the financial accounts with "from-whom-to-whom" information,[11] including a breakdown of assets and liabilities with counterparty information (Tissot (2016c)), to facilitate the analysis of the impact of new monetary tools on a particular sector.

4. Assessing vulnerabilities

Session four was devoted to the statistical information required for the *assessment of vulnerabilities* and sources of financial stress in the aftermath of the GFC. Three main types of fragility were identified and addressed separately, namely those related to exchange rate, macroeconomic and balance sheet vulnerabilities.

[10] TLTROs provide financing to Eurosystem credit institutions for periods of up to four years. They offer long-term funding at attractive conditions in order to further ease private sector credit conditions and incentivise bank lending to the real economy. Two TLTROs series were launched over 2014–2016 (a description of the Eurosystem's instruments is available at www.ecb.europa.eu/mopo/implement/html/index.en.html).

[11] For a description of the three-dimensional "from-whom-to-whom" (FWTW) tables, see the 2008 SNA (eg #2.150).

Exchange rate vulnerabilities

The first sub-session, chaired by Charles Thomas, Board of Governors of the Federal Reserve System, focused on the assessment of *exchange rate vulnerabilities*. It was an occasion to review the different ways of measuring risks related to exchange rates, including through derivatives operations, and capture the associated vulnerabilities both at the level of the country and at that of individual economic agents.

The presentation by the Central Reserve Bank of Peru addressed the measurement issues related to the dollarisation of the Peruvian economy, which could pose significant challenges for the conduct of monetary policy. To assess the degree and persistence of dollarisation, specific questions were added to the regular survey of SMEs. The information collected on the currency composition of their sales and costs suggested that non-financial firms in Peru were still significantly vulnerable to exchange rate fluctuations.

Another key statistical issue when assessing exchange rate vulnerabilities was to analyse the impact of derivatives contracts. In Europe, the European Market Infrastructure Regulation (EMIR) reporting framework was implemented after the GFC with the aim of increasing transparency in the over-the-counter (OTC) derivatives market. A by-product had been the setting up of a granular and rich transaction-level data set on derivatives, which could be used to measure exposures in a detailed manner. The Bank of England's presentation showed the usefulness of these data in analysing the evolution of the Swiss franc/euro exchange rate following the Swiss National Bank's decision to terminate the Swiss franc's peg to the euro in 2015.

The presentation by the Central Bank of the Republic of Turkey emphasised the need to have a detailed and frequent assessment of foreign exchange assets and liabilities to assess exposures in the non-financial sector. Macro information based on counterparty data (eg bank lending) could be usefully complemented by firm-level balance sheet data covering, in particular, intrasector transactions. This second, micro approach allowed for a more flexible data set that supported a wider range of analyses. But it also presented important drawbacks in terms of timeliness and reporting burden. This information should therefore be used as a complement to the macro level data instead of replacing them.

The Central Bank of Malaysia highlighted the statistical efforts undertaken by central banks for the surveillance of capital flows. This monitoring was particularly important for small open economies to better understand the causes and effects of capital flows, and their potential risks (IFC (2017)). To this end, the Central Bank of Malaysia used several databases, as there was no perfect way of monitoring all types of portfolio flow with good timeliness, depth and breadth.

The last presentation, by the Central Bank of Chile, analysed the use of derivatives by Chilean exporters and importers to hedge against exchange rate risks. At a macro level, this use was steadily expanding, as suggested by the link observed between the level of foreign trade flows and turnover in the FX derivatives markets. This relationship was tested and confirmed by looking at individual, contract-level data.

Macroeconomic vulnerabilities

The second sub-session, chaired by Jacek Kocerka from Narodowy Bank Polski (Poland), dealt with general *macroeconomic vulnerabilities*. The focus was on the key statistical indicators that should be looked at to inform central banks and policymakers more generally. The various papers discussed this point by reviewing a wide range of statistical domains related to the "real economy", including production fluctuations, external trade, indebtedness, inflation and asset prices.

A key starting point in the assessment of macroeconomic vulnerabilities was to closely monitor the position in the business cycle and hence output fluctuations. However, collecting, compiling and analysing all the statistical information on domestic production might require significant statistical resources as well as time, and this could be a major problem especially in developing countries. To this end, the Bank of Lebanon had developed a composite indicator to synthetically reflect the evolution of the Lebanese economy. The amount of information that needed to be collected was relatively limited and the indicator appeared to track Lebanese business cycles efficiently, especially their different phases and turning points.

A second important area, in particular for open market economies, was the external sector. While attention had been traditionally on the current account (that is, on trade variables driven by demand, terms of trade and competitiveness), the presentation by the Bank of Portugal emphasised the need to also look at stock indicators (ie financial positions). The level and composition of residents' assets and liabilities were a key element in understanding the improvement in Portugal's current account after the euro sovereign crisis of the early 2010s. The need to look at financial positions was echoed in a second presentation by the Bank of Portugal which focused more specifically on non-financial SMEs. Micro data available from the Central Balance-Sheet Database showed, in particular, that companies' indebtedness and profitability were closely negatively related.

Third, inflation had traditionally been a key focus of vulnerability analyses with an important role played by the formation of price expectations. The presentation by the Bank of Japan looked at the particular impact of business conditions on firms' inflation outlook in this context, using micro data compiled from various sources, including the well known survey of enterprises in Japan (Tankan) and one more specific survey on the inflation outlook. This information helped to understand the response of firms' inflation expectations to observed price movements (eg commodity prices) and labour market conditions, as well as structural differences across economic agents; for instance, the fact that SMEs tend to have higher inflation expectations than larger firms.

A fourth issue to be considered was the impact of asset prices on the real economy. Residential property prices, in particular, could significantly influence macroeconomic developments and economic agents' financial positions. Such prices were of central interest to the authorities in charge of monetary policy as well as to micro- and macro-financial supervisors. The presentation by the Deutsche Bundesbank detailed its multi-indicator approach to the monitoring of the German residential property market, which has experienced significant price increases since 2010, and its analysis of the various impacts that this is having on the economy. The approach relied on a system of alternative indicators (eg prices, financial variables and real economic aggregates), instead of a single, composite indicator. It appeared to have proven useful in analysing the situation of the German housing market, its drivers (eg respective roles of demand and supply factors) and its implications for monetary and financial stability policies.

Balance sheet vulnerabilities

The third sub-session, chaired by Bruno Tissot of the BIS, reviewed the data issues related to the assessment of *balance sheet vulnerabilities*. The various contributions illustrated the importance of compiling sectoral balance sheet and financial account data in the post-GFC era, especially for assessing the liabilities of pension systems, the financial position of the government, and the situation of financial and non-financial firms.

As regards pension liabilities, the presentation from the Bank of Japan focused on their estimation of the new *Flows of Funds Accounts*. These accounts allowed to distinguish between two types of employment-related pension scheme, defined benefit and defined contribution schemes. They also facilitated the analysis of the impact of interest rate changes on retirement benefits. But there were important compilation challenges, related, for instance, to the limited timeliness and frequency of data sources. This was requiring some ad hoc estimations, possibly leading to significant forecast errors, especially in times of significant interest rate fluctuations.

As regards the government balance sheet, the presentation by the People's Bank of China showed that the implementation of the international SNA standards was raising a number of statistical issues, in particular related to the measurement of those public assets and liabilities that were specific to China but also to the delineation of the government sector itself. To address these points, it was important to coordinate the various accounting systems applying to different public sector institutions and, more specifically, to the classification of their respective assets and liabilities.

Turning to non-financial corporates, the presentation by the Bank of Italy analysed the determinants of the country's shift from a net borrowing to a net lending position in recent years. A wide range of factors needed to be considered, including real cyclical developments (eg output gap and demand components), financial indicators (eg profits and leverage) and external influences (eg foreign direct investment). Correctly considering these elements was particularly important in measuring the risks borne by lenders and their associated capital requirements. But assessing counterparty risk could be as much an art as a science. The presentation by Narodowy Bank Polski (Poland) showed that several alternative calibration methods should be considered in estimating default probabilities and establishing rating systems.

As regards banks, the Bank of Portugal emphasised the need to correctly assess international exposures in the light of the dramatic changes observed in cross-border positions after the GFC. The resilience of such exposures to potential shocks could be analysed by comparing existing portfolios with those that would result from an optimal diversification strategy. This exercise suggested that banks' exposures were still in need of further diversification from their "traditional" euro area basis.

Again, a key message was that the assessment of financial positions should consider off-balance sheet items and, in particular, the impact of derivatives. The BIS contribution analysed various data sources that could be considered for this purpose. It noted that each of them served a particular objective, including whether the data were collected for regulatory or statistical purposes. The resulting data sets were neither integrated nor easy to combine, and fundamental differences existed regarding the definitions of similar concepts and measures. There was, however, room to merge or streamline existing derivatives statistics in the context of the ongoing international initiative for collecting aggregated data from trade repositories. But practical obstacles remained as regards both the way to aggregate micro data and the related need for sharing very granular information in this endeavour.

5. Dealing with micro data

The fifth session, chaired by Pedro Silva, President of the ISI, focused on the *management of micro data*. The combination of growing data needs after the GFC and the availability of new, granular sources of data had resulted in the production of very large and diversified data sets. A quick and efficient processing of such sizeable and complex information was crucial to its adequate use for policy purposes. This put a premium on standardised and automated integration systems to effectively manage the increasing number of micro data sets and develop empirical analysis based on them (IFC (2015a)). Several papers were presented to describe how granular data could be used to enhance the collection of existing aggregated statistics (eg on securities and financial market prices) with a possible matching of various data sets. Associated technical and management issues were also considered.

The first presentation by the ECB highlighted the benefits of looking at granular statistics on the security holdings of investment funds. This information had been collected already at an aggregate level for many years for the purpose of monetary policy analysis. However, the more granular details on individual securities and their holdings provided by the newly-developed "Securities Holdings Statistics by Sector" had clearly improved the analysis of economic and financial stability issues. It was also a more flexible tool to address ad-hoc data queries. In particular, greater data granularity allowed for the creation of new indicators tailored to users' evolving needs, without adding to the reporting burden.

A second presentation by the ECB focused on the management issues relating to large, non-standardised micro data sets. In this context, it emphasised the crucial role that unique identifiers could play, as shown with the compilation of the Centralised Securities Database (CSDB). This security-by-security data set contained various indicators derived from multiple sources. Its quality was thus highly dependent on the correct integration of data based on a granular security identifier – the International Securities Identification Number (ISIN). But, in the absence of a standard entity identifier, the individual identification of an issuer was relying on a specific, automated data integration process (eg name-matching algorithm). This was seen as a second best, temporary solution before implementation of the new Legal Entity Identifier (LEI) standard (LEIROC (2016)).

As emphasised by the second ECB presentation in this session, the "matching" of different micro data sources should be considered to facilitate their use for different purposes. For instance, the integration of reference data for both monetary and supervisory analyses had become a key priority in Europe following the implementation of the SSM. To achieve that, a Register of Institutions and Affiliates

Database (RIAD) has been developed as a reference platform for various users' needs. Further data integration was ongoing as well as the development of tools to manage differences in the relevant population and group definitions that exist between the supervisory and statistical approaches (IAG (2015)).

The next paper, written jointly by researchers from the Catholic University of Milan and the University of Basel, illustrated the benefits of using two large high-frequency financial data sets for empirical analysis. The first case was the identification of reactions in FX markets to surprises in monetary policy decisions, using a "minute-tick" database. The study highlighted the difficulties in dealing with the large size of the data and potential ways of addressing them, for instance, by defining narrow time windows around each policy announcements. The second case study showed how to use intraday credit default swap (CDS) and bond data for estimating credit risk contagion effects. The empirical results suggested that making use of high-frequency data could allow users to capture intraday contagion patterns (which would be missed using lower frequency data).

The last presentation, from the multinational management and technology consulting firm BearingPoint, highlighted the need for new technologies in dealing with growing regulatory reporting needs, including those resulting from very large data sets. Collecting quality information from different sources and at a reasonable cost was crucial and called for greater process automation. The industry was considering how to set up a new information value chain to replace template-driven reporting. But this required a greater harmonisation of data sets and the integration of various IT systems, both among reporters and between supervisory authorities and supervised entities.

6. Data-sharing and dissemination

The sixth session, chaired by Robert Kirchner from the Deutsche Bundesbank, reviewed the statistical issues relating to *data-sharing and dissemination*. The presentations covered a number of initiatives aiming at enhancing data-sharing, communicating high-quality information to end-users, ensuring strong data governance and implementing efficient standardised technical processes.

The first paper presented Deutsche Bundesbank's experience in building a data-sharing framework for analytical purposes. The *Integrated Microdata-based Information and Analysis System* initiative was launched to meet the demands of researchers and analysts for a direct access to micro administrative data sets. This initiative relied on two key components, namely a central data warehouse (the *House of Microdata*), and a unit dedicated to support internal and external research (the *Research Data and Service Centre*). This central statistical information system enabled bank-wide integration of various data types. A key supporting factor was that the data warehouse had been built on the generic Statistical Data and Metadata Exchange (SDMX) standard (IFC (2016a)).

As regards communication, the greater emphasis on uncertainties had triggered new ways of presenting data to end users. The contribution by the Central Bank of Malaysia showed how "fan chart"-type presentations could be useful in this context. Fan charts usually represented confidence intervals around a baseline forecast to reflect the degree of uncertainty; for instance, in terms of inflation prospects. This framework was therefore well adapted to visualise the topic in a systematic manner and facilitate their communication.

The presentation by the Central Bank of the Russian Federation emphasised the opportunities provided by modern informational technologies, especially new data visualisation software, in support of data-sharing and communication. To this end, the Statistics Department of the central bank had been using a specific commercial IT solution. It was felt that such a solution could be instrumental in setting up a unified information system integrating in a flexible way multiple data applications, enabling large-scale data distribution (with interactive and visually attractive analytics), facilitating ad-hoc self-service access to the data and reducing internal IT development work.

The success of these various statistical initiatives was often dependent on having a solid data governance framework, as highlighted by the example of the European Insurance and Occupational Pensions Authority (EIOPA). This organisation developed such a framework when designing its information management strategy. The starting point was the need for a data framework that was secure, efficient and adaptable to the changing environment. To this end, the approach relied on the involvement of all key business users so as to define common rules and processes for data collection and dissemination. The new framework was built on a centralised database comprising non-anonymised firm-level data with harmonised reporting data formats and adapted validation rules.

7. The need for new data and related management issues

The conference ended with a panel discussion, chaired by Eugeniusz Gatnar from Narodowy Bank Polski (Poland), covering two main topics: *the new statistical needs of central banks after the GFC*; and *the implications of such needs in terms of data management*.

As regards data needs, a key question was whether existing statistics should simply be enhanced or needed to be replaced with completely new data sets. Obviously, the situation differed across countries, particularly with respect to their degrees of financial development. It also depended on what "good statistics" meant. As recalled by Turalay Kenç (former IFC Chair), statisticians had traditionally focused on the criteria of timeliness, accuracy, reliability and availability. But the post-GFC financial landscape had also underscored the importance of looking at other factors: the insufficient international harmonisation of data, which was hampering cross-countries comparisons as well as the identification of global spillovers; the existence of large data gaps, for instance, to monitor the non-bank financial sector and the real estate market; and the need to link aggregate national data and more micro information when monitoring economic developments and vulnerabilities.

Indeed, a key priority that has emerged for central banks in recent years is to access more granular information, especially at the entity- and transaction-levels. First, more granularity would increase the flexibility of data sets to respond to ad-hoc information needs. Second, assessing financial stability risks often required looking at the trees and not just the forest (Borio (2013)), especially when it came to capturing the situation of systemically important institutions. Aggregated data could even give a false sense of comfort in case of acute financial stress circumscribed at the level of a specific institution. Third, granular data was also important for monetary policy, for instance, to better understand the monetary transmission channels or assist with the implementation of unconventional policy tools – a key point highlighted in particular by Anita Angelovska Bezhoska (National Bank of the Republic of Macedonia). All in all, aggregate indicators had been losing some of their earlier importance with a greater focus now being put on detailed impact assessment studies. This was requiring a deeper knowledge of the individual situation of financial firms, non-financial corporates as well as households. As a result, several initiatives were trying to mobilise balance sheet information at the entity level, in particular by looking at data sets derived from banking books, credit registers, central balance sheet data offices,[12] tax files etc.

Turning to data management issues, a common theme was how to deal with rapidly expanding big data sets. Their collection was costly in terms of reporting burden. It was also essential to communicate adequately with data reporters when making the case for the new collection exercises undertaken since the GFC. From the compilers' point of view, the new data sets were also requiring more resources. This was obvious as regards the IT equipment and skills needed to set up and maintain micro data collection systems.

Yet, dealing with an increasing amount of available information was only one side of the story. The statistical methodologies underpinning the new data collections also needed to be revisited. For instance, a key challenge was to better link micro- and macro-level data, not least when it came to develop meaningful stress tests (IFC (2015a)). Another issue emphasised by Gabriel Quirós Romero (IMF) was to reconcile international statistics (eg global capital flows driven by group-level strategies) with indicators measured within national boundaries on a SNA-type residency basis (Tissot (2016b)). This particular issue was emphasised in the panel presentation by Hyun Song Shin (BIS). The traditional approach was to view capital flows as the financial counterpart to savings and investment decisions but this assumed a "triple coincidence" of GDP area, decision-making unit and currency area which could be a misleading simplification (Avdjiev et al (2015)).

A final issue was to allow for more data-sharing both within and among national authorities as well as at the international level (IFC (2016b)). Claudia Buch (Deutsche Bundesbank) emphasised the messages of her keynote speech, ie that individual data sets provided insufficient information on the drivers and effects of changing data patterns. The way forward was to combine ("share") data sets from different sources, following the examples of other research areas (eg medicine). Looking ahead, statisticians should better balance data usability and confidentiality issues. The way forward for central banks was to: (i) improve mechanisms for enhanced data-sharing across countries and business areas in central banking (and beyond); and (ii) use existing data efficiently as part of central banks' accountability to the general public.

12 Central balance sheet data offices are bodies (mostly located within central banks) that collect and handle firms' financial accounts data (with often a focus on the non-financial sector). See, for Europe, information related to the European Committee of Central Balance-Sheet Data Offices (ECCBSO) on www.eccbso.org/wba/default.asp.

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Eighth Irving Fisher Committee Conference on Central Bank Statistics

Katherine Hennings, Senior Advisor, Central Bank of Brazil and IFC Vice Chair

Basel, 8 September 2016

Opening Remarks

Good morning ladies and gentlemen. It is my pleasure to welcome you all to the 8th biennial conference of the Irving Fisher Committee on Central Bank Statistics (IFC).

I would also like to take this opportunity to extend my appreciation to all IFC Executives and members and to all participants, who are contributing to this meeting.[1]

Having the objective to promote the exchange of views amongst central bank economists, statisticians and policy makers in discussing statistical issues of interest to central banks, we, as the IFC, are pleased to host this year's conference on the topic of "statistical implications of the new financial landscape". We do believe that this year's conference will be very fruitful, as in the previous years, in bringing up valuable ideas together and guide our future research.

As already discussed broadly in many occasions, the recent financial crisis highlighted the need for better quality, more comprehensive and flexible datasets in order to support monetary and financial stability analysis. And since then we tried to improve our statistical data practices, fill-in some data gaps and enhance international cooperation. Given these efforts, a new topic to discuss would be the reflections of them in the data frameworks and it is the focus of our first session. With various presentations on both theoretical and practical point of views, on what is done and what should be done further and on what to expect from these new frameworks, I believe this session will give us the opportunity to effectively share our experiences and discuss the way forward.

While there is an ongoing effort, in our side as central bank statisticians, to adapt our data sets to capture all the relevant information, there is an ongoing evolution in financial markets, too. In particular, the financial intermediation patterns are changing very rapidly suggested by the increasing importance and diversity of special purpose vehicle (SPV) activities, shadow banking and also by the changes in the credit provisioning practices. The second session will provide country-specific clues for the new financial intermediation patterns and share central banks' experiences in building up enhanced datasets to follow this change.

No need to say, the policy needs are also evolving rapidly in response to these changes. But what are the implications for statistics? Do we need to change the statistical practices to keep in line or are we able to observe the relevant information

[1] Special thanks to Ms Burcu Tunç, Visiting Statistician on secondment from the Central Bank of the Republic of Turkey, for her strong support at the IFC Secretariat in the preparation of these remarks.

with the available data? These are the main questions to be discussed in the third session today. We will have various presentations, each of which asks these questions in a different way and giving us a chance to have a broader view.

Our first session in the afternoon will consist in a keynote speech by Pedro Silva, President at the International Statistical Institute (ISI). Living in an era of unprecedented data availability and accessibility, and where "Big Data" emerged as a new paradigm for those seeking to learn from the data, he will be sharing his views on the importance of "statistical thinking" and methodology to guide the "art and science" in this learning.

New financial landscape has its implications for the dynamics and hence vulnerabilities of the economy. We will split into three breakout sessions for the last topic of the day and discuss how to effectively and timely assess these vulnerabilities. More specifically, the presentations will cover three important and potential sources of fragilities which are: exchange rate volatility, fluctuations in macroeconomic variables and balance sheet conditions of the individual sectors or institutions.

- Volatility of exchange rates has implications for both price and financial stability of an economy. The fluctuations in the exchange rates can have pass through effects on inflation in the case of high dollarization while fluctuations can have financial stability consequences in the case of high-level, non-hedged currency mismatches. Thus, assessing the vulnerability requires a comprehensive knowledge beyond the aggregate level of foreign currency imbalances. The presentations in first sub-session will illustrate how the available datasets can be used and also enhanced for this end.
- A clear picture of the economy as a whole is needed to assess fragilities at a systemic level. The fluctuations in the economic growth and current account imbalances are first indicators to look for. However, we will not be done yet. As the recent financial crisis showed, financial soundness of the households and firms are also equally important in a financial stability point of view. A closer look into the dynamics of housing market and non-financial sector including multinational enterprises is also necessary. And this is what the second sub-session offers.
- In the third sub-session, we will follow a balance sheet based approach to assess the risks in a specific sector which are stemming from their own financial positions. The presentations will focus on some ongoing efforts to compile more accurate balance sheet data for pension funds and government sectors. Then we will have a deeper look into the financial positions of the non-financial firms and banking sector including a check for the validity of banks' internal risk assessment methodologies. Last but not least, we will have a presentation on the BIS derivatives database.

The demanding data requirements of the financial stability analysis urges central bank statisticians to build and maintain large databases which depend more and more on granular information. This creates two new areas of challenge for the statisticians: managing the micro databases on one hand and data sharing and confidentiality issues on the other, which are the focus of our next day.

In most of the cases, micro databases are built up on existing databases and by combining different sources. Additionally, they are mostly used to enhance a macro database. Either case requires standardization and an accurate identification of reference data for harmonization and also for an effective processing. The presentations in the first session of the second day will share central banks' experiences regarding management of big micro databases accompanied by two papers on the use of big data to witness the researchers' point of view on the subject.

Building up and maintaining the large micro databases is, however, only the one part of our task, we also need to have a sound policy regarding data sharing, communicating with the public and the confidentiality warnings which takes us to our last session of the presentations. We will discuss how to design a framework which is flexible and rich enough to meet research needs of both internal and external users but at the same time respectful to the confidentiality concerns of the producers while the last two presentations of the conference will focus on the communication side of the issue.

Tomorrow we will also have a keynote presentation by Claudia Buch, Vice President, at the Deutsche Bundesbank. She will be sharing her ideas on the statistical implications of the new financial landscape which will move us to the panel discussion after the lunch.

Let me finish my opening remarks by thanking the BIS for its hospitality and thanking Mr Luiz Pereira, Deputy Manager of the BIS, for participation in the opening session of the Conference.

I also wish you success in your discussions and presentations today and tomorrow.

Eighth Irving Fisher Committee Conference on Central Bank Statistics

Opening Remarks

Luiz Awazu Pereira da Silva, Deputy General Manager, Bank for International Settlements
Basel, 8 September 2016

Good morning ladies and gentlemen.

It is my pleasure to welcome you all to the eighth biennial conference of the Irving Fisher Committee on Central Bank Statistics.

On behalf of BIS Management, I would like to extend a special welcome to Katherine Hennings and Aurel Schubert, Vice Chairs of the IFC, to Pedro Silva, President of the International Statistical Institute (ISI), to all the members of the IFC Executive Committee and to all the presenters and participants at this conference.

We are very pleased to see how this biennial IFC event continues to go from strength to strength. This time we are welcoming more than 120 participants, and 40 papers will be presented on a variety of statistical issues that are highly topical for the central banking community. I would also like to congratulate the six contestants for the IFC's Best Paper by a Young Statistician Award.

The BIS is very supportive of the IFC regular conferences on central bank statistics. The financial crisis was a wake-up call, showing that good data are a pre-condition for achieving monetary and financial stability. A key response to this crisis has been to consolidate and develop the position of Basel as the centre for international financial statistics. But we also need to think ahead and prepare for the new issues that are emerging. From this perspective, the title of this conference – the statistical implications of the new financial landscape – is extremely topical.

Today I would like to structure my remarks in two parts: (1) the actions undertaken in Basel in the area of statistics in response to the crisis; and (2) some thoughts on addressing upcoming statistical challenges.

Basel statistical initiatives in response to the Great Financial Crisis

In response to the crisis, the BIS, its central bank committees and the financial stability groups hosted in Basel have concentrated their efforts on four major statistical areas:

- The first area of focus is ***the production of new financial statistics***. The crisis underlined the key value of the statistics that had been already collected by the BIS over the past decades: international banking statistics, debt securities issuance, property prices, derivatives etc. At a macro level, we have been taking steps to further improve these statistical collections, especially by collecting new types of macro-financial data. For example, the BIS has started to work on the global aggregation of statistics on repos and securities financing. At the micro level, Basel has also become a major centre for the collection of institution-level data on a global basis. Information on global systemically important banks (G-SIBs) is already regularly collected by the BIS International Data Hub and shared among financial supervisory authorities and international organisations. Another related development has been the setting up of so-called quantitative impact study (QIS) exercises to support BIS-hosted regulatory groups such as the Basel Committee, the IAIS and the FSB. The importance of this initiative is perhaps not fully recognised by observers. Almost all new regulatory initiatives are now based on some kind of data collection initiative, something that hardly existed less than 10 years ago. QIS exercises form a central element to draw the lessons of previous regulations, identify additional areas of weakness, and assess the impact of new policy measures.

- Producing statistics is, however, not sufficient: we need to ***disseminate data effectively***. Obviously, the first step is to make information more widely and easily available: we launched the *BIS Statistical Bulletin* last year, and we have developed new tools so that the data can be accessed in a user-friendly way. But we should go beyond this "simple packaging"; I mean we must present information in a way that facilitates the understanding of economic phenomena. To this end, the BIS has focused on developing "research indicators". The idea here is to leverage existing data collections, either in Basel or elsewhere, to produce more meaningful indicators. Cases in point have been the recent production of BIS global liquidity indicators to better elucidate financial spillovers across countries. We have also constructed debt indicators consistent across both countries and sectors so that post-crisis deleveraging patterns can be better analysed. This month, we will take another major step, by publishing daily effective exchange rates for major countries, as well as credit-to-GDP gaps, long series on inflation etc. The bottom line is that making data available is not enough; these data have to be presented and communicated effectively.
- Yet, we need to ensure that ***statistics are effectively used*** by analysts and researchers, not only in academia, but even more so in public circles to support policymaking. Here the IFC has a key role to play in sharing experience and disseminating good practice among central banks in particular. Your presence today is a sign of vitality, underscoring the decisive contribution you can make to promote the use of statistics as a global public good.
- Of course, the fourth, key, aspect is to **anchor Basel statistical work in international initiatives**. Working closely with the ECB, the BIS is actively supporting the G20 Data Gaps Initiative and seeks to ensure that the global central banking community is closely associated with it. We are also deeply committed to cooperating with other international bodies in this endeavour. The active participation of the ISI and the IMF in today's conference is a clear sign of the vitality and success of this international cooperation.

Addressing the new statistical challenges posed by the current financial landscape

Let me turn to a few thoughts on areas for further work. As today's conference rightly asks, what are the statistical implications of the new financial landscape? For sure, there are very diverse and challenging data requirements! We need to be focused and we should avoid multiplying statistical initiatives in a disorganised way. To this end, I believe we should concentrate on five key areas:

- ***Better macro statistics***. We are still not yet in a comfortable situation here. The Data Gaps Initiative has highlighted the numerous efforts we must all make to enhance our "traditional" statistical apparatus. For this, we need to make a better use of all the data we already collect, or that are easily available because they are a by-product of other specific economic – for instance, internet sales or administrative activities, such as credit registers. In particular, attention is focused on the big data revolution. The recent report produced by this Committee was particularly welcome as it shows that we can expect many benefits from it. Moreover, and as this report rightly argued, we should not limit our focus to internet-based data sets; rather, we should aim to better exploit the richness of the large administrative data sets that already exist but are not yet sufficiently mobilised.
- ***Collect macro-relevant, "pure" micro data***. Collecting institution-level information is a prerequisite for better understanding systemic risk and identifying fragilities in the financial system. Our experience in Basel, especially with the collection of data on G-SIBs, is that micro data can reveal crucial information that is hidden by aggregated numbers.

- ***Be capable of linking relevant macro-financial and micro-financial data.*** In order to examine issues such as the impact of negative interest rates on the profitability of financial institutions or the savings behaviour of households, we need to analyse in detail the balance sheets of firms and households to identify structural changes and properly test whether and how they relate to macro-financial policies.
- ***Get a sense of the distribution of aggregate data***. We need to better measure and understand the inherent heterogeneity in economic information. Many of the new policy tools developed since the crisis – eg macroprudential tools, unconventional monetary actions – have put a premium on accessing distributional information to better assess the effectiveness of such instruments. This is obvious: if you want to impose an effective limit in terms of loan-to-value ratios, you have to better distinguish between the type of loan involved (eg mortgages, car loans) and the type of debtor (eg low-income households, financial investors).
- ***Design and assess policies based on statistical evidence***. We need to ensure that the data we collect are useful for policymakers, in particular to design, conduct, assess and refine public policies.
- ***Expand our knowledge frontier***. With the new data we have at our disposal we can understand economic phenomena in a way that was almost inconceivable a few years ago. Cases in point are the nationality-based data sets developed by the BIS that allow us to complement "traditional" residency-based approaches with nationality-based, group-level consolidated information. Nationality-based, group-level consolidated data facilitate the understanding of who makes underlying economic decisions and who takes on the final risks in today's globalised financial markets. Needless to say, such information is crucial for fiscal, monetary and prudential authorities alike.

These are just some personal and preliminary thoughts I wanted to share as a way of opening the discussion today. I have no doubt that this conference will help us to better understand what needs to be done by the central banking community as we address the statistical implications of the unprecedented circumstances we face.

I wish you every success in your discussions and presentations and I very much hope to see you in Basel again soon.

Thank you for your attention.

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Statistical thinking & methodology: pillars for quality in the big data era[1]

Pedro Luis do Nascimento Silva,
President of International Statistical Institute (ISI)
and Principal Researcher, Escola Nacional de Ciências Estatísticas (ENCE), Brazil

[1] This presentation was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

International Statistical Institute

Statistical Thinking & Methodology: Pillars For Quality In The Big Data Era

Pedro Luis do Nascimento Silva
President of ISI
Principal Researcher, ENCE, Brazil

(Big) Data Era

We live in era of unprecedented volume, availability and access to **data**.

(Big) Data Era

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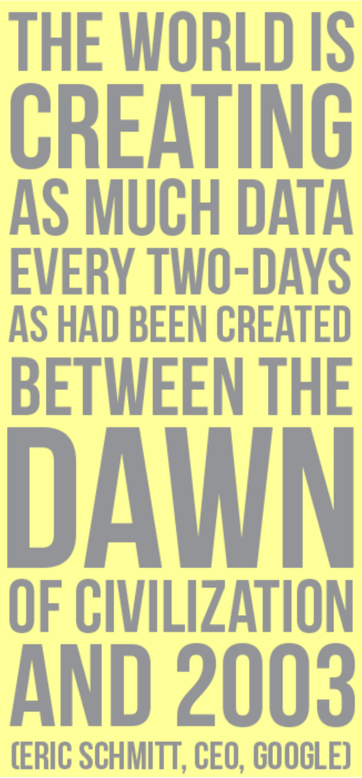

Global Partnership for Sustainable Development Data (GPSDD)
http://www.data4sdgs.org/#news

(Big) Data Era

We live in era of unprecedented volume, availability and access to data.

"Data in the world is doubling every 18 months."

IBM

http://www-01.ibm.com/software/data/demystifying-big-data/

Data Gaps

Despite this *data deluge*, there are glaring **data gaps**.

"For example, in low-income countries more than 70% of births – almost 20 million children annually – are not registered."

Paris21: http://datarevolution.paris21.org/the-project

Data & Development

"On September 27th 2015, 193 world leaders committed to 17 Global Goals to achieve 3 extraordinary things in the next 15 years.

- End extreme poverty.
- Fight inequality & injustice.
- Fix climate change."

Data & Development

“To reach these Sustainable Development Goals (SDGs), we will need to confront **a crisis** at the heart of solving many of the world’s most pressing issues - a crisis of **poor use, accessibility, and production of high quality data** that is stunting the fight to overcome global challenges in every area—from health to gender equality, human rights to economics, and education to agriculture.

The availability and access to **high quality data** is essential to measuring and achieving the SDGs.”

http://www.data4sdgs.org/#intro

IFC Conference 2016 – Most Frequent Words on Paper Titles

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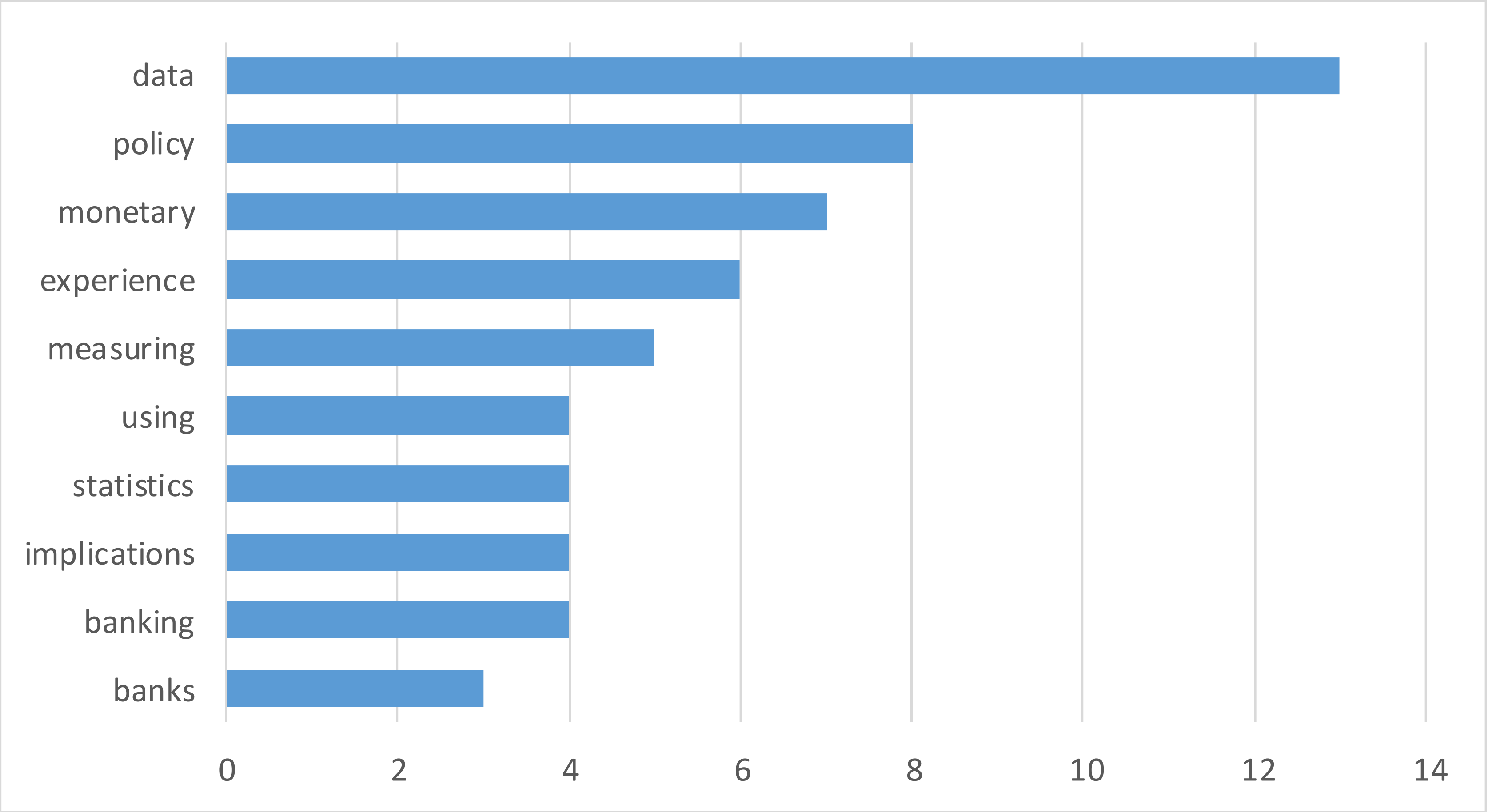


Central Banks

Play a key role in **shaping policy**.

Understand the role of **relevant**, **accurate and timely data** for:

- Informed debate;
- Policy making;
- Policy evaluation & monitoring.

Operate both as **data producers** and **data consumers**.

Official and Public Statistics

Typical data sources (observational studies):

- **Censuses**
  - ➢ Data obtained from **every unit** in the target population.
- **Sample surveys**
  - ➢ Data obtained from **samples of units** in the target population.
- **Administrative records**
  - ➢ Data obtained for admin purposes, but later used for statistical purposes.

Big Data

New and emerging **data sources**:

"Big Data are data sources that can be – generally – described as: high **volume**, **velocity** and **variety** of data that demand cost-effective, innovative forms of processing for enhanced insight and decision making."

UNECE Definition 2013

Types of sources:

Social networks (communications; images; searches);
Traditional business data (transactions; records);
'Internet of things' (sensor data).

UNECE Classification:
http://www1.unece.org/stat/platform/display/bigdata/Classification+of+Types+of+Big+Data

A self-monitoring social and economic eco-system is emerging

- Designed (or traditional survey) data
  - Data produced to discover the unmeasured
- Organic (or big) data
  - Data produced auxiliary to processes, to record the process

Blending these two types of data is the future.

6

GEORGETOWN UNIVERSITY

Robert Groves

http://directorsblog.blogs.census.gov/2011/05/31/designed-data-and-organic-data/

Big Data Quality Issues

Variability or Volatility

Inconsistence and/or instability of data across time.

Veracity

Ability to trust that data is accurate and/or complete.

Complexity

Need to link multiple data sources.

Accessibility

Need to ensure that data is and will remain available.

Data Quality in the Big Data Era

More data **does not** necessarily **mean** good or better data!

Many of the data available **lack the quality** required for its safe use in many applications.

Challenges are even bigger with Big Data!

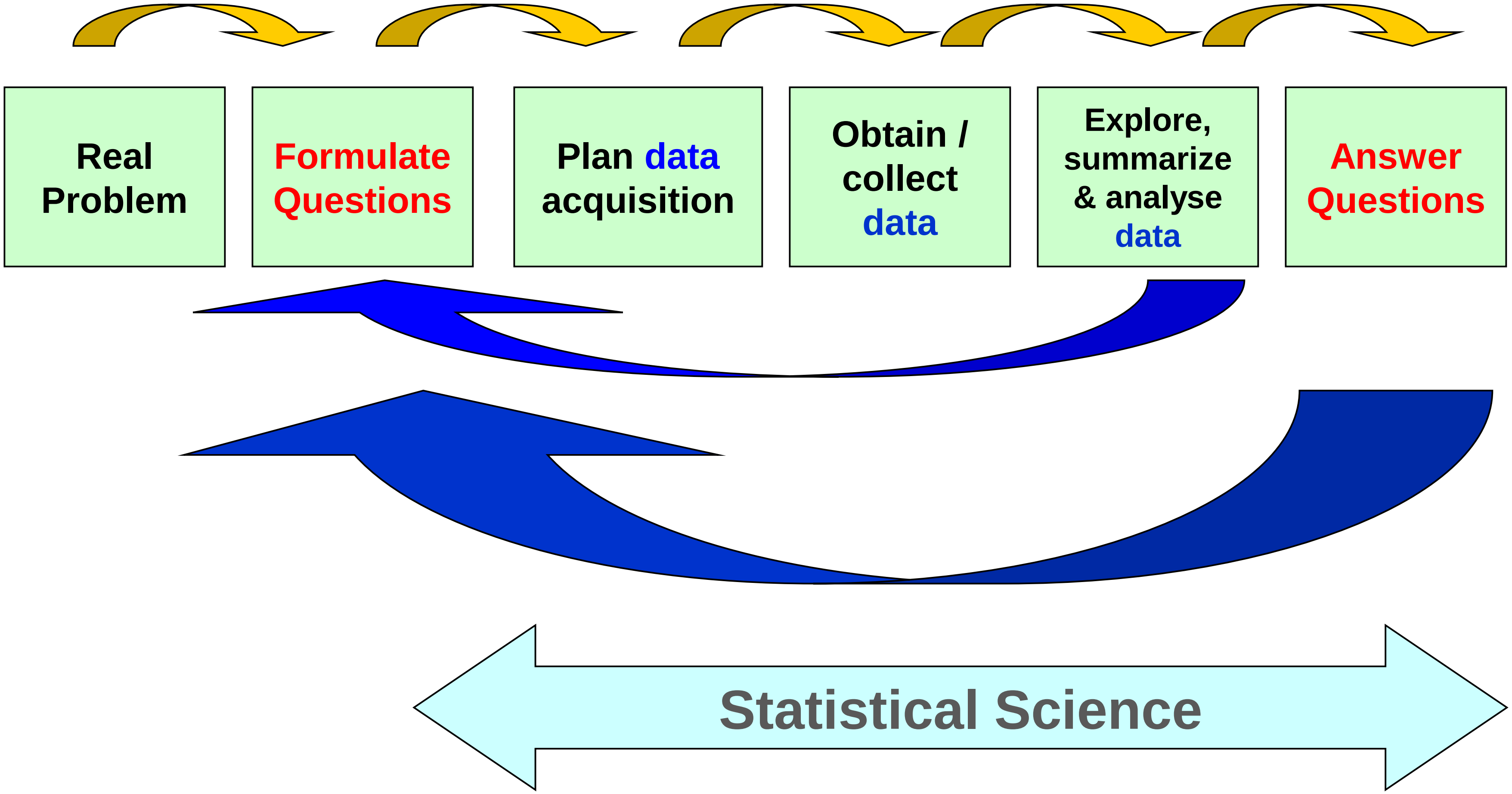
Statistical Science

For all the above reasons, **Statistical Science** has never been in such **evidence** and in such **high demand**.

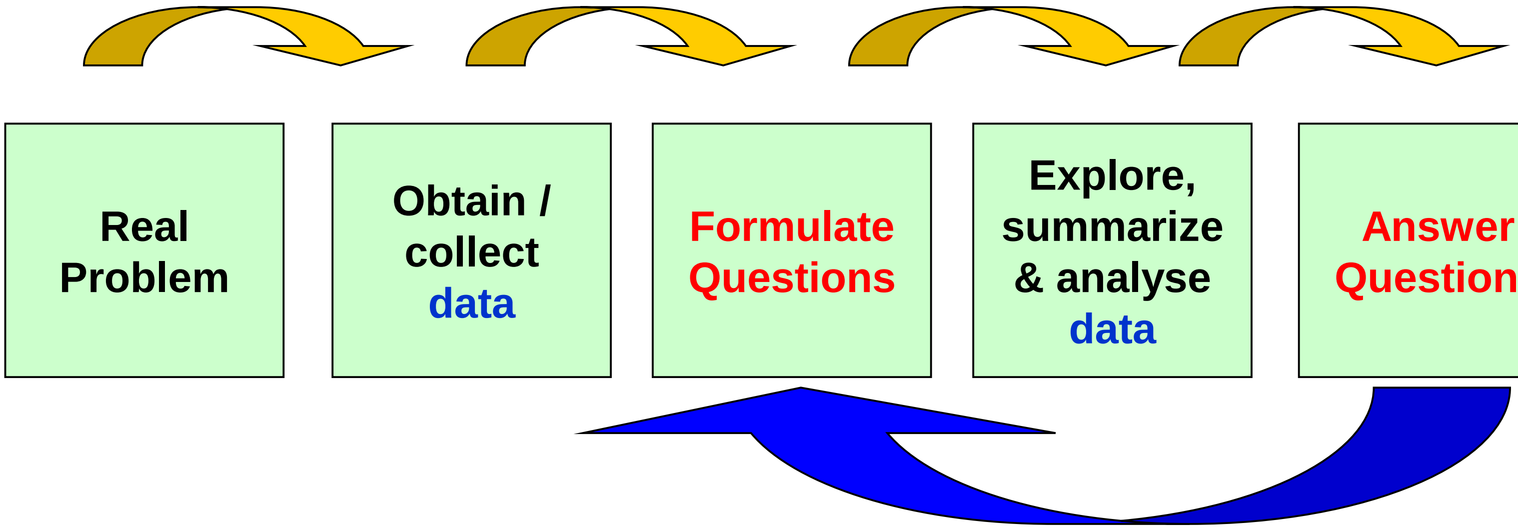
Statistical thinking & methodology offer the essential guidance to obtaining relevant, accurate, current, and cost-effective data.

It also guides the **extraction of useful knowledge from data**, to support decision making.

Conventional Knowledge Generation Process



Knowledge Generation Process in the Big Data Era



Statistical Thinking

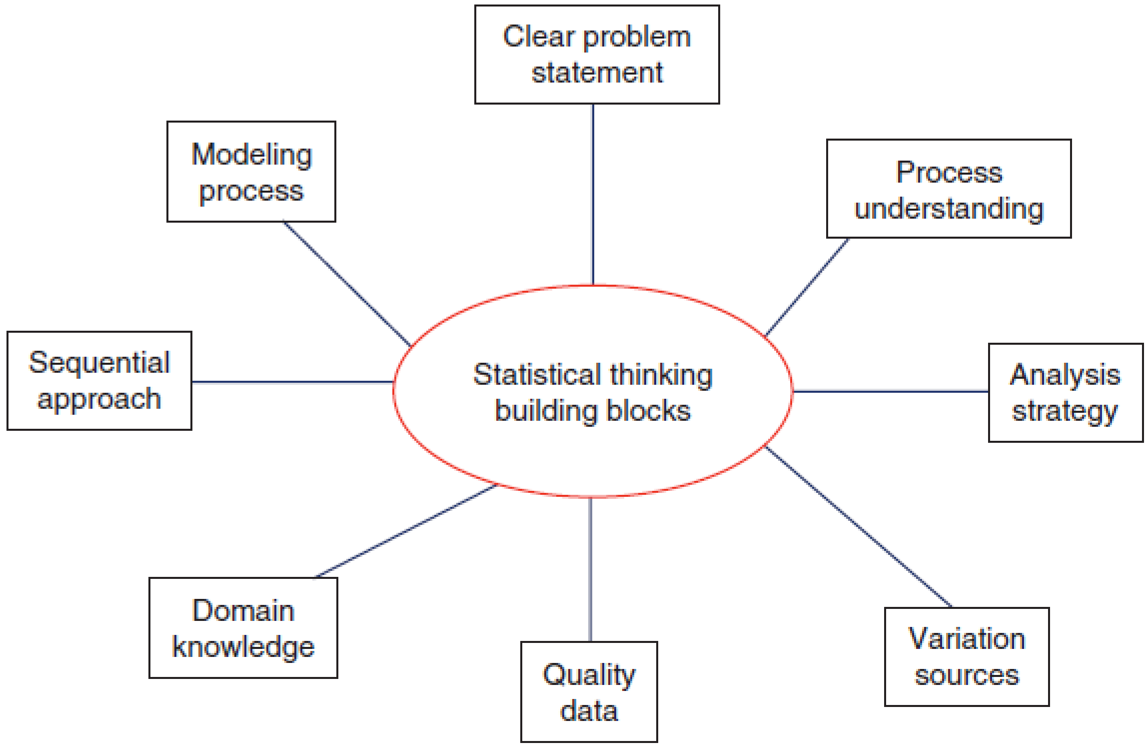


FIGURE 1 | The building blocks of statistical thinking.

Source: Hoerl, Snee & De Veaux (2014)

Statistical Science

Providing solutions for research and knowledge discovery via:

- Careful planning and realization of data & measurement acquisition operations regarding phenomena of interest;

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Statistical Science

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- Formulation and fitting of statistical models to describe data in synthetic form;
- Using fitted models to answer formulated questions (inference); and
- Creating visual displays of data, summaries and key findings revealed from the data.

Obtaining Data

Methods for careful planning and conducting of cost-effective **data gathering** studies:

- Sampling;
- Design of experiments;
- Design for observational studies;
- Measurement protocols (questionnaires, instruments, record keeping protocols, etc.)
- Data checking, cleaning, storage and sharing protocols.

Analysis / discovery

Methods for exploratory and confirmatory data analysis:

- Exploratory data analysis;
- Data mining;
- Hypothesis formulation and testing;
- Model formulation, fitting, selection, diagnostics and interpretation;
- Data summarization, presentation & visualization.

Data Quality

Quality is desirable attribute of all data.

Data quality derives from **quality of the source**(s), **measurement instruments** & **methods**.

Vague concept: **what is data quality**?

Must be defined, so that it can be planned, measured and evaluated.

Data Quality Frameworks

Several important organizations have invested in developing frameworks for data quality:

- ✓ US Office of Management and Budget (2006);
- ✓ Statistics Canada (2009);
- ✓ International Monetary Fund (2012);
- ✓ OECD (2012);
- ✓ UN (2012);
- ✓ IBGE (2013).

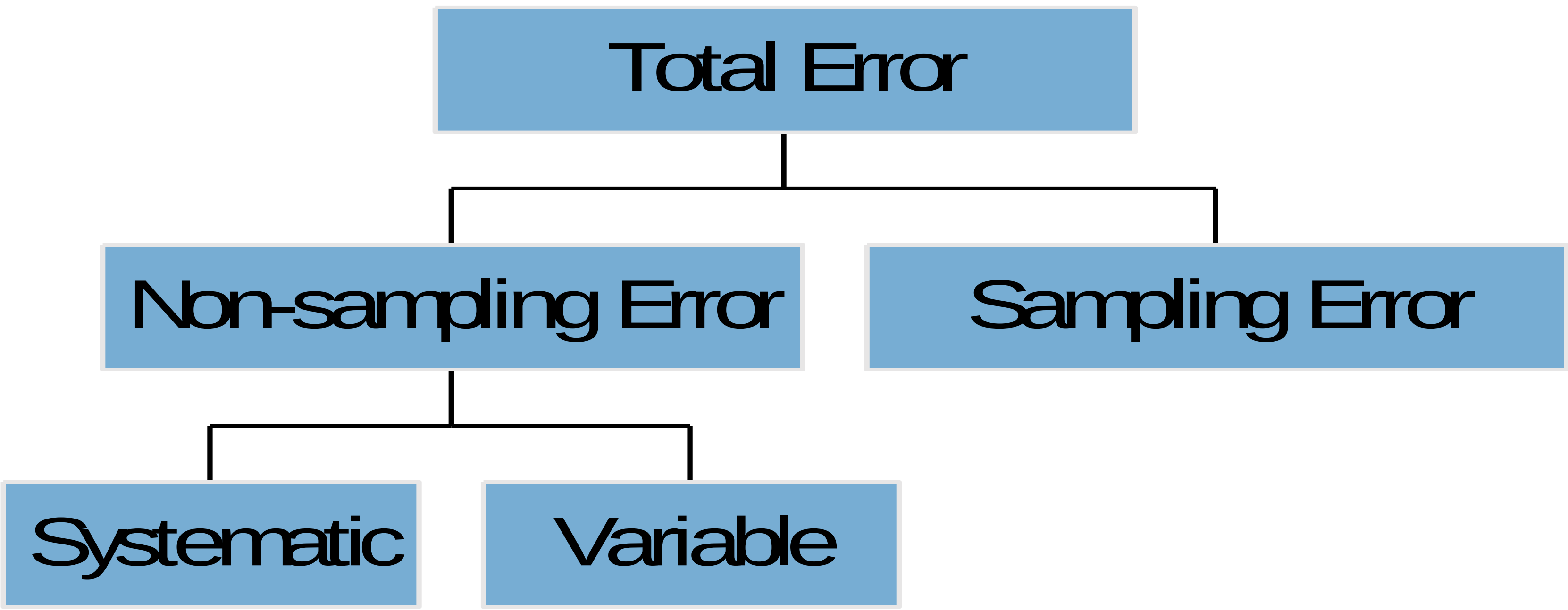
UNECE Framework for the Quality of Big Data

- Institutional / business environment (agency providing the data)
- Privacy and Security
- Complexity
- Relevance
- Time factors

- Accessibility and Clarity
- Usability
- **Accuracy**
- Completeness
- Coherence
- Validity

“Error” in Estimates

Error = Estimate – True Value



Source: United Nations (2005).

Sampling Error

Errors arising due to sampling for observation.

Easier to control.

Bias (systematic error) may be avoided → use **probability sampling**.

Sample design, sample size and **estimator** defined to make **variable sampling error** as small as required.

Sampling Error

Errors arising due to sampling for observation.

Easier to control.

Bias (systematic error) may be avoided ➔ use **probability sampling.**

Sample design, sample size and **estimator** defined to make **variable sampling error** as small as required.

With '**Big Data**', there may no longer be sampling error in many applications!

Non-Sampling Error

Two broad classes of **non-sampling errors**.

Errors due to ‘**non-observation**’:

- Coverage (frames, populations);
- Non-response (collection).

Errors in **observations**:

- Specification;
- Measurement;
- Linking, processing & estimation.

Non-Sampling Error

Two broad classes of **non-sampling errors**.

Errors due to '**non-observation**':

- Coverage (frames, populations);
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Errors in **observations**:

- Specification;
- Measurement;
- Linking, processing & estimation.

With '**Big Data**', non-sampling errors dominate!

Even worse: they may not vanish with large n!

Summarizing

Data quality remains fundamental concern.

Statistical thinking & methodology are essential pillars for promoting:

- **data quality**;
- sound evidence-based decision making.

Big data era will require **more statistical development**, not less.

ISI
Statistical Science for a Better World

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Micro data: making better use through data sharing[1]

Claudia Buch, Vice President, Deutsche Bundesbank

[1] This presentation was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Micro Data:
Making Better Use through Data Sharing

Keynote Speech

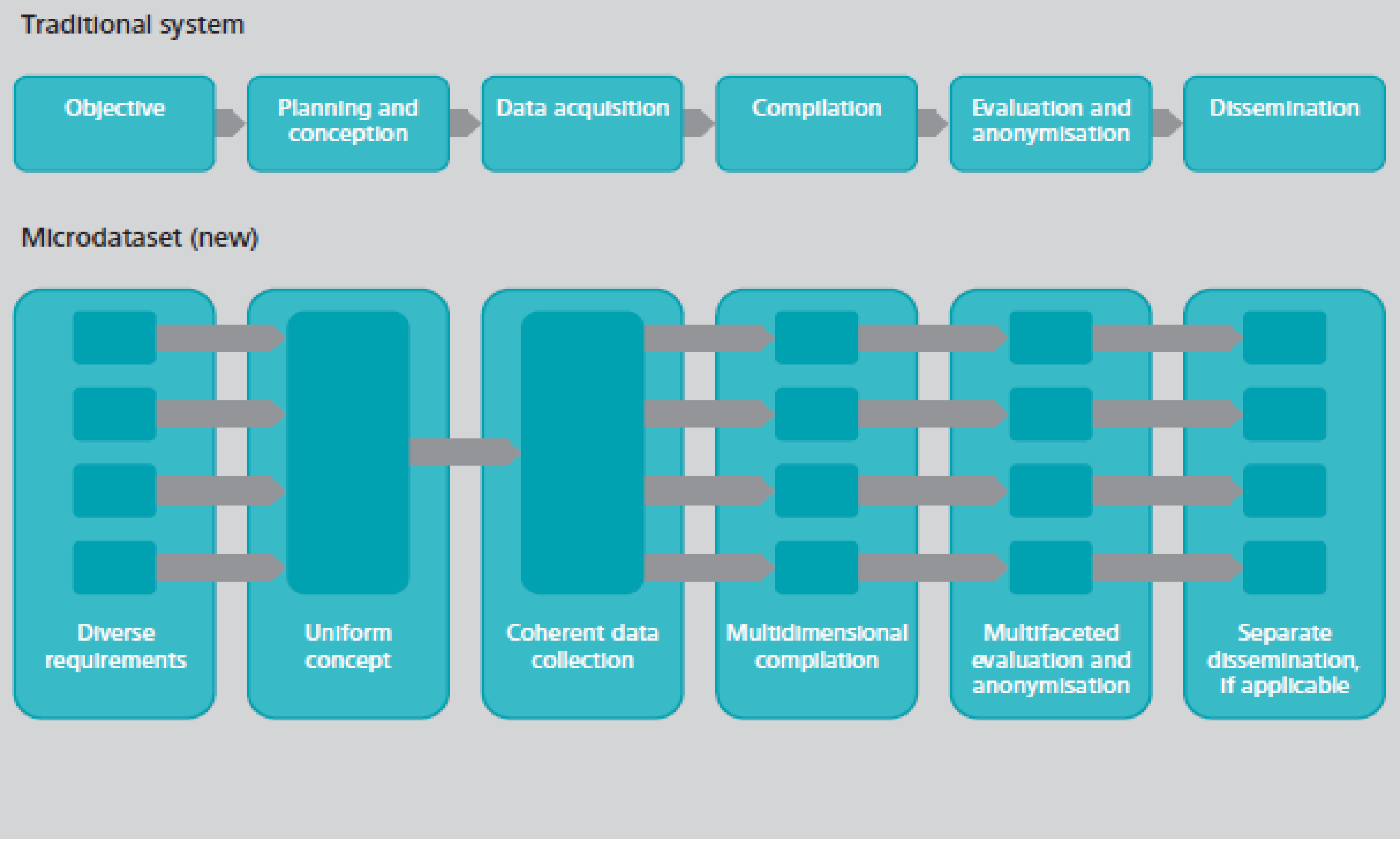
Claudia M. Buch (Deutsche Bundesbank)

Irving Fisher Committee on Central Bank Statistics
8th Biennial Conference
Basel, 8 – 9 September 2016

What's new in (central bank) statistics?

- **Micro data overhaul the traditional value-added chain in central banking statistics.**
  - Traditional central banking statistics are collected for a **specific purpose**.
  - Micro data are collected only once and can be used for **multiple purposes**: The statistical reporting burden declines.
  - **Data protection** becomes more challenging.
- **Technological innovations have revolutionized the infrastructure for collecting, storing, and using micro-data.**
  - Improved tools for analyzing and processing micro-data
  - Cheaper storage technologies
  - Standardisation

The statistical value chain



Deutsche Bundesbank

What's new in (central bank) statistics?

- **Micro data open up new possibilities for analyzing (financial) markets, and they provide new insights into the effects of policies.**
  – What are channels of transmission of monetary policy across different institutions?
  – What are sectoral and firm-level drivers of productivity?
  – How do risks to financial stability build up?
  – What are causal impacts of regulatory and monetary policies?

➢ **Micro data can provide significant benefits, but there are also two key obstacles for their enhanced use:**
  – Inadequate **IT infrastructure** both within central banks and private financial institutions
  – Legal and technological obstacles to **data sharing**

Why is data sharing important?

- **Individual datasets provide insufficient information on drivers and effects of changing patterns in the data.**
- **Take the decline in cross-border banking activities as an example.**
  - Which banks have withdrawn from foreign markets?
  - Has the withdrawal been driven by regulation, by macroeconomic factors, or by bank-specific factors?
  - Are these patterns similar across countries?
  - What have been the effects on bank risk and lending?
- **Answering these questions is not possible without combining ("sharing") datasets from different sources:**
  - Bank income statements and balance sheets
  - Reports on external positions
  - International data

Structure of this talk

(1) What are the challenges for sharing micro data?

(2) What can we learn from other areas?

(3) What are the implications for central banking statistics?

What are the challenges for sharing micro data?

Recommendation # II.20 of the G20 Data Gaps Initiative calls for enhanced data sharing.

The Inter-Agency Group on Economic and Financial Statistics (IAG) and G-20 economies [are called upon] to promote and encourage the ***exchange of data and metadata*** *among and within G-20 economies, and with international agencies, to improve the quality (e.g.,* ***consistency****) of data, and availability for policy use.*

The G-20 economies are also encouraged to increase the ***sharing and accessibility*** *of granular data, if needed by revisiting existing confidentiality constraints.*

Source: G-20 DGI-2 First Progress Report (2016)

Sharing *aggregate* data has been common practice.

- **Sharing aggregate data is common practice and brings many important benefits.**
  - ***International Financial Statistics*** (IMF) have been used for important analysis of macroeconomic developments, current account developments etc.
  - ***Banking Statistics*** (BIS) provide relevant information on global banking and international spillovers.
  - Many other examples (OECD, Eurostat, ESCB, …) could be added.
- **But …**
  - … different **compilation practices** and data definitions can constrain combining and using aggregate statistics.
  - … the financial crisis has highlighted that risks to **financial stability** cannot be monitored based on aggregate data.

Why risks to financial stability cannot be monitored on the basis of aggregate data.

- **Systemic risks in financial systems arise if distress in one institution (or a group of institutions) threatens the functioning of the entire system:**
  - **Direct contagion**: Domino effects due to direct contractual linkages
  - **Indirect contagion**: Informational contagion, fire sale externalities

- **Monitoring systemic risks requires analyzing distress events, the distribution of risks in the financial system, and linkages between markets and institutions.**

- **Macroprudential instruments internalize systemic risk externalities.**
  - Evaluating the effects of these instruments requires a structured **process of policy evaluation**.
  - The **availability** and flexible use of **granular data** early on is an integral part of this policy process.

Who could benefit from increased data sharing?

- **Many different stakeholders would potentially benefit:**

Report-ing agent	General Public	Central Bank					National or inter-national organisati on	Acade-mics	Politics
		Sta-tistics	Banking super-vision	Econo-mic Analysis	Finan-cial Stability	Re-search			

- **Results of the IFC membership questionnaire on sharing of banking data:**
  - Full data sharing between central bank departments takes place in 57% of the cases.
  - Obstacles to data-sharing are legal constraints (31%) and inconsistencies in data requirements (31%)
  - The biggest hurdle to international data sharing are **legal constraints** (74%).

Hence, a large potential for data sharing remains unexploited.

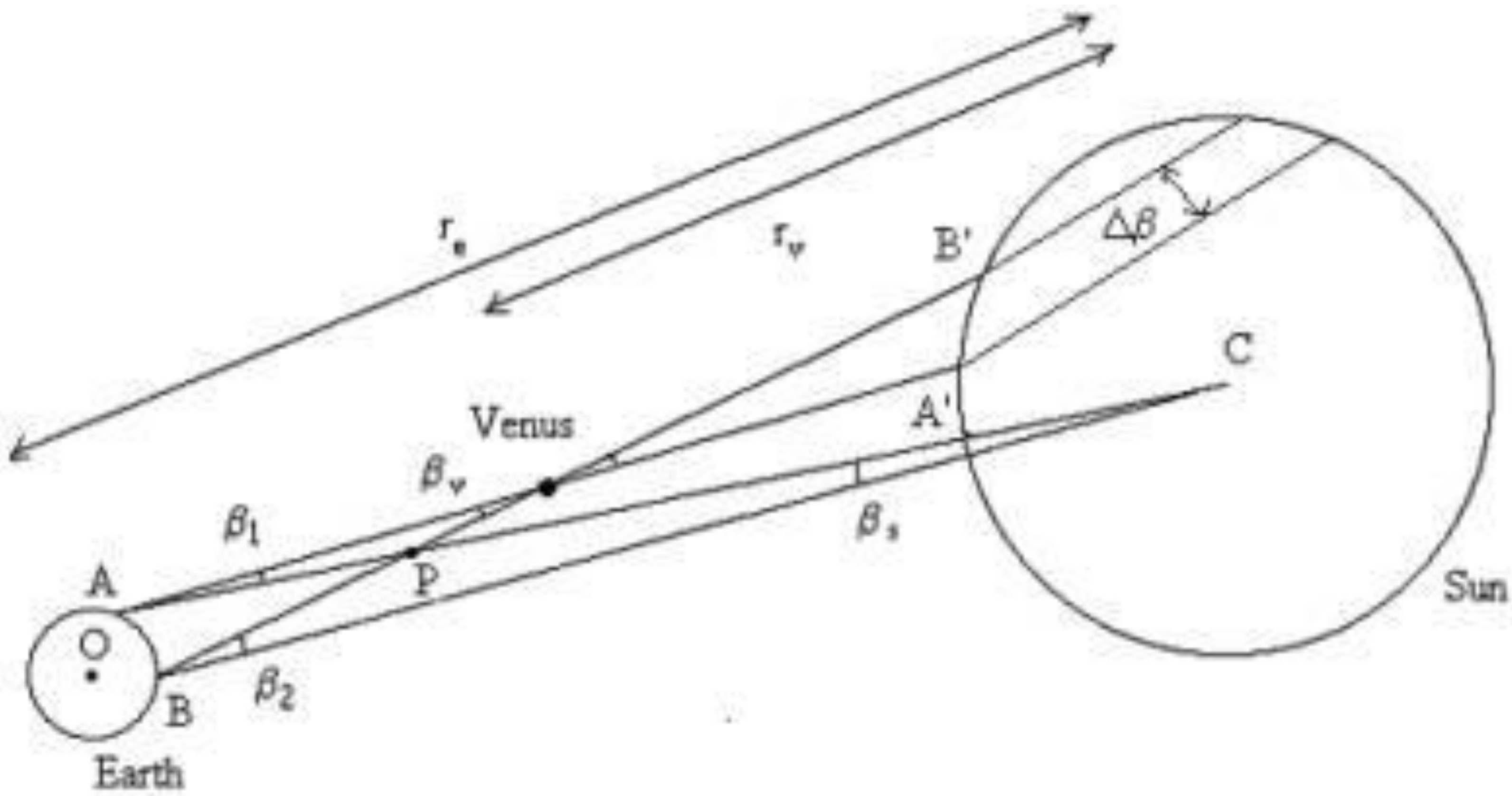
Demand / Supply			Report-ing agent	General Public	Central Bank					National or inter-national organi-sation	Acade-mics	Politics
					Sta-tistics	Banking super-vision	Econo-mic Analysis	Finan-cial Stability	Re-search			
			1	2	3	4	5	6	7	8	9	10
Reporting agent		1			X							
General public		2										
Central Bank	Statistics	3	X									
	Banking super-vision	4										
	Econo-mic An-alysis	5										
	Financial Stability	6										
	Re-search	7										
National and international organisations		8										
Academics		9										
Politics		10										

What can we learn from other areas?

Astronomy:
What is the distance between the sun and the earth?

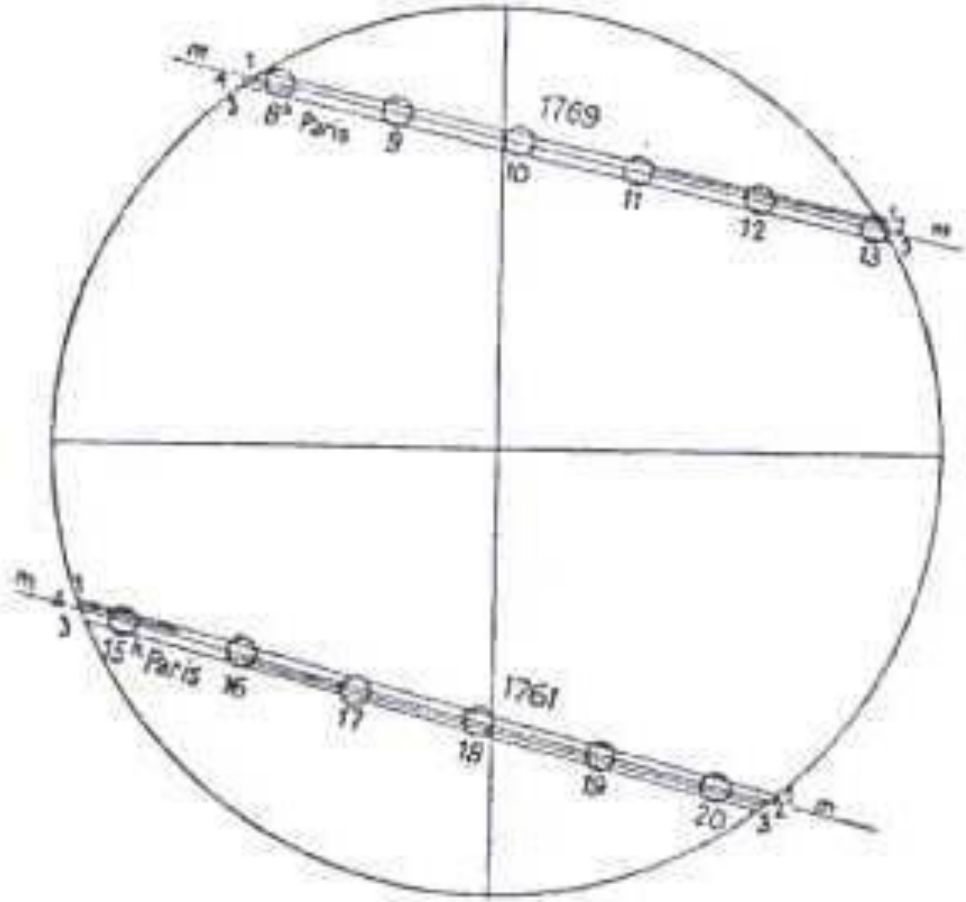
- **Researchers have thought about the distance between sun and earth since millennia.**
  - Estimates have differed widely, today we know that the distance is **150 million kilometers**.
- **The Earth-Sun distance can be calculated from observations of the Venus transit taken from two places with different longitudes but lying on the same meridian.**
- **In the 18th century, the first collaborative effort of international researchers was started.**
  - 1761 : 130 expeditions from 10 countries
  - 1769 : 151 expeditions from 10 countries

Comparing observations on the Venus transit from different locations provides information about the distance between earth and sun.



Source: www.eso.org

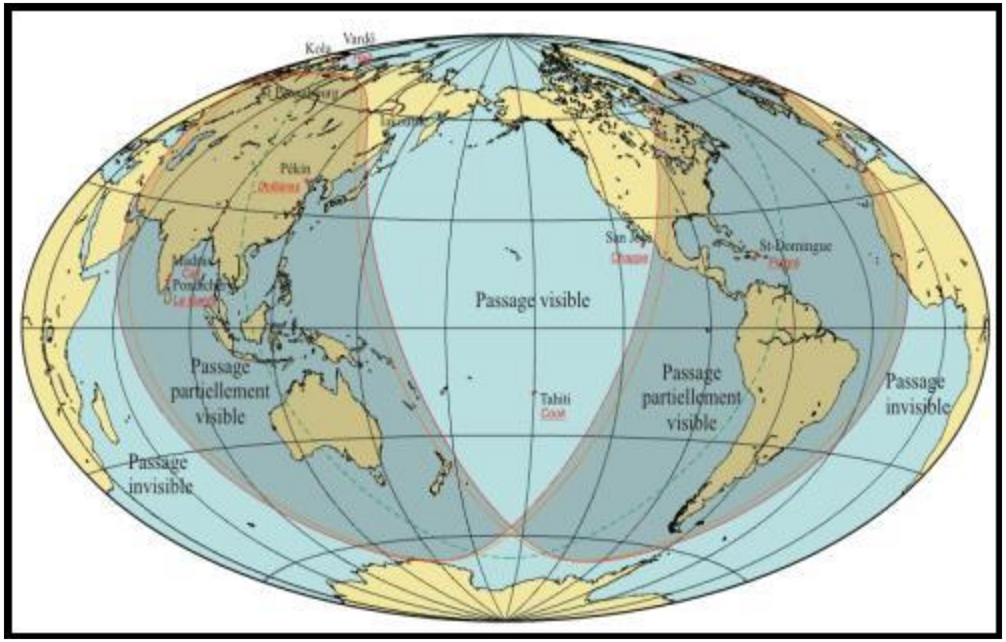
In 1761 and 1769, more than 100 teams of researchers travelled the globe to collect such data.



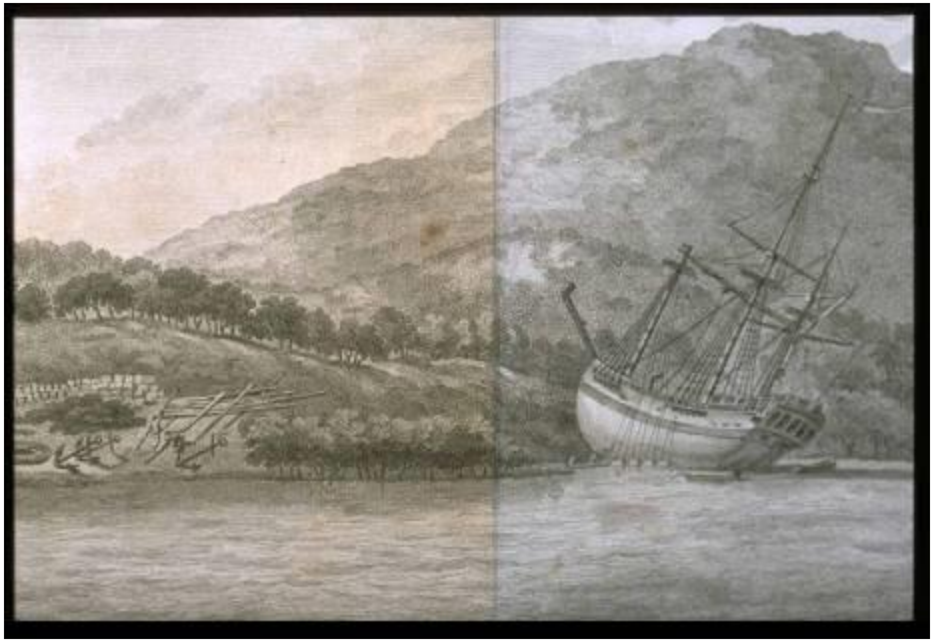
Transit of Venus across the solar disc
m = track of the planet by its central point

1761:	1. Rodrigues	2. Paris	3. Tobolsk	4. Tahiti
1769:	1. Tahiti	2. Batavia	3. Vardö	4. Paris

Source:
www.eso.org



These expeditions encountered many severe obstacles, including the ongoing 7-year war and lack of a global unit of measurement.



Source: www.eso.org

Medicine:
What are the effects and side effects of new drugs?

- **Approval of new medical treatments requires prior trials in controlled lab experiments.**
- **Standards involve:**
  - Randomization
  - Parallel groups, placebo-controlled
  - Double- (or triple-) blind designs
  - Approval by ethics committees
  - Data collection by independent contract research organizations
  - Independent data management organizations
  - Involving **several academic research centers in several countries**

What are the implications for central banking statistics?

Overcoming constraints to data sharing can safe costs and improve analytics.

Demand / Supply			Report-ing agent	General Public	Central Bank					National or inter-national organi-sation	Acade-mics	Politics
					Sta-tistics	Banking super-vision	Econo-mic Analysis	Finan-cial Stability	Re-search			
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Reporting agent		1			X							
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Central Bank	Statistics	3	X			★	★	★	★	★	★	
	Banking super-vision	4			★							
	Econo-mic An-alysis	5										
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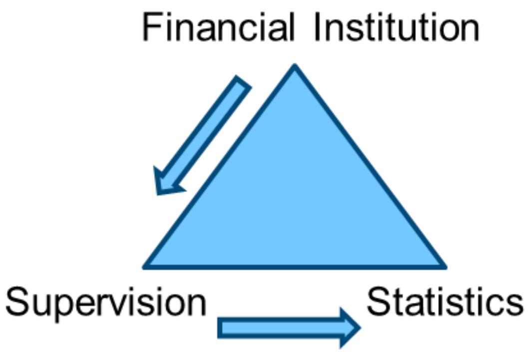
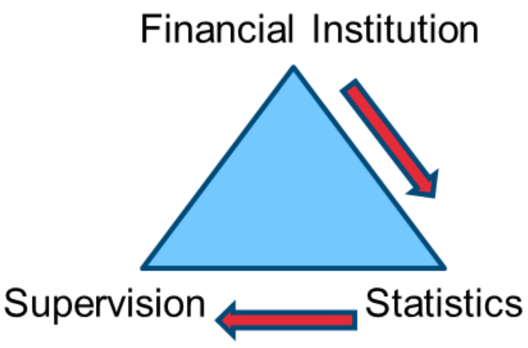
Solution #1:
Sharing of supervisory data

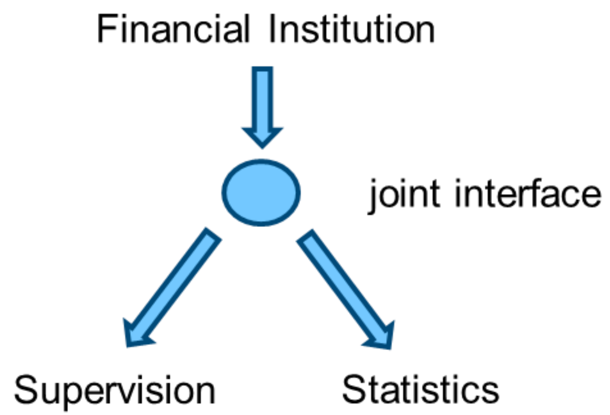




- **Use administrative data to compile banking statistics**
- **But: For supervisors, it may be difficult to deal with queries from statistics to the financial institution.**

- **Supervisors can use the broad experience of statistics with processing extensive volumes and plausibility check of data.**
- **But: Supervisory action cannot be taken on the basis of statistical data.**

Solution #1:
Sharing of supervisory data



- **Use of a joint interface by statistics and supervisors (and by other users) requires …**
  - … clarifying legal access rights
  - … finding adequate IT solutions
- **Current European initiatives: Banks' Integrated Reporting Dictionary (BIRD), European Reporting Framework (ERF)**

Solution #1:
Sharing of supervisory data

- **Banks' Integrated Reporting Dictionary (BIRD)**
  - Standardized model for integrating banks’ internal data warehouses
  - Transformation rules in the reports of banks
  - Voluntary application
  - **Advantages**: Higher data quality, more efficient production of reports, more consistent data, a univocal interpretation, clarity of regulations

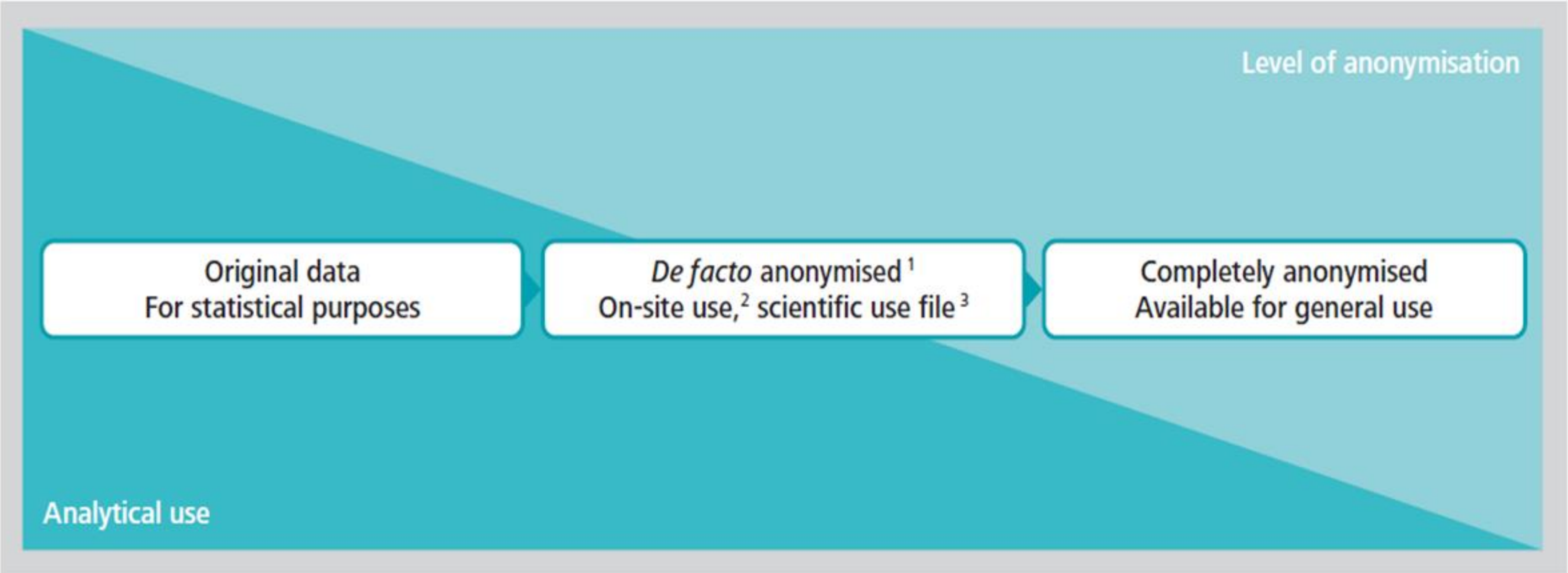
- **European Reporting Framework (ERF)**
  - Ensure that data have to be collected only once, using a harmonized procedure for different purposes.
  - Involves reporting requirements of the ECB and of the European Banking Authority (EBA)

Solution #2:
Sharing of data with external researchers

- **Research data centers can be an effective institutional structure to improve accessibility to (confidential) data.**
- **The Bundesbank's Research and Data and Service Centre (RDSC) aims at better us of existing data – both internally and externally – by overcoming time-, legal, and IT-constraints.**
  - Encourage cooperation with (external) researchers
  - Promote evidence-based policy-making: **Accountability** to the public!
  - Support policymaking processes
- **Key principles:**
  - Data as a public good
  - Democratic data access
  - Data protection

Balancing usability and confidentiality is key.

Analysis potential, data anonymisation and data access



1 Data access in accordance with section 16 (6) of the Federal Statistics Act (Bundesstatistikgesetz). Microdata may be provided to academic institutions for the purposes of academic research if these data can only be traced to their source with a disproportionately large amount of time, costs and labour (de facto anonymisation). **2** Use only within the Research Data and Service Centre. Results are subject to a mandatory disclosure control. **3** Scientific use files are anonymised in such a way that they may be used on the premises of the academic institution requesting the data.

Deutsche Bundesbank

Solution #3:
International data sharing

- **Legal constraints are likely to remain a key obstacles to data sharing across countries.**

➢ **The International Banking Research Network (IBRN) was established in 2012 to bring together researchers from 25 central banks as well as international organizations (BIS, ECB, IMF) to analyze issues pertaining to international banking: A model for future policy work?**

- **Empirical approach:**
  - Analyze (confidential) bank-level datasets locally, share results only
  - Use common methodology and perform meta-analyses

- **Research topics:**
  - Adjustment of banks to liquidity risk (published: ***IMF Economic Review***)
  - Cross-border effects of macroprudential tools (submitted to: ***International Journal of Central Banking***)
  - Cross-border effects of (unconventional) monetary policy

The way forward

Why data sharing is important

- **Individual datasets provide insufficient information on drivers and effects of changing patterns in the data.**
- **Improving mechanisms for enhanced data sharing across countries and business areas in central banking (and beyond) is not *l'art pour l'art*.**
  - Statisticians do not always want "more data" but rather high-quality data that can be used for state-of-the-art analytical work in several business areas of central banks.
  - Collecting and processing data needs to be cost efficient.
- **Using existing data efficiently is part of our accountability to the general public.**
  - Regulatory interventions need to be based on solid evidence.
  - Good data are a necessary – not a sufficient condition – for the surveillance and management of risks to the financial system.

Priorities for closing gaps in the micro-data landscape

- **Results of the IFC report on data sharing:**
  1. Communication with stakeholders and institutional endorsement
  2. Ensure a clear legal basis to support data-sharing
  3. Establish fully fledged cooperation at all levels
  4. Collect common data using joint methodological and technical standards
  5. Ensure sound measures to protect confidential information
  6. Formalize governance and cooperation arrangements

- **Key next steps:**
  1. Harmonization of datasets
  2. Alignment of data access
  3. Central information centre on datasets (search engines)

➢ **G20 work on this will continue: Workshop in Frankfurt in 2017!**

Further reading

- Buch, C.M., Focus on micro data: Potential benefits for the industry?, speech at the 8th European Central Bank Conference on Statistics, Frankfurt a.M., 6July 2016
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Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Macroprudential database[1]

Joao Veiga, Samo Boh, Stefano Borgioli and Anne Koban,
European Central Bank,
Romain Calleja, European Systemic Risk Board,
Thomas Schepens, National Bank of Belgium

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Macroprudential Database

Samo Boh, Stefano Borgioli, Romain Calleja, Anne Koban, Thomas Schepens and Joao Veiga

Abstract

The paper presents the new Macroprudential Database (MPDB), as a part of the European Central Bank's Statistical Data Warehouse, and incentivises its use among external users. The MPDB is a statistical endeavour supporting the macroprudential analysis conducted by the European System of Central Banks and covers European Systemic Risk Board data needs as well. This paper explains the rationale for creating the MPDB and how it can contribute to fulfil the macroprudential data needs within the countries of the Single Supervisory Mechanism and also of the whole Europe Union. The structure of the database and a broad overview of indicators are presented, also dealing with data confidentiality protection. Finally the paper discusses remaining data gaps and expected future enhancements of the MPDB.

Keywords: Macroprudential, statistics

JEL classification: C82, E60

Contents

1. Introduction

The financial crisis and its aftermath confirmed the need for system-wide surveillance and led to the establishment of macroprudential policy as a new key policy area with the objective of an early detection of systemic risk and, in case of materialisation, promoting actions to limit its contagion effects. The literature has identified three broad sources of systemic risk: (i) macroeconomic shocks that are significant enough to cause distress in the financial system, (ii) the unwinding of imbalances in the financial system generated by excessive leverage, and (iii) contagion risk, created by increasing interconnectedness and herd behaviour. Whatever the origin, the primary role of macroprudential authorities is to identify as early as possible, steadily measure and minimise impact of systemic risk.

An input partially missing in the macroprudential field was the availability of a strong and comprehensive statistical basis to support and stimulate research and consequently be used for conducting macroprudential policy by the ECB and national authorities, with the European Systemic Risk Board (ESRB) being in charge of the macroprudential oversight of the EU financial system. A comprehensive and unique Macroprudential Database (MPDB) was thereby essential for analytical and policy oriented work flowing into internal and external reports, and for a consistent cross-country analysis of systemic risk.

The MPDB went live in October 2015 and it is accessible through the ECB's Statistical Data Warehouse (SDW).[1] In its current state, it comprises more than 470 relevant country level variables and indicators grouped into seven main domains (macroeconomic and financial market variables, debt and credit variables, residential real estate variables, commercial real estate variables, bank sector variables, non-bank variables and interconnectedness variables). In order to meet continuously evolving user needs, regular reviews of the MPDB are already taking place, making it a live and easily adjustable product. The majority of variables are also publically available, allowing further research outside the ESCB/ESRB community.

This paper is structured as follows: section 2 explains the motivation for the set-up of the MPDB and increasing user needs that triggered the project; section 3 describes the structure and key features of the database; section 4 points out ideas for future enhancements of the database; and finally, section 5 includes key concluding remarks.

2. Motivation for the set-up of the MPDB and user needs

Macroprudential policies address the emergence of possible systemic risks in the financial system, and thus aim at preserving financial stability.[2] Originally,

1 The MPDB can be accessed in the public SDW via this link: http://sdw.ecb.europa.eu/browse.do?node=9689391

2 Macroprudential policy has several dimensions: (1) The financial cycle should be smoothened by avoiding an excessive build-up of risk. (2) The resilience of the financial sector should be

macroprudential powers in the European Union were established primarily at the national level[3], reflecting the need for a more tailored approach, given that financial cycles and business cycles are not perfectly synchronised in the European Union. Along with the harmonisation of microprudential supervision, the Single Supervisory Mechanism (SSM) Regulation also strengthens consistency of macroprudential policy. Hence, the Eurosystem is able to strengthen coordination and to address potential cross-country spill-overs of macroprudential policies at the national level.[4]

In particular, the SSM Regulation[5] confers upon the ECB and National Competent Authorities (supervisory authorities) or National Designated Authorities specific powers and responsibilities in the field of macroprudential policy.

The role of the ECB in this area is twofold. First, the ECB is involved in the decision making process of macroprudential policy in SSM countries. National authorities are required to notify the ECB before implementing or changing a national measure foreseen in EU laws.[6] The ECB is then required to assess the envisaged macroprudential measure and, if necessary, raise objections, which must be considered by the national authorities.

Second, the ECB has the right to apply more stringent measures at the national level for the instruments included in the EU laws. For example, the ECB may apply higher capital buffer requirements[7] compared to the level set by national authorities.

These decisions are taken jointly with other central banks of the Eurosystem and need to be based on a detailed analysis for which comprehensive and consistent data are a key prerequisite.

The shared responsibilities of national authorities and the ECB for macroprudential policies triggered the need to establish a common ground for macroprudential analysis. A comprehensive and unique database was essential for analytical and policy oriented work flowing into internal and external reports, and for a consistent cross-country analysis of systemic risk. Following the institutional set-up of the decision processes, a key priority became the setting up of a comprehensive and harmonised database - the Macroprudential Database (MPDB).

strengthened to limit the contagion of risks. (3) Influence incentives for market participants, also via the consideration of the system-wide perspective in financial regulation.

3 This is for example reflected in the ESRB Recommendation ESRB/2011/3 on National Macroprudential Mandates:

http://www.esrb.europa.eu/pub/pdf/ESRB_Recommendation_on_National_Macroprudential_Mandates.pdf?87d545ebc9fe76b76b6c545b6bad218c

4 ECB Macroprudential Bulletin, Issue 1, 2016, https://www.ecb.europa.eu/pub/pdf/other/ecbmpbu201603.en.pdf

5 Council Regulation (EU) No 1024/2013 of 15 October 2013 conferring specific tasks on the European Central Bank concerning policies relating to the prudential supervision of credit institutions.

6 Capital Requirements Directive (CRD) IV (Directive 2013/36/EU) and Capital Requirements Regulation (CRR) (Regulation No 575/2013)

7 Countercyclical capital buffer, systemic risk buffer, capital buffers for Global Systemically Important Institutions (G-SII) and Other Systemically Important Institutions (O-SII).

A wide range of indicators is needed to identify vulnerabilities, assess the resilience of the financial system and capture both the cyclical and the structural developments. Naturally, banking sector variables play a key role for macroprudential policy, together with debt and credit variables. In addition, the macroeconomic environments as well as the developments of relevant financial markets need to be taken into account. For instance, as real estate boom-and-bust has been the trigger of many financial crises, indicators reflecting developments of the housing market as well as the commercial real estate market are essential inputs. However, poor data availability and quality in this field often hamper the analysis.

To ensure that the MPDB would not only support the ECB's macroprudential functions at the euro area level but have a wider application, the ESRB joined the MPDB development work.[8] As responsible for the macroprudential oversight of the EU financial system and the prevention and mitigation of systemic risks,[9] the ESRB has a broad remit, covering banks, insurers, asset managers, non-banks intermediaries (the so-called shadow banking), financial market infrastructures and other financial institutions and markets.

By extending the relevant indicators to cover non-bank financial intermediaries and covering the EU to the extent possible, the new database also covers the broader perspective of the ESRB.

The MPDB should also stimulate macroprudential analysis and research both within and outside the European System of Central Banks, and should prove relevant for market-participants and academics (see Box 1 for confidentiality issues).

3. Structure and key features of the database

The MPDB provides a comprehensive set of harmonised, relevant and fit-for-use indicators to analyse the build-up of both cyclical and structural systemic risks.

The development of the database started with the compilation of a list of potential indicators to be included in the database — casting the net relatively wide — based on relevant experience on macroprudential analyses and on the relevant

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8 The MPDB is the result of collaboration between ECB's DG Statistics, ECB's DG Macroprudential Policy and Financial Stability, the ESRB Secretariat, the Secretariats of the ESRB Advisory Technical Committee, of the ESCB/SSM Statistics Committee and of the ESCB/SSM Financial Stability Committee, EU National Central Banks and National Competent Authorities. Members of the FSC MPAG Workstream in charge of setting up the MPDB are listed in Annex 2.

9 According to the ESRB regulation, the ESRB shall be responsible for the macroprudential oversight of the financial system within the Union in order to contribute to the prevention or mitigation of systemic risks to financial stability in the Union that arise from developments within the financial system and taking into account macro-economic developments, so as to avoid periods of widespread financial distress. It shall contribute to the smooth functioning of the internal market and thereby ensure a sustainable contribution of the financial sector to economic growth. See ESRB Regulation: Regulation (EU) No 1092/2010 of the European Parliament and of the Council of 24/11/2010 on European Union macro-prudential oversight of the financial system and establishing a European Systemic Risk Board (the 'ESRB Regulation'): https://www.esrb.europa.eu/shared/pdf/ESRB-en.pdf?cefc86fb4362bd6d4510948235beb079

academic literature. The list also included the indicators selected for the ESRB's quantitative risk analysis tools, such as the ESRB risk dashboard. Following the compilation of this list, the second and longest phase of the work consisted in an extensive inventory exercise. The desired indicators were to allow cross-country comparability (harmonisation), large cross-country availability and, to the extent possible, a long history. This inventory exercise showed that many of the "best available" time series for the desired indicators were already available in datasets included in the ECB's Statistical Data Warehouse (SDW) or in databases of other international institutions (BIS, OECD, Eurostat, IMF) or in commercial data providers (Bloomberg, Thomson Reuters, Datastream, iBoxx, etc.).

A relatively large number of indicators were ultimately integrated in the MPDB. Those indicators cover user needs for macroprudential analyses, while taking into consideration the outcome of the data quality assessment. The resulting database is structured around the following seven domains:[10]

- Macroeconomic and financial market variables
- Debt and credit variables
- Residential real estate variables
- Commercial real estate variables
- Bank sector variables
- Non-bank variables
- Interconnectedness variables

Considering that the MPDB comprise more than 470 variables, grouped along the aforementioned seven domains, a catalogue encompassing all indicators together with underlying SDW codes and indicators calculations is available for download in the SDW. In addition, the catalogues are also available at domain level. These catalogues also include references to few time series that cannot be shown in the SDW, but are available in the other data sources.

The following sections present a summary of the main features of the various MPDB domains.

3.1 Macroeconomic and financial market variables

This first domain covers a very wide range of macroeconomic and financial market variables that can be used to measure the build-up of cyclical and structural systemic risks in the financial system or in the real economy, both on a national and European level (i.e. euro area as well as the EU). As the indicators included in this domain aim to cover financial stability risks stemming from macroeconomic developments (inflation, growth) and imbalances (current account, competitiveness), from household, corporate and public sector debt or from financial markets (equity, bond, foreign exchange), they thus include time series related to :

[10] See Annex 1 for an overview of the full MPDB structure.

- Macroeconomic aggregates (monetary and real variables)
- Financial market variables
- Risk and uncertainty variables
- Financial condition indicators for the main economic sectors (government sector, households, non-financial corporations)
- Borrowing and lending conditions

3.2 Debt and credit variables

According to the Basel Committee on Banking Supervision (BCBS, 2010) an important goal of macroprudential policy relates to the prevention of periods of excess aggregate credit growth that have often been associated with the build-up of system-wide risk. Along this line, it is also well documented that variables related to credit are among the best performing indicators in signalling (banking) crises in a broad set of countries, in particular during the upswing of the economic cycle.[11]

The debt and credit domain considers a wide range of variables aimed to timely detect the build-up of periods of excessive credit growth or the possible emergence of credit bubbles in the economy. Complementing the financial condition indicators of the first domain, this second domain provides time series covering various aggregates and breakdowns of:

- Total credit (loans plus debt securities) granted to households, non-financial corporations and (private) non-financial sector;
- Bank credit (loans) to various types of counterparties;
- Cross-border exposures;
- Information on credit exposures in banks' balance sheet (data from the consolidated prudential COREP and FINREP reports);
- Bank Lending Survey indicators related to the bank's practices and expectations regarding credit standards and lending conditions[12].

3.3 Residential real estate variables

Imbalances in residential real estate markets (RRE) have played a significant role in many of the past financial crises. Often, housing booms coincided with (broad-based) credit booms, as a result of strong feedback effects between the rising house prices and the increased ability of borrowers to lend against the rising value of the residential real estate collateral. As documented in Crowe, Dell'Ariccia, Igan and Rabanal (2013), almost all the countries that experienced a "twin boom" in real estate and credit markets ended up suffering a financial crisis or a severe contraction of GDP.

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[11] For further details see Borio and Lowe (2002, 2004), Borio and Drehmann (2009), Behn et al (2013) and Drehmann and Juselius (2014), BCBS (2010) and Dekten et al. (2014), Alessi and Detken (2014).

[12] See also https://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html

The potentially important role of RRE markets in the build-up of financial vulnerabilities also helps explain why several macroprudential instruments target specifically the loans secured by RRE, which include instruments that target banks (e.g. sectoral capital requirements) and borrowers (e.g. loan-to-value (LTV), loan-to-income (LTI) and debt-service-to-income (DSTI) caps). The MPDB therefore includes times series on variables that have been identified as potential leading indicators for RRE crises and/or that are the basis for the above-mentioned macroprudential instruments. Some of these areas are however still characterised by important gaps in the availability of comprehensive and comparable data for various countries (see Section 4).[13]

Against this background, the MPDB has identified a broad set of indicators for the RRE domain:

- A first set of indicators looks at the domestic household sector's balance sheet and its mortgage liabilities.
- The second set of indicators covers time series that provide information on mortgage loans' key features, such as the interest rate cost of these loans. In the future, these should be complemented with comprehensive and comparable data on mortgage loan maturities and LTV, DSTI or LTI ratios.
- A third group of indicators focuses on time series providing information on house prices and house price valuation.
- The fourth group of indicators relates to time series that provide information on the supply side of the residential real estate market.

3.4 Commercial real estate variables

The information on commercial property should reflect the risk profile of the asset class considered, rather than the ultimate purpose of the property. Therefore, the residential segment of commercial property should be distinguished from residential property owned and occupied by households. This is because commercial property is more often bought as a speculative investment by professional investors than residential property.

The MPDB covers a limited number of commercial real estate (CRE)-related variables, covering mainly available CRE price indicators and some available data on CRE-related exposures in the financial sector (even if these exposures may only be considered to be broad proxies of what would fall under a more precise definition of CRE). For other indicators that were envisaged, no comprehensive and comparable data for various countries could yet be included, due to data gaps related to the different features of the national CRE markets as well as - but to a lesser extent - the financial system's exposures.[14]

[13] See for example ESRB (2015), Report on residential real estate and financial stability in the EU, December.

[14] See for example ESRB (2015), Report on commercial real estate and financial stability in the EU, December.

3.5 Bank sector variables

The indicators used to measure banking sector structure, performance and vulnerabilities in the different EU countries and at the EU and euro area level are regrouped under the following categories:

- Banking structure: This set of indicators shows the degree of financial intermediation and banking concentration to support the identification of structural risks.
- Main elements of the income statement: In this section basic components of the profit and loss account are shown.
- Profitability: Based on the main elements of the income statement this section includes various ratios for profitability and efficiency.
- Main elements of the balance sheet: The section on elements of the balance sheet covers the structure of assets and liabilities on a detailed basis.
- Liquidity and funding: These indicators aim at assessing the resilience of banks' liquidity position, the diversification of funding sources and maturity mismatches between assets and liabilities so as to reduce liquidity risk and cover any unforeseen funding requirements.
- Lending and leverage: Indicators in this category evaluate different types of risk concentrations from lending to the real economy — like the risks from lending in foreign currency, variable rate loans, large exposures and loan concentration per sector — as well as an indicator measuring the leverage ratio of the balance sheet.
- Capital: This category assesses the capacity of the financial sector to absorb losses. Capital adequacy can be viewed as a measure of financial soundness since lenders need to have sufficient capital to absorb shocks on both asset and liability sides of their balance sheets. Indicators cover the main regulatory capital ratios, the quality of regulatory capital as well as the composition of the risk-weighted assets.
- Asset quality: The indicators assess the credit quality of the loan portfolio and banks' related provisioning.
- Locational funding indicators: This section complements indicators provided in other sections.

3.6 Non-bank variables

As systemic risks can also emerge outside the banking sector, other parts of the financial system also warrant monitoring. This is even more relevant given the ongoing evolution of the financial system, including the shift to market-based financing or to more lightly regulated intermediaries. Identifying the build-up of systemic risk in the so called "shadow banking" sector ranks high on the agenda of the international community, as it has been illustrated by the work of the Financial

Stability Board.[15] The MPDB accordingly includes a domain containing variables to assess risks to financial stability originating from non-banking financial sector. The indicators deal for example with structural features of insurance corporations and pensions funds and their exposures to sovereigns. It also covers information on financial vehicle corporations.

3.7 Interconnectedness variables

This domain includes variables that capture interconnectedness within the financial system, and includes for that purpose indicators that have been selected for the ESRB's quantitative risk analysis tools. The Financial Stability Board for instance developed a common data template to be reported by global systemically important banks (G-SIBs). In the MPDB, the indicators deal with total bank assets relative to GDP, banks' interbank liabilities (in addition to their interbank assets) and positions in derivatives, among others.

[15] See for instance the last FSB Global Shadow Banking Monitoring Report, http://www.fsb.org/2015/11/global-shadow-banking-monitoring-report-2015/

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Box: Confidentiality protection and the three layers of MPDB

The MPDB follows the dissemination policy in place for the datasets already available in the ECB SDW, thereby being fully compliant with the confidentiality features of the underlying data.

In this regard, the MPDB has three different layers, which differ in the data availability:

- ECB internal MPDB
- ESCB layer of MPDB
- Public MPDB

ECB internal MPDB

ECB users can access the entire content of the MPDB, including data sourced from commercial data providers. In some cases, authorisation to access particular datasets is based on the principle of business-related "need to know", so as to ensure that information system resources are only accessed by authorised individuals who need these resources in order to undertake their work.

ESCB layer of MPDB

Data are visible to the European System of Central Banks and also associated institutions for which a memorandum of understanding is in place: the European Banking Authority (EBA), the European Commission, the European Insurance and Occupational Pensions Authority (EIOPA), the European Securities and Markets Authority (ESMA), the European Stability Mechanism (ESM), the European Systemic Risk Board (ESRB) and the Bank of International Settlements (BIS). In this layer, some of the data from commercial data providers are not available to the users, as the contracts forbid to share these data outside of the ECB. However, it is allowed to share tickers for specific variables. In case the information is not visible to the users directly, the tickers are included in the MPDB catalogues, available in the node descriptions. If the variables coming from third institutions (e.g. OECD and BIS) are not available in this layer, the MPDB catalogues gives clear instructions on where and how to obtain this data.

Public MPDB

Since the start of the project much effort has been put in making as much data as possible available to a wider audience, being it the ESCB or general public. A review took place to reassess the confidentiality classification of selected time series. In this context, around 100 additional variables previously available in the ECB internal or ESCB layer are now included in the public MPDB.

Admittedly, the coverage of the MPDB available for the general public is limited compared to the ECB or even the ESCB layer, as a significant amount of data reported to the ECB from national authorities, is flagged as non-publishable and thereby can only be shared within the ESCB.

Nevertheless, the public layer of the MPDB is expected to be a useful reference, providing as much information as possible presented in one place. As in the ESCB layer, the MPDB catalogues provides clear instructions where and how to obtain certain time series from commercial providers or third institutions (e.g. OECD and BIS).

4. Future enhancements

4.1 Regular reviews and closing of data gaps

The creation of the MPDB was also accompanied by a macroprudential data gap analysis, which confirmed important data gaps. Some of these data gaps were classified as "possible to be addressed" by collecting information available by national authorities.

Other data gaps are more fundamental in nature, in particular in the area of residential and commercial real estate. These data gaps are difficult to bridge in a satisfactory fashion through "ad hoc" surveys. A good and comparable dataset on very important parameters for the macro-prudential analysis of RRE (such as LTV ratios) will require moves towards "common definitions" and "co-ordinated" collections of data that are at least "representative" for the domestic mortgage and housing markets.

Apart from the already foreseen expansions and enhancements, the MPDB will be regularly reviewed to ensure that it is keeping up with evolving user needs. It is fair to add that such developments may bear costs for the compiling institutions as well as may lead to additional reporting from industry. The ESCB and ESRB will take a cost-conscious and effective approach prior to any significant increase in coverage, and the more so the more costly such extensions may be.

4.2 Further expanding coverage in the area of non-banks

In its current state, the MPDB gives prominence to the banking sector in line with the focus of the ECB's role in macroprudential policy. While many systemic crises are characterised by bank failures or bail-outs, experience shows that financial instability is not always caused or triggered by traditional banking intermediation. As the Regulation that establishes the ESRB provides it with a mandate to oversee systemic risk in the financial system as a whole, a further development of the MPDB to allow for the monitoring of financial stability from outside the banking sector would support the ESRB in its tasks.

Non-bank entities and activities contributed to the propagation of the global financial crisis. The securitisation of mortgages prior to the crisis increased vulnerabilities and lead to over-borrowing. Money market funds following the failure of Lehman Brothers played an amplifying role in the global financial crisis. So too did the near-failure of AIG, an insurer which had become 'too big to fail'. These examples from recent events show that institutions other than traditional banks can contribute to financial instability – both in their own right and through interconnectedness with banks.

Identifying and addressing such risks and assessing the resilience of the financial system is becoming ever more important with the recent growth of the non-bank financial system in the EU.

In addition, the drive toward greater market financing – a key goal of the European capital markets union (CMU) – will likely spark further growth among non-banks.

4.3 Type of indicators

The materialisation of systemic risks emanating from non-banks can be understood in similar terms to those from banking. The impact, sources and transmission channels, however, may vary substantially across sectors.

4.3.1 Credit growth and leverage

By providing services to the real economy some financial firms may take on leverage and undertake maturity transformation. Excessive leverage amplifies the financial cycle, allowing more borrowing to take place, and may lead to a reduction in the resilience of market players. In addition, reliance on short-term and unstable funding may lead to fire sales, market illiquidity and contagion as firms seek to meet withdrawals.

4.3.2 Interconnectedness

Links between financial institutions can help manage risk and distribute funds to where they can be deployed more effectively. Interlinkages between entities may also reduce the system's ability to withstand stress given direct and indirect contagion channels. Risks may materialize also when banks provide financial support to non-bank financial entities beyond contractual obligation.

4.3.3 Too big to fail

Non-bank entities can be systemically important. Mandatory clearing of standard derivatives through CCPs has the potential to increase transparency and the stability of the network. But it also creates new networks and concentrates risks at CCPs. Due to their central position in the network; CCPs may themselves become systemically important.

5. Conclusions

A suitable statistical basis for macroprudential analyses and policies comprises a comprehensive and high-quality set of data and indicators. As systemic risk can originate from different parts of the financial system and from imbalances in the macro-economic environment, a wide set of statistics on macroeconomic variables, financial and real estate markets, credit, debt and funding patterns are needed. Moreover, in order to detect possible contagion risks, created by increasing interconnectedness and herd behaviour, also interconnectedness variables have to be monitored.

This paper describes a major move taken by the E(S)CB, in cooperation with the ESRB, to build such a statistical repository with the creation of the new Macroprudential Database (MPDB). The rationales for setting up the MPDB are put forward, together with the structure of the database and a broad overview of its indicators. Relevant confidentiality issues are dealt with.

En passant, the design and implementation of the MPDB showed how cooperation and mutual involvement of financial stability experts and statisticians can create relevant synergies and value added in terms of conceptual analysis, technical infrastructures, collection and compilation of data.

With the creation of the MPDB a first important step was taken, but more has to be done. Data gaps are still there, especially in some domains of the MPDB and they will have to be filled, always keeping an eye on the burden to data compilers and matching merits and costs of additional data. Data gaps appear to be relevant for instance in the area of residential and commercial real estate. A further important challenge will be expanding the coverage in the area of non-banks credit intermediation, given the growing relevance of the so-called “shadow-banking”. Progresses in the EU dossier of the Capital Market Union will make this area even more relevant. More in general, the MPDB will be regularly reviewed to ensure a robust and harmonised data system capable of satisfying the information needs of macroprudential analyses and policies.

Annex 1 - MPDB structure

The database consists of seven domains with various sub-domains and has the following structure:

Macroeconomic and financial market variables

- Monetary indicators
- Macroeconomic indicators
- GDP indicators
- Foreign exchange indicators
- Financial market indicators
- Risk and uncertainty indicators
- Financial condition indicators
- Borrowing and lending indicators

Debt and credit variables

- Total credit and debt service indicators
- Bank credit indicators
- Financial sector credit by sub-sector (whom-to-whom accounts)
- Cross border / currency / securities exposures
- Credit exposure of banks (FINREP data)
- Credit exposure of banks (COREP data)
- Credit conditions according to bank lending survey

Residential real estate variables

- Mortgage debt and household balance sheet
- Mortgage loan features / credit standards
- House price and house price valuation indicators
- Housing transactions and supply side

Commercial real estate variables

- CRE market: risk indicators
- Financial sector exposure to CRE

Bank sector variables

- Banking structure
- Main elements of the P&L

- Profitability
- Main elements of the balance sheet
- Liquidity and funding
- Lending and leverage
- Capital
- Asset quality

Non-bank variables

- Insurance companies and pension funds
- Other financial institutions

Interconnectedness variables

- Interconnectedness variables

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BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

An overview of the UK banking sector since the Basel accord: brief insights from a new regulatory database[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

An Overview of the UK Banking Sector since the Basel Accord: Brief Insights from a New Regulatory Database

Sebastian J A de-Ramon,[1] William B Francis and Kristoffer Milonas

Abstract

This paper provides an overview of the dramatic changes in the UK banking sector over the 1989-2013 period, seen through the lens of a newly-assembled database built from banks' regulatory reports. This database, which we refer to as the Historical Banking Regulatory Database (HBRD), covers financial statement and confidential regulatory information for all authorized UK banks and building societies at the consolidated (group) and standalone (bank) level. As a result, it permits both a more comprehensive picture of the UK banking sector as well as a more refined view of sub-sectors, such as small banks, than possible with other existing datasets (e.g. from external vendors or aggregate statistics). The overview focuses on developments in banks' CAMEL characteristics (**C**apital adequacy, **A**sset quality, **M**anagement skills, **E**arnings performance and **L**iquidity), and relates these developments to concurrent regulatory changes, such as the Basel Market Risk Amendment. In a forthcoming paper, we suggest ways in which the database can be used for evidence-based research and policy analysis.

Keywords: Bank regulation, regulatory data, database, capital requirements, CAMEL, capital, capital requirements, asset quality, management, earnings performance, liquidity, funding

JEL classification: G21, G28, N2, G01

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Contents

Executive Summary

This note summarises the longer working paper discussed at the fall 2016 IFC conference (forthcoming as a Bank of England working paper available at http://www.bankofengland.co.uk/research/Pages/workingpapers/default.aspx). That paper describes the evolution of the UK banking sector over the years 1989-2013 through the lens of a newly-developed Historical Bank Regulatory Database (HBRD). It also details the new database, highlights its benefits relative to existing commercial databases and discusses potential uses for researchers and policy analysts.

Evolution of the UK banking sector and its regulation

We structure our analysis using the well-known CAMEL framework covering aspects of banking conditions related to **C**apital adequacy, **A**sset quality, **M**anagement skills, **E**arnings performance and **L**iquidity. We focus the analysis mainly on aggregate measures of each CAMEL factor to illustrate the breadth of the new database. We analyse the developments separately for small and large (top 8 in total assets) banks as these two groups present key differences. We overlay this analysis with a review of changes in regulation that interplayed with these developments.

Our findings are as follows:

- *Capital adequacy*, measured according to risk-based standards at the time, increased steadily in the run-up to of the 2008-09 financial crisis, while it fell on a non-risk adjusted basis. This latter trend was especially evident at the largest institutions due to a reduction in risk-weighted assets stemming from wholesale shifts in assets from the banking book to the trading book, attracting lower capital requirement with the introduction of the Basel Market Risk Amendment (MRA) in 1996. Large banks also had lower overall risk-based capital ratios, lower risk-based capital requirements and lower proportions of high-quality (Tier 1) capital relative to small banks.

- With regards to *asset quality*, large banks shifted portfolios from traditional lending to trading activities, reflecting in part the heightened incentives (to lower regulatory capital requirements) under the MRA. Small banks, on the other hand, increased lending as a share of their portfolios throughout 1989 to 2013. Actual and provisioned losses were high during the distressed period in the early 1990s and again during the recent financial crisis, particularly at large banks.

- *Management skills*, as measured by the cost-to-income (efficiency) ratio, remained relatively stable over the period 1989 to 2007, but worsened notably with the onset of the 2008-09 financial crisis as banks faced higher costs of dealing with mounting loan problems and misconduct charges.

- The distress periods of the early 1990s and again during the recent financial crisis can be seen clearly in banks' *earnings performance* measures. Post-crisis earnings measures remain low by historical standards as banks face challenges from legacy assets and low interest margins.

- Aggregate *liquidity* metrics generally worsened up until the crisis. Broadly speaking, large banks had higher levels of liquid assets, but less stable funding (measured as deposits to assets and a proxy for the Net Stable Funding Ratio, NSFR).

In a forthcoming working paper, we explore these developments in greater detail.

Benefits of the database

A key benefit of the HBRD is its application to a wide set of highly relevant policy questions and the opportunities it affords to generate evidenced-based policy.

Important dimensions of the database include:

1. Coverage

   a) Long time series, covering the evolution from Basel I to Basel III, five different regulatory reporting regimes, and several distress episodes (e.g. the UK small-bank crisis in the early 1990s, the dotcom turmoil in 2000-02 and the 2008-09 financial crisis).
   b) Broad cross-section, covering the UK banking sector (UK registered banks, foreign subsidiaries and building societies excluding branches of foreign domiciled banks).
   c) Both solo and group (consolidated) data.

2. Unique content not available from existing external sources.

   a) Confidential regulatory information on required capital not currently available elsewhere.
   b) Level of consolidation is the same as used for regulatory purposes, which is not always the same as in public financial reporting; using the latter could be misleading when evaluating, for example, behaviour in response to changes in regulation.

3. Potential for future use with ease and confidence:

   a) Consistent definitions of variables, constructed using regulatory reporting instructions from the respective reporting regimes.
   b) Extensive data checks.
   c) Accompanying manual and metadata.
   d) Available to external users (subject to security clearance).

Future use of the database in research and policy analysis

In a forthcoming working paper, we suggest ways in which the historical developments we have explored could be investigated in a more granular way, and more generally how the database could be used to address both current policy issues and research questions covered in the literature. We believe the new database offers considerable scope for contributing to the evidence base on the impacts of regulatory changes on bank behaviour and ex post policy reviews.

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What shall we do with pass-through? DNB's experiences with special financial institutions[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

What shall we do with pass-through?

DNB's experiences with Special Financial Institutions

Jurriaan Eggelte, Melle Bijlsma and Krit Carlier[1]

What shall we do with pass-through?

Multinationals channel large financial flows across the globe, which have little or no relation to production activities. Such 'pass-through' activities are difficult to monitor for statisticians and may obscure the analysis of the financial side of the economy. Currently, DNB uses the concept of 'Special Financial Institutions' to get a view of pass-through capital and to allow for an adjustment of its Balance of Payments and International Investment Position statistics. When we replace this national concept by the standard concept of special purpose entities, we will add a nationality breakdown to enable a broader analysis of "pass-through". In case the future manuals might want to target at a more specific measurement of "pass-through" our current SFI concept might still serve as a source of inspiration.

Keywords: pass-through capital, special financial institutions, special purpose entities, ESA2010, BPM6, SNA2008, balance of payments, international investment position.

[1] The authors thank Pim Claassen (Head of Department, Balance of payments and securities statistics at De Nederlandsche Bank) and Ronald Nelisse (Statistics Netherlands) for their comments and suggestions.

Contents

1. Introduction

The last decades saw a surge in financial flows across the globe, partly driven by multinationals taking advantage of different legal and tax regimes. As a result, large amounts of capital and income flow in and out of countries with little to no relation to production activities. Such 'pass-through' flows can easily dominate statistics on cross-border financial linkages. As an example, the IMF CDIS dataset over 2014 shows the Netherlands to be the largest recipient of direct investment *in the world*, with the United States following as runner-up at a respectable distance. For a country ranked 17th globally in terms of GDP this is somewhat surprising. In fact, most of these investments consist of pass-through funds, which is illustrated by the balancing item in this equation: the Netherlands' outward direct investment position is even larger. While our country may not be typical, it is not entirely unique. Pass-through funds are sizeable in many economies across the globe.

For policymakers, having adequate statistics on such pass-through funds has grown ever more important. First, these statistics are necessary to enable international flow-of-fund analyses. Such analyses have gained in relevance since the recent global financial crisis of 2007-2008, which saw an unprecedented collapse in international capital flows after years of rising financial globalization (Milesi-Feretti and Tille, 2011). Statistics on pass-through funds are necessary to trace capital flows around the globe, connecting the dots from the originating country via pass-through countries to their ultimate destination. Conversely, not observing pass-through funds obscures policymakers' vision of the actual flow of capital, and can lead to faulty interpretation of the flows that are observed.[2]

Second, if left unidentified, pass-through funds have the potential to substantially distort national macro-economic statistics that may signal vulnerabilities, leading to their over- or underestimation.[3] The relevance of such statistics – for instance, corporate sector debt levels in the context of the European Union's Macroeconomic Imbalance Procedure – has increased in recent years. In this case, pass-through funds need to be identified to properly *exclude* them from analyses as necessary.

The policy relevance of observing pass-through flows is confirmed by the work plan of the G-20 data gaps initiative, a broad effort aimed at addressing the statistics needs that were revealed by the crisis. The initiative lists improvements in both monitoring of global capital flows and sectoral analysis as important ambitions underpinning its action plan (Heath and Goksu, 2016). Furthermore, the importance of observing pass-through flows and separating them as necessary is confirmed by the BPM6 handbook for Balance of Payment compilers, which states that pass-through funds should be included in observed financial flows and recommends that countries compile separate supplementary data on them (IMF, 2009).

2 E.g. this could cause a pass-through country to be mistaken for an originating country. Inter alia, this creates issues when compiling regional statistics, such as those for the Eurozone.

3 E.g. when pass-through entities are classified as non-financial corporations, and their intercompany debts are added to the debt level of the corporate sector.

That is not to say that compiling adequate statistics on pass-through funds is an easy task. The population of entities channeling pass-through flows can be large, fast-changing and therefore difficult to monitor. Moreover, due to the large flows involved, small errors in reported gross data can have a large impact on net statistics. In the Netherlands, the balance sheets of observed pass-through entities amounts to around EUR 3800 billion in 2015 - between 5 and 6 times Dutch GDP and larger than the banking sector.

So given the policy relevance of these statistics and the complexity of producing them, the question for policymakers and statisticians is: what shall we do with pass through? This paper examines this question from the perspective of De Nederlandsche Bank (DNB) as a compiler of Balance of Payments and International Investment Position statistics (BOP/IIP statistics). DNB has a long-standing tradition in observing pass-through funds dating back to the early 1950s when the concept of 'Special Financial Institutions' (SFIs)[4] was developed. At the time, entities channelling funds from non-residents to other non-residents were deemed to be irrelevant for Dutch monetary policy, and labelled SFIs to be exempted from capital restrictions. The SFI-concept became obsolete over the years for monetary reasons, but has remained in use for statistical reasons.

The SFI concept has long placed DNB at the forefront of the identification of pass-through capital. But the international statistical community has caught up by introducing related concepts, such as *Special Purpose Entities* (SPEs) and captive financial institutions. The newest handbooks such as the UN's System of National Accounts (SNA2008), Eurostat's national accounts manual (ESA2010) and the IMF's Balance of Payments Manual (BPM6) provide new options to identify "pass-through". Fully aligning with these latest statistical guidelines means that the Netherlands will soon abandon its SFI concept, a move which will coincide with the implementation of a new integrated framework for the production of BOP/IIP statistics and sector accounts by DNB and Statistics Netherlands.[5]

The remainder of this paper is structured as follows. Section 2 describes our current approach in measuring SFIs' activities and their contribution to our BOP/IIP figures. Section 3 assesses this approach from the perspective of the latest statistical guidelines. Next, section 4 explains our planned new method for compiling pass-through statistics. Section 5 offers suggestions from our current SFI methodology on how to enhance the potential for future statistical frameworks to compile pass-through statistics. Finally, section 6 provides concluding remarks.

2. Current approach

'Special Financial Institutions'

The key role in DNB's approach towards pass-through is played by SFIs. SFIs come in all shapes and sizes. Some are stand-alone, others are part of 'clusters', or broader groups of entities with one ultimate controlling institution abroad. SFIs report

[4] In Dutch: Bijzondere Financiële Instellingen.

[5] See for more details: Bieleveldt and Claassen (2014).

individually to DNB on the basis of their own set of accounts, usually with the help of legal services providers operating on their behalf. These 'trust offices' are under the supervision of DNB. Nowadays, several types of SFIs are distinguished:[6]

- Financing companies issuing securities, borrowing from banks and attracting intercompany loans to provide financing to foreign subsidiaries;
- Holding companies owning shares of foreign subsidiaries;
- Royalty and licensing companies paying and receiving (sub-)licensing fees for the cross-border rights to use intellectual property (and similar intangible assets); and
- Vehicles securitizing portfolios of foreign loans.

Box 1 provides additional information on DNB's collection and compilation strategy of BOP/IIP statistics for SFIs, and describes some of the challenges involved.

Box 1. Sampling and compilation of data on SFIs

More than fifteen thousand SFIs are reporting to DNB which is far more than in any other Dutch ESA-sector. DNB relies on three mechanisms to maintain its reporting population of SFIs. First, it is mandatory for new SFIs to register themselves at DNB under Dutch statistical regulations, leading to a steady stream of new registrations. This works well for entities represented by trust offices, with whom we maintain close contact. In order to also detect SFIs without such representation our compilation team engages in periodical analyses of public data sources such as data on mergers and acquisitions – an activity locally referred to as *scouting*. Finally, Statistics Netherlands sometimes detects SFIs in their process of profiling non-financial corporations, which are communicated to DNB.

Given the large population of SFIs, it is not feasible to cost-effectively subject every entity to a full reporting regime. Therefore a subset of SFIs is required to provide extensive monthly and annual reports on transactions. All other SFIs report annually in a trimmed down 'benchmark survey', the information from which is subsequently used to revise earlier macro figures.

The selection of monthly reporting SFIs used to be based on a cutting of the tail approach, motivated by the fact that the distribution of SFI's assets and liabilities is highly skewed. Under this approach, all SFIs with assets over EUR 300 million were obliged to send in monthly reports. For all other SFIs a grossing up was included based on a benchmark survey (initially held every two years). As the incidence of mid-sized SFIs grew over time, however, an increasing number of monthly reporters were needed in order to maintain our desired coverage ratio of 90%. Another drawback was that the financial activities of large SFIs turned out to be not representative for those of small SFIs. Hence, the information from the benchmark survey increasingly led to rather large revisions.

To reduce the size of the revisions later on and to contain the processing costs for DNB, a stratified sampling approach was introduced in 2014. The top ranked SFIs were fully included, the bottom ranked SFIs fully excluded, and the mid-sized SFIs

[6] Other pass-through entities, such as invoicing companies and leasing companies are of minor importance and are ignored in this paper.

randomly sampled.[7] The sample is used to gross-up the figures. The past years have taught that the behavior of the sampled mid-sized SFIs is generally representative of the non-sampled population. Revisions based on the - benchmark survey (currently held on an annual basis) are still needed but are considerably smaller than before. There are, however, also costs involved, as the compilation process has become more complex. A practical problem is that large transactions in the mid-sized SFIs stratum, which occur sporadically, are magnified by the grossing up factor. This may lead to large swings in monthly and quarterly figures, which we aim to correct for in case we consider the transactions to be not representative.

Because of the complexity and unfavorable side-effects of the stratified sampling approach, we will change course. More specifically, we will return in 2017 to a cut-off approach in selecting our monthly reporting sample accepting a lower coverage ratio than before (about 66%). A provisional grossing up will be made using information from monthly reporting SFIs, and including an estimate for new entities to be established during 2017. These provisional SFI figures will then be finalized on the basis of the annual benchmark survey.

Generally speaking, data quality management is an important issue in the compilation of data on SFIs. Small errors in reported gross data can have a large impact on net BOP/IIP data due to the large size of flows and stocks. The SFI concept, being especially targeted at passing through, enables an effective quality check: large changes in net BOP/IIP data are by definition reporting errors, unless they can be explained by occasional specific domestic transactions. Although in principle reporting errors should be corrected at the micro level, in practice, given time and resource constraints, the quality of our BOP/IIP statistics is managed with macro adjustments. Net figures for income, transactions and positions are targeted, to prevent error driven volatile swings in these BOP/IIP items. The exact targets are based on information on SFIs' domestic transactions and positions extracted from a non-financial corporations survey by Statistics Netherlands.

Whether a new entity should be classified as SFI (or an existing entity reclassified as such) is determined on the basis of a decision tree, jointly developed by DNB and Statistics Netherlands. Key criteria, to be applied to a cluster's consolidated balance sheet, are:

- A SFI should be resident, but ultimately controlled by non-residents.
- At least 90% of a SFI's assets and liabilities should be foreign (for financing companies this criterion is only applied to their assets).
- A royalty and licensing company's revenues from export of royalties and licences should be at least 90% of total turnover.
- A securitization vehicle should be originated by a foreign bank (and at least 90% of its assets and liabilities should be foreign).
- The domestic turnover of a SFI should not exceed EUR 25 million.

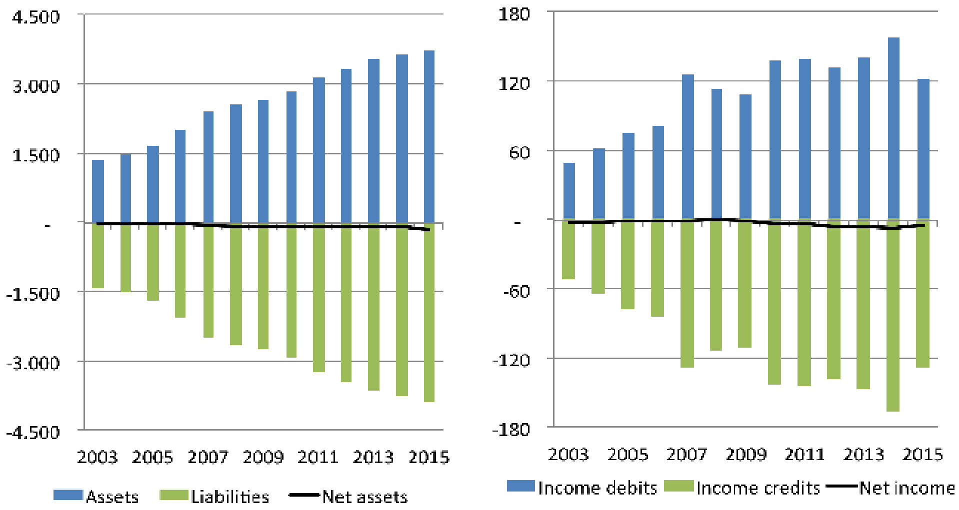
Once identified, SFIs are pooled into a separate subsector within the financial sector statistics. DNB then essentially observes pass-through flows by assuming that all SFIs exclusively engage in pass-through activities, while other types of entities do

[7] Carlier and Chaudron (2014).

not at all. Under this assumption, the sectoral totals for SFIs thus represent the observed pass-through flows in the Netherlands.

Figure 1 illustrates the resulting balance sheets and primary income flows for SFIs through time. The figure shows that the assumption of these entities exclusively engaging in pass-through activities is valid to a high degree: they generate rather large gross flows and stocks, but very small net flows and stocks. The chart in the right panel shows that large income flows are channeled through SFIs, between EUR 100 and 150 billion in recent years. A similar picture emerges when looking at SFIs' assets and liabilities, in the left panel. The domestic assets of SFIs are only EUR 100 billion (0.3% of total SFI assets).[8]

Figure 1. Pass-through activities by SFIs (EUR bln)



SFIs dominate in the FDI account, on the asset and liability side (respectively 78 % and 82% of total FDI). To a far lesser extent their activities show up in the Other Investment Account and the Portfolio Investment Account.

It should be noted that although the compilation of statistics on SFIs allows DNB to identify a large proportion of pass-through funds flowing through the Netherlands, it does not capture them perfectly. The main reason for this is that foreign multinational corporations also channel funds through the Netherlands via the balance sheets of local production affiliates, which are classified as non-financial corporations rather than SFIs. According to our estimates approximately one-third of the debt of Dutch non-financial corporations, equal to 40% of Dutch GDP, consists of pass-through funds. Although the size of these funds is relatively small compared to the balance sheets of Dutch SFI, they still result in a sizeable distortion of non-SFI balance sheet statistics.

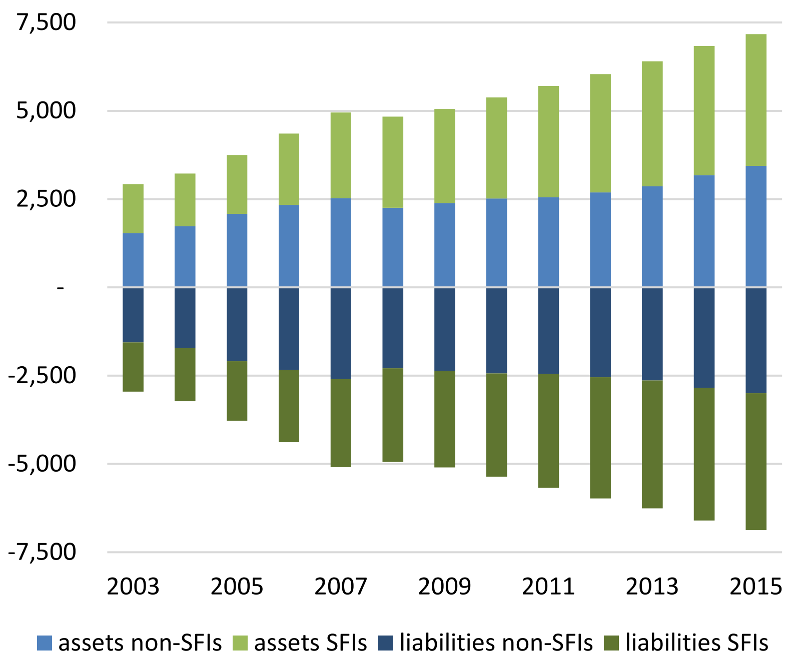
Quality and use of our BOP/IIP figures

Over the past decades DNB has collected data on SFIs' activities to adjust its BOP/IIIP figures for pass-through funds. Until recently the official BOP/IIP dataset published at

8 This net position results from intercompany loans to Dutch production affiliates, participations in these affiliates and intellectual property rights on SFIs' balance sheets.

DNB's website and by international organizations had been based on adjusted figures from which SFIs were largely excluded: the large gross flows of SFIS were netted and only the net activities included in the BOP/IIP figures.[9] This changed at time when the BPM6 handbook was implemented, which calls for inclusion of pass-through flows on a gross basis. Since then unadjusted BOP/IIP figures which include all SFIs' activities are nationally released as our official dataset. To provide users with the possibility to separate out pass-through funds, the BOP/IIP figures of SFIs are published as an "of which" item in the main statistical tables. Figure 2 shows the evolution of the Dutch international investment position on the basis of these figures.

Figure 2. International investment position (EUR bln)



Users thus have a choice in the figures they find most useful for their purpose. They can use unadjusted BOP/IIP figures including pass-through funds, or adjusted figures excluding pass-through funds. In practice, we see that the choice follows from users' objectives. Those primarily interested in regional and global capital flows generally opt for the first set. This includes the ECB and Eurostat, who compile euro area and EU BOP/IIP aggregates by summing up the contributions of all membership countries and need coherent symmetrical BOP/IIP statistics of all membership countries.[10]

Policymakers analyzing shadow banking have been a significant user of BOP/IIP-statistics on SFIs. Initial monitoring exercises conducted after the crisis typically utilized a broad definition of shadow banking activities, which led to the SFIs being

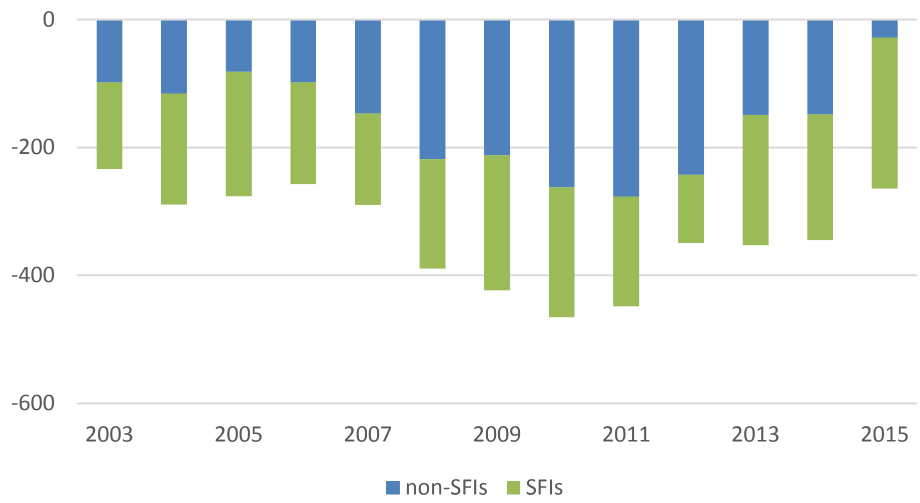
9 However, at the same time, data sets including gross data on SFIs were submitted to international organisations for compiling aggregates.

10 Capital passing through a Dutch SFI can be an inflow or an outflow at the euro area level. Not including this capital in the Dutch BOP/IIP figures would directly impact the size of the euro area BOP/IIP aggregates, and create asymmetries with non-euro area countries. Furthermore, capital passing through a Dutch SFI but remaining within the euro area should also be included in the Dutch BOP/IIP figures. This capital does not have a direct effect on the euro area BOP/IIP aggregates, but could push up the euro area errors and omissions.

included in shadow banking estimates. Based on the recently constructed, more targeted definition by the Financial Stability Board, SFIs have however been removed from the assumed scope of shadow banking (van der Veer et.al., 2015).

Finally, users primarily interested in the surveillance of national vulnerabilities generally prefer to use adjusted BOP/IIP figures. As pass-through funds are largely neutral to the Dutch economy and do not point to real economic vulnerabilities, including them can in several cases create misleading signals. For instance, external debt positions by pass-through entities count towards the national economies' external debt position, one of the 'auxiliary' indicators in the European Union's Macro-economic Imbalances Procedure (MIP). This may easily lead to misperceptions of national vulnerabilities. Figure 3 shows how the interpretation of net external debt in the Netherlands is influenced by the inclusion of SFIs' activities. The decrease in net external debt for non-SFIs between 2011 and 2015 is much stronger than the MIP-indicator shows.

Figure 3. Net external debt (EUR bln)*

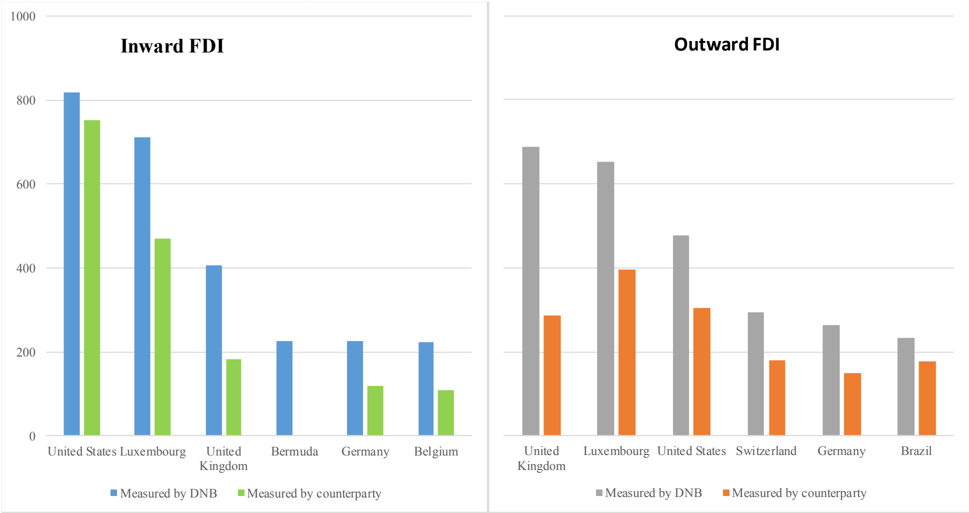


* Net external debt is calculated as external debt minus external assets in debt instruments. Debt includes intercompany loans, debt securities issued and other investment.

The quality of our official BOP/IIP dataset is determined by the quality of its components: the non-SFI data and the SFI data. Due to the large and volatile SFI population substantial efforts are needed to preserve the quality of the latter component. Occasionally, substantial revisions to the SFI data – and thus to the official BOP/IIP dataset – result from a few dormant SFIs suddenly increasing in size, and from newly incorporated large SFIs that are not immediately identified.

A comparison between the Netherlands and counterpart countries suggests that DNB is relatively complete in its observation of pass-through and other capital flows. Figure 4 shows so-called *mirror data* from the IMF's Coordinated Direct Investment Survey. The bilateral direct investment positions between the Netherlands and several relevant counterpart countries are compared. In most cases the positions as measured by DNB are substantially higher than those measured by the counterparty countries.

Figure 4. Bilateral FDI asymmetries vis-a-vis the Netherlands in 2014 (USD bln)



3. Aligning with the latest statistical guidelines

The publication of Eurostat's ESA2010 has prompted an evaluation by DNB of its current SFI-approach to identifying pass-through funds. This is because ESA2010 complicates the execution of our current approach, while at the same time providing suitable alternatives.

Under the previous edition of the European System of National and Regional Accounts (ESA1995), DNB and Statistics Netherlands dealt with the SFI population as a subsector of its other financial intermediaries sector (S.123). This approach facilitated the compilation process of SFI statistics as the sum of all activities of a single subsector of institutions. The 2010 edition of the framework (ESA2010) changes this. It provides a more detailed subdivision of the financial sector and changes guidance on certain classification rules. As a result, the population of SFIs is now spread over several sectors. Most are currently classified into the newly introduced sector captive financial institutions (S.127), which consists of financial corporations and quasi-corporations neither engaged in financial intermediation nor in providing financial auxiliary services, and where most of either their assets or their liabilities are not transacted on open markets. Securitization vehicles have meanwhile been classified into the new other financial intermediaries sector (S.125), which is more narrowly defined than its namesake under ESA1995. Others would have to be classified as non-financial corporations (S.11). This concerns three classification issues.

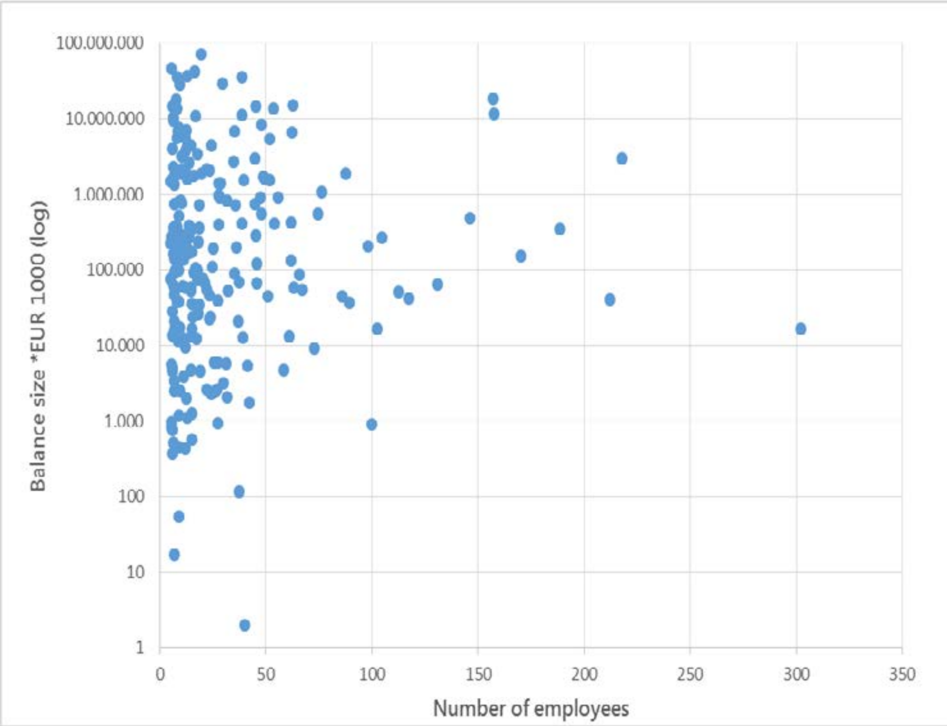
First, independent royalty and licensing companies holding intellectual property rights on their balance sheets are to be classified in the non-financial corporations sector (S.11) as these entities have substantial non-financial assets.

Second, DNBs current methodology implicitly assumes that all SFIs are institutional units.[11] This is indeed the case for all stand-alone SFIs, and for all clusters

[11] An institutional unit is an entity that can incur liabilities, engage in economic activities, has a meaningful set of accounts, and has autonomy of decision making. Other entities are called *artificial subsidiaries* and treated as an integral part of their parent's units. That is, unless they are resident in an economy different from that where the parent is resident.

without regular production affiliates. But it is not true for all SFIs. Some financing companies in the SFI population are subsidiaries of regular production affiliates. These entities meet the SFI balance sheet criterion, as they raise funds abroad from other sources than from their parents. However, following the latest statistical guidelines, these SFIs are artificial residents as they are linked to a resident parent and should be consolidated in S.11.

Figure 5. Employment of SFIs



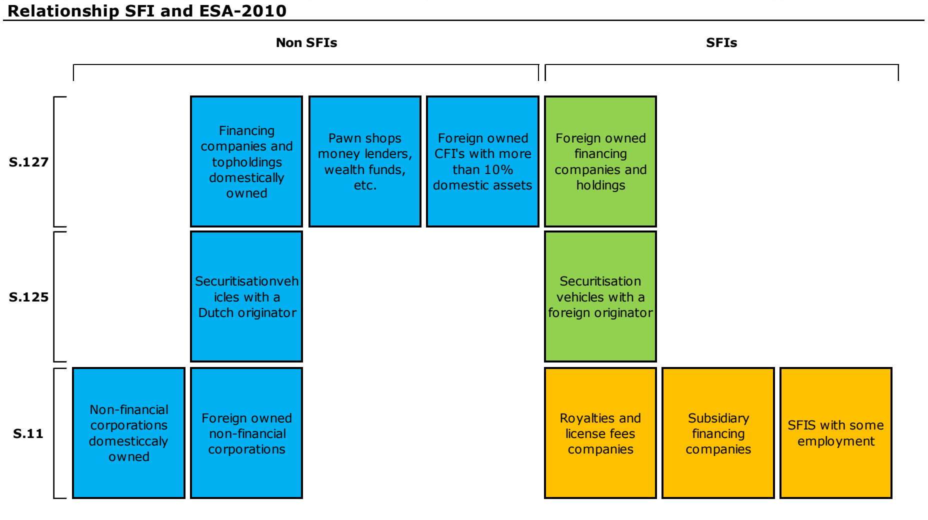
Third, and most substantially, several SFIs currently classified in S.127 as holding companies would qualify as head offices of non-financial corporations under the latest statistical guidelines, which requires them to be classified into to S.11.[12] An employment criterion is key in determining whether an entity classifies as a holding or head office. In 2013, a special taskforce on Head Offices, Holding Companies and Special Purpose Entities has given extra guidance on this, and has stated that employment of three or more persons should be seen as a first indicator for an institutional unit being a head office (ECB, Eurostat, and OECD 2013). Although in total SFIs' employment is rather limited (less than 9 thousand persons in 2015), individual SFIs can have some employed persons. The effect of the employment criterion on our sector classification, depends on the exact threshold that will be implemented. This is shown in figure 5 by plotting employment versus balance sheet size for individual SFIs. Around 240 individual SFIs have more than 5 employees, with combined assets of EUR 450 billion.[13]

As a result of such reclassifications, the population of SFI entities would be dispersed among S.127, S.125 and S.11 Figure 6 shows schematically where different types of SFIs are to be classified, in full alignment with the latest statistical guidelines.

12 Head offices of financial firms would instead be moved to S.126, but these entities are less prevalent.

13 This is a lower limit, as some SFIs are consolidated into clusters.

Figure 6. Current classification of SFIs in S.125 and S.127



4. Identifying pass-through within the current statistical framework

Aligning to the latest statistical guidelines would have no implications for our official BOP/IIP dataset, as the total of pass-through funds would still be observed.[14] Identifying pass-through funds within total capital flows, however, would be potentially problematic. This presents a problem specifically to users of macro-economic statistics that seek to exclude pass-through capital from their analyses. In order to maintain this functionality, we have looked into several options.

First, we could continue to compile pass-through statistics by grouping relevant entities into a single sector, by using S.127 for this purpose. However, the information content of such statistics would be greatly reduced compared to our current SFI statistics, as S.127 includes not only pass-through entities but also companies holding the shares of domestic enterprise groups, and some other types of captive financial institutions (see figure 6). Of the S.127 population, only the foreign owned S.127 entities can be seen as pass-through entities. Furthermore, the resulting statistics would not include SFIs in S.125 and S.11.

Second, we could label relevant entities in different ESA-sectors and use the label as a basis to compile statistics. A prime candidate for a label would in this case be the SPE concept, which is closely related to the SFI concept. The latest statistical guidelines introduce the SPE concept on the basis of a list of its typical characteristics.[15]

- SPEs have no employees and no non-financial assets;

[14] The reclassification of SFIs does influence the BOP/IIP figures broken down by sector, but these data have not yet been published.

[15] It is, at the same time acknowledged that there is no common definition. SNA2008 contains a similar list of characteristics, less strongly worded.

- SPEs have little physical presence;
- SPEs are always related to another corporation, often as a subsidiary;
- SPEs are resident in a territory other than the territory of residence of the related corporations;
- SPEs are managed by employees of another corporation which may or not be a related one.

Judged by these characteristics there is a substantial overlap with SFIs, and thus with pass-through capital. Compiling pass-through statistics based on SPE labelled entities would provide a better proxy for pass-through activities than statistics on the S.127 sector. However, this option would still be expected to have less information content relative to our current methodology. The SPE population comprises a subgroup of entities not involved in pass-through as it includes foreign holding companies in S.127 with substantial Dutch participations. Additionally, the SPE population excludes the existing pass-through entities reclassified to S.11. In short, SPE labelled entities are still a poorer proxy for pass-through entities than our SFI labelled entities. Another option – which would remedy this drawback – would be to simply use our existing SFI concept as a label across sectors instead. Such a SFI label however would not come with the international recognition that the SPE label does bring.

Third, a separate approach to identify pass-through funds would be through identification of the actual pass-through *activities* rather than *entities*. Such a methodology would relax the assumption that certain labelled entities exclusively engage in channelling pass-through funds while all other entities don't engage in this at all. Instead, it would involve identifying certain subsets of capital flows across all entities that could feasibly be interpreted as pass-through funds. For instance, the foreign assets of foreign-owned entities registered in the Netherlands could be interpreted as a proxy for pass-through funds. The potential increase in quality from this method is substantial, as it would also pick up the material pass-through activities undertaken by non-financial corporations – a category which our statistics based on the SFI concept currently do not capture. However, some aspects of pass-through may be easier to proxy in this manner than others. For instance, the foreign liabilities of the foreign-controlled entities are difficult to interpret being a mix of pass-through flows and 'genuine' investment flows.

Given these options, we have chosen to opt for a combination of the second and the third approach. We will implement the SPE label (second approach), which will allow us to compile comprehensive statistics on a group of institutions typically engaged in pass-through activities. Using the SPE concept brings the advantage of using an internationally harmonized concept that is understood across borders, at the cost of a less comprehensive coverage compared to our SFI population. Notably, the current SFIs which will shift to S.11 and which will not be labelled SPE will not be regarded as passing through. As a result our statistics will show The Netherlands to have higher figures of 'non-pass-through' FDI than before. These figures may also be more volatile than before because of the fast-changing nature of the pass-through funds that end up being included. Additionally, we will identify pass-through *activities,* irrespective of the classification of the entity (third approach). Thus, we aim to construct indicators for pass-through funds which also capture pass-through flows in the wider population of financial and non-financial entities – perhaps coming to a better coverage than we achieve today.

A key element in constructing such 'activity-based' indicators is observing the nationality of the financial and non-financial corporations reporting for our statistics, as this can make a large difference in the interpretation of observed capital flows. With this in mind we are planning to implement the voluntary ESA-sub-classification of domestic and foreign-owned entities. Such a sub-classification could also serve broader needs of data users. For instance, Dutch controlled entities are likely to draw the most interest from domestic policymakers, in particular in understanding their financial exposures and integration in global value chains. These users will also be helped with the proposed breakdown by nationality.

5. Enhancing pass-through identification in future statistical frameworks

The Dutch experience in compiling statistics on pass-through funds may also contribute to the further development of international frameworks on the subject. There is still room for international convergence on this point, as illustrated by the fact that BPM6 stops short of offering up such a framework and instead advocates the implementation of national solutions.

Developing an internationally consistent label for entities primarily involved in pass-through would be an interesting avenue to explore. The SPE concept provides a natural starting point for this, but has not been designed specifically for the identification of pass-through funds, as it excludes entities with little substance and furthermore lacks a balance sheet criterion. The SPE concept could either be adapted in the new handbooks by adding this criterion, or a SFI type of pass-through concept could be introduced.

In this regard, it could also be discussed how to weigh production and financial activities. It is not unusual that pass-through entities combine large balance sheets with some employment (and little production activities). This is the sizeable group of institutions that historically have been classified as SFI in the Netherlands, but will not be captured in the future as they are reclassified as non-financial corporations under the latest statistical guidelines. Drawing from the Dutch experience, a pass-through concept would ideally be inclusive of entities that have some physical presence but nevertheless primarily carry out pass-through activities. One way of achieving this would be to re-examine the definition of 'principal activity' of an entity, which is instrumental in determining its sectoral classification and by which entities combining minor value added with large balance sheets are considered non-financial companies.

Today, the statistical handbooks deem balance sheets characteristics as irrelevant in determining an institutional unit's principal activity, and instead take value added as a central measure. This methodology leads to outcomes which not always seem to reflect the dominant character of an entity. An entity with a EUR 10 bln balance sheet and ten employees is prima facie more likely to be financial than non-financial. Under a methodology where an entity's principal activity is co-determined by financial variables such as the size of its balance sheet, it would be easier to ensure that financial activities such as pass-through would be classified in the financial sector. Thus, also entities with a disproportionate balance sheet relative to their value added would be considered financial corporations and included as SPEs, bringing them under the umbrella of pass-through statistics. Of course, as a consequence also minor (non-financial) value added would shift to the financial sector. Box 2 discusses further how production and financial activities could be weighed.

Box 2. Weighing production and financial activities

When an entity has both production and financial activities, there is obviously a dilemma. Either an entity is classified as a non-financial corporation (head office) which means that S.11 would include extra passing through activity. Or an entity is seen as a financial corporation (holding) which means that S.127 would include real activities. The table below gives a stylized example with two holdings that also have some employment.

	Employment (persons)	Foreign assets (EUR)	Domestic assets (EUR)
Holding A	1	10 mln	0.1 mln
Holding B	10	10 bln	0.1 bln

On the basis of their characteristics, only holding A will currently be classified as a financial corporation in S.127. However, holding B is, in relative terms, very similar, and has in absolute terms much larger pass-through activities. Classifying entity B as a head office, because of its employment of 10 persons, results in extra pass-through capital in S.11's balance sheet which may hamper the interpretability for users.

If an institutional unit's principal activity would be co-determined by its balance sheet, entities having very large balance sheets can be classified as financial corporations in S.127. From a user perspective, the drawbacks of shifting some limited employment and production activities to S.127 may be considered smaller than that of shifting large financial flows to S.11. Weighing both effects calls for specific relative thresholds, like total assets per employee, or the ratio of assets versus domestic turnover.

This issue is all the more relevant as it is unlikely to go away, and could very well grow in the future. It is conceivable that national tax authorities will require pass-through entities to increase their economic substance, given the G20 statement that multinationals should be taxed where economic activities take place and where value is created. In the Netherlands we already see an increasing number of SFIs creating substance, the wage sum almost tripling since 2005. If multinationals would respond by combining pass-through entities with small value generating activities the current definition would imply a large reclassification with limited economic meaning for users.

6. Concluding remarks

Although our SFI concept has worked well over the years in making adjustments for pass-through capital, it will be abandoned in the near future to fully align with the international guidelines adopting the SPE concept. We thus accept a less optimal identification of pass-through entities in order to harmonize our approach with international standards. In our future approach, we intend to make an adjustment for pass-through on the basis of the SPE concept and a nationality breakdown. Although pass-through activities may be relatively large in the Netherlands as compared to GDP, such activities can also be found in other countries. Users of BOP/IIP figures in other countries may be hindered by similar, albeit probably smaller distortionary effects. A stricter definition of SPEs would reinforce the benefits of harmonisation using this concept. If users and compilers consider it important to get a better handle on pass-through capital in the next national accounts and BOP/IIP manuals, our 'old' SFI concept may still serve as a source of inspiration, being a concept specifically targeted at pass-through.

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Multichannel contagion vs stabilisation in multiple interconnected financial markets[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Multichannel Contagion vs Stabilisation in Multiple Interconnected Financial Markets

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(initially submitted in April 2016)

Abstract

The theory of multilayer networks is in its early stages, and its development provides powerful and vital methods for understanding complex systems. Multilayer networks, in their multiplex form, have been introduced within the last three years to analysing the structure of financial systems, and existing studies have modelled and evaluated interdependencies of different type among financial institutions. The empirical studies have considered the structure as a non-interconnected multiplex rather than as an interconnected multiplex network. No mechanism of multichannel contagion has been modelled and empirically evaluated, and no multichannel stabilisation strategies for pre-emptive contagion containment have been designed. This paper formulates an interconnected multiplex structure, and a contagion mechanism among financial institutions due to bilateral exposures arising from institutions' activity within different interconnected markets that compose the overall financial market. We introduce structural measures of absolute systemic risk and resilience, and relative systemic-risk indexes. The multiple-market systemic risk and resilience allow comparing the structural (in)stability of different financial system or the same system in different periods. The relative systemic-risk indexes of institutions acting in multiple markets allow comparing the institutions according to their relative contributions to overall structural instability within the same period. Based on the contagion mechanism and systemic-risk quantification, this study designs minimum-cost stabilisation strategies that act simultaneously on different markets and their interconnections, in order to effectively contain potential contagion progressing through the overall structure. The stabilisation strategies subtly affect the emergence process of structure to adaptively build in structural resilience and achieve pre-emptive stabilisation at a minimum cost for each institution and at no cost for the system as a whole. We empirically evaluate the new approach using large regulatory databases, maintained by the Prudential Regulatory Authority (PRA) of the Bank of England, that include verified capital requirements for UK-incorporated deposit takers and investment firms and granular information on their bilateral exposures due to transactions in the fixed-income market, securities-financing market, and derivatives market. The empirical simulations of the designed multichannel stabilisation strategies confirm their capability for containing contagion. The potential for multichannel contagion through the multiplex contributes more to systemic fragility than single-channel contagion, however multichannel stabilisation also contributes more to systemic resilience than single-channel stabilisation.

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[3] Any views expressed are solely those of the author, and they should not be interpreted or reported as those of the Bank of England or its policy committees.

I: Introduction

Real and engineered systems have multiple subsystems and layers of connectivity. Networks are now established as models providing insights into the structure and function of complex systems. Single-layer networks, however, are unable to address the emerging multilayer patterns of interactions and self-organisation among entities in complex systems. That challenge has called for the development of a more general framework – multilayer networks. The theory of multilayer networks is in its early stages, and a comprehensive review of recent progress is provided in Kivelä et al. (2014) and Boccaletti et al. (2014). Among existing studies, a promising mathematical framework is based on tensors and introduced by De Domenico et al. (2013, 2015). A special case of multilayer networks are multiplexes, where each layer consists of mostly the same nodes, and edges within a layer exist only between different nodes while links between layers exist only between instances of the same node in different layers. According to the formal definition in De Domenico et al. (2013, 2015) and Kivelä et al. (2014), a fundamental aspect of modelling multiplex networks is taking into account and quantifying the interconnectivity between layers, as it is responsible for the emergence of new structural and dynamical phenomena in multiplex networks.

Multilayer networks, through the special case of multiplexes, have only been used in the last three years to study interdependencies among entities within financial systems. Multiplexes can model different type of relations (edges) existing among a set of entities (nodes) in a system and include interlayer dependence (edges). Serguieva (2012) argued that though single-layer network models had been gradually adopted in the structural analysis of financial systems, such analysis rather required more effective models as network of networks and ensemble networks. Serguieva (2013a, 2013b) outlined how an interconnected multiplex can be used to model the different type of exposures among banks, arising from their activities in different markets trading different financial instruments, and suggested using the tensorial framework. The current paper starts with this earlier idea, and now – having access to data – develops the model in detail, implements empirically, and extends the methodology towards contagion and stabilisation analysis. Serguieva (2015, 2016) address how the multilayer network can be extended further to incorporate financial market infrastructures. A multiplex model is also used in Bargigli et al. (2015) to present the Italian interbank market, where exposures are broken down in different layers by maturity and by the secured and unsecured nature of contracts. They evaluate similarity between the structures of different layers and find the differences are significant. The conclusion is that the structural differences will have implication for systemic risk. The authors do not formulate or evaluate systemic risk, and the study considers the layers separately as a non-interconnected multiplex. The interconnected multilayer structure of the interbank market is not analysed.

Next, Poledna et al. (2015) use a multiplex model to quantify the contributions to systemic risk of the Mexican banking system from four layers: deposits and loans, securities cross-holdings, derivatives, and foreign exchange. They implement Debt Rank (Battiston et al., 2012) to measure systemic risk as fraction of the economic value in a network that is potentially affected by the distress of some banks. The systemic risk of a layer is the average Debt Rank of all banks due to their connectivity in that layer, and the total risk of the system is the average Debt Rank of all banks due to the connectivity in the projection of all layers. The results show a non-linear effect, with the sum of systemic risk of all layers underestimating the total risk. The suggested comprehensive approach in the study accounts for the capital, assets and liabilities of banks, but does not consider their minimum capital requirements and risk-weighted assets. A bank is considered failed, however, when its capital depletes to the level of minimum capital requirements, not when it depletes entirely. The minimum capital requirements are based on risk weighted assets, and two banks with the same amounts of capital, assets and liabilities, will differ in their amounts of risk-weighted assets, and therefore differ in their minimum capital requirements and their available funds to cover the liabilities. Our study shows that this requires modifying to a different extent the impacts among different financial institutions, in order to simulate contagion that accounts for each institution's individual conditions for failure and corresponding spreading rates within the contagion process. This has a significant effect on potential contagion processes and their outcome. Further, Poledna et al. (2015) consider different layers but assume the combined system is the projection of all layers rather than the multiplex of interconnected layers, and therefore do not model contagion through the multiplex structure.

The current paper also builds on research done at the Bank of England by Langfield et al. (2014), where the authors argue that markets for different financial instruments are distinct in their economic rationale and function, and discuss potential advantages of analysing the interbank market as an interlinked structure of different network layers. They provide an in-depth empirical analysis of layers in the UK banking system, but do not model a multilayer network neither quantify systemic risk. In conclusion: (i) the theory of multilayer networks is in its infancy, (ii) there are very few studies addressing multilayer or multiplex networks when analysing the structure of financial systems, (iii) existing studies of interlinkages within banking systems have recognised their multilayer structure and modelled each layer as a network, (iv) contagion processes within each layer and within the projection of all layers have also been modelled, and the corresponding systemic risk has been quantified in monetary terms. However, (i) the system has not been modelled as an interconnected multiplex; (ii) multilayer contagion processes have not been formulated, (iii) the existing single-layer contagion models are not closely aligned with regulatory requirements, and (iv) no stabilisation strategies have been designed for pre-emptive, minimum-cost contagion containment. The tensorial mathematical framework has not been used in financial analysis. With this paper we address concerns (i)-(iv), formulate solutions, and provide empirical results. We work with the tensorial framework, and in Serguieva (2016) derive step-by-step tensors of ranks two, four, and six within the context of financial systemic risk. Providing detailed domain interpretation of the models allows Serguieva (2016, 2017a) to extend the range and scope of stress-testing scenarios. Here, we will directly use the derived tensor models and focus only on concerns (i)-(iv). Their solutions effectively formulate an approach for building-in structural stability within the banking system and resilience against potential crises. Though resilience is quantified as a structural rather than monetary measure, when built in it provides for sustaining a system's monetary value. Importantly, resilience is achieved through subtly and adaptively balancing the emergence process of structure, rather than through penalising institutions. Systemic instability is due to the emerged structure rather than being a fault of an institution. We do not recommend collecting a fund of penalties and waiting for institutions to get in distress before accessing it. Instead, containment of potential contagion is achieved pre-emptively by introducing a minimum change to the structure in each period, at a minimum cost for each institution and no cost for the system as whole.

This study explores large regulatory databases, including the extensive Banking Sector Monitoring (BSM) database maintained by the Prudential Regulatory Authority (PRA) of the Bank of England, and an in-house PRA tool for verifying the Capital

Adequacy of each reporting institution. It also explores the large granular database collected by PRA through its Bank Exposures Data Request to UK-incorporated deposit takers and significant investment firms, reporting on the firm's UK-consolidated basis. These data are exemplary of the 'Big Data' or granular data now available to the Bank of England (Bholat, 2013, 2015, 2016). The exposures data request, in particular, is tailored to the purposes of structural analyses of the UK financial system, and the data include bilateral exposures resulting from institutions' activity in the main three types of markets composing the overall financial market – fixed-income, securities-financing, and derivatives markets. The three layers in the multilayer structure we model correspond to these markets. The paper is organised as follows. Section II describes and visualizes the datasets. In Section III: (i) a single-layer contagion mechanism is formulated aligned with current regulatory requirements; then (ii) corresponding relative systemic-risk indexes of institutions and absolute measures of the layer's systemic risk or resilience are quantified; and finally (iii) a single-layer strategy is designed for building in structural resilience and evaluated empirically. Section IV: (i) formulates a multichannel contagion mechanism within the banking system due to exposures arising from banks' interactions in the three interconnected markets; (ii) quantifies corresponding multiplex systemic-impact indexes of institutions and structural systemic risk of the multilayer system; (iii) designs and empirically evaluates minimum-cost multichannel stabilisation strategies. Finally, Section V states the conclusions and sets directions for further research.

II: Empirical data and visualisation

The data used in this paper are large counterparty exposures reported by systemically important UK-incorporated deposit takers and investment firms to the Bank of England's supervisory arm, the Prudential Regulation Authority. At the time of our investigation, the data spanned five quarters, a pilot in June 2014 and collections in December 2014 to September 2015. We access from the database, the firms' twenty largest exposures to banks, where banks are broadly defined as

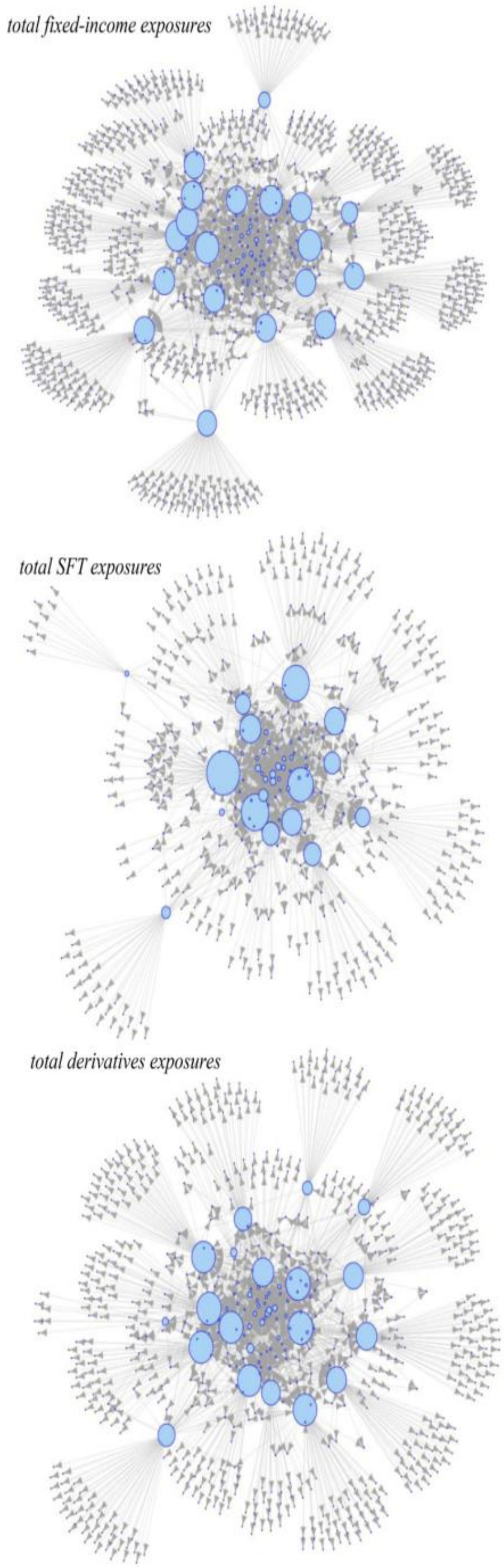
- banks
- building societies
- broker-dealers
- and additionally, exposures to the eight largest UK banks are reported if not a top twenty counterparty

The firms report these large exposures gross, except where a legally enforceable netting agreement exists between the transacting entities. The reports are on a UK-consolidated basis. Further, we have data on counterparty exposures broken down by financial market. Each market in turn consists of a range of financial instruments and transactions. These markets and their attendant instruments and transactions are as follows:

- the fixed income market, consisting of senior, subordinated and secured debt instruments reported gross at mark-to-market (MtM) values, further segmented by residual maturity and currency
- the securities financing market, consisting of securities lending and borrowing, and repo and reverse repo transactions reported gross notional, with further breakdowns by residual maturity, currency and type of collateral

- derivative exposures reported net MtM after collateral and net MtM at default, split by various derivative contract types

Figure 1: *Large exposures of UK-incorporated deposit takers and significant investment firms – empirical multilayer structure by type of market*



The second database used in this study is the extensive Banking Sector Monitoring (BSM) database maintained by the PRA, where we access quarterly data on UK-consolidation basis for the reporting institutions, including:

- Total Own Funds
  (Common Equity Tier 1 Capital + Additional Tier 1 Capital + Tier 2 Capital);
- Total Risk Exposure Amount (risk-weighted assets)
- Ratio of Total Own Funds to Total Risk Exposure Amount

These data are further complemented with calculations from an in-house PRA tool for verifying the Capital Adequacy of each reporting institution, including:

- Minimum Capital Requirement;
- Ratio of Available Regulatory Capital to Total Own Funds.

The empirical data on inter-institutional exposures are visualised in Figure 1, where each of the three layers corresponds to the exposure structure within a different type of market – fixed-income, securities-financing, and derivatives. The size of nodes representing institutions is proportionate to the number of exposure links they participate in. Figure 1 is based on one of the quarterly periods, between June 2014 and September 2015, however it presents key features observed in all periods – the markets differ in their emerging exposure structures. Particularly, different institutions to a different extent, and a different number of institutions, have a key role (visualised as more interconnected, larger size nodes) in different markets.

Figure 2: *Large exposures of UK-incorporated deposit takers and significant investment firms – empirical single network*

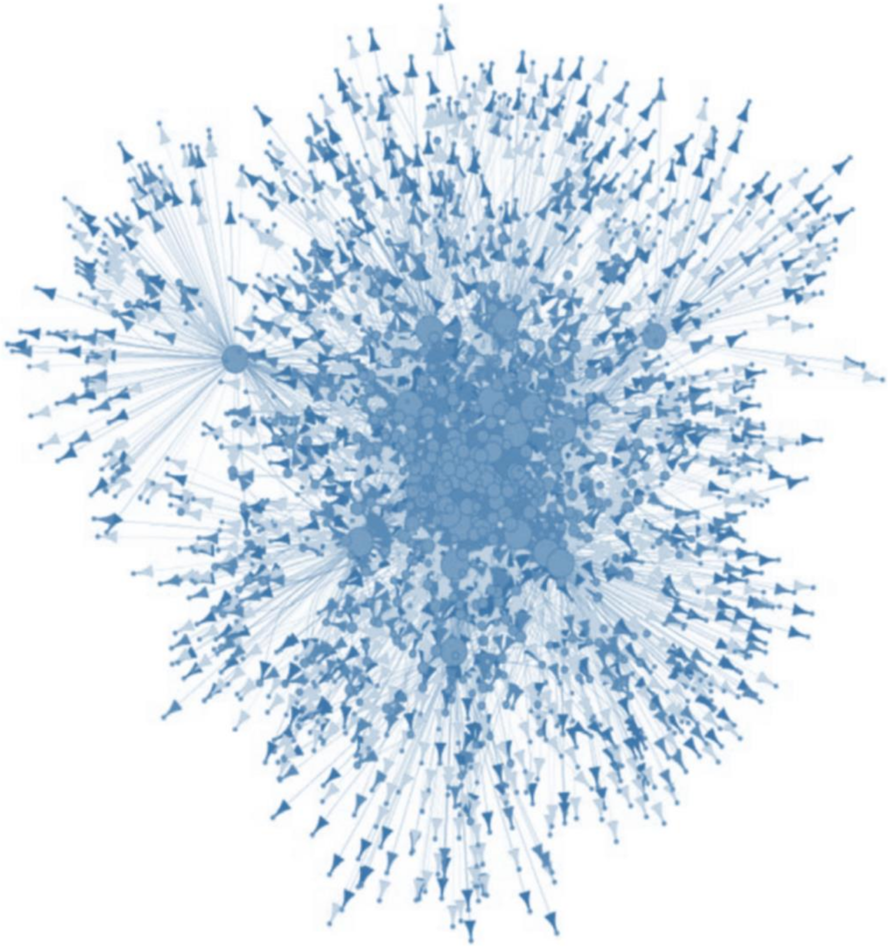
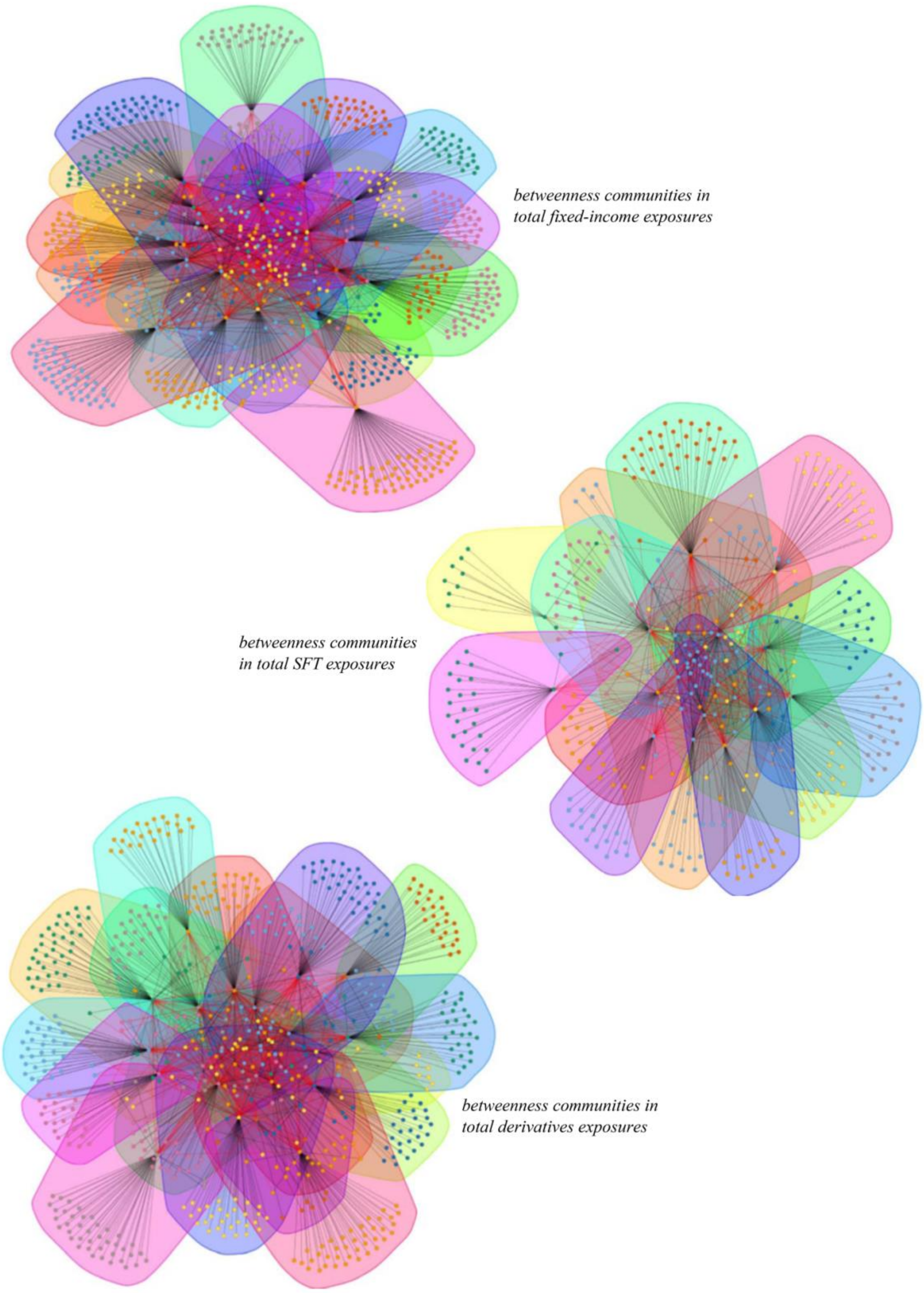


Figure 3: *Large exposures of UK-incorporated deposit takers and significant investment firms – empirical betweenness communities by type of market*



Therefore, the analysis will better inform and facilitate regulation if each market is incorporated distinctly within an overall multilayer structure, rather than all markets being amalgamated into (projected on) a single network of exposures as visualised in Figure 2. This figure presents the same quarterly period but does not observe the richer structure from Figure 1.

The argument for the structural differences between markets is further supported with the visualisation in Figure 3, where each market is clustered into communities according to edge betweenness. Betweenness of an edge (exposure link) is a measure based on the number of shortest paths (smallest number of links) between any two nodes (institutions) in the network that pass through that edge. If a large number of shortest paths pass through the same edge, then it is in the bottleneck linking communities of nodes. Different colours are used in Figure 3 for different betweenness communities within the three financial markets. Possible contagion paths within communities are little obstructed but such between communities are less accessible. Therefore, contagion will progress differently within the different layers (markets), as they have different betweenness communities.

We provide a detailed comparison in Serguieva (2016, 2017a) of the structure and centralities of single-layers (markets) within any of the available quarterly data periods, and a comparison among periods, concluding decisively that the structures differ. Thus analytical approaches that consider markets are incorporated distinctly (Figures 1 and 3) or indistinctly (Figure 2), within the overall structure of exposures, will observe different contagion processes, identify different systemic risk measures and indexes, and recommend different stabilisations strategies. It is also necessary to evaluate links between markets (see section IV), and then the argument is clear that a multilayer network – incorporating all interconnected markets simultaneously but distinctly – provides the more realistic results.

III: Formulation and evaluation of single-market contagion dynamics and design of effective stabilisation strategies

3.1. Contagion dynamics in the derivatives market

A link in the derivatives market will generally represents how an institution i impacts another institution j in that market – the contribution of i to j's probability of failure – as suggested in (Markose, 2012). We build the structure here involving further details and scenarios and following closely the current regulation and the definition of different exposures data, in comparison with existing studies, and modify the optimisation in approximating the contagion process. First, the probability of failure of an institution j after the start of a contagion process is modelled as dependent on j's own funds and its minimum capital requirement (Serguieva, 2016, 2017a). The contagion dynamics is analysed for the 22 reporting institutions, referred to collectively as 'banks'.

- The current regulatory reporting framework recommended by the Basel Committee on Banking Supervision and implemented in the UK, and the accounting standards with reference to UK GAAP and the International Financial Reporting Standards, look at the different nature of derivatives in comparison with other financial instruments. Banks report their net MtM after collateral derivatives exposures (NAC), and their net derivatives exposures-at-default (EAD). Reported NAC values are non-negative and account for enforceable bilateral netting arrangement[4] between non-defaulted banks throughout

[4] According to the regulatory reporting directives, derivatives transactions are only netted if they are in the same netting set. A 'netting set' is a group of transactions with a single counterparty that are subject to a single, legally enforceable, bilateral netting arrangement. Each transaction that is not subject to a

different netting sets, and for received collateral[5]. The reported exposure-at-default values[6] (EAD) are non-negative and account for collateral, netting arrangement, and adds-on applicable at default (see footnotes 4,5,6), and as a result the EAD amounts are larger than the NAC amounts. We will first use EAD values, and the impact among institutions in the derivatives market will be denoted with the matrix $S^{EAD} = \left[s_{ij}^{EAD}\right]$ of size $n \times n$, where each element s_{ij}^{EAD} reflects a failed bank's i contribution to the default probability of a second bank j, and n is the number of reporting institutions. The elements s_{ij}^{EAD} are proportionate to the reported by bank j exposure at default EAD_{ji} to bank i, and inversely proportionate to the own funds C_j of bank j. The impact matrix S^{EAD} can include both a positive component s_{ij}^{EAD} proportionate to EAD_{ji}/C_j and a positive component s_{ji}^{EAD} proportionate to EAD_{ij}/C_i. This is due to received collaterals, netting sets and adds-on applicable at default. In comparison, existing studies on contagion in derivatives markets assume that impact between two institutions exists only in one direction and approximate it as proportionate to the differences in gross exposures.

- Further, when bank i defaults, then the available funds A_j of bank j are reduced with the reported amount of its exposure at default EAD_{ji} to bank i. Here, the available funds $A_j = C_j - MC_j$ are the difference between the total own funds C_j and the minimum capital requirements MC_j of j. When bank j defaults, the own funds available funds A_i of bank i are reduced with the reported amount of its exposure at default EAD_{ij} to bank j. The Own Funds of a bank are evaluated as the sum of its Common Equity Tier 1 Capital (CET1), Additional Tier 1 Capital (AT1), and Tier 2 Capital (T2). The Minimum Capital Requirements to be maintained by a bank are set by current regulation as a percentage of its Total Risk Exposure Amount (risk weighted assets), including buffers in the case of some institutions, and verified by the Prudential Regulatory Authority.

- The non-negative impacts s_{ij}^{EAD} include the case when j receives greater collateral from i that brings the reported exposure to zero (see footnote 5). If bank j does not report an exposure EAD_{ji} to i because the two institutions do not interact in the derivatives market (though they may interact in the fixed-income and/or the securities-financing markets) then $s_{ij}^{EAD} = 0$. When the exposure of j to i is below the reporting threshold then again $s_{ij}^{EAD} = 0$, as i does not significantly impact j directly and so does affect the structural analysis insignificantly.

legally enforceable bilateral netting arrangement is interpreted as its own netting set. Where cross-product netting is legally enforceable, such transactions are considered 'nettable'.

[5] According to the regulatory reporting directives, Net MtM After Collateral for a netting set is computed as Net MtM Before Collateral less the value of collateral received from a counterparty to collateralise the exposure of that netting set. The collateral includes the one received under legally enforceable credit support annexes, as well as any collateral held in excess of what is legally required. The collateral only represents what is received / is in hand on a confirmed settlement basis, and does not include collateral owed to but not actually held by the firm. When collateral received is greater than Net MtM Before Collateral, then Net MtM After Collateral is zero.

[6] Exposure At Default (EAD) is the counterparty credit risk exposure net of collateral, as specified in the Prudential Requirements for Banks, Building Societies and Investment Firms BIPRU 13, and calculated either using the Mark-to-Market Method (BIPRU 13.4), the Standardised Method (BIPRU 13.5), or the Internal Model Method (BIPRU 13.6).

Therefore, the derivatives layer here is built as accurately as possible, using reported data without attempting approximation. In comparison, most studies work with aggregated data and approximate institution-to-institution exposures and impact. However, approximated structures differ from empirical systems in a way that cannot be anticipated, and thus mislead analysis and regulatory implications (Cont et al., 2013).

Here, we consider the boundary case of a single market in isolation, when it is not aware of the liabilities in other markets. An intermediate case is to assume that institutions in the single market are aware of their overall but not bilateral liabilities in other markets, and the approach presented here can also be applied for that case. The intermediate case will account for the overall amount of exposures, but not for the dynamics of activating exposures in other layers and propagating impact among institutions and markets. The case when the multiple market system is aware of all granular exposures is analysed in Section IV.

- When the available funds A_i of i deplete, the bank is considered failed. Therefore, $p_i = \frac{A_i}{C_i}$ is the percentage of own funds that can be used to cover triggered exposures, and p_i differs from institution to institution. Even if two banks i and j have equal total own funds $C_i = C_j$, they may have very different minimum capital requirements $MC_i \neq MC_j$, and therefore different ratios $p_i \neq p_j$. Within the database used here, the ratios p_i differ up to a factor of 4, $\max_{1 \le i,j \le n} (p_i/p_j) \approx 4$. In comparison, existing studies assume that p is the same for all institutions and does not depend on risk weighted assets.

  Assuming p is the same corresponds to a spreading rate $(1-p)$ in the contagion process, for each institution. Instead, we set $p = p_{min} = \min_{1 \le i \le n}(p_i)$, which corresponds to a maximum spreading rate $(1-p_{min})$, but then modify in Equation (1) the condition for default of each bank i at step $(q+1)$ in the contagion process. Instead of using $\sum_{\substack{j \in B_q \\ i \notin B_q}} \left(s_{ji}^{EAD}\right) > p$, we use $\sum_{\substack{j \in B_q \\ i \notin B_q}} \left(s_{ji}^{EAD}\right) > p_i$:

$$\sum_{\substack{j \in B_q \\ i \notin B_q}} \left(s_{ji}^{EAD}\right) = \sum_{\substack{j \in B_q \\ i \notin B_q}} \left(\frac{EAD_{ij}}{C_i}\right) > p_i = \alpha_i \; p_{min} \qquad \text{for } \alpha_i > 1 \qquad (1)$$

  Here, B_q is the set of banks defaulted by step q and $B_q = \cup_{k=1}^{q} \beta_k$, where β_k represents the set of banks failed at step k. If the own funds of institution i in the denominator are modified to $C_i^{modified} = a_i C_i > C_i$, then the equivalent condition for i defaulting at step $(q+1)$ is:

$$\sum_{\substack{j \in B_q \\ i \notin B_q}} \left(\frac{EAD_{ij}}{C_i^{modified}}\right) = \sum_{\substack{j \in B_q \\ i \notin B_q}} \left(\frac{EAD_{ij}}{\alpha_i C_i}\right) > p_{min} \qquad \text{for } \alpha_i > 1 \qquad (2)$$

  The unique α_i for each bank i is applied, and though the spreading rate is $(1-p_{min})$, the unique default condition for each institution and its unique spreading rate is incorporated into the contagion dynamics through α_i.

In order to describe the contagion process, we follow the logic in Firfine (2003) and Markose (2012), and extend with the steps listed above as well as with additional details and clarification:

- **step $q = 0$**
  A set of banks fail at time $q = 0$. This is due to a trigger that is internal or external to the system of reporting banks. It is not known what trigger will be active and which banks will fail. However, if the defaulted banks are denoted with β_0, then the probability of default of a bank $i \in \beta_0$ at $q = 0$ is assumed as $\pi^{EAD}_{\substack{i,0\\ i\in\beta_0}} = 1$.
  The probability of default of the other banks $i \notin \beta_0$ is assumed as insignificantly small $0 < \pi^{EAD}_{\substack{i,0\\ i\notin\beta_0}} = \frac{1}{C_i^{modified}} \ll 1$. Due to the failure of banks β_0, a contagion process starts, and the model derived here will account for any possible set β_0.

- **step $q = 1$**
  The set of banks that fail at step $q = 1$ is denoted with β_1. It is not known which banks participate in β_1, as the elements of β_0 are not known in advance. A bank $i \in \beta_1$ fails at step $q = 1$, because $\frac{\sum_{j\in\beta_0} \underset{(i\in\beta_1)}{(EAD_{ij})}}{C_i^{modified}} > p_{min}$, and its probability of default at $q = 1$ is $\pi^{EAD}_{\substack{i,1\\ i\in\beta_1}} = 1$. On the other hand, the probability of default of banks $i \in \beta_0$ at $q = 1$ is $\pi^{EAD}_{\substack{i,1\\ i\in\beta_0}} = 0$, as they already failed at step at $q = 0$.
  Let us denote the set of banks that have failed by step $q = 1$ as B_1, then $B_1 = \beta_0 \cup \beta_1$. For completeness, the set of banks that have failed by $q = 0$ can be denoted as B_0 where $B_0 = \beta_0$, and therefore $B_1 = B_0 \cup \beta_1$. The probability of default of a bank $i \notin B_1$ surviving at $q = 1$ is $\pi^{EAD}_{\substack{i,1\\ i\notin B_1}} = \frac{\sum_{j\in\beta_0} \underset{(i\notin B_1)}{(EAD_{ij})}}{C_i^{modified}} < p_{min}$.
  Here, $\pi^{EAD}_{\substack{i,0\\ i\notin\beta_0}} \approx 0$ are not taken into account as these are insignificantly small.

- **step $q = 2$**
  The set of banks that fail at step $q = 2$ is denoted with β_2, and the set of banks that have failed by step $q = 2$ is denoted with B_2, where $B_2 = B_1 \cup \beta_2$. A bank $i \in \beta_2$ (for $i \notin B_1$) fails at step $q = 2$ because the depletion of its available funds exceeds the threshold $\frac{\sum_{j\in B_1} \underset{(i\in\beta_2)}{(EAD_{ij})}}{C_i^{modified}} > p_{min}$, and its probability of default is $\pi^{EAD}_{\substack{i,2\\ i\in\beta_2}} = 1$. The probability of default of banks $i \in B_1$ at step $q = 2$ is $\pi^{EAD}_{\substack{i,2\\ i\in B_1}} = 0$, as they already failed at step $q = 0$ or $q = 1$. The probability of default of a bank $i \notin B_2$ surviving at $q = 2$ is $\pi^{EAD}_{\substack{i,2\\ i\notin B_2}}$. By analogy with the epidemiology literature, $(1 - p_{min})$ is the rate of infection, which in this case is a rate of 'spreading default' or spreading losses. One percent of bank i's capital probably infected at step $q = 1$ has the potential to infect $(1 - p_{min})$ percent of its capital at step $q = 2$. If a bank fails due to infected (lost) capital it also loses up to $(1 - p_{min})$ percent of its capital that hasn't been infected so far. Then these losses will affect other banks at the next step, etc. The percentage of i's capital

probably lost at $q=1$ is $\pi^{EAD}_{\substack{i,1\\ i\notin B_1}} = \frac{\sum_{\substack{j\in\beta_0\\ (i\notin B_1)}}(EAD_{ij})}{C_i^{modified}}$, which depends on i's exposures to banks that failed prior to $q=1$. This $\pi^{EAD}_{\substack{i,1\\ i\notin B_1}}$ is also i's probability of default at $q=1$ and has the potential to infect or to bring probable losses of $(1-p_{min})\pi^{EAD}_{\substack{i,1\\ i\notin B_1}}$ percent of its capital at $q=2$. Exposures of i to banks $j\in\beta_1$ that failed at $q=1$ are lost at $q=2$, and also contribute to the probability $\pi^{EAD}_{\substack{i,2\\ i\notin B_2}}$ of i's default at $q=2$. Therefore:

$$\pi^{EAD}_{\substack{i,2\\ i\notin B_2}} = (1-p_{min})\,\pi^{EAD}_{\substack{i,1\\ i\notin B_2}} + \sum_{\substack{j\in\beta_1\\ (i\notin B_2)}}\left(\frac{EAD_{ij}}{C_i^{modified}}\,\pi^{EAD}_{\substack{j,1\\ j\in\beta_1}}\right) \quad \text{where} \quad \pi^{EAD}_{\substack{j,1\\ j\in\beta_1}} = 1$$

It is not known prior to the start of contagion which banks will default at each step, and the probability $\pi^{EAD}_{\substack{i,2\\ i\notin B_2}}$ is derived here for any possible B_0, B_1, B_2.

- **step q**
  The set of banks that fail at step q is denoted with β_q, and the set of banks that have failed by step q is denoted with B_q, where $B_q = B_{q-1}\cup\beta_q$. A bank $i\in\beta_q$ (for $i\notin B_{q-1}$) fails at step q because $\frac{\sum_{\substack{j\in B_{q-1}\\ (i\in\beta_q)}}(EAD_{ij})}{C_i^{modified}} > p_{min}$, and its probability of default at q is:

$$\pi^{EAD}_{\substack{i,q\\ i\in\beta_q}} = 1 \tag{3a}$$

  For banks $i\in B_{q-1}$, the probability of default at step q is:

$$\pi^{EAD}_{\substack{i,q\\ i\in B_{q-1}}} = 0 \tag{3b}$$

  as they already failed prior to step q. The probability of default of banks $i\notin B_q$ surviving at q is:

$$\pi^{EAD}_{\substack{i,q\\ i\notin B_q}} = (1-p_{min})\,\pi^{EAD}_{\substack{i,q-1\\ i\notin B_q}} + \sum_{\substack{j\in\beta_{q-1}\\ (i\notin B_q)}}\left[\left(\frac{EAD_{ij}}{C_i^{modified}}\right)\pi^{EAD}_{\substack{j,q-1\\ j\in\beta_{q-1}}}\right] \tag{3c}$$

  for $\pi^{EAD}_{\substack{j,q-1\\ j\in\beta_{q-1}}} = 1$ and $\pi^{EAD}_{\substack{i,q-1\\ i\notin B_q}} = (1-p_{min})\,\pi^{EAD}_{\substack{i,q-2\\ i\notin B_q}} + \sum_{\substack{j\in\beta_{q-2}\\ (i\notin B_q)}}\left[\left(\frac{EAD_{ij}}{C_i^{modified}}\right)\pi^{EAD}_{\substack{j,q-2\\ j\in\beta_{q-2}}}\right]$.

- **step $q = q_{stop}$**
  The contagion process ends at $q=q_{stop}$ because all remaining banks fail by q_{stop} or because none of the remaining banks fails at q_{stop}.

Equations (3a,b,c) present an iteration in the contagion process, and can be summarised into and approximated with the linear system of equations:

$$\Pi_q^{EAD} = \left[(1-p_{min})I + S'^{EAD}\right]\Pi_{q-1}^{EAD} \tag{4a}$$

where Π_q^{EAD} is the non-negative probabilities vector of size n :

$$\Pi_q^{EAD} = \left[\ \pi_{1,q}^{EAD},\cdots,\ \pi_{i,q}^{EAD},\cdots,\ \pi_{n,q}^{EAD}\right]' \tag{4b}$$

The impact matrix S^{EAD} at each step q of the contagion process, $0 < q \leq q_{stop}$, is:

$$S^{EAD} = \begin{bmatrix} s_{11}^{EAD} \dots s_{1j}^{EAD} \dots s_{1n}^{EAD} \\ \vdots \quad \ddots \quad \vdots \quad \iddots \quad \vdots \\ s_{i1}^{EAD} \dots s_{ij}^{EAD} \dots s_{in}^{EAD} \\ \vdots \quad \iddots \quad \vdots \quad \ddots \quad \vdots \\ s_{n1}^{EAD} \cdots s_{nj}^{EAD} \cdots s_{nn}^{EAD} \end{bmatrix} \quad \text{with} \quad s_{ij}^{EAD} = \begin{cases} \dfrac{EAD_{ji}}{c_j^{modified}} \geq 0 \ , \ for \ i \neq j \\ 0 \qquad\qquad\quad , \ for \ i = j \end{cases} \tag{4c}$$

At step q , the impact s_i^{EAD} of bank i on institutions in the derivatives market is:

$$s_i^{EAD} = \sum_{j=1}^{n}\left(s_{ij}^{EAD}\right) = \sum_{j=1}^{n}\left(\frac{EAD_{ji}}{c_j^{modified}}\right) > 0 \tag{5}$$

and bank j is affected with s_j^{EAD} by all institutions' activity in this market:

$$s_j^{EAD} = \sum_{i=1}^{n}\left(s_{ij}^{EAD}\right) = \sum_{i=1}^{n}\left(\frac{EAD_{ji}}{c_j^{modified}}\right) > 0 \tag{6}$$

The contagion dynamics throughout steps from $q = 0$ to $q = q_{stop}$ is expressed as the system of equations:

$$\Pi_{q_{stop}}^{EAD} = \left[(1 - p_{min})\ I + S'^{EAD}\right]^{q_{stop}} \Pi_0^{EAD} \ . \tag{7}$$

3.2. Relative systemic-risk indexes and a structural measure of systemic-risk in a single market

Control systems theory (Nise, 2011) tells us that if the maximum Eigenvalue of $\left[(1 - p_{min})\ I + S'^{EAD}\right]$ is $\lambda^{\max}_{\left[(1-p_{min})\ I\ + S'^{EAD}\right]} > 1$ then the contagion process diverges to the destruction of the banking system at some $q = q_{stop}$. If $\lambda^{\max}_{\left[(1-p_{min})\ I\ + S'^{EAD}\right]} < 1$ then the system survives and converges to a steady state at some $q = q_{stop}$. This stability condition can be formulated in terms of the maximum Eigenvalue $\lambda^{\max}_{S^{EAD}}$ of matrix S^{EAD}. Using Eigenvalue shifting and considering that the right and left Eigenvectors have the same corresponding maximum Eigenvalue, i.e. $\lambda^{\max}_{S^{EAD}} = \lambda^{\max}_{S'^{EAD}}$ denoted as $\lambda^{\max}_{EAD}$, produces the stability condition:

$$\lambda^{\max}_{\left[(1-p_{min})\ I\ + S'^{EAD}\right]} = (1 - p_{min}) + \lambda^{\max}_{EAD} < 1 \quad \Rightarrow \quad \lambda^{\max}_{EAD} < p_{min} \tag{8}$$

Further, matrix analysis (Chatelin, 2013) asserts that the largest Eigenvalue of a real-valued non-negative matrix is positive and has positive corresponding right and left Eigenvectors, if the matrix is irreducible. Here, S'^{EAD} is real-valued and non-negative but reducible, and its irreducible submatrix can be identified by applying Tarjan's algorithm. This submatrix, denoted with $S_{connected}^{EAD} = \left[s(ij)_{connected}^{EAD}\right]$, corresponds to the strongly connected subtensor of rank 2 for the derivatives market. It does not include all reporting banks, however banks outside the strongly connected component have incomparably lower potential to influence the system. Therefore, the Eigenpair analysis is performed on the irreducible submatrix $S_{connected}^{EAD}$, and corresponds to the contagion process:

$$\Pi_{q_{stop}}^{EAD} = \left[\left(1 - p_{\substack{min \\ connected}}^{EAD}\right) I + S'^{EAD}_{connected}\right]^q \Pi_0^{EAD} \tag{9}$$

within the strongly connected component with $m_{EAD} \le n$ participating banks. The largest Eigenvalue of $S_{connected}^{EAD}$ is $\lambda^{\max}_{S_{connected}^{EAD}}$ and we denote $\lambda^{\max}_{S_{connected}^{EAD}} = \lambda^{\max}_{S'^{EAD}_{connected}} = \lambda^{max}_{\substack{EAD \\ connected}}$. Then the stability condition from Equation (8) transforms into:

$$\lambda^{max}_{\substack{EAD \\ connected}} < p_{\substack{min \\ connected}}^{EAD} = \min_{1 \le i \le m_{EAD}} \left(\frac{A(i)_{connected}^{EAD}}{C(i)_{connected}^{EAD}}\right) \tag{10}$$

where $p_{\substack{min \\ connected}}^{EAD}$ is evaluated over the m_{EAD} banks. The Eigenvalue satisfies the following inequalities:

$$\lambda^{max}_{\substack{EAD \\ connected}} \le \left\| S'^{EAD}_{connected} \right\|_{\infty} = \max_{1 \le j \le m_{EAD}} \left(s(j)_{connected}^{EAD}\right) \tag{10a}$$

$$\lambda^{max}_{\substack{EAD \\ connected}} \le \left\| S^{EAD}_{connected} \right\|_{\infty} = \max_{1 \le i \le m_{EAD}} \left(s(i)_{connected}^{EAD}\right) \tag{10b}$$

and according to Equations (5,6) this leads to:

$$\lambda^{max}_{\substack{EAD \\ connected}} \le$$

$$\le \min\left[\max_{1 \le i \le m_{EAD}} \left(\sum_{j=1}^{m_{EAD}} \left(\frac{EAD(ji)_{connected}}{C(j)^{EAD}_{\substack{modified \\ connected}}}\right)\right), \max_{1 \le j \le m_{EAD}} \left(\sum_{i=1}^{m_{EAD}} \left(\frac{EAD(ji)_{connected}}{C(j)^{EAD}_{\substack{modified \\ connected}}}\right)\right)\right] \tag{11}$$

In other words, the largest Eigenvalue is bounded by the maximum impact of a bank on the strongly-connected derivatives submarket and by the maximum impact caused by that derivatives submarket on a bank.

Notice that Eigenvalue shifting preserves Eigenvectors, and therefore finding the Eigenpair $\left(\lambda^{max}_{\substack{EAD \\ connected}}, v_{\left[\left(1-p_{\substack{min \\ connected}}^{EAD}\right) I + S'^{EAD}_{connected}\right]}\right)$ of matrix $\left[\left(1 - p_{\substack{min \\ connected}}^{EAD}\right) I + S'^{EAD}_{connected}\right]$ that represents the contagion process is equivalent to finding the Eigenpair $\left(\lambda^{max}_{\substack{EAD \\ connected}}, v_{S'^{EAD}_{connected}}\right)$ of $S'^{EAD}_{connected}$. This Eigenpair is generated here through an iterative optimisation as follows:

$$\vartheta_\tau = \frac{\left(S'^{EAD}_{connected}\right)\vartheta_{\tau-1}}{\left\|\left(S'^{EAD}_{connected}\right)\vartheta_{\tau-1}\right\|_\infty} = \frac{\left(S'^{EAD}_{connected}\right)\vartheta_0}{\left\|\left(S'^{EAD}_{connected}\right)^\tau \vartheta_0\right\|_\infty} \qquad \text{for} \quad \tau \ge 1 \tag{12a}$$

including a normalisation with the infinite norm $\left\| \left(S'^{EAD}_{connected} \right) \vartheta_{\tau-1} \right\|_{\infty}$ at each iteration τ, which assures that Equation (11) is satisfied. This Eigenpair $\left(\lambda^{max}_{EAD_{connected}} , v_{S'^{EAD}_{connected}} \right)$ is produced at convergence $\vartheta_{\tau} = \vartheta_{\tau-1}$, for $\vartheta_{\tau} = \vartheta_{\tau-1} = S'^{EAD}_{connected} \; v_{S'^{EAD}_{connected}} = \lambda^{max}_{EAD_{connected}} \; v_{S'^{EAD}_{connected}}$. Therefore:

$$v_{S'^{EAD}_{connected}} = \left(S'^{EAD}_{connected} \right)^{-1} \vartheta_{\tau} \tag{12b}$$

If the resulting Eigenvector $v_{S'^{EAD}_{connected}}$ is divided by the square of its Euclidean norm $\left(\left\| v_{S'^{EAD}_{connected}} \right\|_2 \right)^2$ then:

$$u = \frac{v_{S'^{EAD}_{connected}}}{\left(\left\| v_{S'^{EAD}_{connected}} \right\|_2 \right)^2} \qquad \text{and} \qquad u' \, v_{S'^{EAD}_{connected}} = 1 \tag{13a,b}$$

Here, vector u corresponds to $\lambda^{max}_{EAD_{connected}}$ and to the right Eigenvector v of the transposed $S'^{EAD}_{connected}$ and satisfy Equation (13b). These are the qualities of the right Eigenvector of the impact matrix $S^{EAD}_{connected}$. So the positive vector $u = u_{S^{EAD}_{connected}}$ gives the ranking, according to their systemic impact, of the banks participating in the strongly connected substructure of the derivatives market. The maximum Eigenvalue satisfies:

$$\lambda^{max}_{EAD_{connected}} = u'_{S^{EAD}_{connected}} \; S'^{EAD}_{connected} \; v_{S'^{EAD}_{connected}} = v'_{S'^{EAD}_{connected}} \; S^{EAD}_{connected} \, u_{S^{EAD}_{connected}} \tag{14}$$

and relates to system's stability. In the condition from Equation (10), the difference $\lambda^{max}_{EAD_{connected}} - p^{EAD}_{min_{connected}}$ can be interpreted as the system's distance from structural stability. If $\lambda^{max}_{EAD_{connected}}$ is only slightly larger than $p^{EAD}_{min_{connected}}$ then the system will be eventually destroyed but the contagion process will take long time, and it may be possible to intervene constructively. If $\lambda^{max}_{EAD_{connected}}$ is quite larger than $p^{EAD}_{min_{connected}}$ then the contagion will be more intense, and the system will be destroyed quickly. Therefore, we can formulate the systemic risk emerging in the derivatives market as the structural measure:

$$SR^{EAD}_{risk} = \begin{cases} \lambda^{max}_{EAD_{connected}} - p^{EAD}_{min_{connected}} > 0 & \text{(area of fragility)} \\ 0 \, , \; if \; \lambda^{max}_{EAD_{connected}} - p^{EAD}_{min_{connected}} < 0 & \text{(area of resilience)} \end{cases} \tag{15a}$$

This measure allows comparing the stability of two structures (markets) irrespectively of monetary values. For example, the banking systems in two countries may be similarly instable but involving different monetary values. The objective here, through designing stabilisation strategies in the next Sections, is to build in structural resilience. Then the system will better sustain its associated monetary values.

We also formulate with Equation (15b) the systemic risk index of a bank i in percentages. This can be interpreted as the percentage that i contributes to systemic instability or to the systemic risk SR_{risk}^{EAD} of that market:

$$SRI(i)_{index}^{EAD} =$$

$$\begin{cases} SRI(i)_{\substack{index \\ connected}}^{EAD} = \dfrac{u(i)_{S_{connected}^{EAD}}}{\sum_{i=1}^{m_{EAD}} \left(u(i)_{S_{connected}^{EAD}} \right)} > 0; \quad \text{for} \quad i \in \{1, \cdots, m_{EAD}\} \\ SRI(i)_{\substack{index \\ unconnected}}^{EAD} = 0 \ ; \quad \text{for} \quad i \in \{m_{EAD} + 1, \cdots, n\} \end{cases} \tag{15b}$$

Banks participating in the strongly connected substructure of the market have positive indexes, while banks outside it have zero indexes and do not contribute to the SR_{risk}^{EAD}. Here, $SRI(i)_{\substack{index \\ connected}}^{EAD}$ are relative measures and SR_{risk}^{EAD} is an absolute measure, due to interconnectivity in the derivatives market. The index $SRI(i)_{\substack{index \\ connected}}^{EAD}$ of bank i can be translated in absolute terms as the part $\left(SRI(i)_{\substack{index \\ connected}}^{EAD} \ SR_{risk}^{EAD} \right)$ that i contributes to the structural systemic risk SR_{risk}^{EAD} .

3.3. Stabilisation strategies in a single market

Most studies analysing the structure of financial systems do not quantify systemic risk. The few studies quantifying risk rarely comment on single-layer stabilisation strategies, and multilayer strategies have not been addressed. Existing studies of the derivatives market recommend that capital surcharges are collected only from very few top-ranked systemically important institutions, and set aside in a fund that then can be accessed by any institution when in distress. Such step will be helpful but not optimal. It will not really build in structural resilience into the system, and is not pre-emptive as it expects institutions to fall in distress. When institutions fall in distress, they will need large funding to be able to recover, and such approach is still at a significant cost for the system. The fund may deplete while helping some institutions and not others, as well. We consider that it is not sufficient to collect surcharges but it is important to distribute them optimally among all institutions, and it is necessary to collect them in an optimal cost-effective way. In order to achieve structural balance, not only the very top few institutions should participate in the stabilisation strategy but all institutions with nonzero systemic impact (nonzero systemic risk index). The most important institutions can be viewed as and are 'most guilty', but system's instability is not entirely their fault – it is rather a fault of the emerged structure. Therefore, if a stabilisation strategy subtly and adaptively affects the emergence process of structure, it will build in systemic resilience and achieve pre-emptive stabilisation at a minimum cost. The participation of institutions in the strategy is proportionate to their systemic indexes but with a very small fraction of their capital, and these fractions are immediately redistributed optimally and granularly among the same institutions. The strategy is at no cost for the system, the surcharges are optimised at their minimum for an institution in comparison with other mechanisms, and the participation of any institution is less than its surcharges as it immediately proportionate compensations. The strategy includes a stabilisation step in the current period only if the systemic risk or resilience at the end of the last period was less than a targeted threshold. Therefore, the structure is maintained around the threshold, only minimum adjustments are required, and in some periods they may not be required. This could be implemented as part of the infrastructure mechanism, and would also play the role of monitoring systemic stability. If we look for an analogy, this mechanism may resemble the varying margin within the current clearance mechanisms.

Based on the indexes from Equation (15b), a systemic risk surcharge for an institution i is formulated as:

$$SRS(i)^{EAD}_{surcharge} = \gamma_{EAD}\, SRI(i)^{EAD}_{index} = \\ = \begin{cases} SRS(i)^{EAD}_{\substack{surcharge\\connected}} = \gamma_{EAD}\, SRI(i)^{EAD}_{\substack{index\\connected}} & \text{for } 0 < \gamma_{EAD} \ll 1\,;\ i \in \{1, \cdots, m_{EAD}\} \\ SRS(i)^{EAD}_{\substack{surcharge\\unconnected}} = 0 & \text{for } i \in \{m_{EAD}+1, \cdots, n\} \end{cases} \tag{16}$$

It is applied to evaluate a fraction $\gamma_{EAD}\, SRI(i)^{EAD}_{\substack{index\\connected}}\ C(i)^{EAD}_{\substack{modified\\connected}}$ of its capital. Here, γ_{EAD} is very small and optimised to estimate minimum surcharges for each institution i that when distributed in a balancing way to each institution j, in proportion to the impact of i on j, will bring the system to the targeted structural threshold. This is equivalent to building in structural resilience. The proportion is the ratio of the impact $s(ij)^{EAD}_{connected}$ of bank i on j divided by the overall impact of bank i on the derivatives market, $s(i)^{EAD}_{connected} = \sum_{j=1}^{m_{EAD}} \left(s(ij)^{EAD}_{connected} \right)$, for $i, j \in \{1, \cdots, m_{EAD}\}$. Let us denote with $X(ij)$ the proportion of the surcharge on i distributed to j. Equation (17) shows how impact matrix $S^{EAD}_{connected} = \left[s(ij)^{EAD}_{connected} \right]$ changes into $S^{rebalanced}_{\substack{EAD\\connected}}$:

$$\left[s(ij)^{rebalanced}_{\substack{EAD\\connected}} \right] = \left[S(ij)_{\substack{EAD\\connected}} \Big/ \left(1 + \sum_{i=1}^{m_{EAD}} \left(\frac{X(ij)}{p^{EAD}_{\substack{min\\connected}}\ C(j)^{EAD}_{\substack{modified\\connected}}} \right) \right) \right] = \\ = \left[\frac{S(ij)_{\substack{EAD\\connected}}}{1 + \sum_{i=1}^{m_{EAD}} \left(\gamma_{EAD}\ SRI(i)^{EAD}_{\substack{index\\connected}} \left(\frac{C(i)^{EAD}_{\substack{modified\\connected}}}{p^{EAD}_{\substack{min\\connected}}\ C(j)^{EAD}_{\substack{modified\\connected}}} \right) \left(\frac{S(ij)_{\substack{EAD\\connected}}}{\sum_{q=1}^{m_{EAD}} \left(S(iq)_{\substack{EAD\\connected}} \right)} \right) \right)} \right] \tag{17}$$

It considers that the funds $A(j)^{EAD}_{connected} = C(j)^{EAD}_{connected} - MC(j)^{EAD}_{connected}$ available to j increase to $A(j)^{EAD}_{\substack{rebalanced\\connected}} = A(j)^{EAD}_{connected} + \sum_{i=1}^{m_{EAD}} X(ij)$ with the proportionate fractions $X(ij)$. In Section 3.1, we denoted the ratio of available to total own funds of j as $p(j)^{EAD}_{connected} = a(j)^{EAD}_{connected}\; p^{EAD}_{\substack{min\\connected}} = \frac{A(j)^{EAD}_{connected}}{C(j)^{EAD}_{connected}} = \frac{a(j)^{EAD}_{connected} A(j)^{EAD}_{connected}}{C(j)^{EAD}_{\substack{modified\\connected}}}$

Maintaining the parameter $p^{EAD}_{\substack{min\\connected}} = p^{\substack{EAD\\rebalanced}}_{\substack{min\\connected}}$ in the simulation of contagion within the rebalanced structure leads to:

$$p^{EAD}_{\substack{min\\connected}} = \frac{A(j)^{EAD}_{connected}}{C(j)^{EAD}_{\substack{modified\\connected}}} = \frac{A(j)^{\substack{EAD\\rebalanced}}_{connected}}{C(j)^{\substack{EAD\\rebalanced}}_{\substack{modified\\connected}}} = \frac{A(j)^{EAD}_{connected} + \sum_{i=1}^{m_{EAD}} X(ij)}{C(j)^{\substack{EAD\\rebalanced}}_{\substack{modified\\connected}}} \tag{18a}$$

and to a new modified value $C(j)^{\substack{EAD\\rebalanced}}_{\substack{modified\\connected}}$ after rebalancing:

$$C(j)^{\substack{EAD\\rebalanced}}_{\substack{modified\\connected}} = C(j)^{EAD}_{\substack{modified\\connected}} \left(1 + \frac{\sum_{i=1}^{m_{EAD}} X(ij)}{p^{EAD}_{\substack{min\\connected}}\; C(j)^{EAD}_{\substack{modified\\connected}}}\right) \tag{18b}$$

This produces the denominator in Equation (17), because $s(ij)_{\substack{EAD\\connected}} = \frac{EAD(ji)}{C(j)^{EAD}_{\substack{modified\\connected}}}$

and:

$$s(ij)^{rebalanced}_{\substack{EAD\\connected}} = \frac{EAD(ji)}{C(j)^{\substack{EAD\\rebalanced}}_{\substack{modified\\connected}}} =$$

$$= \frac{EAD(ji)}{C(j)^{EAD}_{\substack{modified\\connected}} \left(1 + \frac{\sum_{i=1}^{m_{EAD}} X(ij)}{p^{EAD}_{\substack{min\\connected}}\; C(j)^{EAD}_{\substack{modified\\connected}}}\right)} = \frac{s(ij)_{\substack{EAD\\connected}}}{\left(1 + \frac{\sum_{i=1}^{m_{EAD}} X(ij)}{p^{EAD}_{\substack{min\\connected}}\; C(j)^{EAD}_{\substack{modified\\connected}}}\right)} \tag{18c}$$

The rebalancing preserves $S^{rebalanced}_{\substack{EAD\\connected}}$ as non-negative, and the Eigenpair analysis can be validly applied. Equation (17) reduces $\max\limits_{1 \le i \le m_{EAD}} \left(s(j)^{rebalanced}_{\substack{EAD\\connected}} \right)$ and $\max\limits_{1 \le j \le m_{EAD}} \left(s(i)^{rebalanced}_{\substack{EAD\\connected}} \right)$, and from Equation (11) it follows that:

$$\lambda^{EAD\_max}_{\substack{rebalanced\\connected}} \le \min\left[\max_{1 \le i \le m_{EAD}} \left(s(j)^{rebalanced}_{\substack{EAD\\connected}} \right), \max_{1 \le j \le m_{EAD}} \left(s(i)^{rebalanced}_{\substack{EAD\\connected}} \right) \right] \le \lambda^{EAD\_max}_{connected} \tag{19}$$

The largest Eigenvalue is reduced[7], which is equivalent to increasing structural resilience. The parameter γ_{EAD} is identified, through search and optimisation, as the

[7] If the model is considered without the financial context, then reducing the maximum Eigenvalue can be attempted alternatively. For example, by reducing the sum of elements in a row of the transposed $\left[s(ji)_{\substack{EAD\\connected}} \right]'$ by increasing the denominator of the elements with a factor of $(1 + \delta)$. (notice that each element in a row is $s(ji)_{\substack{EAD\\connected}} = EAD(ij)_{connected} \big/ C(i)^{EAD}_{\substack{modified\\connected}}$ and has the same

smallest value that when applied in Equation (17) transforms the system $S_{\substack{EAD \\ connected}}$ into a system $S^{rebalanced}_{\substack{EAD \\ connected}}$ with targeted threshold $SR^{EAD}_{\substack{risk \\ threshold}}$. With a minimum structural change, the value of systemic risk in Equation (15a) moves in direction towards the area of resilience.

Empirical Contagion Dynamics
in the Derivatives Market

based on data for one of the quarters in the period from June 2014 to September 2015 — Table 1

number of reporting banks	$n = 22$
number of banks in the strongly connected subtensor	$m_{EAD} = 19$
$p^{EAD}_{\substack{min \\ connected}}$	0.14573
stability condition	$\lambda^{max}_{\substack{EAD \\ connected}} < 0.14573$
$\lambda^{max}_{\substack{EAD \\ connected}}$ for $\gamma_{EAD} = 0$	0.07268
$SR^{EAD}_{resilience}$ for $\gamma_{EAD} = 0$	0.07305

The empirical analysis next is performed for one of the quarters in the period from June 2014 to September 2015, and the results are presented in Table 1. In that quarter, 19 out of the 22 reporting institutions participate in the strongly connected component within the structure emerging from interlinkages in the derivatives market. Therefore, 19 institutions have nonzero systemic-risk indexes and affect structural stability. The largest Eigenvalue is 0.07268 and satisfies the condition $\lambda^{max}_{\substack{EAD \\ connected}} < 0.14573$, indicating that the system is in the area of structural resilience. We can define a measure $SR^{EAD}_{resilience}$ of structural resilience as:

$$SR^{EAD}_{resilience} = \begin{cases} 0\,,\ if\ p^{EAD}_{\substack{min \\ connected}} - \lambda^{max}_{\substack{EAD \\ connected}} < 0 \\ p^{EAD}_{\substack{min \\ connected}} - \lambda^{max}_{\substack{EAD \\ connected}} > 0 \end{cases} \tag{20}$$

If $p^{EAD}_{\substack{min \\ connected}}$ is only slightly larger than $\lambda^{max}_{\substack{EAD \\ connected}}$, the contagion process will eventually be contained but this will take long time, and a number of institutions will default though part of the system will survive. If $p^{EAD}_{\substack{min \\ connected}}$ is quite larger than

denominator) In the financial context here, this will mean that we charge an institution i with a fraction of its capital and then use that fraction to increase the capital of the same institution. The meaning of a systemic risk charge for i, however, is rather to increase funds available to institutions affected by i and so reduce the impact of i on them.

$\lambda_{\substack{EAD \\ connected}}^{max}$, then the contagion will be contained quickly and a large part of the system will survive. The empirical result here is $SR_{resilience}^{EAD} = 0.07305$. For a threshold of $SR_{\substack{risk \\ threshold}}^{EAD} = 0$, no stabilisation step is necessary at the start of the next quarterly period, and therefore results of simulating stabilisation strategies are not included in Table 1. We will note, however, that any movement in direction towards smaller $SR_{risk}^{EAD} > 0$ or larger $SR_{resilience}^{EAD} > 0$ is equivalent to building in resilience. For example, a meta strategy may involve different thresholds $SR_{\substack{risk \\ threshold}}^{EAD}(t_k) > 0$ in different periods t_k, $1 \leq k \leq T$, so that the system gradually moves to a long-term target. A meta strategy may also involve buffer thresholds $SR_{\substack{resilience \\ threshold}}^{EAD}(t_k) > 0$ in some periods, as the current contagion and stabilisation analysis is in response to a trigger and the contagion it activates, but does not account for two different triggers activating a second contagion processes while the first is still running or just after it ends. A threshold must be selected carefully for a subtle effect, and the selection may depend on the scope, size and monetary value of the system or subsystem being analysed.

Comparative Empirical Results
under NAC and EAD scenarios

based on data for one of the quarters in the
period from June 2014 to September 2015

Table 2

NAC		EAD	
number of reporting banks	$n = 22$	$n = 22$	number of reporting banks
number of banks in the strongly connected subtensor	$m_{NAC} = 16$	$m_{EAD} = 19$	number of banks in the strongly connected subtensor
$p_{\substack{min \\ connected}}^{NAC}$	0.26843	0.14573	$p_{\substack{min \\ connected}}^{EAD}$
stability condition	$\lambda_{\substack{NAC \\ connected}}^{max} < 0.26843$	$\lambda_{\substack{EAD \\ connected}}^{max} < 0.14573$	stability condition
$\lambda_{\substack{NAC \\ connected}}^{max}$ for $\gamma_{NAC} = 0$ (no rebalance implemented)	0.00715	0.07268	$\lambda_{\substack{EAD \\ connected}}^{max}$ for $\gamma_{EAD} = 0$ (no rebalance implemented)
$SR_{resilience}^{NAC}$ for $\gamma_{NAC} = 0$	0.26128	0.07305	$SR_{resilience}^{EAD}$ for $\gamma_{EAD} = 0$

Notice that Equations (4a,7) represent a more intensive contagion dynamics (a boundary scenario) than Equations (3a,b,c). The formulation of $\left[s(ij)_{connected}^{EAD}\right]$ corresponds to analysis of a structure functioning as if the going-concern exposures to non-failed banks were also equal to the exposures at-default. The going concern principle in accounting is the assumption that an entity will remain in business for the foreseeable future. Next, we will perform the analysis of the derivatives layer for a structure functioning as if the going-concern exposures are equal to the net MtM exposures after collateral (NAC). These are the correct going-concern exposures, because up until its failure, a non-failed bank i affects with NAC exposures the other non-failed banks j. The NAC-scenario is also boundary, as it assumes that a failed bank i affects with the going-concern exposure NAC a non-failed bank j, instead with the exposure at-default EAD . The reported non-negative NAC_{ij} , for $1 \leq i, j \leq n$, account for received collateral and for enforceable bilateral netting arrangement between non-defaulted banks throughout different netting sets. The tensor (structure) can include both a positive impact $s_{ij}^{NAC} > 0$ of bank i on bank j proportionate to NAC_{ji} , and a positive impact $s_{ij}^{NAC} > 0$ of bank j on bank i proportionate to NAC_{ij}. Next, the steps described above for the S^{EAD} analysis are now applied to S^{NAC}, and lead to evaluating the Eigenpair $\left(\lambda_{\substack{NAC\\connected}}^{max}, u_{S_{connected}^{NAC}}\right)$ of the strongly connected substructure $S_{connected}^{NAC} = \left[s(ij)_{connected}^{NAC}\right]$, the indexes:

$$SRI(i)_{\substack{index\\connected}}^{NAC} = \frac{u(i)_{S_{connected}^{NAC}}}{\sum_{i=1}^{m_{NAC}}\left(u(i)_{S_{connected}^{NAC}}\right)} \qquad \text{for} \quad i \in \{1, \cdots, m_{NAC}\} \tag{21a}$$

and the resilience:

$$SR_{resilience}^{NAC} = \begin{cases} 0\,, \; if \quad \lambda_{\substack{NAC\\connected}}^{max} - p_{\substack{min\\connected}}^{NAC} \geq 0 \\ \left|\lambda_{\substack{NAC\\connected}}^{max} - p_{\substack{min\\connected}}^{NAC}\right| \,, \quad if \; \lambda_{\substack{NAC\\connected}}^{max} - p_{\substack{min\\connected}}^{NAC} < 0 \end{cases} \tag{21b}$$

Systemic Risk Ranking and Indexes in the Derivatives Market

based on data for one of the quarters in the period from June 2014 to September 2015

Table 3

institutions	A	B	C	D
rank at $\gamma_{NAC} = 0$, (going-concern systemic dynamics)	10	8	0 (not participating in the fragility strongly-connected component)	7
rank at $\gamma_{EAD} = 0$, (at-default systemic dynamics)	3	8	10	15
$SRI_{\substack{index\\connected}}^{NAC}(i)$ at $\gamma_{NAC} = 0$	2.34%	3.01%	0%	4.00%
$SRI_{\substack{index\\connected}}^{EAD}(i)$ at $\gamma_{EAD} = 0$	13.15%	5.09%	4.03%	0.81%

Tables 2 and 3 report and compare empirical results for the NAC-scenario and the EAD-scenario. The structural resilience of the empirical system under the NAC-scenario is $SRR_{resilience}^{NAC} = 0.26128$, which is higher than the resilience under the EAD-scenario $SRR_{resilience}^{EAD} = 0.07305$. Different number of reporting banks have nonzero structural impact, $m_{NAC} = 16 \neq m_{EAD} = 19$, and participate in the corresponding two strongly connected components. The ranking and index of each bank are different under the two scenarios. The institution encoded with A in Table 3 is of higher ranking under EAD but lower ranking under NAC, which is also confirmed by its corresponding indexes. The opposite is true for institution D, it is of higher ranking under NAC and of lower ranking under EAD. Institution B has the same rank 8 among the m_{NAC} banks and among the m_{EAD} banks, but it has different indexes $SRI^{NAC}_{\substack{index\\connected}}(B) = 3.01\%$ and $SRI^{EAD}_{\substack{index\\connected}}(B) = 5.09\%$. Bank C is of medium ranking under EAD and is not ranked under NAC, therefore has zero structural impact $SRI^{NAC}_{\substack{index\\connected}}(C) = 0$.

The empirical results confirm that if we would like to introduce subtle changes in the structure in order to increase its resilience, then different banks and to a different extent will participate in a strategy under each of the two scenarios. NAC and EAD are boundary scenarios, and the strategy can be formulated with surcharges depending both on NAC and EAD indexes, instead. In the terminology, we will use from now on 'systemic-impact index' $SII(i)$ instead of systemic-risk index $SRI(i)$, and correspondingly 'systemic-impact surcharge' $SIS(i)$ instead of systemic-risk surcharge $SRS(i)$. This terminology accounts for the fact that the index measures the proportionate contribution of an institution to systemic risk, but also for the fact that this potential of an institution for structural impact can be used in stabilisation strategies to build in structural resilience. In the case of the EAD and NAC scenarios, the new terminology translates as:

$$SIS(i)_{surcharge} = f\left(\gamma_{EAD}\, SII(i)^{NAC}_{\substack{index\\connected}}, \gamma_{NAC}\, SII(i)^{EAD}_{\substack{index\\connected}}\right) \tag{22}$$

In comparison, Poledna et al. (2015) and Markose (2012) do not differentiate between the two types of derivatives exposure. The contagion algorithm in Poledna et al. (2015) prevents a failed bank to have effect beyond the period of its failure. The approach presented here builds in targeted resilience even when none of the institutions fails. It also does not directly restrict and so preserves the emerged preferences of interaction among banks, and so introduces minimum changes to the system. However, it introduces an incentive for institutions to adapt their preferences to the emergence of a more resilient structure of interactions. A next task is to extend the algorithm to provide that the effect of a non-failed bank is proportionate to NAC exposures, the effect of a failed bank is proportionate to EAD exposures, and a failed bank has no effect beyond the period it fails.

IV: Formulation and evaluation of multiple-market contagion dynamics and stabilisation strategies

Banks interact simultaneously in multiple markets. The database used here accounts for the interaction of reporting institutions in the fixed-income market, securities-financing market and derivatives market. Section III above does not consider simultaneously contagion dynamics due to connectivity within all markets and among markets. If a bank i is highly affected in the fixed income market by failing banks $j \epsilon \{1, \dots, n\}$, then the position of bank i in the derivatives market is affected by the probability of i failing due to its interaction in the fixed-income market. In other words, the interaction of bank i within the fixed-income market has an impact on its interaction within the derivatives market, and contributes to the probability of bank i failing due to interlinkages in the derivatives market.

4.1. Theoretical formulation

A model incorporating simultaneously but distinctly all interconnected markets can be formulated as a tensor-multiplex (Serguieva, 2016, 2017a), where S is a tensor of rank four:

$$S = \sum_{k=1}^{m} \sum_{\ell=1}^{m} \sum_{j=1}^{n} \sum_{i=1}^{n} \left(S^{i}{}_{j}{}^{\ell}{}_{k} \right) \vec{\varepsilon}_i \otimes \vec{\omega}^{j\,\prime} \otimes \vec{\varepsilon}_\ell \otimes \vec{\omega}^{k\,\prime} \tag{23}$$

$$\text{for} \quad S^{i}{}_{j}{}^{\ell}{}_{k} \begin{cases} = 0 & \text{if} \quad i = j \wedge \ell = k \vee i \neq j \wedge \ell \neq k \\ \geq 0 & \text{if} \quad i \neq j \wedge \ell = k \vee i = j \wedge \ell \neq k \end{cases}$$

where $m = 3$ corresponds to the three markets, i.e. $k, \ell = 1$ for the fixed-income market, $k, \ell = 2$ for the securities-financing market, and $k, \ell = 3$ for the derivatives market. The number of institutions is n, and $S^{i}{}_{j}{}^{\ell}{}_{k} \geq 0$ is the impact of bank i – due to its interaction in market ℓ – on institution j acting in market k. The impact $S^{i}{}_{j}{}^{\ell}{}_{k} \geq 0$ between two different institutions $i \neq j$ is due to their interaction within the same market $\ell = k$, while the impact is $S^{i}{}_{j}{}^{\ell}{}_{k} = 0$ when we consider i and j as acting in different markets $\ell \neq k$. Further, $S^{i}{}_{j}{}^{\ell}{}_{k} \geq 0$ when the same institution $i = j$ acts in different markets $\ell \neq k$, while $S^{i}{}_{j}{}^{\ell}{}_{k} = 0$ when this institution acts in the same market $\ell = k$. An interconnected multiplex is a multilayer network where mostly the same nodes participate in different type of interactions (interdependencies), and the interaction of a node due to one type of activities is dependent on its interaction due to another type of activities. A tensor can be considered as an interconnected multiplex that also incorporates a basis (innate) structure. In Equation (23), $\vec{\varepsilon}_i \otimes \vec{\omega}^{j\,\prime} \otimes \vec{\varepsilon}_\ell \otimes \vec{\omega}^{k\,\prime}$ stands for the basis structure that includes four vectors $\vec{\varepsilon}_i$, $\vec{\omega}^{j\,\prime}$, $\vec{\varepsilon}_\ell$, $\vec{\omega}^{k\,\prime}$ in their cohesion or tensor multiplication, hence the tensor is of rank four. These vectors characterise, correspondingly, institutions i, institutions j, markets ℓ, and markets k, for $i, j \in \{1, \cdots, n\}$ and $\ell, k \in \{1, \cdots, m\}$. Tensor-multiplex models expand the scope of feasible structural analysis and stress testing of the financial system (Serguieva, 2016, 2017a). Here, they are only used in modelling contagion and stabilisation processes within multiple interconnected markets.

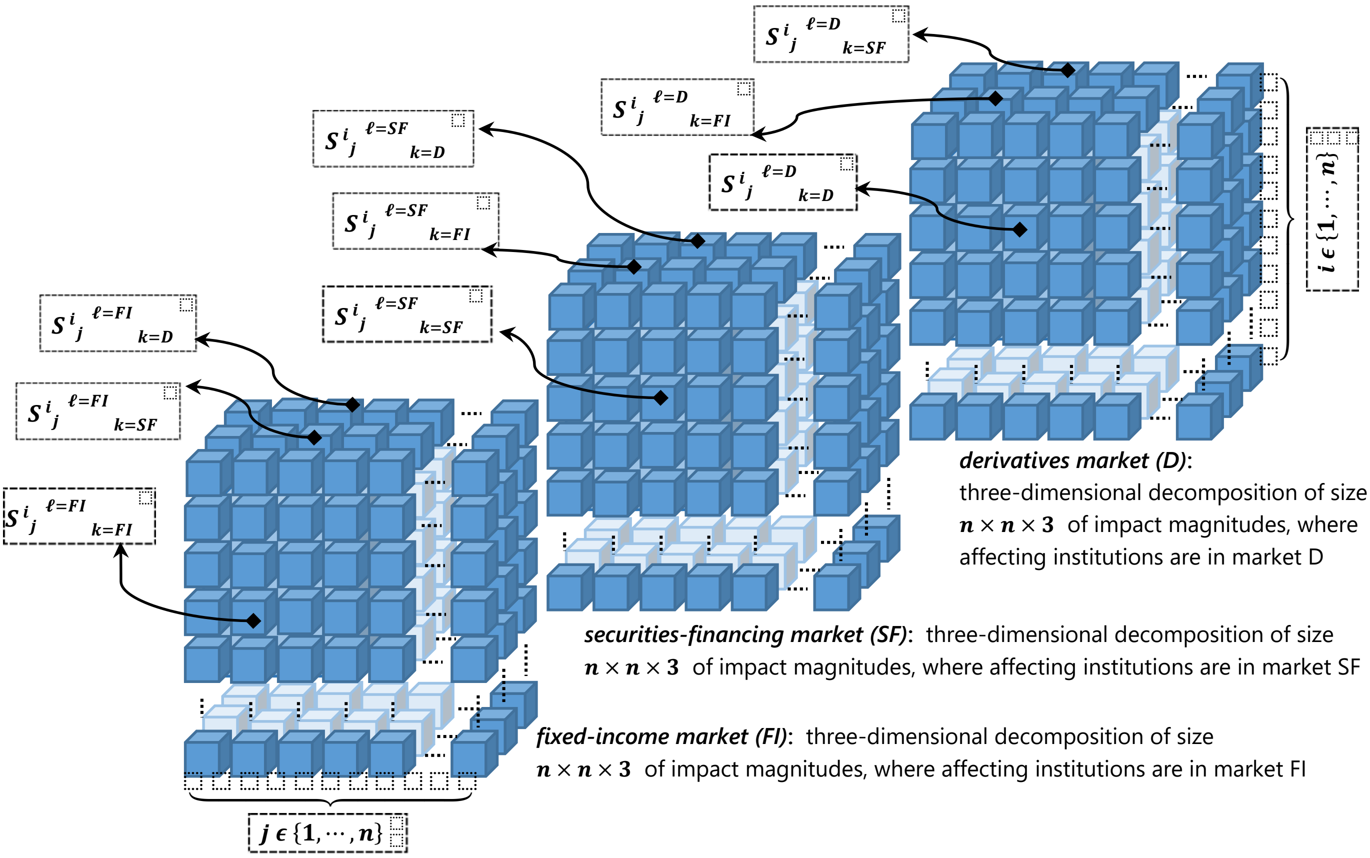
We build the tensor of rank four as including nine subtensors of rank 2 (see Figure 4). The impact matrix $\left[s(ij)_D \right]$ in the derivatives market (D) has the same meaning as $\left[s_{ij}^{EAD} \right]$ in Section III and:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j \neq i}{}^{\ell = D}{}_{k = D} \right) = s(ij)_D = s(ij)_{EAD} \\ \left(S^{i}{}_{j = i}{}^{\ell = D}{}_{k = D} \right) = s(ii)_D = 0 \end{cases} \quad \text{for} \quad i, j \epsilon \{1, \cdots, n\} \tag{24a}$$

Banks report to the PRA database their exposures in the fixed-income market (FI) as gross MtM values, then $MtM(ji)_{FI}$ will denote the exposure of bank j to bank i in the FI layer. Banks also report their exposures in the securities-financing market

(SF) as gross Notional values, then $Notional(ji)_{SF}$ will denote the exposure of institution j to institution i in the SF layer. This reported information does not allow differentiating between going-concern and at-default multiplex exposures.

Figure 4: *Four-dimensional structure of impact*
It captures impact among institutions within each financial market and between any pair of markets.



The impact structure $\left[S^{i}{}_{j}{}^{\ell}{}_{k}\right]^{multiplex}$ will be evaluated as follows. The impact matrix $\left[s(ij)_{FI}\right]$, due to interconnectivity in the FI market, has elements:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j\neq i}{}^{\ell=FI}{}_{k=FI}\right) = s(ij)_{FI} = \begin{cases} \frac{MtM(ji)_{FI} - MtM(ij)_{FI}}{C(j)} > 0 \\ 0\,,if\ \frac{MtM(ji)_{FI} - MtM(ij)_{FI}}{C(j)} \leq 0 \end{cases} \\ \left(S^{i}{}_{j=i}{}^{\ell=FI}{}_{k=FI}\right) = s(ii)_{FI} = 0 \qquad \text{for } i,j\epsilon\{1,\cdots,n\} \end{cases} \tag{24b}$$

where $C(j)$ are the total own funds of bank j. The impact matrix $\left[s(ij)_{SF}\right]$, due to interconnectivity in the SF market, has elements:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j\neq i}{}^{\ell=SF}{}_{k=SF}\right) = s(ij)_{SF} = \begin{cases} \frac{Notional(ji)_{SF} - Notional(ij)_{SF}}{C(j)} > 0 \\ 0\,,if\ \frac{Notional(ji)_{SF} - Notional(ij)_{SF}}{C(j)} \leq 0 \end{cases} \\ \left(S^{i}{}_{j=i}{}^{\ell=SFT}{}_{k=SF}\right) = s(ii)_{SF} = 0 \qquad \text{for } i,j\epsilon\{1,\cdots,n\} \end{cases} \tag{24c}$$

The impact magnitudes between markets are correspondingly:

- $\left[s(ij)_{FI\to SF}\right]$ composed by the impact of institutions i in the fixed-income market $\ell = FI$ on institutions j in the securities-financing market $k = SF$:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j=i}{}^{\ell=FI}{}_{k=SF}\right) = s(ii)_{FI\to SF} = \sum_{q=1}^{n} s(qi)_{FI} \\ \left(S^{i}{}_{j\neq i}{}^{\ell=FI}{}_{k=SF}\right) = s(ij)_{FI\to SF} = 0 \end{cases} \quad \text{for } i,j,q\epsilon\{1,\cdots,n\} \tag{25a}$$

- $\left[s(ij)_{FI\to D}\right]$ composed by the impact of banks i in market $\ell = FI$ on banks j in market $k = D$:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j=i}{}^{\ell=FI}{}_{k=D}\right) = s(ii)_{FI\to D} = \sum_{q=1}^{n} s(qi)_{FI} \\ \left(S^{i}{}_{j\neq i}{}^{\ell=FI}{}_{k=D}\right) = s(ij)_{FI\to D} = 0 \end{cases} \quad \text{for } i,j,q\epsilon\{1,\cdots,n\} \tag{25b}$$

- $\left[s(ij)_{SF\to FI}\right]$ comprises the impact of i in market $\ell = SF$ on j in market $k = FI$, and $\left[s(ij)_{SF\to D}\right]$ comprises the impact of i in market $\ell = SF$ on j in market $k = D$:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j=i}{}^{\ell=SF}{}_{k=FI}\right) = s(ii)_{SF\to FI} = \sum_{q=1}^{n} s(qi)_{SF} \\ \left(S^{i}{}_{j\neq i}{}^{\ell=SF}{}_{k=FI}\right) = s(ij)_{SF\to FI} = 0 \end{cases} \quad \text{for } i,j,q\epsilon\{1,\cdots,n\} \tag{26a}$$

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j=i}{}^{\ell=SF}{}_{k=D}\right) = s(ii)_{SF\to D} = \sum_{q=1}^{n} s(qi)_{SF} \\ \left(S^{i}{}_{j\neq i}{}^{\ell=SF}{}_{k=D}\right) = s(ij)_{SF\to D} = 0 \end{cases} \quad \text{for } i,j,q\epsilon\{1,\cdots,n\} \tag{26b}$$

- $\left[s(ij)_{D\to FI}\right]$ includes the impact of i in market $\ell = D$ on j in market $k = FI$, and $\left[s(ij)_{D\to SF}\right]$ includes the impact of i in market $\ell = D$ on j in market $k = SF$:

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j=i}{}^{\ell=D}{}_{k=FI}\right) = s(ii)_{D\to FI} = \sum_{q=1}^{n} s(qi)_{D} \\ \left(S^{i}{}_{j\neq i}{}^{\ell=D}{}_{k=FI}\right) = s(ij)_{D\to FI} = 0 \end{cases} \quad \text{for } i,j,q\epsilon\{1,\cdots,n\} \tag{27a}$$

$$S^{i}{}_{j}{}^{\ell}{}_{k} = \begin{cases} \left(S^{i}{}_{j=i}{}^{\ell=D}{}_{k=SF}\right) = s(ii)_{D\to SF} = \sum_{q=1}^{n} s(qi)_{D} \\ \left(S^{i}{}_{j\neq i}{}^{\ell=D}{}_{k=SF}\right) = s(ij)_{D\to SF} = 0 \end{cases} \quad \text{for } i,j,q\epsilon\{1,\cdots,n\} \tag{27b}$$

Equations (24a,25a,25b), Equations (24b,26a,26b) and Equations (24c,27a,27b) describe, respectively, the bottom, middle and top three-dimensional matrixes within the four-dimensional structure in Figure 4, which corresponds to the impact multiplex $\left[S^{i}{}_{j}{}^{\ell}{}_{k}\right]^{multiplex}$ of size $\mathrm{n}\times\mathrm{n}\times 3\times 3$. The next step is to identify the multiplex strongly connected component. We apply Tarjan's algorithm to the unfolded $[S^{i}{}_{j}]^{multiplex}_{unfolded}$ of size $3n\times 3n$:

$$[S^{i}_{j}]^{multiplex}_{unfolded} = \begin{bmatrix} [s(ij)_{FI\to FI}] & [s(ij)_{FI\to SF}] & [s(ij)_{FI\to D}] \\ [s(ij)_{SF\to FI}] & [s(ij)_{SF\to SF}] & [s(ij)_{SF\to D}] \\ [s(ij)_{D\to FI}] & [s(ij)_{D\to SF}] & [s(ij)_{D\to D}] \end{bmatrix} \tag{28}$$

and identify the $m_{multiplex}$ number of banks that have nonzero structural impact on the multiplex. The parameter $p^{multiplex}_{\substack{min\\connected}}$ in simulating the contagion process is evaluated over the multiplex strongly connected component $[S^{i}_{j}]^{multiplex}_{\substack{connected\\unfolded}}$ of size $3m_{multiplex} \times 3m_{multiplex}$, and $C(j)^{multiplex}_{\substack{modified\\connected}}$ are the modified own funds corresponding to this parameter. The unfolding $[S^{i}_{j}]^{multiplex}_{\substack{connected\\unfolded}}$ is in the format from Equation (28), now for the $m_{multiplex}$ banks, and preserves the spectral properties of $\left[S^{i\ \ell}_{j\ k}\right]^{multiplex}_{connected}$ of size $m_{multiplex} \times m_{multiplex} \times 3 \times 3$. By analogy with the algorithm from Sections 3, now the Eigenpair $\left(\lambda^{max\_unfolded}_{\substack{multiplex\\connected}}, u^{unfolded}_{s_{\substack{multiplex\\connected}}}\right)$ of $[S^{i}_{j}]^{multiplex}_{\substack{connected\\unfolded}}$ is generated. Then, the Eigenpair $\left(\lambda^{max}_{\substack{multiplex\\connected}}, U_{s_{\substack{multiplex\\connected}}}\right)$ for $\left[S^{i\ \ell}_{j\ k}\right]^{multiplex}_{connected}$ is obtained as:

$$\lambda^{\max}_{\substack{multiplex\\connected}} = \lambda^{\max\_unfolded}_{\substack{multiplex\\connected}} \quad \text{and} \quad U_{s_{\substack{multiplex\\connected}}} \overset{folding}{\Longleftarrow} u^{unfolded}_{s_{\substack{multiplex\\connected}}} \tag{29}$$

where $U_{s_{\substack{multiplex\\connected}}}$ is an Eigenmatrix of size $m_{multiplex} \times 3$ rather than an Eigenvector. Following the approach in Serguieva (2016, 2017a), we formulate the multiplex systemic risk $SR^{multiplex}_{risk}$ and resilience $SR^{multiplex}_{resilience}$ as:

$$SR^{multiplex}_{risk} = \begin{cases} \lambda^{max}_{\substack{multiplex\\connected}} - p^{multiplex}_{\substack{min\\connected}} > 0 \\ 0\ ,\ \ if\ \ \lambda^{max}_{\substack{multiplex\\connected}} - p^{multiplex}_{\substack{min\\connected}} \le 0 \end{cases} \tag{30a}$$

$$SR^{multiplex}_{resilience} = \begin{cases} 0\ ,\ \ if\ \ \lambda^{max}_{\substack{multiplex\\connected}} - p^{multiplex}_{\substack{min\\connected}} \ge 0 \\ p^{multiplex}_{\substack{min\\connected}} - \lambda^{max}_{\substack{multiplex\\connected}} < 0 \end{cases} \tag{30b}$$

The multiplex systemic-impact indexes are:

$$SII(i)^{multiplex}_{index} = \\ = \begin{cases} SII(i)^{multiplex}_{\substack{index\\connected}} = \dfrac{r(i)_{s_{\substack{multiplex\\connected}}}}{\sum_{i=1}^{m_{multiplex}} \left(r(i)_{s_{\substack{multiplex\\connected}}} \right)}\ ,\quad \text{for}\ \ i \in \left\{1, \dots, m_{multiplex}\right\} \\ SII(i)^{multiplex}_{\substack{index\\unconnected}} = 0\ ,\quad \text{for}\ \ i \in \left\{m_{multiplex} + 1, \cdots n\right\} \end{cases} \tag{31a}$$

where:

$$r_{S^{multiplex}_{connected}} = U_{S^{multiplex}_{connected}} \; [1\ 1\ 1]' \tag{31b}$$

and the with corresponding surcharges are:

$$SIS(i)^{multiplex}_{surcharge} = \gamma_{EAD}\, SII(i)^{multiplex}_{index} =$$

$$= \begin{cases} SIS(i)^{multiplex}_{\substack{surcharge\\connected}} = \gamma_{EAD}\, SII(i)^{multiplex}_{\substack{index\\connected}} & \text{for } 0 < \gamma_{EAD} \ll 1;\ i \in \{1, \cdots, m_{multiplex}\} \\ SRS(i)^{multiplex}_{\substack{surcharge\\unconnected}} = 0 & \text{for } \ i \in \{m_{multiplex}+1, \cdots, n\} \end{cases} \tag{31c}$$

The multiplex stabilisation strategy is designed as follows. The parameter $\gamma_{multiplex}$ is optimised to estimate the minimum fractions of capital $\gamma_{multiplex}\ SII(i)^{multiplex}_{\substack{index\\connected}}\ C(i)^{multiplex}_{\substack{modified\\connected}}$ for each institution $i \in \{1, \dots, m_{multiplex}\}$ that when distributed in a balancing way among institutions $j \in \{1, \dots, m_{multiplex}\}$, in proportion to the impacts of i within the multiplex, will bring the system to a targeted threshold $SR^{multiplex}_{\substack{risk\\threshold}}(t)$ or $SR^{multiplex}_{\substack{resilience\\threshold}}(t)$. The proportion is the ratio of the impact $\left(S^{i\ \ell}_{\ j\ k}\right)_{\substack{multiplex\\connected}}$ of bank i in market ℓ on bank j in market k, divided by the overall impact $s(i)_{\substack{multiplex\\connected}} = \sum_{z=1}^{3}\sum_{y=1}^{3}\sum_{q=1}^{m_{multiplex}}\left(S^{i\ y}_{\ q\ z}\right)_{\substack{multiplex\\connected}}$ of bank i within the multiple-market structure, for $i, j \in \{1, \cdots, m_{multiplex}\}$ and $\ell, k \in \{1,2,3\}$. Let the fraction that j receives from i, in result of this, is denoted with $X(ij)$. Then the non-charged four-dimensional matrix $S_{\substack{multiplex\\connected}} = \left[\left(S^{i\ \ell}_{\ j\ k}\right)_{\substack{multiplex\\connected}}\right]$ representing the multiplex is modified into the impact structure $S^{rebalanced}_{\substack{multiplex\\connected}}$ as follows:

$$\left[\left(S^{i\ \ell}_{\ j\ k}\right)^{rebalanced}_{\substack{multiplex\\connected}}\right] = \left[\left(S^{i\ \ell}_{\ j\ k}\right)_{\substack{multiplex\\connected}} \middle/ \left(1 + \sum_{i=1}^{m_{multiplex}}\left(\frac{\sum_{\ell=1}^{3}\sum_{k=1}^{3}\left(X^{i\ \ell}_{\ j\ k}\right)}{p^{multiplex}_{\substack{min\\connected}}\ C(j)^{multiplex}_{\substack{modified\\connected}}}\right)\right)\right] =$$

$$= \left[\frac{\left(S^{i\ \ell}_{\ j\ k}\right)_{\substack{multiplex\\connected}}}{1 + \sum_{i=1}^{m_{multiplex}}\left(\gamma_{multiplex}\ SII(i)^{multiplex}_{\substack{index\\connected}}\left(\frac{C(i)^{multiplex}_{\substack{modified\\connected}}}{p^{multiplex}_{\substack{min\\connected}}\ C(j)^{multiplex}_{\substack{modified\\connected}}}\right)\left(\frac{\sum_{\ell=1}^{3}\sum_{k=1}^{3}\left(S^{i\ \ell}_{\ j\ k}\right)_{\substack{multiplex\\connected}}}{\sum_{z=1}^{3}\sum_{y=1}^{3}\sum_{q=1}^{m_{multiplex}}\left(S^{i\ y}_{\ q\ z}\right)_{\substack{multiplex\\connected}}}\right)\right)}\right] \tag{32}$$

$$\text{for } 0 \le \gamma_{multiplex} \ll 1\ ;\ i, j \in \{1, \cdots, m_{multiplex}\}\ ;\ \ell, k \in \{1,2,3\}$$

It considers that the funds $A(j)_{connected}^{multiplex} = C(j)_{connected}^{multiplex} - MC(j)_{connected}^{multiplex}$ available to j increase to $A(j)_{\substack{multiplex \\ connected}}^{rebalanced} = A(j)_{connected}^{multiplex} + \sum_{i=1}^{m_{multiplex}} X(ij)$ with the proportionate fractions $X(ij)$. We denote the ratio of available funds to total own funds of j as $p(j)_{connected}^{multiplex} = a(j)_{connected}^{multiplex}$ $p_{\substack{min \\ connected}}^{multiplex} = \frac{A(j)_{connected}^{multiplex}}{C(j)_{connected}^{multiplex}} = \frac{a(j)_{connected}^{multiplex} A(j)_{connected}^{multiplex}}{C(j)_{\substack{modified \\ connected}}^{multiplex}}$.

Maintaining the parameter $p_{\substack{min \\ connected}}^{multiplex} = p_{\substack{min \\ connected}}^{\substack{multiplex \\ rebalanced}}$, for comparability of the simulation of contagion within the rebalanced structure leads to:

$$p_{\substack{min \\ connected}}^{multiplex} = \frac{A(j)_{connected}^{multiplex}}{C(j)_{\substack{modified \\ connected}}^{multiplex}} = \frac{A(j)_{connected}^{\substack{multiplex \\ rebalanced}}}{C(j)_{\substack{modified \\ connected}}^{\substack{multiplex \\ rebalanced}}} = \frac{A(j)_{connected}^{multiplex} + \sum_{i=1}^{m_{multiplex}} X(ij)}{C(j)_{\substack{modified \\ connected}}^{\substack{multiplex \\ rebalanced}}} \tag{33a}$$

to a new modified value $C(j)_{\substack{modified \\ connected}}^{\substack{multiplex \\ rebalanced}}$ after rebalancing:

$$C(j)_{\substack{modified \\ connected}}^{\substack{mutliplex \\ rebalanced}} = C(j)_{\substack{modified \\ connected}}^{multiplex} \left(1 + \frac{\sum_{i=1}^{m_{multiplex}} X(ij)}{p_{\substack{min \\ connected}}^{multiplex} \; C(j)_{\substack{modified \\ connected}}^{multiplex}} \right) \tag{33b}$$

which produces the denominator in Equation (32).

The rebalancing reduces the largest Eigenvalue $\lambda_{\substack{multiplex \\ connected}}^{\substack{max \\ rebalanced}} < \lambda_{\substack{multiplex \\ connected}}^{max}$, which is equivalent to building in structural resilience. Thus, the minimum redistribution pre-emptively reduces the effect of potential contagion in quarter t based on the multiplex structure of exposures and the minimum capital requirements at the end of quarter $(t-1)$. The mechanism can be implemented automatically within the market infrastructure. It does not restrict the emerged preferences of banks for interaction within the multiplex of markets, but rebalances – at minimum cost and adaptively – how the system covers exposures collectively through the existing interlinkages. The mechanism also allows the banks to adapt their interaction preferences within the rebalancing impact structure, through incentives towards the emergence of a more resilient structure. In the terminology of computational intelligence approaches, this is analogous to the methodology of 'reinforcement learning'. The optimum mechanism involves not only the very top few but all reporting institutions that have nonzero systemic impact within the multiplex of markets at end of quarter $(t-1)$. The institutions are involved proportionately to their systemic impact at $(t-1)$, which is their potential to affect structural fragility and resilience in quarter t. The subtle rebalancing uses this potential and builds in resilience, instead of allowing this potential to drive the system further into fragility. The mechanism does not collect the surcharges into a fund to sit aside, but immediately uses them to achieve a stabilisation effect pre-emptively. Waiting for institutions to get in distress in order to access a fund will cost more. The redistribution also immediately compensates all institutions after the surcharges, where different institutions are compensated to a different extent. Thus effectively, each institutions is charged even less than the fraction of capital evaluated at the first step of the algorithm. While the charge depends on the systemic impact of a bank, its compensations depend on the systemic impact of other banks that affect the first bank through interlinkages. Finally, the potential for multichannel contagion through the multiplex structure contributes more to systemic fragility than single-channel contagion, however a positive point is that multichannel stabilisation also contributes more to systemic resilience than single-channel stabilisation.

4.2. Empirical evaluation

The empirical results presented in Tables 4 and 5 are evaluated for one of the quarters in the period from June 2014 to September 2015. Table 4 indicates that the multiplex structure does not meet the stability condition $\lambda^{max}_{\substack{multiplex\\connected}} =< 0.1457$, and therefore is in the region of structural fragility. The systemic risk of the unbalanced structure is $SR^{multiplex}_{risk} = 0.32867$, and contagion will not be contained if triggered. If a threshold of $SR^{multiplex}_{\substack{risk\\threshold}} = 0$ is targeted, then a stabilisation strategy with an optimum parameter $\gamma_{multiplex} = 0.02850$ will bring the system below this threshold.

Structural Resilience of the Empirical Multiplex

based on data for one of the quarters in the period from June 2014 to September 2015

Table 4

number of reporting banks	$n = 22$
number of banks in the strongly connected subtensor	$m_{multiplex} = 19$ (18 overlapping banks with the derivative market)
$p^{multiplex}_{\substack{min\\connected}}$	0.14573
stability condition	$\lambda^{max}_{\substack{multiplex\\connected}} < 0.14573$
$SR^{multiplex}_{risk}$ (no stabilisation implemented and $\lambda^{max}_{\substack{multiplex\\connected}} = 0.47440$ at $\gamma_{multiplex} = 0$)	0.32867
$SR^{\substack{multiplex\\rebalanced}}_{resilience}$ (stabilisation implemented and $\lambda^{\substack{max\\rebalanced}}_{\substack{multiplex\\connected}} = 0.14568$ at $\gamma^{min}_{multiplex} = 0.02850$)	0.00005

The structural resilience of the rebalanced system is $SR^{\substack{multiplex \\ rebalanced}}_{resilience} = 0.00005$, and contagion will be contained if triggered. The number of banks with nonzero systemic impact at the end of this quarter is 19, and they participate in the stabilisation step at the start of the next quarter. Notice that the threshold may be $SR^{multiplex}_{\substack{risk \\ threshold}} \neq 0$. Ffor example, within a long-term meta-strategy $0 < SR^{multiplex}_{\substack{risk \\ threshold}}(t) < SR^{multiplex}_{\substack{risk \\ threshold}}(t-1)$. Alternatively, $SR^{\substack{multiplex \\ rebalanced}}_{resilience} = 0.00005$ may be considered as too small. Though a potential contagion will be contained, a significant part of the system may be destroyed. Thus, a larger resilience threshold may be targeted $SR^{multiplex}_{\substack{resilience \\ threshold}} > 0.00005$.

Systemic Impact Ranking and Indexes
in Multiple Markets vs a Single Market

based on data for one of the quarters in the
period from June 2014 to September 2015

Table 5

institutions	E	F	G
rank at $\gamma_{multiplex} = 0$, (multiple-market contagion dynamics)	2	10	0 (not participating in the multiplex strongly-connected component)
rank at for $\gamma^{EAD}_{derivatives} = 0$, (single-market contagion dynamics)	17	9	18
$SII(i)^{multiplex}_{index}$ at $\gamma_{multiplex} = 0$ (multiple-market systemic impact)	16.34%	0.33%	0%
$SII^{derivatives}_{EAD\_index}(i)$ at $\gamma^{EAD}_{derivatives} = 0$ (single-market systemic impact)	0.28%	4.05%	0.23%

Table 5 presents the systemic impact indexes of three banks encoded as E, F, G. Institution E has a high systemic impact in the multiplex and contributes significantly to multiple-market contagion and stabilisation. However, E is of little importance in the single-layer structure of the derivatives market, and will contribute little to destabilising or stabilising processes there. Institution F is of medium importance in both structures, but contributes different proportions to systemic risk (resilience) in the multiple-market system and in the single market. Bank G has no systemic significance in multiplex contagion, while still contributing systemic impact in the single market. The empirical results show that banks differ in their significance and ability to influence the structure under the multiple-market scenario and the single-market scenario. The institutions will participate to a different extent in strategies to embed structural resilience under the two scenario. Stabilising the single market will not stabilise the multiplex of markets. Stabilising the multiplex will stabilise the single markets in the context of their interlinkages within the overall system.

We can improve the stabilisation analysis further and include that available funds $A(j)^{multiplex}_{connected}$ of bank j decrease with $Q(j) = \gamma_{Q\_multiplex}\, SII(j)^{multiplex}_{\substack{index\\connected}}\, C(j)^{multiplex}_{\substack{modified\\connected}}$ in proportion to the surcharge $SIS(j)^{multiplex}_{\substack{surcarge\\connected}}$ on j, along with increasing with the compensations $\sum_{i=1}^{m_{multiplex}} X(ij)$ in proportion to the surcharges $SIS(i)^{multiplex}_{\substack{surcarge\\connected}}$ on banks $i \in \{1, \cdots, m_{multiplex}\}$. Therefore, the contagion parameter is:

$$p^{multiplex}_{\substack{min\\connected}} = \frac{A(j)^{multiplex}_{connected}}{C(j)^{multiplex}_{\substack{modified\\connected}}} = \frac{A(j)^{\substack{multiplex\\rebalanced}}_{connected}}{C(j)^{\substack{multiplex\\rebalanced}}_{\substack{modified\\connected}}} = \frac{A(j)^{multiplex}_{connected} + \sum_{i=1}^{m_{multiplex}} X(ij) - Q(j)}{C(j)^{\substack{multiplex\\rebalanced}}_{\substack{modified\\connected}}} \tag{34a}$$

and the modified value for $C(j)^{\substack{multiplex\\rebalanced}}_{\substack{modified\\connected}}$ after rebalancing is:

$$C(j)^{\substack{multiplex\\rebalanced}}_{\substack{modified\\connected}} = C(j)^{multiplex}_{\substack{modified\\connected}} \left(1 + \frac{\sum_{i=1}^{m_{multiplex}} X(ij) - Q(j)}{p^{multiplex}_{\substack{min\\connected}}\, C(j)^{multiplex}_{\substack{modified\\connected}}}\right) \tag{34b}$$

This transforms Equation (32) into:

$$\left[\left(S^{i}{}_{j}{}^{\ell}{}_{k}\right)^{rebalanced}_{\substack{multiplex\\connected}}\right] = \left[\left(S^{i}{}_{j}{}^{\ell}{}_{k}\right)_{\substack{multiplex\\connected}} \middle/ \left(1 + \frac{\sum_{i=1}^{m_{multiplex}} X(ij) - Q(j)}{p^{multiplex}_{\substack{min\\connected}}\, C(j)^{multiplex}_{\substack{modified\\connected}}}\right)\right] =$$

$$\left[\frac{\left(S^{i}{}_{j}{}^{\ell}{}_{k}\right)_{\substack{multiplex\\connected}}}{1 + \frac{\gamma_{Q\_multiplex}}{p^{multiplex}_{\substack{min\\connected}}}\left(\sum_{i=1}^{m_{multiplex}}\left(SII(i)^{multiplex}_{\substack{index\\connected}} \frac{C(i)^{multiplex}_{\substack{modified\\connected}}}{C(j)^{multiplex}_{\substack{modified\\connected}}}\left(\frac{\sum_{\ell=1}^{3}\sum_{k=1}^{3}\left(S^{i}{}_{j}{}^{\ell}{}_{k}\right)_{\substack{multiplex\\connected}}}{\sum_{y,z=1}^{3}\sum_{q=1}^{mmultiplex}\left(S^{i}{}_{q}{}^{y}{}_{z}\right)_{\substack{multiplex\\connected}}}\right)\right) - SII(j)^{multiplex}_{\substack{index\\connected}}\right)}\right] \tag{35}$$

Due to limits on the period that access to data has been granted for this research, the empirical analysis here does not include simulating the strategy from Equation (35). We have instead simulated with synthetic data resembling characteristics of the empirical data, and observed how the process from Equation (35) changes the systemic risk of structure like $\left[\left(S^{i}{}_{j}{}^{\ell}{}_{k}\right)^{rebalanced}_{\substack{multiplex\\connected}}\right]$ when the parameter $\gamma_{Q\_multiplex}$ is at value $\gamma^{min}_{multiplex}$ optimising Equation (32). The results show that the built-in resilience $\Delta SR^{Q\_multiplex}_{risk} = SR^{Q\_multiplex}_{risk}\left(\gamma^{min}_{multiplex}\right) - SR^{\substack{Q\_multiplex\\rebalanced}}_{risk}\left(\gamma^{min}_{multiplex}\right) > 0$ is at least 55% of $\Delta SR^{multiplex}_{risk}\left(\gamma^{min}_{multiplex}\right)$. Therefore, the larger part of the built-in resilience is preserved. Due to limits on the access to data, contagion and stabilisation processes have not been yet simulated for the fixed-income single market and the securities-financing single market, either. A detailed comparison is provided in Serguieva (2016, 2017a) of centralities across different quarters in 2014 and 2015, and across the three single markets, the non-interconnected and the interconnected multiplexes. The analysis there though addresses the exposure structure rather than the impact structure and contagion is not simulated. The Katrz-Bonacich centrality of the exposure structure differs for the interconnected multiplex, the non-interconnected multiplex, and for each single market. Our next task will be to analyse empirically the impact structure across markets and reporting quarters, and to account for both surcharges and compensations in the rebalanced structure. We anticipate a nonlinear effect in the results for the interconnected and non-interconnected multiplexes.

V: Conclusions

Single-layer networks have now been adopted in modelling financial systems, however this task rather requires multilayer models, or interconnected multiplex networks as first approximation. There are few studies using non-interconnected multiplexes for modelling the structure of financial systems, and this has limitations in representing and analysing the complex system. The existing analyses also use the networks to represent but not affect the structure, and the approaches quite loosely follow regulatory requirements. We have identified gaps not addressed in current research, and then formulated solutions and provided empirical analysis.

There are powerful implementations of ensemble networks to non-financial domains. We touched on their ability to approach problems where single networks cannot cope, when evolving an ensemble and implementing to equity analysis in (Serguieva, Kalganova, 2002). The nature of the problem in focus here requires multilayer rather than ensemble networks, however we still address the capabilities of evolving networks as highly effective computational-intelligence techniques. Evolving an interconnected multiplex network through multiple periods allows not only modelling the multiple-market structure but also simulating strategies and suggesting meta-strategies for subtly affecting the structure towards building in targeted resilience. The hybrid approach can work with dynamic meta-strategies.[8]

The contributions in this study are as follows:

(i) The structure accounts for minimum capital requirements based on risk weighted assets.

(ii) The contagion model is formulated with an overall 'infection' (spreading) rate that allows for a unique spreading rate of each institution, both in single-market contagion and in multiple-market contagion.

(iii) The structure of the derivatives market accounts for positive net exposures in two directions between the same two institutions, due to different netting sets and enforceable netting agreements.

(iv) The derivatives market is analysed acknowledging that exposures on a going-concern basis (to a non-failed bank) and exposures at-default (to a failing bank)

[8] The dynamic meta-strategies provide incentives for the participants to adapt to and discover more-resilient structures but do not impose a particular structure. In computational intelligence terminology, this is a reinforcement learning technique.

differ. The values of MtM net derivatives exposures after collateral and MtM net derivatives exposures at default are used, correspondingly.

(v) Systemic risk measures and systemic resilience measures are formulated, both for a single market and for the interconnected multiplex of markets. These are structural rather than monetary measures. However, the focus here is on building in structural resilience that then allows a system to sustain its associated monetary value.

(vi) Systemic impact indexes are formulated for each institution, both in a single market and within the multiple-market structure. The terminology 'systemic impact index' rather than 'systemic risk index' is used to indicate that the potential of an institution to affect the structure, though contributing to contagion processes, can also be used in strategies to contribute to stabilisation processes.

(vii) An interconnected multiplex network is formulated to model multichannel contagion within multiple markets. The model is based on a recent study in (Serguieva, 2016, 2017a) using the tensorial framework, where tensors of different rank are derived step by step with detailed interpretation within the systemic risk domain. Here, the derived model is used directly and implemented to analyse the structure that incorporates simultaneously but distinctly three interconnected markets – the fixed-income, securities-financing and derivatives markets.

(viii) Single-channel and multiple-channel stabilisation strategies are formulated that subtly and adaptively evolve the structure towards targeted thresholds of lower systemic risk or higher systemic resilience. The stabilisation mechanism works at a minimum cost for each institution and no cost for the system as a whole. It introduces subtle structural changes that do not restrict emerged interactions and preferences among institutions but rather balance how the system as a whole copes with the emerged structure of exposures. The mechanism could be implemented as part of the market infrastructure. This may also lead to institutions gradually adapting their preferences to the mechanism, and thus leading to the emergence of interactions underlying a more stable structure that would involve fewer and infrequent stabilisation steps.

(ix) All institutions that participate at the end of a period in the strongly connected component of the multilayer network, also have nonzero systemic impact indexes and the potential to affect the structure at the beginning of the next period. Only if the system does not meet a targeted threshold at the end of a period, a stabilisation step is applied at the beginning of the next period. It involves all institutions with nonzero systemic index rather than the very top few, in order to achieve effective rebalancing, where minimum charged fractions are immediately redistributed as compensations. If we look for an analogy, this mechanism may resemble the varying margin within the current clearance mechanisms. This also acknowledges that systemic risk is not entirely a fault of an institution but of the emerged structure.

(x) Empirical simulations of single-channel and multiple-channel contagion and stabilisation processes are performed using large granular databases now available to the Bank of England. The simulations confirm the ability of the multiplex network to capture contagion dynamics throughout multiple interconnected markets. The simulations also confirm the ability of the designed multilayer stabilisation strategies to pre-emptively build in structural resilience and reduce a potential contagion effect. The empirical systemic impact indexes for the same institutions differ within a single market and multiple markets, and therefore a strategy that builds in resilience within a single market will not stabilise the interconnected multiplex of markets. Building in resilience within the multiplex will stabilise the single markets in the context of their interlinkages within the overall structure.

Next, we will extend the current analysis comparatively across different quarterly periods, involving in each period the three markets first separately and then as an interconnected multiplex. We will further design, simulate and compare different multi-period meta-strategies with dynamic thresholds. Finally, the multichannel processes can be instantiated with more granular and higher frequency data. We anticipate confirming within the more dynamic setting, the current result that the potential for multichannel contagion through the multiplex structure contributes more to systemic fragility than single-channel contagion, but multichannel stabilisation also contributes more to systemic resilience than single-channel stabilisation.

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Locating global value: National statistical infrastructures and multinational banks[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Locating Global Value: National Statistical Infrastructures and Multinational Banks

Jess Bier and Willem Schinkel

Abstract

In this article, we argue that attention to the infrastructural work of statistics can help to specify the spaces of capital flows. Global finance is often characterized as a realm that supersedes the nation-state. In contrast, we show that financial statistics produce specific geographies that are both national and gobalized.

Statistical infrastructures facilitate the circulation of capital that, with the rise of financialization, has become increasingly central to daily life. The BIS is one of the world's premier financial monitoring institutions, and nations are integral to their efforts to classify multinational banks. This article analyzes two sets of distinctions in BIS banking statistics: first, the distinction between bank nationality and residency, and second, that between domestic, international, local, foreign and/or cross-border claims.

These distinctions change depending on who observes them (Esposito 2013; see also Stark 2013) and where they are reported. So, rather than a view from nowhere (Haraway 1988) or a deterritorialized space of flows (Castells 1998), BIS statistics rely upon a grounded view of capital as a substance that flows through discrete passages (P. Peters, Kloppenburg, and Wyatt 2010) or channels (Tsing 2000). The globalization that emerges can be viewed as a form of infrastructural globalism (Edwards 2006) that complexly performs the nation-state.

Tax Inversion: Traitors to all Nations

In the 18th century Atlantic, a ship's flag was a marker of identity. It indicated which state or empire the ship's crew served and, as a result, who their enemies were. Caribbean pirates used to play off such symbolism by varying their ship's flag depending on the situation. One day, they might display a Spanish flag when approaching a Spanish ship, then raise their pirate flag to terrify their victims as they drew near. The next day, they might display a French flag in order to 'legally' attack a British ship—that is, if the British and French happened to be at war. In part because of these practices, pirates weren't considered to be ordinary criminals. Instead, they were called 'villains of *all* nations' (Rediker 2004, emphasis added) or 'enemy of mankind' (*hostis generi humanis*) (Schmitt 2011 [1937]), a move that has inspired some to liken pirates to terrorists (Cowen 2014; e.g. Puchala 2005).[i] It wasn't the trespass of the laws of a single state or empire that so angered the authorities. It was the pirates' decision to adopt different laws and nationalities at will. It was their instrumental use of the notion of *the state* itself (Rediker 2004; Schmitt 2011 [1937]).

In the 21st century, some corporations operate with similar logic when they selectively use state boundaries in order to make a profit. Through a sort of international loophole, the right tax acrobatics can allow them to avoid criminal litigation, get around legal protections, lower their tax rate, and otherwise maximize their returns. For example, in 2014, an international uproar erupted over the related practice of *tax inversion*, where corporations renounce their U.S. citizenship and legally become Dutch or Irish, for example—metaphorically raising a different flag over the same ship in order to avoid taxes. They do so by merging with a small company in the new nation, then reincorporating their headquarters there—but generally without moving the bulk of the company abroad. This in turn drives *tax competition*—a race to the bottom in which different national governments lower their tax rates as a way of drawing in multinational corporations (McCauley, McGuire, and von Peter 2010).

In recent years, a string of well known companies have 'inverted', or reincorporated abroad, in order to evade U.S. taxes on corporate profits. Among others, they include Fruit of the Loom, Chiquita, and Burger King. So like pirates, multinational corporations use the flag of nations instrumentally in order to increase their returns—and like pirates, the implications can be a matter of profiting from life and death. But the comparison should not be taken too far. For not all large corporations have inverted, even in cases where they might lose profits, and not all international financial institutions (IFIs) have the same 'anything goes' reputations as do corporations. What then, of the stalwarts of finance: the traditional, supposedly respectable banks? What role does the nation-state play in banks that, like corporations, are increasingly multinational?

Measuring Multinationals at the BIS

Many of the debates over tax inversion focus on how it is a betrayal of the nation-state, a theft of taxes that are used for social programs, infrastructure, and public goods. However, this focus on single nations omits one key aspect of IFIs: multinationality. Participants tend to mistakenly assume that it even makes sense for such large and heterogeneous institutions to belong to any one nation. Yet, banks are often so multinational that it can be very difficult, even on a practical level, to pinpoint the numerous branches, assets, and liabilities that—not unlike pirate networks—are spread across innumerable jurisdictions. This difficulty is compounded by the fact that, until recently, scarce publicly available information existed on the international holdings of both retail and commercial banks—let alone corporations. In the past few decades this has begun to change, however, as waves of banking data have been initiated, and the volume reported has increased after every successive financial crisis (BIS 2013; BIS 2009). Grudgingly, banks have begun to give their information to regulators, including both supranational entities like the Organization for Economic Cooperation and Development (OECD) (Drucker 2014), as well as central banks like the Dutch National Bank and the Federal Reserve, that collect data at the national level.

The Bank for International Settlements (BIS) was one of the first organizations to broaden the scope of this central bank data by collecting and aggregating data from multiple nations and supranational entities. To date, the BIS continues to be unique. It produces some of the only, not to mention some of the most widely-used, international datasets on multinational banks. The BIS is an emblematic supranational institution. It was created in 1930, making it a predecessor to other supranational financial institutions such as the IMF and the World Bank, which were the outcome of the Bretton Woods conference that followed World War II. However, the BIS has evaded some of the criticism of these other institutions by focusing not on direct economic or political transformation at a broad level, but rather on incremental change in close working contact with bankers and heads of state. It therefore represents an ideal case with which to study the multinationality of contemporary banks.

Locating Banks and Tracing Claims

The BIS international banking statistics are released in two groups: *locational* and *consolidated*. Both groups are designed to measure banks' exposures (risk of loss) in particular countries. The locational statistics are the largest and oldest datasets that the BIS collects, and they date back to the mid-1960s (BIS 2009). They are 'locational' because they separate out subsidiaries in the countries where they operate. The consolidated statistics are slightly younger, dating to the 1970s spread of offshore finance—i.e. the deliberate location of companies in small havens like the Cayman Islands to avoid paying taxes. The consolidated statistics are 'consolidated' because they give a bank's overall exposure, with all of a bank's subsidiaries are consolidated to the bank's head office. The locational statistics are further divided into two groups: respectively, the *residence* and *nationality* of banks. In combination, these two subsets of the locational data include a broader picture of the spread and location of bank activity by nation.

As a geographic category, the nation is thus integral to the classification of BIS statistics. This article analyzes two primary distinctions: first, between the nationality and residency of a *bank* in the locational statistics, and second, in the consolidated statistics, those between *claims* that are classified as domestic, international, local and/or foreign. Since the statistics for a particular flow can change depending on who observes it and where it is being measured, the BIS statisticians make no explicit pretentions to a 'view from above' (Haraway 1988) or a view from outside the economy (Esposito 2013; see also Stark 2013). In this context, during our interviews, they readily allowed that no observer is outside the system, and eschew purely objective data in favor of 'best practices'. As such, in their statistics, a specific form of globality emerges from a recasting of existing geographic categories like *domestic* and *international*. Those categories become increasingly tangled as they are applied across—among others—currencies, securities, collateral, international counterparties, and branches of multinational banks.

This article analyzes the specific globalities of multinational banks that are performed through BIS statistics. We do so in order to demonstrate the variety and multiplicity of globalization even among the financial institutions that are allegedly at its core. Like the high seas, finance has no single legal or regulatory body. Thus, rather than a deterritorialized space of flows (Castells 1998), BIS statistics describe sets of flows through discrete passages (P. Peters, Kloppenburg, and Wyatt 2010) or channels (Tsing 2000) among different regulators, regimes, and institutions for the movement of capital. In addition, the determination of both flows and channels are infused with institutional and political legacies, as can be seen by the continuing prevalence of the nation-state. Thus authority and legitimacy—as well as nationality—must constantly be renegotiated and performed anew (Esposito 2013; 2011).

So, whereas in tax inversion debates, it is sometimes assumed that large institutions have one primary nationality, by contrast the intricate intertwining of categories like *domestic* and *foreign*, or *local* and *international* in BIS statistics serves to demonstrate the complicated role of the nation-state under processes of globalization—processes that stretch back much further than tax inversion, or even 18th century Caribbean pirates. Indeed, a closer look at the BIS's recent banking statistics reveals simultaneous continuity and change, both mess and hierarchical network. Therefore, rather than an all-encompassing break, BIS statistics embody specific forms of globality that complexly incorporate and perform the nation-state.

We thus consider the nation-state as part of the BIS' classificatory system, and not as a given entity. The BIS, we argue, incorporates a contingent conception of the nation-state, and in statistics based on its classifications, it in turn performs the nation-state in a highly particular way that does not necessarily overlap with other existing conceptions. Even in these statistics, which are a core infrastructure *of* international finance, globalization and the nation thus emerge as processes that are changeable, bounded, and contingent.

For analyzing systems for the long-distance coordination and standardization of information, the literatures in science and technology studies (STS), sociology, and media studies are especially relevant. In the next section, we argue that conceiving of BIS statistics as a case of what Paul Edwards (2006) calls 'infrastructural globalism' therefore allows for a more textured view of globalization on the ground.

BIS Statistics as a Case of Infrastructural Globalism

In 1998, when then US Treasury secretary Lawrence Summers commented on the Asian financial crisis of the late 1990s, he argued against the (alleged) flow of capital from rich to poor countries, for the liberalization of markets, and for a 'strong domestic financial infrastructure'. Primarily, this infrastructure should involve certain accounting standards. Employing an analogy between financial markets and jet aircraft, Summers argued:

> "No one sensible is against jets. But everyone sensible is for safety regulations (…) Countries need bankruptcy laws. And they need judiciaries to enforce them. That is the price of being part of a global capital market. We also need procedures for countries which get themselves into profound difficulties with their sovereign debt." (quoted in Panitch and Gindin 2013, 278)

The BIS is very much part of that 'infrastructure', but it is far from 'domestic'—or at least, as we show, it is not and cannot be straightforwardly so. Taking finance's infrastructural character literally, we argue, is helpful for understanding the very meaning of a concept like *capital market* and its relation to a concept like *globality*. Recently, a growing literature on infrastructure has emerged in STS and related fields such as media studies and architecture and design. In particular, Susan Leigh Star has, by herself and in various collaborations, contributed to a conception of infrastructure as not only hugely networked systems that enable circulation (as it is understood for instance in Graham & Marvin (2001)), but also as a work of categories, naming conventions and standards. For many authors, a key feature of infrastructure is its 'invisibility' (Lampland and Star 2009, 17, 207), its 'concealment' (Parks 2010) or its 'forgetting' (J. D. Peters 2015, 36). This invisibility is part of infrastructure's operating in the background. In a sense, the BIS functions as a typical infrastructure in this respect, since its workings are usually invisible, and are surrounded by a shroud of mysteriousness (Durden 2015; LeBor 2013), even giving rise to conspiracy theories (e.g. Garner 2010).

The invisibility of the BIS is relative, however, and its published reports provide ample insight into its workings. In addition, this article draws on over 30 interviews that we have conducted with key workers at the BIS. However, Star and Ruhleder (1996) emphasize that infrastructure is a highly relational concept, meaningful only in particular organizational practices. In other words, infrastructure is observer-dependent. What is infrastructure for some, is a brick wall for others (Lampland and Star 2009, 17). So, too, may the visibility of infrastructure be relative. Another way, then, to consider the invisibility of the BIS as an infrastructural organization is to note that infrastructure is usually not subject to democratic governance, and here the BIS fits the profile very well.

Keller Easterling argues that much infrastructure is in fact highly visible in today's globalized world. She calls such work 'extrastatecraft' indicating that increasingly, infrastructural work constitutes governing power that bypasses democratic control. She describes extrastatecraft as "a portmanteau describing the often undisclosed activities outside of, in addition to, and sometimes even in partnership with statecraft" (2014, 14). So while she considers infrastructure as 'far from hidden'

(2014, 11), she notes how what she calls infrastructure space is a medium of extrastatecraft, which includes various 'undisclosed' practices. Here, too, infrastructural visibility is relative. Easterling considers the spatio-legal concept of the 'zone' as a key technique of extrastatecraft, and, though unmentioned by her, the BIS offers a striking illustration here. The BIS resides in Basel, but formally it is exempted from Swiss territory and law, and it controls its own premises.

Extrastatecraft, for Easterling, is a key feature of what she calls 'global infrastructure'. As such, it can also be considered as key to the very notion of 'globality'. As Paul Edwards has shown, earth-spanning governing organizations such as the WMO (World Meteorological Organization) have been crucial in providing credibility to conceptions of 'the world'. Edwards therefore speaks of an 'infrastructural globalism', by which he understands "the (...) phenomenon by which 'the world' as a whole is produced and maintained — as both object of knowledge and unified arena of human action — through global infrastructures" (2006, 230). Such infrastructural globalism can be considered as key to modernity in general (Edwards 2002), and as central to the formation of global economic spaces, such as global capital markets, in specific. Without global governing institutions such as the IMF, the World Bank and the WTO, the global economy could scarcely exist (Peet 2009). Bretton Woods was thus a key moment in economic infrastructural globalism. We argue that the BIS, a forerunner of Bretton Woods, should be considered as a crucial element in this economic infrastructural globalism.

In terms of the emerging orgnaizational infrastructure supported by the BIS, the Basel accords have sparked a number of initiatives that seek to control capital markets. The accords are determined by the heads of various Central Banks and G-20 representatives, who convene at the BIS as the Basel Committee on Banking Supervision (BCBS). Additionally, the BIS collects, organizes and publishes key statistics on international capital flows. As such, the BIS delivers forms of standardization and ordering of fundamental terms to global markets that are profoundly infrastructural (Lampland and Star 2009; J. D. Peters 2015, 37). Edwards emphasizes a 'force-amplifying' character when he defines infrastructures as "large, force-amplifying systems that connect people and institutions across large scales of space and time" (2002, 221). Considered as such, we argue that BIS statistics help structure and order global capital markets, help to channel capital flows, and in the process perform the nation-state as part of a particular type of globality. Due attention to the practice of the BIS' infrastructural statistical work helps bring into focus a more concrete rendering of the global space of capital flows, which forms a global circuitry facilitating the circulation of capital that has, with the rise of financialization in the economy, become ever more important (Lapavitsas 2013; LiPuma and Lee 2004).

Global infrastructure is key to understanding notions such as 'global flows' or 'circulation of capital', since the global is not a 'smooth space' of continuous free-flowing, nomadically traversing capital (Deleuze 1988). Rather, it is a 'striated space' that is differentiated, gridded, and internally bounded in multiple ways, but that is also calculable and measurable. When, in 1983, the BIS's Concordat of 1975 was expanded towards the requirement that banks report their international transactions to national bank supervisors, this was accompanied by rules for both overseeing and enabling cross-border capital flows (Panitch and Gindin 2013, 236). As is often the case, the division between *measurement* or *recording* and *management* or *regulation* is hard to make, but the BIS fulfils a crucial infrastructural function when it contributes to *the striation of the global space of the circulation of capital by recording it*. Indeed, this striation is so complex that even the idea of 'international transactions' is too simple to capture what goes on between bank transactions across countries or domiciles. In order to illustrate the complexities of the BIS' statistical infrastructural work, here we practice a form of what Geoffrey Bowker (1994) has called 'infrastructural inversion', bringing into the light what is usually hidden, and foregrounding a key aspect of what normally forms the background of global capital traffic.

The Nation-State by the Numbers

We now return to Lawrence Summers who, although a known proponent of deregulation, nonetheless argues that "No one sensible is against jets. But everyone sensible is for safety regulations" (Panitch and Gindin 2013, 278). In the longer block quotation that opens the previous section, Summers compares the regulation of jets to the regulation of finance in an attempt to make visible a financial infrastructure that is inscrutable to many. Indeed, although the crisis that began in 2008 has helped to steer attention towards regulation, public understandings of finance continues to draw heavily upon tropes that are, at times, hundreds of years old.

The figure of the financier in popular culture has not kept pace with changes in global finance. Evidence of this can be seen most easily in the long-term evolution of the character of Ebenezer Scrooge. From his origins as a businessman and moneylender in Charles Dickens's *A Christmas Carol*, Scrooge has featured in innumerable adaptations of the original work, including the Disney character Scrooge McDuck and Bill Murray's portrayal of a TV executive in *Scrooged* (Donner 1988). Within each story, Scrooge transforms from cold-hearted miser to generous benefactor after being visited by three ghosts of Christmas. Over time, his evolution across adaptations has paralleled this change as, overall, Scrooge is intended to be far more empathetic for contemporary viewers. For example, Scrooge McDuck is a caring single parent for his three nephews, and Jim Carrey's portrayal of Scrooge reimagines him, not unpredictably, as a comedic action hero.

But if Scrooge is a major and often-updated stereotype of finance in popular culture, nonetheless the depiction of his professional affairs remains unchanged. His character's personality evolves over time, but his business practices continue to reflect those of 19th-century finance. This shows the difficulties that broader perceptions of finance have had in terms of adapting to the sweeping changes in finance over the past fifty years. Even in contemporary adaptations, Scrooge McDuck still presides over oceans of coins that he stockpiles in one location, where he is depicted diving into his personal vaults. He is rarely, if ever, shown jet setting around the globe. He does not manage his money online or store it in offshore accounts. His value is still measured in hard gold.

This popular notion, that wealth involves the hoarding of physical currency, might persist because recent developments in finance are so difficult to visualize or even imagine over the past 100 years. Finance, and bankers in particular, served as figureheads that represented both stability and power, even as this representation was continually contested over time through protests and the labor movement. Yet today's banks are incredibly complicated. Wealth has arguably become more consolidated over time, but there is not necessarily one stable symbol, or one dominant bank in any single location. This is likely at least partly by design to avoid taxes and other responsibilities. In addition, formal banks are losing ground to 'shadow' banking practices that exist in no small part to evade regulation.

However, this doesn't mean that global financial infrastructure is indescribable. Nor does it suggest that it is truly global, since certainly places exist that are unserved, or damagingly served, by global banks. But it does suggest that more attention needs to be paid to attempts to describe, measure, and visualize global finance, including BIS statistics. It is precisely to this that we now turn. Two main aspects of the ongoing changes in global financial infrastructure are especially evident in BIS banking statistics. First, whereas Scrooge served as an identifiable figurehead, instead today the structure of many banks is a complex web of entities, sometimes without any clear center, that is defined *relationally* in terms of its location. We explore this in more detail below. Second, in terms of nationality, banks are constituted through claims that, although bulwarked by national laws, themselves simultaneously cross a multitude of borders.

The idea of one vault, or even one bank, existing within the purview of a single nation-state is not as salient as it might once have been. Indeed, even when *A Christmas Carol* was written, finance was already thoroughly international and colonial. But nonetheless the image that persists is of a Scrooge that is very much of one nationality, whether English as in the original, or another nation in the many later adaptations. In contrast to this depiction, as banking has become systemically diffuse, it has also become geographically complex. A single transaction might original in one country, be collateralized in another, paid for in a third, travel through a fourth—only to be deposited in the territory of a fifth nation. And this is a simplified representation! To better understand attempts to classify and measure global banking, we now analyze the classification systems of the BIS banking statistics, one of the most widely influential attempts to concretize just these kinds of practices.

No Head Office is Discernible: Classifying Banks by Nationality and Residency

As we have argued, banks are not bounded by the nation-state, but they are shot through with it in innumerable ways that differ depending on one's vantage point. In the BIS banking statistics, nations are explicitly present in nearly every category, but the 'nationality' of a bank is present in a highly complex and contingent way. The definition of nationhood is textured, informed both by official lists as well as by colloquial notions of a 'country' [March 2013, v] in cases where a particular nation-state might not be internationally recognized, but where banks identify as belonging to that unrecognized country. This is especially relevant for some offshore centers that are not independent nations, but that may be recognized as such for the BIS's statistical purposes. The determinations of nationality also must be made multiple times for each bank. Indeed, no single bank, or even a single branch of a bank, has one individual nationality. Different nationalities can be attributed to a bank's head office, subsidiaries, consortium partners, employees, exchanges, collateral holders, and infrastructure.

Thus a bank has multiple attributes, all of which might have different nationalities that are defined based on both formal and colloquial notions of nationhood. If this were not complicated enough, the extent to which these entities are considered local or foreign, domestic or international, also depends on the viewer—or, in this case, where the statistic is recorded. Indeed, the terms themselves imply relationality. For, if we say that a particular transaction is *local* or *domestic,* this raises the questions: For whom is it local? Domestic with respect to which nation? What might be local to some will be foreign to others. And although *domestic* can be construed to include, for example, every transaction that doesn't cross any national borders, in practice different nations define those borders in varying ways. They depend in part on whether each of the aspects noted above (head office, subsidiaries, etc.) is domestic as well. To understand how the statistics seek to contend with these issues, we now delve deeper into one particular classification: the locational statistics.

At the broadest level, the BIS *locational* statistics—as opposed to the consolidated statistics, which are dealt with in the next section—are grouped by country. The main division within the statistics is that between nationality and residency, both of which rely upon the category of the nation. Therefore, they include bank assets and liabilities that are located in one particular country—for example, the holdings of all of the banks that are located in the Republic of Korea, whether those banks are Korean or not. Alternately, it's also possible to see, for instance, the holdings of all Korean banks regardless of location. Then, on the next level of specificity, the statistics are split between local and foreign holdings or debts, and domestic and international ones. These terms of *local/foreign* and *domestic/international* all have precise definitions that we explore below—definitions that do not always coincide with the colloquial uses of the terms. As a result, using the locational statistics, it is possible to speak of local-domestic or foreign-international holdings, which makes some intuitive sense. However, perhaps less intuitively, the statistics also enable an examination of local-international and foreign-domestic holdings, which deserve further explanation.

To examine the role of these crisscrossing divisions and what they mean, we will now consider nationality and residency in turn. The determination of a bank's nationality is particularly important. Nationality impacts the how assets and liabilities are classified further down the line, because it is essential to later determinations of local/foreign and domestic/international. Yet deciding a bank's overall nationality is far from a straightforward process. The BIS guidelines note that: "Classifying banks according to their nationality is not a simple matter because it depends on the identification of a single controlling parent institution." (BIS 2013, 16). So how is overall nationality determined? There are numerous issues to consider, including subsidiaries, consortiums that have "no clearly identifiable controlling parent" (BIS 2013, 16) and international organizations that "are considered to be resident in an economic territory of their own, and not of the economy in which they are physically located" (BIS 2013, 15).

While determining nationality, the regulators also have to assess the substance of any individual office. Because of offshoring and related practices like tax inversion described earlier, some controlling parents are simply front agencies. In light of such attempts, the BIS attributes nationality using three main indicators. The controlling parent is determined according to the following criteria. Paraphrased from the documentation (BIS 2014, 4), the office must be one or more of the following:

1. It is where important decisions are made and/or over 50% of available capital is used.

2. It is the highest level that regulatory authority can supervise.

3. It is where the head office is located.

There are three major implications of these three indicators for considerations of the role of the nation-state. First, banks are attributed nationality in ways that are analogous to how people are attributed nationalities, but there's actually far greater official acknowledgement of transnationalism than there often is for individuals. Banks can belong to a nation-state if they do two of these three things there: make major decisions, are regulated, or locate their head office. A bank's 'nationality', then, is the contingent outcome of a classification that consists of highly heterogeneous activities. This is part of what provides banks with opportunities for tax inversion. For while it can be exceedingly difficult for an individual to obtain formal residency, not to mention citizenship, in a new country, banks are often heartily welcomed with tax breaks and other subsidies. In this way, banks are a bit like professional sports teams. A team's home city or country can inspire loyalty, but this masks the fact that many of the players might come from elsewhere, live elsewhere, and that the team might be owned by a corporation or person who is based elsewhere. The players may also spend their time away playing in tournaments and matches sponsored by an international organization that is owned by a conglomerate with no specific national headquarters.

The second implication for considerations of the nation-state is that the current home country is by no means a simple legal category. Indeed, it is not apparent at the outset, nor does it necessarily align with colloquially accepted ideas of a bank's nationality. It requires negotiation within the statistics unit of the BIS based on the three indicators listed above. So while many would assume that, for example, Chase Bank is from the USA, this may not have any bearing on its classification in the statistics. The determination might also differ from more formally accepted conceptions of nationality. For example, the guidelines note that, if the indicator of the highest applicable regulatory authority is used, then it is possible that "the home country from a prudential perspective could differ from the country where the ultimate parent is located" (BIS 2013, 17 n.2). This is because the statisticians are interested in where the bank is primarily operating, more than where it legally might be headquartered (such as the Cayman Islands). When you add in the need to also classify the nationalities of counterparties and entities that hold collateral for the bank, determinations of nationality quickly become immensly complicated. They require detailed knowledge of the banking industry and the pragmatic effects of official designations such as 'ultimate parent'.

Third, each bank's nationality is not necessarily determined by the same criteria as another's. Since two of the three criteria are used in any one case, then the criteria for different banks don't necessarily overlap entirely. So for example, one bank may be 'Indian' because of how it is subject to regulatory authorities (indicator 2), while another bank may also be 'Indian' because it does the majority of its business in India (indicator 1), and a third bank may be 'Indian' because its head office is in India, even though it does most of its business in a different country. However, this isn't apparent form the statistics themselves after the fact. It is part of the deeper process of classification that makes the statistics possible. There also is an option for being unallocated to any nation, in the case of consortiums, but this is treated as a residual category, and the vast majority of banks are not in it, which demonstrates that nationality still holds sway, not least because national governments still play a major regulatory role. Overall, the three indicators that are used to determine nationality show how much work goes into maintaining notions of nationality despite the geographical complexities involved.

In addition to nationality, residency is the second most high-level category. In comparison to notions of a bank's overall nationality, bank residency seems to be more straightforward, since in theory each branch is resident in one specific nation, and these could simply be listed.[ii] Yet, in practice, the BIS's classification of residency is entirely dependent upon the nationality determination just outlined. Resident banks are broken into the following categories (BIS 2013, 12, Table B2): domestic banks, foreign subsidiaries, foreign branches, and consortiums. The *domestic banks* are defined as "banks whose controlling parent institution is located in the reporting country" (ibid.)—and this controlling parent is determined according to the three criteria described above. It is important to note that the BIS collects and standardizes statistics rather than making them themselves, so the *reporting country* is the country that provides statistics to the BIS. However, the BIS only accepts statistics that are formatted and produced according to the guidelines that we are examining throughout this article. So in essence, they control the official form of the statistics. Even though the central banks of individual countries are responsible for providing the content.

After domestic banks, the difference between *foreign subsidiaries* and *foreign branches* is simply that subsidiaries are incorporated in the reporting country, whereas branches are unincorporated. Both are foreign because their nationality (controlling parent institution) is not the same as that of the reporting country. As noted earlier, consortiums are something of a special category. Although at times exempt from nationality, this is actually because they have too many nationalities, and so determining one controlling nationality is challenging and, to some extent, inaccurate.

There are two important implications of this breakdown into classifications like *domestic banks* and *foreign branches*. One, as already briefly mentioned, it's not just that banks belong to a specific country, have a clear nationality, even if they're located somewhere else. Instead, it's that the classification of where they're located (i.e. whether they're a domestic bank or foreign branch) also depends on conceptions of nationality, with respect to the 'controlling parent'. So nationality is infused throughout residency. Two, also as noted, the classification is also always already relational to a reporting country. So a Dutch bank is domestic with respect to the Netherlands, but foreign with respect to Britain.

As with determinations of nationality, residency quickly becomes incredibly tangled. For example, in the UK you might find a branch of a Dutch subsidiary that in turn is owned by a British company (in terms of 50% of capital) that also, by nationality, belongs to the Virgin Islands (because its ultimate parent is incorporated there), but whose ultimate regulatory authority is still in the UK. So, is the branch's nationality from the Netherlands, the UK, or the Virgin Islands? The answer is that it would be worked out in practice with BIS oversight, in relation to both controlling parents and reporting countries. Thus the attribution of nationality is intricate and related to other nationalities throughout, in ways that are obscured through statistical tables that list, for example, assets of Dutch banks or, alternately, assets of banks residing in the Netherlands. A bank can belong to multiple nations and multiple levels and in multiple ways, and the popular view of a bank consisting of a vault in one location is an unfitting representation for today's banks.

Defining Banks by What They're Not: Local and Cross-Border Claims

The challenges of nationality become even more intricate when we consider how spatial categories are attributed to claims that can cross national borders. While banks are still one of the most visible and well-known financial institutions, they are no longer the only dominant players in comparison to other financial institutions, as well as to shadow banks that are formed in such a way as to avoid regulations. Up until the latter half of the twentieth century, banks largely avoided being involved in risky financial speculation, but all of that has changed in recent decades. In the current crisis, it has become apparent just how exposed banks have become, including to shadow banks.

A financial *claim* is an exposure between banks, for example a debt, under some kind of contractual agreement. A claim might consist of an agreement to pay back a specific debt at a future date. So if banks are 'objects' or institutions, then a claim is a relationship between banks. Banks and other institutions become entangled through claims, such that a bank that may appear to be fully solvent and have high liquidity might in fact be bankrupt due to outstanding claims (in this case, debts) that other institutions have upon it. During the crisis, systemic financial institutions folded, and many more threatened to fold, like dominoes because of these kinds of exposures. Once investors start to lose faith in financial institutions, they rush in droves to get any outstanding debts repaid to them, and this means that one institution might be hit all at once by a multitude of requests to repay its innumerable outstanding claims. So claims are crucial to understanding the financial and geographic interdependencies in global finance.

Like banks themselves, claims are often not bounded by individual nation-states, but they are infused with national categories. In the last section, we focused on the banks and their classification through the BIS locational statistics, which are an older type of classification. We now turn to the *consolidated* statistics, which were created as a response to the beginning of the crisis in 2008. As we saw, locaitonal statistics are released by country, not by individual banks or groups of banks. In contrast, consolidated statistics are provided for banks (in aggregate), rather than by country. Thus the breakdowns are related, but reversed. So as we discussed, locational statistics have a row for a nation, then are broken down by nationality or residence, and then by type of institution (domestic bank, foreign subsidiaries, and so on). In contrast, consolidated statistics have a row for bank type, and this is then broken down by country. The reason this is done is so that consolidated statistics can focus on the claims that are held upon on different types of banks, since outstanding claims have played such a big role in the crisis.

Yet this raises the question: how is it possible to determine whether individual claims are local or foreign, domestic or international? Such determinations are important because they help regulators to determine where those claims should be regulated, which government's laws apply is something goes wrong. In the last section we looked at nationality and residence, but now let's investigate the spatial categorizations that follow from attributing nationality to banks. In the consolidated statistics, statistics for claims are broken down according to the terms already noted: local, foreign, domestic, and international (as well as one additional term *cross-border)*. However, perhaps surprisingly, any one claim might belong to all these categories at once. For example, consider a claim that is made inside the reporting country, and that is between one domestic bank and one foreign subsidiary (of another bank), and denominated in foreign currency. To give a hypothetical example, say that, in Japan, one Japanese bank that 'resides' in Japan might owe money in US dollars to a subsidiary of a Brazilian bank. So, when Japan's central bank reports its statistics to the BIS, it might classify this claim as follows:

1. It is local, in terms of where the claim's contract is in force (Japan).

2. It is foreign, in terms of the currency (US Dollars).

3. It is domestic, in terms of the residence of the counterparties (both Japan).

4. It is international, in terms of the nationality of one counterparty (Brazil).

In addition, this is all with respect to Japan as a reporting country. The same claim could also be reported by the USA and Brazil, and the determinations would differ in each case, although the statistics are organized in such a way that such double or triple reporting is taken into account.

The statistics are constructed to account for these layers of belonging, both in terms of double reporting and in the reporting of individual countries. To understand how, it is necessary to look in greater depth at the consolidated statistics. To determine locality or foreigness, for example, the claims are sorted by the following seven aspects—aspects that we are here paraphrasing from the BIS documentation (BIS 2014, 10, see Table 21; 2009):

1. The nationality of the claimant (in this case, Brazil)

2. The residency of the claimant (Japan, since the Brazilian bank branch is in Japan)

3. The nationality of the counterparty (in this case, Japan, the bank that owes money)

4. The residency of the counterparty (Japan)

5. The location where the claim is booked (Japan)

6. The nation that issued the currency of the claim (USA)

7. Whether any one of the above aspects crosses a border (which this example does)

These seven aspects are used to classify the claim on four levels according to whether it's considered domestic, foreign, local, international, and/or cross-border. The four levels are as follows, in descending order:

1. Domestic or foreign

2. Local or cross-border

3. Local or foreign

4. Domestic or international

At the first of the four levels, *domestic* refers to claims on residents of the reporting country, and *foreign* refers to claims on residents who are not residents of the reporting country. So our example claim would indeed be domestic, because the Japanese bank owes money, and Japan is the reporting country. At the second level, *local* refers to claims booked by offices inside the reporting or counterparty country, and *cross-border* refers to claims booked by offices outside the reporting or counterparty country. In this case, the example claim would be local, because it takes place within Japan.

At the third level, *local* refers to claims in local currency, and *foreign* refers to claims in foreign currency. So then the claim would be foreign, because it is in US Dollars. At the fourth and finest level, *domestic* refers to claims on residents of the reporting country that are booked inside the reporting country, and are in local currency. Foreign claims can also be domestic if they are on non-residents of the reporting country, are booked inside the counterparty country, and are in local currency for the counterparty country. *International* refers to everything that doesn't meet the above two options, and indeed our example would also be international.

So, the example is then domestic-local-foreign-international, and only with respect to Japan as a reporting country! Residence and nationality feed in at every level, and it is all framed with respect to the reporting country as seen, for instance, in determining local currency or foreign currency. This is just for a specific claim between two specific organizations. To figure this out for a branch, one would have to look at it for every transaction for every subsidiary and branch.

Through these mechanisms, the statistics describe banks, of multiple nationalities and residencies, who interact through claims that also have multiple nationalities and residencies. The resulting classifications change depending upon who is observing and reporting the statistics. The nation-state is thus incorporated throughout the statistics in a manner that is incredibly complicated, yet nonetheless also entirely salient in a global context. Rather than losing one nationality, global banks gain many. In addition, there is no overhead view of, say, a claim, but rather each claim is defined with respect to its constituents, and to its observers. Rather than abandoning such everyday notions of closeness and foreignness in a push for a space of flows, the BIS statistics therefore specify and incorporate them into the backbone of the infrastructure of global finance.

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Endnotes

[i] In an NPR *On Point* radio broadcast on on tax inversion, one caller named Gigi obliquely referenced this by claiming that: "capital is its own country without allegiance to a nation" (Ashbrook 2014, 41:10).

[ii] This of course assumes that every place in the world belongs to a nation, which is itself problematic—not least for people who are officially viewed as 'stateless'.

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New data collection on SPVs in Ireland: findings and implications for the measurement of shadow banking[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

New Data Collection on SPVs in Ireland: Findings and Implications for the Measurement of Shadow Banking

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Abstract

Statistical gaps in the non-bank financial sector have attracted increasing global attention in recent years. International organisations have highlighted special purpose vehicles (SPVs) as a significant area requiring more information sources, improved data coverage and monitoring. This paper provides some initial results and analysis of a new database collected by the Central Bank of Ireland. The database covers 822 SPVs with aggregate assets of €324 billion in Q4 2015, improving oversight of these vehicles and filling data gaps. Key findings point to the diversity and complexity of the activities undertaken in the SPV sector, and the range of geographical and institutional sector linkages. The new database also enhances the measurement of the shadow banking sector, resulting in a €172 billion reduction in the measure of shadow banking in Ireland, as estimated for Q4 2015.

Keywords: Special purpose vehicles, non-bank financial sector, shadow banking, Ireland.

JEL classification: C18, G23.

Contents

Introduction

The years since the financial crisis of 2007-2008 have seen an increased focus on closing gaps in available statistical data on financial intermediation outside the banking sector. In particular, the lack of information on special purpose vehicles (SPVs)[1] highlighted gaps for financial stability analysis both on linkages within and between institutional sectors, and on exposures to both domestic and foreign counterparties. In this respect, international organisations such as the International Monetary Fund (IMF) and the Financial Stability Board of the G20 countries (FSB) focused on three inter-related areas requiring more information sources, namely, the build-up of risk in the financial sector, cross-border financial linkages and the exposure of the domestic economy to shocks (IMF and FSB, 2009).

Ireland is a globally significant location for non-bank financial intermediaries whose activities are overwhelmingly with non-residents, and SPVs account for an important portion of this sector.[2] SPVs are legal entities created by a sponsoring financial or non-financial entity in order to fulfil narrow, specific purposes, typically in the areas of taxation, risk management, funding and liquidity. These objectives can include tax neutrality, the isolation of risks or exposures from the sponsor, lower funding costs through issuing debt collateralised by ring-fenced assets and improving liquidity management through the issuance of debt securities collateralised by non-liquid assets (such as trade receivables). Securitisation is simply a particular form of these activities, whereby contractual debt is re-packaged into debt securities to be sold on to investors.

The Central Bank of Ireland (the Central Bank) has collected comprehensive data at a granular level on securitisation vehicles (known as financial vehicle corporations, or FVCs) since Q4 2009, following the introduction of Regulation ECB/2008/30[3]. However, information has been limited on vehicles engaged in activities other than securitisation. These SPVs are often part of complex financial structures that span a number of countries, which creates particular challenges for statistical compilers in developing a comprehensive database on their activities and structures.

Against this background, the Central Bank launched an initiative to extend its reporting data to SPVs in Q3 2015, with the objective of closing data gaps, enhancing information on exposures and identifying potential financial stability risks. The new collected data on SPVs domiciled in Ireland aims to enhance knowledge on the types of activities undertaken by these entities, including who sponsors them, and whether they are stand-alone entities or consolidated into larger group structures.[4] The data also allows for a more precise estimation of the size of non-bank financial intermediation (and shadow banking) in Ireland.

This paper presents some key findings extracted from the new SPVs database. It illustrates the diversity and complexity of the activities undertaken in the Irish SPV sector, and the network of country and institutional sector links. SPVs are often part

1 SPVs are also known as special purpose entities (SPEs).

2 For the purposes of this paper, SPVs refer to vehicles that are primarily engaged in activities other than securitisation.

3 https://www.ecb.europa.eu/ecb/legal/pdf/l_01520090120en00010013.pdf.

4 Table 1 includes a glossary of terms, with a brief definition of 'sponsor' and 'consolidator'.

of elaborate multi-vehicle structures, with consolidation and sponsor links across a wide range of countries and sectors. Moreover, the database enhances the understanding of the range of activities and linkages within shadow banking in Ireland.

The remainder of the paper is structured as follows. Section 2 briefly reviews the data and the collection process. Section 3 presents the main findings by focusing on the types of activities undertaken by SPVs and on their geographical and institutional sector linkages. Section 4 quantifies the implications for the estimation of the size of the shadow banking sector in Ireland, and section 5 concludes.

New Data Collection on Irish SPVs

The Central Bank and the Central Statistics Office (CSO) share the collection of data for Ireland on the financial corporations sector, as defined in ESA 2010 under classification categories S122 to S129. This data is based on a combination of granular reporting, mostly at the level of each security on an entity's balance sheet, with those parts of the sector not covered by the current reporting framework estimated using various statistical techniques. Currently, the Central Bank collects granular balance sheet and profit and loss data on deposit taking corporations (S122) and money market funds (S123), and other major components of other financial corporations classified within subsectors S124 to S125 of ESA 2010, namely non-MMF investment funds and FVCs.[5]

The granular data are combined with data from both CSO and the Central Bank on insurance corporations and pension funds (S128 and S129) and with CSO data on treasury companies and asset finance companies. However, a significant residual remains for the financial corporations sector, which is not covered within the current collection process. Data on the remainder of the financial sector (otherwise known as the OFI residual) is limited. This remainder is largely made up of non-FVC S125, S126 and S127 companies, and includes the significant presence of SPVs in Ireland. The new data on SPVs collected by the Central Bank, which is assigned to subsector S127, helps to enhance the quality and coverage of non-bank financial entities by expanding data coverage and improving the identification of the Irish OFI residual.

Regarding the data collection process, the main challenge faced relates to the definition of a reporting population for SPVs. Various SPV definitions exist, and they are either very narrowly focused or straddle multiple types of financial activity. A pragmatic approach was undertaken in this light, confining the reporting population to all companies availing of 'Section 110'[6] of the Taxes Consolidation Act 1997 (Godfrey et al., 2015). SPVs engaged in securitisation (that is, FVCs) qualifying as `Section 110' vehicles already report to the Central Bank under Regulation ECB/2008/30. The existing reporting form was extended to the remaining SPVs not

[5] The total assets of the Irish non-bank financial sector amounted to around €3.8 trillion in Q4 2015, based on quarterly financial accounts data published by the Central Bank of Ireland: http://www.centralbank.ie/polstats/stats/qfaccounts/Pages/Data.aspx.

[6] 'Section 110' companies are Irish domiciled SPVs holding or managing assets that qualify for tax neutrality.

required to report under Regulation ECB/2008/30.[7] This approach provides a clear definition of what entities are included in the extended reporting framework. The disadvantage of this strategy is that it is limited to entities availing of `Section 110', as some vehicles operate outside this designation.[8]

The SPVs database, introduced for the first time in the Q3 2015 reporting period, covers 822 vehicles reporting total assets of €324 billion in Q4 2015, with most instruments reported on a security-by-security basis. Besides requesting detailed balance sheet information, a registration form requires information on whether the vehicle is consolidated into another entity, the sponsor of the vehicle and whether another entity has an unconsolidated interest in the vehicle. This information, which is critical in order to identify who created and sustains the SPV, is often not available from balance sheet or financial accounts information. Moreover, it allows the identification of a complex range of SPV types and activities in the sector.

Key Findings

The Central Bank and the Central Statistics Office (CSO) share the collection of data for Ireland on the financial corporations sector, as defined in ESA 2010 under classification categories S122 to S129. This data is based on a combination of granular reporting, mostly at the level of each security on an entity's balance sheet, with those parts of the sector not covered by the current reporting framework estimated using various statistical techniques. Currently, the Central Bank collects granular balance sheet and profit and loss data on deposit taking corporations (S122) and money market funds (S123), and other major components of other financial corporations classified within subsectors S124 to S125 of ESA 2010, namely non-MMF investment funds and FVCs.

Types and Activities

A diverse range of activities are identified in the SPV sector, often taking place within a network of entities which facilitates intermediation activity elsewhere in the chain. The SPV database can help assess any potential financial stability risks arising from the activities of SPVs domiciled in Ireland, for example, if the activities of SPVs involve loan origination and bank-linked asset management. The range of activities undertaken is outlined in Table 1, with the corresponding percentage distribution of total assets shown in Figure 1. Fourteen different types of activity are identified for SPVs, although the top three categories account for 70 per cent in terms of total assets, namely, intra-group financing, external financing and fund-linked asset management.[9]

7 Further information can be found at: http://www.centralbank.ie/polstats/stats/reporting/Pages/spv.aspx.

8 'Section 110' vehicles cover the SPV population for the most part.

9 The only instances where an SPV could undertake more than one activity occurs for the operational and financial leasing categories and, in these cases, the vehicle is classified into the predominant activity in terms of assets held.

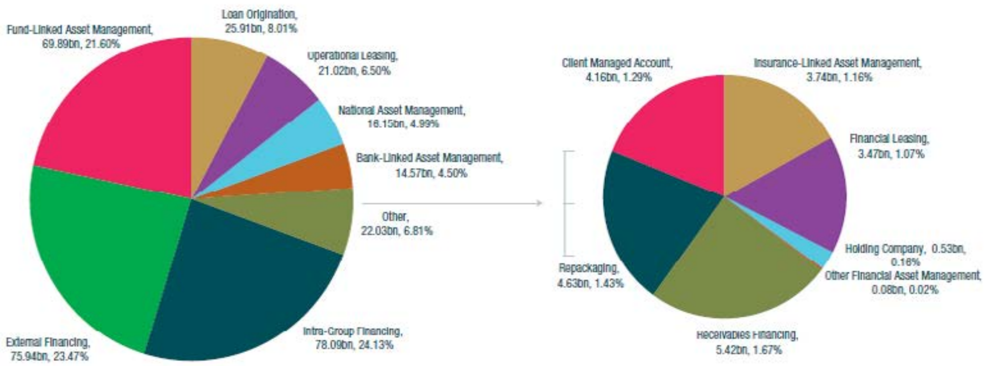
Table 1: Glossary of terms

Vehicle Type	Activity Description
Intra-Group Financing	Loan funding from, and to, inter group companies.
External Financing	Funding obtained from external sources and provided to the parent as a loan.
Fund-Linked Asset Management	Linked to investment funds/firms, which hold debt, equity, loans, or other financial assets with the goal of capital appreciation, interest or dividend income.
Loan Origination	Funding obtained from the parent and furthered to external sources.
Operational Leasing	Hold fixed assets such as plant and machinery for the purposes of leasing them out.
National Asset Management	Set up by national authorities to resolve insolvent financial institutions (incl. NAMA).
Bank-Linked Asset Management	Linked to deposit taking corporations, which hold debt, equity, loans, or other financial assets with the goal of capital appreciation, interest or dividend income.
Receivables Financing	Funding secured by trade/other receivables, furthered to the parent/external sources.
Repackaging	The proceeds and/or capital gains/losses from the SPV’s financial assets are structured so that investors obtain different exposure than had they simply purchased the assets.
Client Managed Account	Set up by financial institutions on behalf of clients which hold debt, equity, loans, or other financial assets with the goal of capital appreciation, interest or dividend income.
Insurance-Linked Investments	Primarily hold Insurance-Linked Securities such as catastrophe bonds, or investments in life settlement policies.
Financial Leasing	Engaged in lease-in lease-out agreements, or as a financial intermediary in a chain of vehicles in which the end vehicle is involved in the leasing of equipment or fixed assets.
Holding Company	Owns enough voting stock in another company to control its policies and management and exists for this sole purpose.
Other Financial Investments	Not linked to banks, client accounts, or investments funds/firms, but hold debt, equity, loans, or other financial assets with the goal of capital appreciation, interest or dividend income.
Other terms	**Description**
Consolidator	The ultimate parent of the SPV, into which the SPV's accounts are consolidated. Consolidation is determined by the ability to

	exercise a sufficient level of control over the entity.
Sponsor	This refers to the entity on whose behalf the SPV was established. For example, where an investment fund sets up a vehicle to hold assets, the fund manager would be considered the sponsor. If a bank sets up an SPV in order to remove mortgages from its balance sheet, this bank would be considered the sponsor. This does not however refer to a charitable trust that owns shares of the SPV in an orphan vehicle structure.
Residency	Refers to the country of residency of the consolidator/sponsor, and would not necessarily reflect the country of residency of the shareholders of these.

Intra-group financing is dominated by non-financial sponsors, mainly reflecting the treasury operations of multinational corporations and concentrated in a relatively small number of, mostly US-linked, vehicles. External financing also reflects such activities but also includes a sizeable presence of Russian banks issuing debt through the Irish stock exchange. Fund-link asset management would appear to be driven primarily by taxation neutrality considerations, availing of Ireland's extensive double taxation treaties, with UK-based sponsors featuring strongly. Bank-linked sponsors are mainly connected to vehicles with a focus on asset management activity designed to achieve capital appreciation. For bank sponsored vehicles loan origination is also a significant activity, though concentrated in a small number of vehicles.

Figure 1: SPV distribution by activity type (€bn and percentage of total assets)



Source: Central Bank of Ireland.

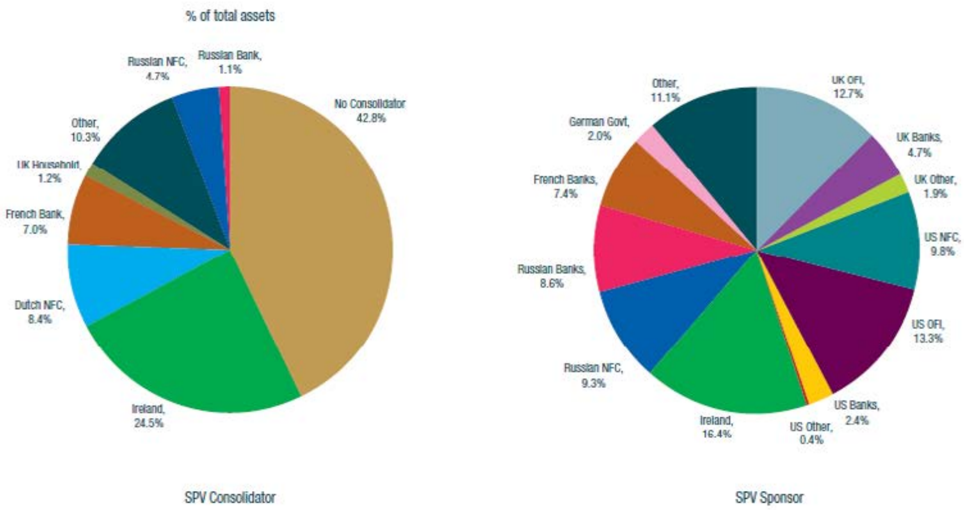
Linkages

The registration form provides data on the name, country, sector of the entity into which the SPV is consolidated and its sponsor, if any. Consolidation and sponsor information allow for a more precise analysis of any potential risks emanating from Irish SPVs. These risks would apply to the vehicle itself when it is unconsolidated, or would be otherwise attributable to the entity that the SPV is ultimately consolidated into. These parent entities are generally outside Ireland and could, on occasions, step in to protect the vehicle in particular circumstances. While some information is available on country and sector links, the extent of international co-operation required for a comprehensive analysis of SPV global linkages is evident.

The main cross-border consolidator links are to the Dutch and Russian NFC sectors and the French banking sector (Figure 2a). Unlike FVCs, which are bankruptcy remote vehicles, over half of Irish domiciled SPVs are consolidated into other entities. There are also linkages for the non-consolidated entities, with around one sixth declaring an unconsolidated interest by another entity. Geographic and sector linkages are also highlighted by the 'Other' sector, which includes 37 consolidator links to institutional sectors in 22 countries, reflecting relatively small SPVs engaged in a diverse range of activities.

While the range of SPV sponsors is quite diverse, typically the same type of sponsor tends to concentrate in similar activities. A broad overview of sponsor linkages suggests that UK and US OFIs, French and Russian banks and US and Russian NFCs are the most prominent sponsors of bankruptcy remote vehicles engaging in off-balance sheet activity (Figure 2b). The 'Other' sector includes 66 sponsorship links to sectors in 35 countries, a significantly larger network than for consolidation links.

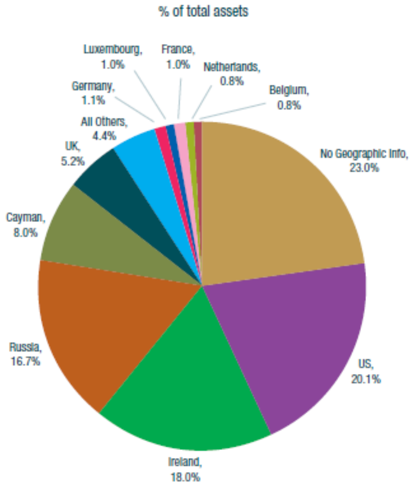
Figures 2a and 2b: SPV distribution by consolidator residency and institutional sector and sponsor residency and institutional sector (percentage of total assets)

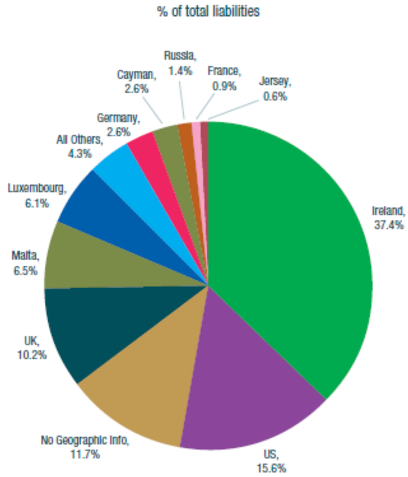


Source: Central Bank of Ireland.

Analysis of assets and liabilities on SPV balance sheets also allows for the identification of cross-border exposures, many of which arise as part of complex multi-vehicle structures (Figures 3a and 3b). US, Russia, Cayman Islands and UK stand out in terms of immediate cross-border linkages of Irish SPV assets. On the liability side, US, UK, Malta and Luxembourg represent the most important country linkages of Irish SPVs.

Figures 3a and 3b: Geographical linkages of SPV assets and liabilities (percentage of total assets and liabilities)





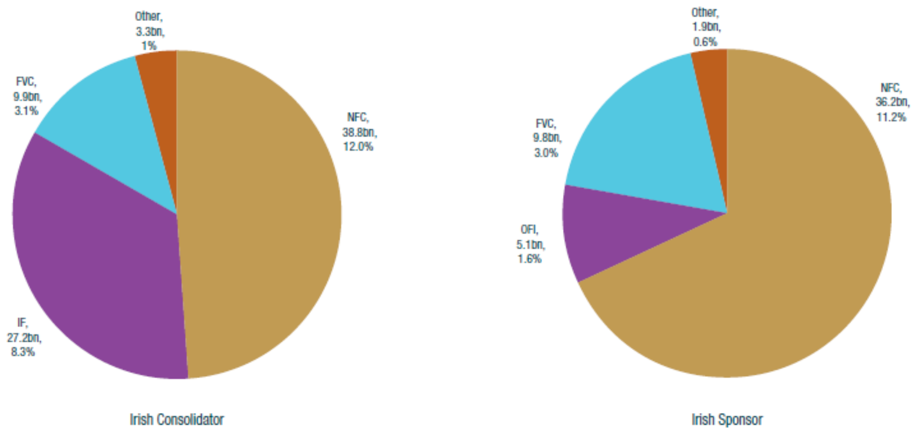
Source: Central Bank of Ireland.

Despite significant consolidation and sponsor links to domestic entities in the Irish NFC, investment fund, and FVC institutional sectors, the potential impact on the Irish economy from links to Irish SPVs appears to be limited (Figures 4a and 4b). Irish NFC links largely reflect a small number of SPVs sponsored by multinational companies domiciled in Ireland as part of intra-group funding activities for their global operations. A significant portion of the remainder is accounted for by external financing activities carried out by large multinationals and SPVs undertaking operational leasing activities involving aircraft.[10] In most cases, the SPV is both sponsored by and consolidated into the Irish NFC. Links to the Irish investment fund industry reflect international vehicle structures, mainly sponsored by funds located in the US, UK and Ireland. Finally, the link to the Irish FVC sector includes a resolution vehicle which is part of the NAMA[11] structure, as highlighted in the figures.

[10] Aircraft leasing is included with non-financial corporates within Irish national and financial accounts statistics.

[11] NAMA is an Irish state agency set up to hold distressed bank loans following the crisis. It is structured so that vehicles dealing with specific areas, such as loan management, property management or management services are 100 per cent owned by a master vehicle.

Figures 4a and 4b: SPV with IE resident consolidator and sponsor by institutional sector (€bn and percentage of total assets)



Source: Central Bank of Ireland.

The impact on Ireland from SPVs is very limited in terms of the contribution to Irish GDP. These entities are generally designed to be tax neutral. As such, the contribution to the domestic economy is limited, and is largely confined to the payment of fees for professional services, particularly in the legal and accountancy fields.

Implications for the Measurement of the Irish Shadow Banking Sector

The FSB conducts an annual shadow banking monitoring exercise, where non-bank financial entities are included within shadow banking unless a clear rationale can be presented for their exclusion. Ireland took part for the first time in 2015, providing results based on data up to Q4 2014. The FSB defines shadow banking as "credit intermediation involving entities and activities outside of the regular banking system" (FSB, 2015). The OFI residual was included in its entirety in the measurement of shadow banking for Ireland, on the basis that no breakdowns by type of activity were available.

Following the FSB's measure of shadow banking, which provides comparable cross-country estimates that are widely quoted, the quantification of the SPV sector has a significant impact on the size of shadow banking in Ireland. The 2015 FSB shadow banking monitoring exercise estimated the Irish shadow banking sector at €2.25 trillion for end-2014, including the entire OFI residual (€498 billion for end-2014) (FSB, 2015). The new collected SPV database provides a more precise identification of much of the Irish OFI residual, raising the prospect that over half of the SPV sector can be excluded from shadow banking in this year's exercise, based on data up to Q4 2015.

The FSB measure is relatively broad in terms of the range of shadow banking definitions that exist in the literature. The estimation of the size of the SPV sector would not necessarily have an impact on other definitions of shadow banking, where the SPV sector may not be included in the first place. McCulley (2007) refers essentially to non-bank financial institutions engaged in maturity transformation, where liabilities mature on average before asset holdings. Moreover, alternative academic definitions of shadow banking tend to focus on specific areas, such as money market funds, wholesale funding, deposit taking or lending activity, securitisation products or securities financing (Gorton et al., 2010; Gennaioli et al., 2011; Claessens et al., 2014 and Pozsar, 2014).

The FSB's main measure of shadow banking is relatively broad in a number of respects. Firstly, the definition is based on shadow banking activities covering credit intermediation involving significant maturity/liquidity transformation or leverage. These are outlined under five economic functions, namely, (*i*) mutual funds susceptible to runs, (*ii*) lending dependent on short-term funding, (*iii*) intermediation dependent on short-term funding or secured funding of client assets, (*iv*) facilitating credit creation, and (*v*) securitisation (FSB, 2015). Secondly, where an entity engages in such activity, the total assets of the entity are included. Thirdly, entities are included on a non-consolidated basis, so that if entity *x* is consolidated into another entity *y* shadow banking equals the sum of total assets of entities *x* and *y*. Exceptions are allowed where entity *y* is not a shadow bank (e.g. it may be a bank or an NFC). Entities sponsored by, but not consolidated into NFCs can also be excluded. Finally, the total assets of non-bank financial intermediaries are included, when there is insufficient evidence to prove they should be excluded. In the case of Ireland, the OFI residual was included in its entirety on this basis.

With respect to the FSB definition, the new collected SPV database provides some important insights. Credit instruments (issuing/holding debt securities or originating loans) can be identified, as can consolidation and sponsorship patterns. Table 2 provides estimates of the size of SPVs within the shadow banking sector in terms of total assets, based on the current FSB methodology (Column 1). However, SPVs should only be included where they are part of a shadow banking credit intermediation chain. This means that SPVs should be excluded where the balance sheet contains no credit instruments, or where they are consolidated into a bank or linked to an NFC. Columns 2 and 3 provide revised estimates after taking both of these adjustments into account. These estimates reduce the size of shadow banking activity linked to the SPV sector by €172 billion, as shown in column 4, from €324 billion to €152 billion as of Q4 2015. This is largely due to the exclusion of SPVs consolidated into non-shadow banking entities. It should be noted however, that the FSB definition is subject to refinement on an annual basis and estimates included in Table 2 are based on the methodology used in the 2015 FSB shadow banking monitoring exercise.

Table 2: Irish SPV Shadow Banking Total Asset Estimates based on the FSB's 2015 Methodology

Consolidated? If Yes, consolidator by sector. If No, sponsor by sector		Included in shadow banking?	(1) Total Assets of all Irish SPVs	(2) Total Assets of Credit SPVs	(3) Amount included in measurement of shadow banking	(4) Amount excluded from measurement of shadow banking
YES	Bank	NO	33.5	30.1	-	33.5
YES	Other financial corporation*	YES	57.9	46.2	46.2	11.7
YES	Non-financial corporation	NO	93.8	84.8	-	93.8
NO	Bank	YES	46.6	40.1	40.1	6.5
NO	Other financial corporation*	YES	70.7	65.4	65.4	5.3
NO	Non-Financial Corporation	NO	21.1	16.1	-	21.1
			323.6	**282.7**	**151.7**	**171.8**

Note: Figures in €bn. Source: Central Bank of Ireland, authors' calculations. *All SPVs linked to non-bank financial corporations are included in the adjusted shadow banking estimate following a prudent approach. It also includes a very small number of vehicles linked to non-profit entities that undertake similar activities to investment funds.

Conclusions

This paper explores a new database on SPVs collected by the Central Bank and provides some initial findings and analysis. The database covers 822 SPVs with aggregate assets of €324 billion in Q4 2015, improving oversight of these vehicles and filling data gaps. Key findings point to the diversity and complexity of the activities undertaken in the SPV sector, and the range of geographical and institutional sector linkages. The analysis of the new SPVs database has resulted in a €172 billion reduction in the measurement of the size of the shadow banking sector in Ireland.

Irish domiciled SPVs are often part of complex multi-vehicle operations operating across borders. The new collected database addresses important data gaps on SPV activities, and brings improvements for the assessment of potential financial stability risks arising from these. In this context, the need to co-operate across borders and to improve data sharing capabilities is essential to fully understand the rationale underlying SPV activities and any risks arising. The new data will, therefore, help inform discussions at international level, as the availability of granular data for SPVs is limited.

Work is ongoing within the Central Bank to further develop the SPV database. The SPVs database enhances coverage of the S127 subsector, and fosters work with the CSO to integrate these within macroeconomic aggregates. While the new database represents a significant step forward, further work is required, both domestically and at international level, to develop a full understanding of SPV activities and to better inform policy making in this area.

A key challenge is to develop a comprehensive register of all SPV type activities, including those not covered by 'Section 110'. The work also feeds into international initiatives at the FSB and the European Systemic Risk Board (ESRB) level to address data gaps on shadow banking. However, the cross-border nature of SPV activities highlights the need for international co-operation and data sharing to fully understand the rationale underpinning the various SPV structures.

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Measuring cross-sectoral shifts in credit provisioning: an enhanced framework[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Measuring cross-sectoral shifts in credit provisioning

An enhanced framework

Melle Bijlsma, Jan Kakes and Eric Klaaijsen

Measuring cross-sectoral shifts in credit provisioning

The financial crisis made clear that the credit intermediation process had in part shifted to non-bank entities, due to the emergence of shadow banking. Such cross-sectoral shifts have a long history and are likely to continue in the future, driven by several factors including financial innovation and new regulation. We discuss the consequences of using inadequate credit statistics for macroprudential policy. To avoid policy mistakes, monitoring of financial flows and related risks needs to be enhanced. In the Netherlands, this will be facilitated by a new statistical framework and extended macroprudential data collection powers.

Keywords: credit intermediation, non-banks, statistics macroprudential policy

JEL classification: E58, G21, G23

Contents

1. Introduction

Credit growth is a strong predictor of future financial crises, and as such a very relevant indicator for policymakers.[1] Adequately measuring it has however proven to be a complex task. Methodological issues aside[2], an important reason for this is the potential for missing relevant information. The nature of the financial institutions involved in the credit intermediation process is diverse and evolves over time. Although banks typically play a persistent central role, credit can also be extended or facilitated by a myriad of other institutions such as insurers, pension funds, investment firms, securitisation vehicles and financing companies. For compilers and users of credit data, this creates the risk of only partially observing or misinterpreting the figures at hand. A case in point is the run-up to the global financial crisis of 2007-2008, when part of the credit creation process shifted away from banks to other financial institutions less well observed by statisticians and policymakers leading - inter alia - to the coining of the term *shadow banking*. However, such cross-sectoral shifts in credit supply have a long history prior to this period and are likely to continue in the future. The need to properly calibrate newly developed macro-prudential tools has recently added to the importance of accurate credit statistics.

Generalizing the case, the recent crisis has illustrated our lack of insight into the financial system's vulnerabilities. Cross-sectoral shifts in credit growth and other activities are just one example; banks' exposures to complex products and systemic linkages across financial institutions and markets are others. This lack of insight partly reflects fundamental uncertainty, which will always play a role, also in future crises. To some extent, however, it also reflects data gaps and insufficient use of the available information. For statisticians and policymakers alike, the conceptual question is how to maximize the potential to track such vulnerabilities in a financial system that will keep evolving in the future. Better and more timely information is an important element of recent regulatory reforms. At the international level, the G20 data gaps initiative was launched in 2009 to improve the data needs that were revealed by the recent financial crisis.[3]

Better information not just depends on "more data", but also on the ability of policymakers to focus on the most relevant indicators and combine data sources in a flexible way. This involves two main challenges. First, from a conceptual point of view, policymakers need to acknowledge that statistical indicators are likely to become less accurate over time. Due to financial innovation and regulation, the financial system evolves continuously, which may reduce the reliability of indicators.[4] A specific example is "Goodhart's Law", which states that indicators become less reliable if they are linked to policy instruments. [5] Second, from an operational perspective, sufficient

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[1] See e.g. Schularick and Taylor (2012).

[2] See e.g. Carlier and Eggelte (2016) for a discussion on how pass-through capital flows have the potential to distort statistics on credit to the corporate sector, and ECB (2016) for a description of how the reporting of cash pooling activities can materially effect banks' business credit statistics.

[3] This initiative addresses data gaps including, for instance, the improvement of financial soundness indicators, a monitoring framework for global systemically important banks and the extension of data sharing arrangements. See Heath and Goksu (2016).

[4] See Borio (2010) and Eichner et al. (2015) for examples.

[5] According to Goodhart's original formulation, "Any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes", see Goodhart (1975).

flexibility is needed to ensure access to information when needed. Especially in a crisis, policymakers' data needs become more urgent and more specific. In practice, however, legal and operational obstacles hamper flexible access to information. Confidentiality may restrict access to existing data, while the possibility to collect additional data often lacks a legal basis.

This paper provides an illustration of the data challenges involved in measuring credit growth from the perspective of the Netherlands. To address the data challenges, DNB has enhanced its statistical framework to facilitate a flexible access to data. Elements of this enhanced framework are a more intensive cooperation between DNB and Statistics Netherlands, a better alignment of statistics and an extended legal basis to collect data for macro-prudential purposes.

The remainder of this paper is structured as follows. Section 2 discusses credit data by sector over time. Section 3 shows the implications of using different sectoral credit aggregates for the credit gap in the scope of the countercyclical capital buffer, and therefore the need for complete data. Section 4 describes the enhanced statistical framework for collecting and compiling these data. Section 4 concludes.

2. Credit statistics in the Netherlands

Credit provisioning by main financial sectors

Traditionally, in the Netherlands banks are the major providers of credits[6] to households and businesses (non-financial corporations). However, in the first decades after the Second World War, the Netherlands – just as many other countries – operated a policy of credit restrictions. This was done by formulating credit growth restrictions, which were part of monetary toolkit of De Nederlandsche Bank (DNB).[7] Until the early 1990s, DNB regularly imposed curbs on lending with the aim of keeping the growth in the money supply – and therefore inflation – under control. This prompted the development of credit vehicles outside the banking system, such as "near banking", in which businesses began lending to each other – with or without the mediation of a bank – or institutional investors took over a part of the intermediation function. DNB responded to these developments by extending the scope of credit restrictions. Presumably, there will be similar sectoral shifts in the future, for instance to the shadow banking system.

This is reflected in the credits to households and businesses (non-financial corporations) granted by institutional investors (insurance companies, pension funds and investment funds). In early 1990s, institutional investors' share in total loans, as well as for credits to households as for credits to businesses, was 28% (Graph 1). This amounted to 25% of GDP. The main loan components were residential mortgages granted by insurance companies and credits to businesses by pension funds. At that time insurance companies were a major player on the Dutch mortgage market, having a market share of 15%. In addition, credits to businesses by pension funds accounted for 15% of the total loans to non-financial corporations. This was supported by a lively

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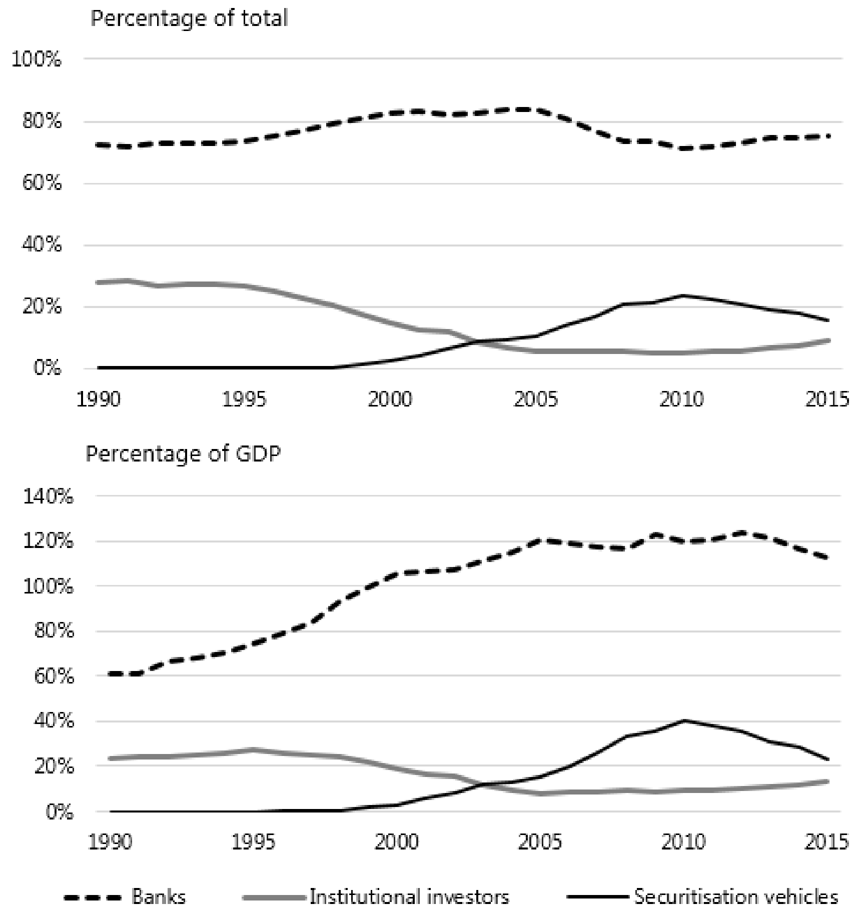
6 Meant here are private loans, excluding debt securities.

7 See De Greef, Hilbers and Hoogduin (1998).

market for private loans which existed in the Netherlands before the introduction of the euro.

In the subsequent years, institutional investors' share declined to 5% in 2008 (9% of GDP) due to both the strong increase in lending by banks, especially residential mortgages, and a shift in investments by institutional investors towards more liquid assets, particularly securities, in conjunction with a more active investment policy and the development of an European market for corporate bonds which drove out private loans to the background.

Graph 1: Credits to households and businesses by granting sector



In recent years, lending by institutional investors increased again, especially since 2012 with an annual average of 12%. In particular, investments in residential mortgages grew strongly. In 2015, lending to households and business reached a peak at EUR 92 billion. Due to the low interest environment and the search for higher yields, institutional investors expanded their investments in private loans and in particular in residential mortgages, also through new mortgage lenders or platforms. Investments in mortgages may also be boosted by the fact that Dutch life insurers prove to be relatively vulnerable to a prolonged low interest environment, which can be explained by long-term insurance liabilities and shorter term investments (known as the duration mismatch).[8] The provision of mortgage loans – which in the

[8] See De Nederlandsche Bank (2014)

Netherlands typically have fixed interest rates over a long period – provide a natural match with their liabilities that reduces their duration gap. Moreover, the current low-interest rate environment provides an additional incentive to enter the mortgage market, where interest rates are higher than in other fixed-income markets with a low risk profile.

Despite the strong increase, institutional investors' share of total credits granted by the main financial sectors in 2015 was 9% (14% of GDP), still well below its highest levels in the beginning of the nineties. Although e.g. the outstanding residential mortgage loans granted by insurance companies almost doubled in size, the share of insurers in the total of outstanding residential mortgages is still half of the 15% it was twenty years ago. Credits to businesses provided by pension funds, the other major historical component of loans granted by institutional investors, remain subdued in recent years. Outstanding amounts tumbled to only a tenth of the level of the early 1990s, and accounted for only 1% of the total loans to businesses in 2015 (declining from 15%).

In the meantime, in 1996 the first securitisation in the Netherlands took place. Securitisations involve bundling of credit assets, especially bank loans to households and businesses, which are then packaged and sold as marketable debt securities via dedicated securitisation vehicles. Securitisations constitute an additional source of funding, especially for banks. For this reason, the issuance of securitisations expanded enormously in the first decade of this century, mainly to finance the strong credit growth, particularly residential mortgages. In the years following the outbreak of the credit crisis (mid-2007), it became increasingly difficult to place securitisations with external investors, as trust in these products had been compromised. Still, a large number of retained securitisations were carried out. Banks did not sell these securitisations in the market, but retained them, principally for use as collateral in obtaining liquidity from central banks. From late 2009, placed (external) securitisation issues picked up again, although they have remained below pre-crisis levels, due in part to the market's continued ill reputation, stricter rules governing securitisations and weakened credit growth. Outstanding securitisations (placed and retained) reached a peak level at EUR 253 billion in 2010, with a 24% share in the total loans to households and businesses (34% for just households) and 40% of GDP.[9] In recent years, the favourable general funding terms prevailing on financial markets, which partly reflect the accommodating financing facilities offered by central banks, reduced incentives for banks to securitise assets. Furthermore, as already mentioned above, banks scaled back their exposure to residential mortgages, also reducing their funding requirements. The substantial expiring securitisations, both placed and retained, led to a further drop in outstanding securitisations to pre-crisis levels (about 16% of share in the loans of the non-financial sectors and 23% of GDP).

During the whole period, banks remained the dominant financial institutions granting credits to households and businesses. Their proportion of total loans outstanding increased from 72% in 1990 to a peak of 84% in 2004 and 2005 and returned to a lower level of 75% in 2015, almost their share in 1990. In recent years,

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9 This excludes securitisations of loans which were not derecognised by the originators (meaning that the securitised loans were kept on their balance sheet) in order to prevent double counting. Non-derecognised securitisations are not the same as retained securitisations. Loans of both placed and retained securitisations could be derecognised or not derecognised. Retained securitisations are, therefore, included here, as far as the securitised loans have been removed from the balance sheet of the originator.

banks' declining position in the mortgage market, partly attributed to a regulatory tightening including higher capital requirements, and a decrease in corporate lending had a negative impact on the volume of banks' loan portfolios. On the other hand, the expiration of securitisations caused an increase in banks' outstanding credits, especially on loans to households (mortgages), as those loans were transferred back to the banks' balance sheets.

Credit provisioning by other sectors

The above-mentioned developments are shown on the basis of the major part of the financial institutions granting credits to households and businesses, in this case banks, institutional investors (pension funds, insurance companies and investment funds) and securitisation vehicles[10]. For these institutions, detailed information is collected by DNB and available for further analysis, also on a micro level. There are, however, also other financial institutions providing loans to households and enterprises, such as finance companies and other financial intermediaries. On an aggregated level, data for these institutions are included in the national accounts. Loans held by these financial institutions comprise about 5% of total loans granted to households and enterprises. However, with regard to frequency, lending details and to a certain extent coverage, there is room for improvement. Apart from that, households and enterprises are borrowing from other sectors as well, especially non-residents, households and non-financial corporations (e.g. through intercompany loans). The non-resident share in credits to households and enterprises is 20%. For a good understanding and interpretation more insight into the credit granting sectors is needed. Another issue is peer-to-peer lending, such as crowd funding. In the Netherlands, the amounts concerned are still small, but the case for monitoring of these developments and future inclusion in the macroeconomic statistics is indisputable. The intermediation platforms involved would be well positioned to provide data on what is essentially household-to-counterpart lending, strengthening the case to include them into the macro-economic statistics framework.

3. Different sectoral credit aggregates: implications for the credit gap

Credit data are important for new macroprudential policy tools that have been introduced in recent years. One of these tools is the countercyclical capital buffer (CCyB), which is part of the Basel 3 buffer framework.[11] The CCyB requirement varies over time and is set by national jurisdictions. Through this mechanism, banks are required to build up an extra capital buffer during booms which they can draw down in a recession.

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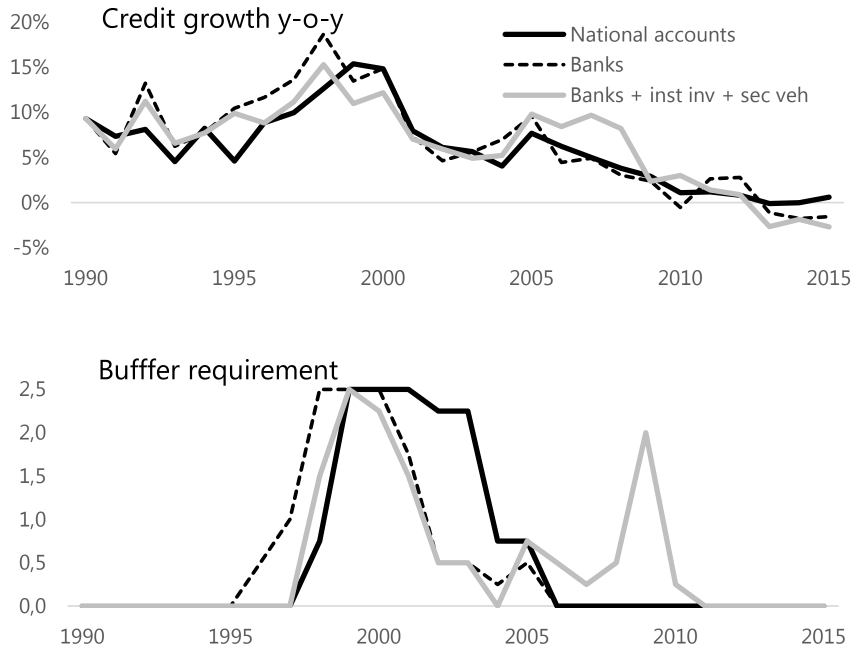
10 Securitisation vehicles do no grant new loans but acquire already provided loans. They are included here to prevent that securitised loans which are transferred to such vehicles and removed from the balance sheet of the originator, would be missing in the data on outstanding credits.

11 Three other macroprudential instruments that have been activated in The Netherlands are non-cyclical systemic capital buffers, the loan-to-value limit and the loan-to-income limit. See De Nederlandsche Bank (2016a).

The so-called "credit gap" is used as a common reference guide to set country-specific CCyB rates, although countries have flexibility to use additional indicators as well.[12] The credit gap is defined as the deviation from the credit / GDP ratio from its long-term trend, which is determined using a one-sided Hodrick-Prescott filter. In principle, credit should be a broad aggregate, including credit extended to households and firms by banks as well as non-banks. Based on this general guidance, it is up to the national authorities to choose the best aggregate.

Graph 2 Credit gaps and countercyclical buffer rates

Mechanical translation of credit gaps into CCyB buffer rates



The graphs above present credit growth rates and a mechanical translation into CCyB rate for three credit aggregates: (1) bank credit, (2) banks, institutional investors and securitisation vehicles and (3) a broad credit aggregate, published in the Dutch national accounts. The latter is the one currently used; the other two are the series as presented in Section 2. While growth rates of the three aggregates follow similar trends over a long period, there are also years in which they diverge significantly. This can have important implications for the associated CCyB rates. With a mechanical application of the broadest aggregate, the CCyB requirement would have been released about three years later than with the other two aggregates, which may have helped to contain the build-up of risks prior to the crisis. Moreover, with the "bank + institutional investors + securitisation vehicles" aggregate, the buffer guide would have turned positive again in 2009.[13]

12 See BCBS (2010).

13 Mechanically translating this into a higher buffer requirement, this would imply that the CCyB would have a pro-cyclical impact. In practice, however, the CCyB would have been released due to the crisis, so banks would not have to build up capital.

Of course, CCyB decisions are not mechanically linked to credit data and also require judgement. Nonetheless, this example shows that using different credit aggregates may have a significant impact on key policy indicators. To make an assessment which aggregate is most accurate, a deeper analysis of their main differences is needed.[14] While a broad aggregate is most likely to be immune to cross-sectoral shifts, it is also more likely to include elements that distort the indicator's function to reflect financial stability risks. For instance, the broad national accounts aggregate includes business-to-business lending, including intercompany loans through Dutch subsidiaries of foreign multinationals that are hardly relevant for the Dutch economy.[15]

Another element to take into account is the difference between continuous statistics as mostly applies to the - secondary (integrated) - national accounts and up-to-date statistics as mostly applies to the - primary (source) - sectoral statistics. In the national accounts priority is often given to the strategy of continuity in published time series. This means that data from different reference periods must be mutually comparable and do not contain breaks, which result from e.g. changes in the reporting population. In this case figures that denote a level, such as the amount of outstanding credit, may not always reflect the most up-to-date information available. Usually national accounts data are revised at periodic intervals to take such new information on board. Nevertheless, the implication of this strategy is that national accounts data do not always represent the best information on level figures that is available. [16]

4. Enhancement of the statistical framework

The analysis in Section 3 makes clear that comprehensive data on loans, including the financial flows between financial and non-financial sectors, are important for monitoring and policy analysis. Currently, most of these data are collected by DNB through several statistical requirements, such as sectoral statistics, sector accounts (as part of the national accounts) and the balance of payments. These data are used by Statistics Netherlands, which adds other sources for the compilation of the national accounts. However, for some financial sectors the data gathering is not comprehensive or detailed enough, at least not on a more frequent (than annual) basis. There are some weak spots, which require enhancement of the data collection to avoid that new developments are not taken on board. In the Netherlands, a new statistical framework will facilitate an improved monitoring of the financial sector as a whole.[17]

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14 See, for instance, the analysis by the European Systemic Risk Board (Detken et al, 2014), which compares the performance several specifications of the credit gap, using different credit aggregates.

15 See Eggelte, Bijlsma and Carlier (2016).

16 See Bos (2007).

17 This will improve data contributions to the Financial Stability Board's shadow banking monitoring exercise, see FSB (2015) and Van der Veer et al. (2015).

Enhanced statistical reporting and closer cooperation by authorities

In the new statistical framework, the close co-operation between DNB and Statistics Netherlands, which already existed for the collection and compilation of statistics, has been further strengthened. A new, consistent report has been developed for all financial sectors and the non-financial corporations, with the aim of compiling high-quality sector statistics (and meeting the relevant ESCB legislation), which will also serve as input for the national accounts. While the balance of payments takes a centre stage in the current Dutch system, in the new system it will be "derived" from the sector accounts. That is because there will be a comprehensive and consistent reporting framework that reconciles data for all observable sectors, covering both domestic and cross-border transactions and positions. Reporting institutions will have to provide a complete balance sheet and profit and loss account, with a breakdown by counterparty country and sector if relevant. The new process primarily focuses on the production of quarterly statistics. This will meet users' demand for consistent and high-quality quarterly macroeconomic statistics.[18] For this purpose, the balance of payments and the national accounts will also be aligned.

In addition, the division of labour between DNB and Statistics Netherlands will change. DNB will collect and compile all the data for financial institutions and data on securities (which are processed through the ESCB Centralised Securities Database), while Statistics Netherlands will do so for the non-financial sectors. This is in line with the competences and comparative advantages of both institutions.

Although the focus in the new statistical framework will be on quarterly data, DNB will collect and compile data on securities for all sectors on a monthly basis. This will provide basic input for the monthly balance of payments and will also produce monthly data for e.g. securities holdings statistics, which are increasingly used for policy analyses. Other data for all financial sectors needed for sector statistics and sector accounts (and balance of payments) will be gathered on a quarterly basis (except for data on banks, which on the basis van ECB Regulations will continue to l be collected monthly).

As mentioned, in this new framework of monthly and quarterly reports the coverage of institutions will be improved. This will be achieved through the implementation of a direct reporting regime for the larger entities in the subsectors that are currently compiled using indirect sources, such as annual reports. This is the case for finance companies and other financial institutions, such as financial holdings and head offices of financial institutions. Some of these groups of institutions are certainly relevant to monitoring lending to non-financial sectors and shadow banking developments. For others, this relevance seems more limited ex-ante, but they still are needed for establishing a coherent framework for flows between all financial sectors and thus to provide policymakers with a complete picture of the financial sector on quarterly basis.

Extended data collection powers

The changes discussed so far are important to increase the availability and consistency of macroeconomic statistics. The internally consistent sectoral accounts and balance of payments data provide a powerful combination to policymakers: the

[18] See Bieleveldt and Claassen (2014).

former provides detailed data on balance sheets and domestic exposures, while the latter provides rich information on international capital flows. Furthermore, given that entities in all financial subsectors will be subjected to direct statistical reporting, the risk of vulnerabilities shifting away into unobserved parts of the system is reduced.

However, these statistics are not specifically designed for financial stability purposes. In practice, there are also data needs and queries that go beyond the data that are collected for macroeconomic statistical requirements. In such cases of further information needs, DNB will collect additional data on an ad hoc basis. Legal powers to collect information have been extended in the Banking Act in 2015 (see box). More specifically, DNB can request data to support its financial stability task and, its task to collect and produce statistics, and to comply with information requests from international organisations (BIS, FSB and IMF). As an example, DNB recently used these legal powers to collect a granular loan-by-loan dataset of financial institutions' credit exposures to the commercial real estate sector.

The two elements of the DNB's statistical framework – enhanced access to regular statistics and powers to collect additional information – are in line with recent studies on statistical data collection for financial purposes.[19] The overall view in these studies is that authorities should follow two-step approach. The first step is the use of general information, typically aggregate data, to spot imbalances.[20] The second step is to collect information that is needed for more specific analysis, which may be triggered by general concerns in step 1. As it is impossible to specify in advance what would be needed for step 2, it is most efficient to arrange flexible access to information, and give the relevant authorities – in this case DNB – legal powers to collect information. In order to use these powers quickly and effectively, it is considered helpful that DNB can leverage on the existing reporting relationships and registers of financial entities that exist for the purposes of for the macro-economic statistics.

The enhanced regular statistical framework and the possibility to extend the gathering of data lead to more complete data sources, which should facilitate policymaking. Together with other initiatives by various international organisations to close data gaps – among which data on derivatives, securities lending, G-SIFIs (Global Systemically Important Financial Institutions) and loan-by-loan data – this is important to provide the information that is needed for policies to promote financial stability.

DNB's extended data collection powers

After the recent crisis, it was concluded that data collection powers of DNB should be extended to improve monitoring and analysis of systemic risk. The new data collection powers are included in the Bank Act, and are linked to DNB's new financial stability task as well as its statistical task.

In its motivation to this extension of the Bank Act, the Government referred to the need to be able to collect data from firms that usually do not report to DNB, for instance because they are not regulated. Moreover, a reference was made to

[19] See Borio (2010), Cecchetti et al. (2010) and Eichner et al. (2015).

[20] This goes beyond the statistical framework described in this paper, which focuses on data reporting for statistical purposes, but also includes other information (e.g. asset prices, non-financial statistics).

international data gaps and the importance to meet data requests from international organisations, particularly the BIS, the FSB and the IMF.

A number of checks and balances are put in place to ensure that DNB's extended powers to not lead to excessive administrative burden. DNB should always check first whether a specific data need can be met with the information DNB already possesses through its other tasks (such as monetary policy, statistics and supervision). If that is not the case, a three-step procedure must be followed:

1. Check whether the information is available in other government agencies, such as the tax authority.
2. If this is not the case, check whether the information is available in non-government organisations that are financed by the government or by levies. Examples are the land registry and the Chamber of Commerce.
3. If the information is not available from any of these sources, DNB can request information from enterprises, corporate bodies, institutions and professionals. These may be institutions that are regulated by DNB, such as banks, or non-regulated firms.[21]

This approach acknowledges that it is hard to know in advance what information is needed to monitor financial stability risks, as relevant developments may take place outside the regulated sectors. In addition, it is important firms can be requested to provide information even if they are not "responsible" for specific risks. For instance, the land registry collects relevant information on real estate which may be used.

Finally, in the implementation of its data collection powers, DNB closely cooperates with Statistics Netherlands. This is because much of the information in step 1 and 2 is already available in the databases of Statistics Netherlands, which also has a lot of expertise in linking various datasets. This facilitates access to the data in a format that can easily be used for risk analyses.

5. Conclusion

Better and more timely information is essential to get more grip on financial stability risks. Due to regulatory reforms, more data is becoming available for risk analyses. However, just "more data" is not enough. Policymakers should also enhance their access to information when data gaps arise and have the flexibility to collect additional data. An example, which is explored in this paper, is the importance to track cross-sectoral shifts in credit provisioning. Credit aggregates play an important role in setting macro-prudential instruments. But credit-based indicators are likely to change over time, as we have seen in the past, leading to inadequate statistics.

To avoid policy mistakes, monitoring of financial flows and related risks needs to be enhanced. In the Netherlands, this will be enhanced by a new statistical framework that involves closer cooperation between DNB and Statistics Netherlands, a better

[21] In the case of information from regulated firms, the possibility to request information is relevant insofar as DNB cannot do this on the basis of its other tasks, such as monetary policy or supervision. An example is recent data collection on real estate, see De Nederlandsche Bank (2016b).

alignment and coverage of statistics and an extended legal basis to collect data for macro-prudential purposes.

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Enhancing euro area data on loans to the private sector adjusted for sales and securitisation[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Enhancing euro area data on loans to the private sector adjusted for sales and securitisation

Clive Jackson and Anna Michalek[1]

Abstract

Monitoring banks' lending to the economy is a key element of the ECB's monetary analysis. For the interpretation of developments in lending it is important to properly account for the potential distortionary effects arising from loan transfers between banks and non-banks. This paper discusses two methods of adjusting loans series for sales and securitisation. The first method was introduced by an ECB statistical regulation implemented in 2010 to correct banks' balance sheets developments for the impact of loan transfers. The second method – introduced by the ECB in September 2015 and replacing the former method – focuses on loans originated by banks whether or not these are on or off their balance sheets, thus providing a more comprehensive view on loans to the real economy. This paper also presents some information regarding ongoing work to provide users with improved measures of euro area lending.

Contents

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1. Introduction

Monitoring banks' financing of the economy is a key element of the European Central Bank's (ECB) monetary analysis, as bank lending is a key channel through which monetary policy decisions are transmitted. Policy makers therefore need to monitor the provision of funding to households and non-financial corporations from the banking system. Reliable statistics are required for this task, and they need to be periodically reviewed in light of financial innovations or updated user needs. An innovation which has had particularly strong implications for monitoring banks' lending has been the practice of securitisation by banks. The ECB has aimed to remove the distortionary impact of securitisation (and other transfers) by "adjusting" loans series for sales and securitisation. This provides a better picture of actual credit developments from the perspective of the borrower, and enhances the comparability of cross-country data. This paper discusses these developments in the context of ECB's monetary financial institution (MFI) balance sheet statistics which are the basis for monetary analysis.

The following section provides background on the relevance of securitisation in light of its impact on MFI balance sheets. Section 3 reviews the change in methodology used to calculate adjusted loans series and the impact of the new approach. Section 4 provides information on the efforts of the ECB in close cooperation with national central banks (NCBs) to produce long historical back data on adjusted loans to the euro area private sector[2], households and non-financial corporations (NFCs), while Section 5 concludes.

2. Relevance of securitisation activities for statistics

Securitisation, in general terms, is a practice where an asset or a pool of cash flow-producing assets is converted into marketable securities. In particular, securitisation allows banks to transfer credit risk and create liquid instruments out of normally illiquid loans. This was the reason why the practice became an important element of some banks' business models up to 2007. With the onset of the financial crisis however, most securitisation activity in the euro area was related to the need to create collateral for central bank borrowing. Instead of being placed with investors, the instruments resulting from the securitisation transactions were "retained" by banks.

From the statistical perspective, securitisation and other loans transfers which result in a change in the reported stocks on MFI balance sheets impede the proper analysis of lending to the real economy. The ECB has been publishing data on loans adjusted for sales and securitisation since December 2008.[3] This first covered only loans to the private sector as a whole and was based on data collected from NCBs in a short-term approach (on a non-harmonised and "best effort" basis). The requirements were then formalised in Regulation ECB/2008/32 on MFI balance sheet statistics,[4] which was implemented in 2010. The adjustment was possible through the

2 Private sector refers to euro area non-MFIs excluding general government.

3 See ECB (2009).

4 Regulation (EC) No 25/2009 of the European Central Bank of 19 December 2008 concerning the balance sheet of the monetary financial institutions sector (Recast) (ECB/2008/32), OJ L 15, 20.1.2009, p. 14.

collection of data on the net amount of loans transferred from MFI balance sheets during the month in order to correct a negative flow resulting from loan derecognition (or positive flow due to loans being transferred back to the balance sheet). The adjusted series also covered breakdowns of the total private sector, including households and NFCs. Other data relating to securitisation were also collected from MFIs, including data on securitised loans which are not derecognised from the balance sheet[5] or continue to be serviced by MFIs after their derecognition.[6]

These new data were released for the first time in June 2011[7] and the loans series adjusted for sales and securitisation became one of the headline series in the monthly press releases on monetary developments in the euro area.

3. Change in methodology from an MFI balance sheet to a borrower perspective

As part of the process to update Regulation ECB/2008/32, the ECB and NCBs – through the Working Group on Monetary Financial Statistics (WG MFS) of the ESCB Statistics Committee – carried out a consultation on user requirements. Responses to the consultation included a request that the adjustment for loan sales and securitisation should take into account the ongoing developments in derecognised loans subsequent to their transfer. This would provide a view of loans originated by MFIs and still outstanding from a borrowers' perspective. The data necessary for the amendment to the adjustment method were included in the recast regulation on MFI balance sheet statistics (Regulation ECB/2013/33).[8]

As described in the previous section, the method of adjusting for loan sales and securitisation before the introduction of Regulation ECB/2013/33 (the "former method") consisted of a one-off adjustment to the loan transactions to remove the impact on MFI balance sheets of (net) transfers of loans off-balance sheet in the period in which the transfer took place. No further information relating to the derecognised loans was taken into account in the subsequent periods (e.g. loan repayments by borrowers). Similarly, the outstanding amounts of loans derecognised in a securitisation or other transfer were not reflected in growth rates.

In contrast, the method applied under Regulation ECB/2013/33 (the "current method") takes into account not only the impact of loan transfers, but also the ongoing developments in derecognised loans, insofar as data are available.[9] It also

5 The derecognition of transferred loans from the (statistical) balance sheet of MFIs normally follows the accounting rules in the reporting of transferred loans. For instance, where the MFI applies the International Financial Reporting Standards (IFRS) at the solo level, the transfer may not meet the test for derecognition (based on transfer of risk and rewards and surrender of control of the assets).

6 These data were also collected to complement the new statistics on financial vehicle corporations which were also introduced by an ECB Regulation at that time. These data became crucial for the change in the adjustment method and calculation of historical data, as detailed in Section 3 and in the Annex.

7 See ECB (2011) for more information on the new data released at that time.

8 Regulation (EC) No 1071/2013 of the European Central Bank of 24 September 2013 concerning the balance sheet of the monetary financial institutions sector (recast), OJ L 297, 7.11.2013, p. 1.

9 Data on securitised loans which have been derecognised are collected from euro area MFIs under Regulation ECB/2013/33 where the loans are still serviced by the MFIs. Some NCBs also provide

considers the outstanding amounts of loans derecognised in a securitisation or other transfer in the calculation of the adjusted growth rates. This provides a more comprehensive view on loans to the real economy originated by euro area banks and improves the comparability of country-level data, regardless of the accounting practices applicable to loan transfers.

The calculation of outstanding amounts, transactions and annual growth rates for the unadjusted series, as well as the former and current methods of adjustment, are summarised in Table 1.

Table 1: Overview of adjustment methods for loan sales and securitisation

	Outstanding amounts	Transactions	Growth rate (in period *t*)
Unadjusted	L_t^{MFI}	F_t^{MFI}	$\frac{F_t^{MFI}}{L_{t-1}^{MFI}}$
Former method	L_t^{MFI}	$F_t^{MFI} + N_t$	$\frac{F_t^{MFI} + N_t}{L_{t-1}^{MFI}}$
Current method	$L_t^{MFI} + L_t^{DR}$	$F_t^{MFI} + N_t + F_t^{DR}$	$\frac{F_t^{MFI} + N_t + F_t^{DR}}{L_{t-1}^{MFI} + L_{t-1}^{DR}}$

L_t^{MFI} = Outstanding amounts of loans on MFI balance sheets at the end of period *t*

F_t^{MFI} = Transactions in loans on MFI balance sheets in period *t*, not adjusted for sales and securitisation

N_t = Net transfers of loans off MFI balance sheets with derecognition (disposals minus acquisitions) in period *t*

L_t^{DR} = Outstanding amounts of derecognised loans at the end of period *t*

F_t^{DR} = Transactions in derecognised loans *excluding transfers* during period *t*, i.e. the repayments of derecognised loans

The difference in adjusted annual growth rates between the current and former methods can be decomposed into two effects:

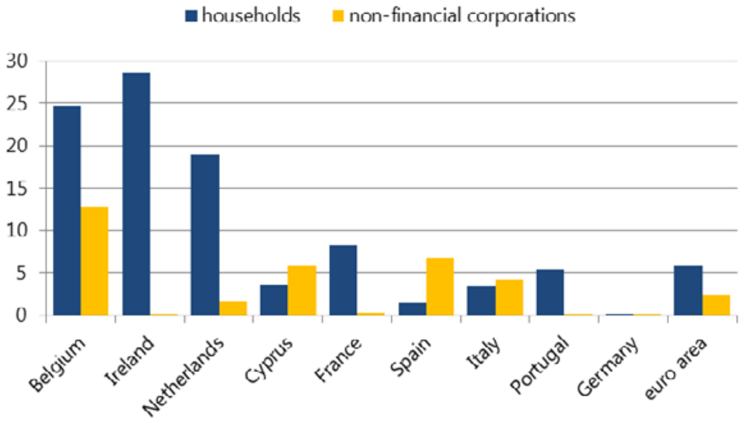
1. Flow effect – the inclusion of repayments of derecognised loans (F_t^{DR}) in the current method results in lower adjusted flows of loans compared with the former method.
2. Stock effect – the inclusion of derecognised loans' stocks (L_{t-1}^{DR}) contributes to making positive growth rates lower, or negative growth rates less negative, under the current method compared with the former method.

The quantitative impact on growth rates therefore depends on the relative scale of derecognised loans compared to on-balance-sheet loans (see Chart 1), and the characteristics of the derecognised loans – e.g. the shorter the average residual maturity of the derecognised loans, the lower the growth rates delivered by the current method relative to the former one, as the rate of principal repayments in comparison to outstanding amounts is generally higher.

available data on loans not serviced by MFIs (e.g. where the servicing of loans is performed by another part of the banking group) or for loans that have been transferred to non-MFIs in transactions other than securitisation.

Chart 1: Share of derecognised loans to total outstanding loans

June 2016, percentages



Sources: ECB and ECB calculations.

Note: Total outstanding loans means those both on- and off- MFI balance sheets. Derecognised loans volumes are not relevant for the euro area countries not shown.

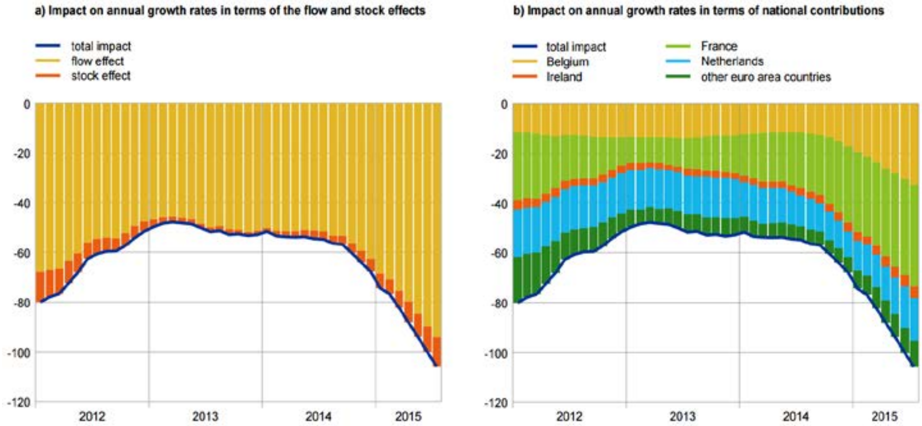
The new enhanced adjusted loans data were published by the ECB in September 2015. In line with the above effects, the current method of adjustment tended towards lower growth rates than the former method, although the euro area trends remained basically unchanged.

For loans to households (Chart 2), the difference in growth rates came from countries with a relatively large share of derecognised loans, which resulted in greater loan repayments being included under the new method. The main national contributors to the overall impact of the new method were Belgium, France and the Netherlands which have a large share of derecognised loans to euro area households (Chart 1). On average for the period January 2012 to July 2015 (when the former method was discontinued)[10] the current method produced annual growth rates around 60 basis points lower for the euro area.

10 These data refer to the impact of the current method at the time of its introduction and do not include subsequent changes or revisions. See also ECB (2015a) on the changeover to the current method.

Chart 2: MFI loans to euro area households: impact of the current method on annual growth rates

Basis points difference in annual growth rates, non-seasonally adjusted



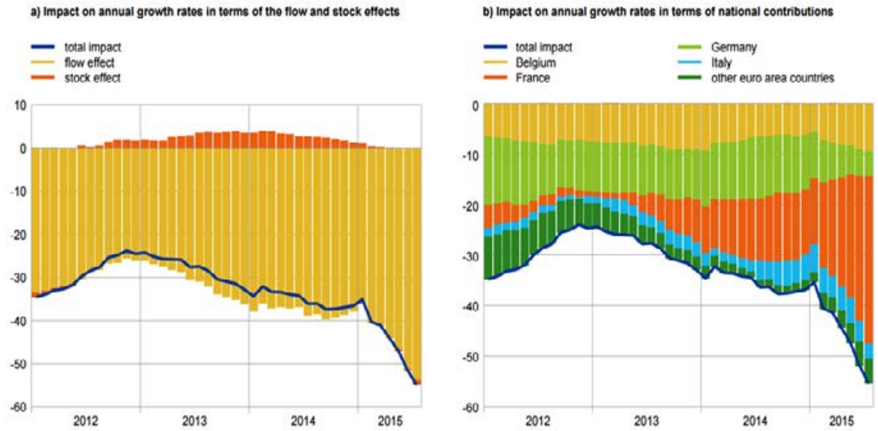
Sources: ECB and ECB calculations.

Note: Impact on the growth rate of the current method when it was introduced (latest observation: July 2015).

While derecognised loans to NFCs as a share of total NFC loans was quite low, the annual growth rates under the current method were on average around 30 basis points lower than the former methods for the period January 2012 and July 2015 (Chart 3). This resulted from the fact that NFC loans tend to have shorter maturities, resulting in repayments that are large relative to the outstanding amounts. The main national contributions to the lower growth rates under the current method came from Belgium, France and Germany which had the majority of derecognised loans to euro area NFCs. In France, increased securitisation activity at shorter loan maturities resulted in an increasing impact from 2014.

Chart 3: MFI loans to euro area non-financial corporations: impact of the current method on annual growth rates

Basis points difference in annual growth rates, non-seasonally adjusted



Sources: ECB and ECB calculations.

Note: Impact on the growth rate of the current method when it was introduced (latest observation: July 2015).

4. Compiling historical data on adjusted loans

As there are significant differences between the adjusted loans series resulting from the former and current methods, the need arose to avoid a break in methodology in loans series in order to produce times series of sufficient length to be useful for analytical purposes. The time series of adjusted loans can be split into three periods:

- Up to December 2009, for which data were compiled by NCBs on a "best effort" basis from available sources;
- January 2010 to November 2014, for which data were collected under Regulation ECB/2008/32 and the adjustment was based on loan transfers only; and
- From December 2014, for which all data necessary for the current adjustment are collected under the ECB/2013/33 framework.

The first priority was to compile consistent series for adjusted loans to households and NFCs from 2010 onwards. In advance of the implementation of the new Regulation ECB/2013/33, the WG MFS began to explore the possibility to provide data on the current adjustment method based on the older reporting requirements. As Regulation ECB/2008/32 included quarterly requirements on securitised loans which are serviced by MFIs – whether these loans are still on-balance sheet or not – in addition to monthly data on non-derecognised loans, there was already some basis for estimating data specifically on derecognised loans. (The method for deriving monthly adjustment data from available quarterly loan servicing data is outlined in the Annex.)

Besides the quarterly data collected under Regulation ECB/2008/32, some NCBs also collected these or similar requirements on a monthly basis. Based on data reported directly by MFIs and/or estimations, the publication in September 2015 of loans to households and NFCs adjusted for sales and securitisation included data on a comparable basis from the beginning of 2010. This release was able to fully replace the time span of data previously available to users under the former method.

In the next stage, the data for the period up to December 2009 were examined to see if internally available data on derecognised loans to households and NFCs could also be made consistent with subsequent data. ECB internal users, in particular, requested longer time series for the analysis of loans developments in a historical context – and ideally encompassing the situation before the financial crisis.

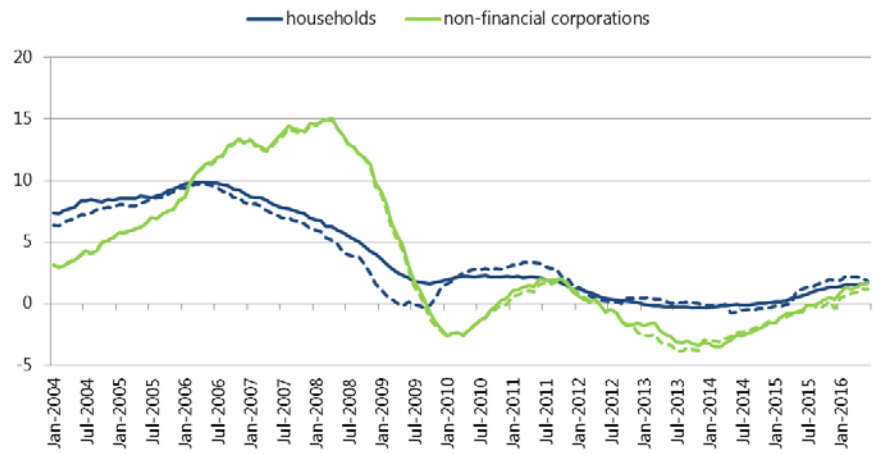
Following this request, the ECB together with the euro area NCBs where securitisation was relevant before 2010[11] performed an exercise to extend euro area back data on loans to households and NFCs adjusted for sales and securitisation to the period from 2003 to 2009. This was possible due to the fact that some data on adjusted loans to the private sector were already available for this historical period as well as by using additional back data available at the NCBs. The historical data back to January 2003 (January 2004 for annual growth rates) were published by the ECB in May 2016. These data marked a significant enhancement in availability of data on adjusted loans to users and marked an improvement on the internal estimates that they had been using prior to the back data exercise. This concerned especially loans to euro households where the euro area adjusted growth rate has a markedly different pattern to the unadjusted growth rate in the period before 2010 (Chart 4).

[11] These were Belgium, Germany, Ireland, Greece, Spain, France, Italy, the Netherlands, and Portugal.

The differences for certain countries are even more significant in that period (see Chart 5).

Chart 4: MFI loans to euro area households and non-financial corporations

Annual growth rates, non-seasonally adjusted

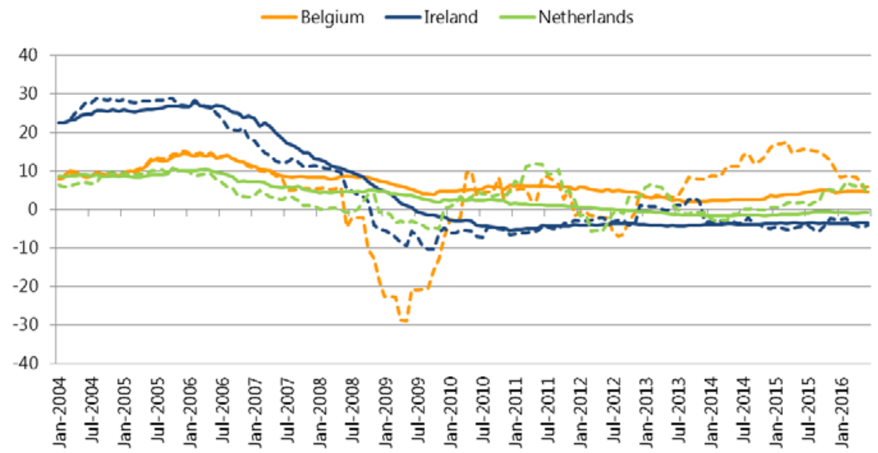


Sources: ECB and ECB calculations.

Note: Solid lines represent the adjusted series and dotted lines represent unadjusted series. The latest observation is for June 2016.

Chart 5: MFI loans to euro area households: selected country data

Annual growth rates, non-seasonally adjusted



Sources: ECB and ECB calculations.

Note: Solid lines represent the adjusted data and dotted lines represent the unadjusted data. The latest observation is for June 2016.

5. Conclusion

Monetary and financial statistics need to remain relevant for policy purposes within a changing landscape of financial innovation and new demands of policy-makers. As remarked in ECB (2012) in connection with the treatment of repos and reverse repos with central counterparties: "*A strength of the ECB's monetary analysis is the virtuous circle it creates between the policy analysis and the statistical framework.*"

In close cooperation with users and NCBs, the ECB has been able to enhance statistics on lending to circumvent the distortionary impact of loan sales and securitisations through the publication of long and consistent times series on loans to the euro area private sector, and in particular households and NFCs.

Work continues to provide improved indicators to users for their analysis. This includes for example a further enhancement to adjusted loans series implemented in July 2016 which excludes the impact arising from "notional cash pooling" (a type of cash management service mainly offered by MFIs in the Netherlands).[12] Besides this, efforts are being made based on data provided by NCBs and estimations to provide long time series with additional breakdowns, with the highest priority being loans to households by purpose (i.e. house purchase, consumer credit and other lending).

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[12] This change was implemented with the ECB press release on monetary developments on 27 July 2016, with an accompanying explanatory note. For further information on types of cash pooling and the implications for MFI balance sheets, see Colangelo (2016).

Annex: Estimating monthly adjustments from quarterly loan servicing data

Where data from NCBs were not available as far back as 2010, estimates of derecognised loans were carried out using monthly and quarterly data collected under Regulation ECB/2008/32 in order to replace the former method of adjustment with a long time series of data constituent with the current method of adjustment. The main source of data was statistics collected on securitised loans serviced by MFIs, which included both derecognised and non-derecognised volumes.

These estimations had three steps:

1. Quarterly estimates for the outstanding amounts of derecognised loans were calculated from the quarterly data on the outstanding amounts of securitised loans serviced by MFIs minus the outstanding amounts of loans securitised and not derecognised from the MFI balance sheet (monthly data).
2. Quarterly estimates for financial transactions excluding loan disposals and acquisitions (i.e. loan repayments) were derived using the above quarterly estimates of the outstanding amounts of derecognised loans, quarterly reclassifications of derecognised loans, and the monthly data on the net flows of loans securitised with derecognition from the balance sheet.
3. These above quarterly items were used to calculate financial transactions excluding loan disposals and acquisitions and outstanding amounts for months between quarter-ends. For this purpose, it was assumed that the loan repayments in a month are dependent on the outstanding amount of the previous month and that this "amortisation rate" is constant for the quarter. In this way, the monthly amortisation rate which satisfies the given data for a quarter can be derived.

The necessary data for calculating adjusted monthly loan growth rates are provided in Table 2, including the elements which are available from Regulation ECB/2008/32; i.e. the quarterly outstanding amounts of derecognised loans and the monthly net flows of loans securitised with derecognition.

Table 2: Data necessary for monthly adjustments of loan growth rates

	Outstanding Amounts	Net Flows	Reclassifications	Financial transactions excluding loan disposals and acquisitions
End-quarter (t=0)	L_0 (*)	-	-	-
Month 1 (t=1)	L_1	N_1 (*)	X_1	F_1
Month 2 (t=3)	L_2	N_2 (*)	X_2	F_2
Month 3 (t=3)	L_3 (*)	N_3 (*)	X_3	F_3

(*) denotes items that are available from Regulation ECB/2008/32 data.

These elements in Table 2 can be used to illustrate the estimation of the monthly outstanding amounts and financial transactions excluding loan disposals and acquisitions. The quarterly servicing data and monthly data on non-derecognised loans include requirements for loan reclassifications. The quarterly reclassification, *X*, may therefore be calculated as:

$$X = X_1 + X_2 + X_3$$

As the monthly reclassification adjustments in derecognised loans are not known from Regulation ECB/2008/32 data, for the purposes of the estimations carried out so far, the quarterly reclassification, *X*, was applied in the third month of the quarter – i.e. it is assumed that X_1 and X_2 are zero and $X_3 = X$.[13]

Quarterly data on financial transactions excluding loan disposals, *F*, can be derived from the available Regulation ECB/2008/32 data:

$$\begin{aligned} F &= F_1 + F_2 + F_3 \\ &= L_3 - L_0 - \sum_{t=1}^{3} N_t - X \end{aligned}$$

A monthly rate of amortisation, *f*, is defined as the share of the outstanding amount of the month t-1 which is repaid by borrowers during month *t*. The monthly rate of amortisation is assumed constant for the three months of a given quarter. This rate of amortisation must be less than or equal to 1 (where a value of 1 means full repayment), and should normally be greater than zero.

$$f = \frac{-F_t}{L_{t-1}}; \quad 0 \leq f \leq 1$$

$$F_t = -f L_{t-1}$$

First, the outstanding amounts of derecognised loans may be expressed in terms of available Regulation ECB/2008/32 data and *f*:

$$\begin{aligned} L_1 &= L_0 + N_1 + X_1 + F_1 \\ &= L_0 + N_1 + X_1 - f L_0 \\ &= L_0(1-f) + N_1 + X_1 \\ L_2 &= L_1 + N_2 + X_2 - f L_1 \\ &= L_0(1-f) + N_1 + X_1 + N_2 + X_2 + f[L_0(1-f) + N_1 + X_1] \\ &= L_0(1-f)^2 + (N_1 + X_1)(1-f) + N_2 + X_2 \end{aligned}$$

And similarly, the end of quarter outstanding amount can be derived:

$$L_3 = L_0(1-f)^3 + (N_1 + X_1)(1-f)^2 + (N_2 + X_2)(1-f) + N_3 + X_3$$

Rearrangement of the above equation for L_3 provides the following cubic equation in (1 – *f*) which is the basis for determining the monthly rate of amortisation which satisfies the given data for the quarter. This equation can be solved to find the rate of amortisation, *f*.

$$L_0(1-f)^3 + (N_1 + X_1)(1-f)^2 + (N_2 + X_2)(1-f) + N_3 + X_3 - L_3 = 0$$

[13] Such reclassifications in the data are very rare, although the volumes can be large when they occur. If possible (e.g. where known from other sources) the reclassifications were applied to a specific month in the quarter, rather than the default of third month of the quarter.

The monthly developments in outstanding amounts and financial transactions excluding loan disposals and acquisitions can therefore be derived from the data collected in the Regulation ECB/2008/32 and the rate of amortisation, f, as summarised in Table 3.

Table 3: Summary of the derivation of data on derecognised loans

	Outstanding amounts of derecognised loans	Financial transactions excluding loan disposals and acquisitions
End-quarter (t=0)	L_0	-
Month 1 (t=1)	$L_1 = L_0\,(1-f)+N_1+X_1$	$F_1 = -f\, L_0$
Month 2 (t=3)	$L_2 = L_0\,(1-f)^2+ (N_1+X_1)(1-f)+N_2+X_2$	$F_2 = -f\,[\, L_0\,(1-f)+N_1+X_1\,]$
Month 3 (t=3)	L_3	$F_3 = -f\,[\, L_0\,(1-f)^2+ (N_1+X_1)(1-f)+N_2+X_2\,]$

Due to the fact that some NCBs were collecting quarterly Regulation requirements also at a monthly frequency, for most countries the above estimation method was not required to derive monthly adjustments data but was used only for checking purposes.

The above method may be extended and adapted for the estimation of loans to households broken down by loan purpose, however these estimates are more challenging as the level of data which was collected in the historical period is more restricted (unless NCBs have collected data beyond the ECB Regulation requirements applicable at the time), and so additional assumptions are necessary. Efforts will continue in this direction in order to supplement the available data with further breakdowns of loans adjusted for securitisation.

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What drives shadow banking? A dynamic panel evidence[1]

SungJun Kim, Bank of Korea

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

What Drives Shadow Banking?:[1]

A dynamic panel evidence

SungJun, Kim[2]

Abstract

This paper examines what drives shadow banking by employing dynamic panel estimation. Utilising annual data from mainly G20 countries for 2002~2013 periods, we provide empirical evidence which suggests that long-term institutional investors including pension funds, insurance companies play a pivotal role in the growth of shadow banking. Our findings also indicate that the size of banks' assets has a statistically significant effect on the growth of shadow banking as the Originate-to-Distribute Model implies. This result reveals that the growth of shadow banking is accompanied with the growth in traditional banking. In the long-run, one percentage point increase in pension funds to GDP ratio can lead to the increase in the broad shadow banking by 4.5~7.0%p which is measured by OFI as a % of GDP. One percentage point increase in the size of traditional banking to GDP attributes to the growth of shadow banking by 0.51~0.66%p in the long run.

Keywords: Shadow banking, dynamic panel

1 The views expressed in this paper are those of the author and are not necessarily reflective of views at the Bank of Korea. Any errors or omissions are the responsibility of the author.

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1. Introduction

In the wake of global financial crisis, many studies have focused on the role of the shadow banking[3] in the financial crisis and the meaning on macro-prudential policies. See Adrian and Shin (2009), Pozsar et al (2010), Claessens et al (2012), Claessens and Ratnovski (2014), etc. Adrian and Ashcraft (2012) provide a literature review on the shadow banking.

According to these literatures, the shadow banking system can raise the systemic risk in the financial markets via reinforcing interconnectedness between financial institutions, even though it has contributed to enhancing the efficiency in the financial markets and improving the credit availability in the real sector. Shadow banks are financed mainly by market-based funds rather than retail funds, whereas they manage long-term illiquid assets. As a result, it is vulnerable to runs or sudden stops, and likely to cause fire sales of assets when the financial market confidence drops. Luttrell et al (2012) deal with intrinsic risks of shadow banking.

The studies highlight that shadow banks have faced weak regulation comparing to the traditional banks. They call for stronger regulation to prevent excessive leverage and maturity mismatch to achieve financial stability.

However, there have not been that many studies that provide empirical evidence due to the lack of statistics on the shadow banking and the ambiguity on its definition[4] of the shadow banking (IMF, 2014)[5]. IMF (2014) and Duca (2014) can be illustrated as the recent empirical studies on the determinants of the shadow banking. IMF (2014) demonstrates cross-country panel estimation on the growth rate of shadow banking using Non-core debt, flow of funds measure, and FSB measure as a dependent variable. IMF (2014) suggests that a search for yield, regulatory arbitrage, institutional cash pools and financial developments contribute to the growth of the shadow banking. They mainly provide Pooled OLS estimation which requires strong assumptions for consistency, though they employ partially a static panel estimation with fixed effects. They did not employ a dynamic model. In the following we illustrate the estimation method for more details.

Duca (2014) implements the time series analysis for the long-term time series data based on the Flow of Funds Statistics in the United States. Duca (2014) indicates that the shadow share was affected by the deposit rate ceilings, the economic outlook, and the risk premia in the short-run, but over the long-run it was affected by the changing information and reserve requirement costs, and the shifts in the impact of regulations on bank.

Recently, more than 10 years of cross-country panel data for mainly G20 countries following the definition and the methodology of FSB can be available after FSB has published the Global Shadow Banking Monitoring Report in the line with the G20 DGI(Data Gaps Initiative). This paper provides empirical evidence on the

3 Shadow banking system is defined as credit intermediation involving entities and activities outside th e regular banking system (FSB, 2015).

4 The term of shadow banking is firstly used by PIMCO managing director, Paul McCulley. (McCulley(2007)). He describes shadow banking as "Unlike regulated real banks, who fund themselve s with insured deposits, back-stopped by access to the Fed's discount window, unregulated shadow b anks fund themselves with un-insured commercial paper, which may or may not be backstopped by li quidity lines from real banks."

5 Shadow banking has been measured in different ways depending on researchers and institutions. IMF(2014) provides a summary of the different definitions of and perspectives on shadow banking.

determinants of the shadow banking using these new data series. Also, we provide more rigorous empirical analysis using not only a static model with fixed effects estimation, but also a dynamic panel model.

The estimation results indicate that the size of long-term institutional investors including pension funds and insurance companies promotes the growth of shadow banking. It implies that the demand of long-term institutional investors for instruments issued by shadow banking sectors plays a crucial role in the growth of shadow banking.

In addition, long-term market interest rates(10 year Treasury Bond yields) have a negative impact on the shadow banking growth as expected, even with weak statistical significance. This is because the high long-term interest rate discourages the incentive to a search for higher yield. As the Originate-to Distribute Model implies, the estimation results indicate that the growth in the size of traditional banking has a significant effect on the growth of shadow banking. It shows that the growth of the shadow banking is accompanied with the growth of traditional bank. In a dynamic panel model, a 1%p increase in pension funds to GDP ratio can lead to 4.5~7.0%p increase in the broad shadow banking which is measured by OFI as a % of GDP. A 1%p increase in the size of traditional banking has a 0.51~0.66%p effect on the growth of the shadow banking in the long run.

The paper is organised as follows. Section 2 provides a brief literature review of the determinants that affect the growth of the shadow banking. Section 3 and 4 describe our data sets, outline estimation method, and present the estimated results. Finally, Section 5 summarizes and concludes.

2. Literature review

This section provides a brief literature review of the determinants of the shadow banking growth. As shown in IMF(2014) and Duca (2014), the existing literatures suggest various factors including the demand of institutional investors, regulatory arbitrages, and a search for yield, financial innovations, etc, as a determinant. Here, we focus on the demand factors and regulatory arbitrages.

Regarding the demand, Adrian and Shin(2009) suggest that institutional investors which include pension funds, mutual funds and insurance companies as well as foreign central banks outside the banking system play an important role as a new funding source of banks. These investors buy those securitized claims, which are issued in the process of credit creation.

Banks originate loans and sell them to broker and dealers, hedge funds. The buyers pool and securitize them as types of ABS, CDO, etc, then distribute them to investors with different risk appetites including SIVs, hedge funds, asset managers, and insurance companies. Pozsar(2008) and Pozsar et al(2010) illustrate this Originate-to-Distribute model in more detail.

Next, looking at the regulatory arbitrage, deposit-insurance scheme, reserve requirements, and capital requirement rules are mentioned as representative examples of regulatory arbitrages of shadow banking compared to traditional banks. While bank deposits cost insurance fees for deposit protections, shadow banking without insurance fees has a room for providing higher return. See Pozsar et al (2010) for the absence of deposit insurance of shadow banking which differentiates it from deposits of traditional banks.

Reserve requirements imposed on the traditional banks can decrease their revenue because the amount of credit supply would shrink as banks piled up reserves at the central bank. Meanwhile, shadow banking such as MMF has no reserve requirement, resulting in offering higher return (Duca, 2014).

Shadow banks can expand their activities by taking advantage of loose capital requirement or employing evasive behaviours. As an example, securitization can be noted in that because the transfer of assets is recognized as true sale, originators can not only book off securitized assets in the balance sheet, but also originators don't have to record funds raised by securitization in a borrowing. Moreover, originators such as banks can have an advantage in improving the capital requirement ratio through securitizing non-performing loans(FSS, 2013). Adrian and Ashcraft(2012) also introduces that regulatory changes to ABCP played a significant role in the growth of the shadow banking system.

3. Data and Empirical models

3.1 Data

The data for shadow banking are obtained from FSB '2015 Global Shadow Banking Monitoring Report'. These datasets are compiled based on the financial accounts, called the Flow of funds in each country. See FSB(2011a), FSB(2011b), FSB(2015) for detail on the definition and the compilation method led by FSB. While the raw data are available for 26 countries for the 2002-2014 period, we use datasets excluding a few countries including Argentina and Brazil which are assumed to be outliers or to contain missings in covariates[6]. Due to missing values, unbalanced panel data are used to estimate.

OFI(Other Financial Institutions) as a % of GDP, a dependent variable, is drawn from FSB. This is called "broad shadow banking".[7] The definition of shadow banking led by FSB can be divided into the broad shadow banking and the narrow shadow banking. Broad shadow banking is measured as the asset size of OFI(Other Financial Institutions) which denotes financial sector except banks, pension funds and insurance companies, public financial institutions, and financial auxiliaries.

On the other hand, the narrow shadow banking is limited to the institutions with high systemic risks after classifying financial institutions into five groups based on their functions[8]. <Box> illustrates how to derive shadow banking statistics from the Flow of Funds statistics.

6 Due to missing values in variables, the number of observations which are used in estimation depends on model specifications.

7 In narrow measure, just data for 5 time periods are available, it is not easy to get significant results from them.

8 Economic Function classifications(EF1~5) are as follows. EF1 is management of collective investment vehicles with features that make them susceptible to runs. EF2 is loan provision that is dependent on short-term funding, EF3 is intermediation of market activities that is dependent on short-term funding or on secured funding of client assets. EF4 is facilitation of credit creation. EF5 is securitization-based credit intermediation and funding of financial entities.

For covariates, we want to classify the determinants into 3 categories, that is, the demand factor of institutional investors on instruments issued by shadow banking sectors, regulatory arbitrages, and a search for yield.

For the demand factor, we use the asset size of pension funds and insurance companies as a % of GDP. The data on asset size of banks are calculated as a % of GDP, and is drawn from FSB to verify the Originate-to-Distribute model.

For the data on regulatory arbitrages, we use long-term interest rates as a proxy of reserve requirements tax following Duca(2014). Long-term interest rates can indicate a search for yield together with term spread(10yr-3M). Besides, net interest margin(NIM) and bank capital ratio are included in control variables.

We include income, stock market size, and financial development index to capture the financial innovations or financial developments. Financial development index is drawn from Svirydzenka(2016) who compiled it considering the depth, access, efficiency in financial institutions or financial markets in a comprehensive manner.

Chart1 plots the relationship between broad measure of shadow banking and covariates. It shows that pension funds, insurance companies, and banks are positively correlated with the broad measure of shadow banking. On the other hand, it indicates that the long-term interest rates, the bank capital ratio, and the bank net interest margin are negatively correlated with the shadow banking system. Chart2 with the narrow definition also shows similar relationships between them.

Table 1 provides descriptive statistics of variables, and Table 2 presents correlation coefficients.

Summary Statistics

Table 1

	Source	Unit of Measurement	Mean	Overall S.D	Between S.D	Within S.D	Min	Max
OFI	FSB	as a % of GDP	87.584	132.210	127.545	39.878	0.519	828.198
Treasury Bond yield(10Yr)	Bloomberg	%	4.483	2.461	2.440	1.056	0.509	13.624
Spread (10yr-3M)	Bloomberg	%	1.652	1.178	0.838	0.999	-1.544	4.890
Bank Capital Ratio	World Bank	%	7.563	2.895	2.796	0.979	3.000	14.600
Bank Net Interest Margin	World Bank	%	3.211	2.185	1.849	1.216	0.140	14.636
Log(GDP per capita)	World Bank	lagged by one time period	9.739	1.169	1.073	0.510	6.175	11.385
Pension Fund	FSB	as a % of GDP	36.431	36.569	36.736	6.591	0.001	156.708
Insurance	FSB	as a % of GDP	38.997	28.299	28.512	6.109	1.254	105.315
Bank	FSB	as a % of GDP	237.070	186.769	184.419	45.026	29.112	815.767
Stock Market	World Bank	as a % of GDP	101.438	85.354	82.743	26.659	14.154	570.155
Financial Development Index	IMF	index	0.685	0.200	0.200	0.040	0.281	1.000

Correlation Matrix

Table 2

	OFI (as a % of GDP)	Treasury Bond yield (10Yr)	Spread (10yr-3M)	Bank Capital Ratio	Bank Net Interest Margin	Log (GDP per capita)	Pension Fund (as a % of GDP)	Insurance (as a % of GDP)	Bank (as a % of GDP)	Stock Market (as a % of GDP)
OFI(as a % of GDP)	1									
Treasury Bond yield(10Yr)	-0.2830	1								
Spread (10yr-3M)	0.0619	0.0052	1							
Bank Capital Ratio	-0.3377	0.3411	0.0718	1						
Bank Net Interest Margin	-0.3658	0.6266	-0.0419	0.5155	1					
Log(GDP per capita)	0.3722	-0.6979	0.1186	-0.2829	-0.4906	1				
Pension Fund(as a % of GDP)	0.7946	-0.3047	-0.0963	-0.1490	-0.2614	0.4289	1			
Insurance(as a % of GDP)	0.4676	-0.5952	0.0030	-0.5105	-0.5467	0.5835	0.4083	1		
Bank(as a % of GDP)	0.2766	-0.5687	0.0896	-0.1446	-0.4922	0.4469	0.3178	0.5752	1	
Stock Market(as a % of GDP)	-0.0207	-0.2346	-0.0916	0.3240	-0.0440	0.1355	0.2185	0.1429	0.5209	1
Financial Development Index	0.3236	-0.7215	0.1019	-0.3671	-0.5896	0.8031	0.3977	0.6093	0.4848	0.2263

Shadow banking in broad measure

Chart 1

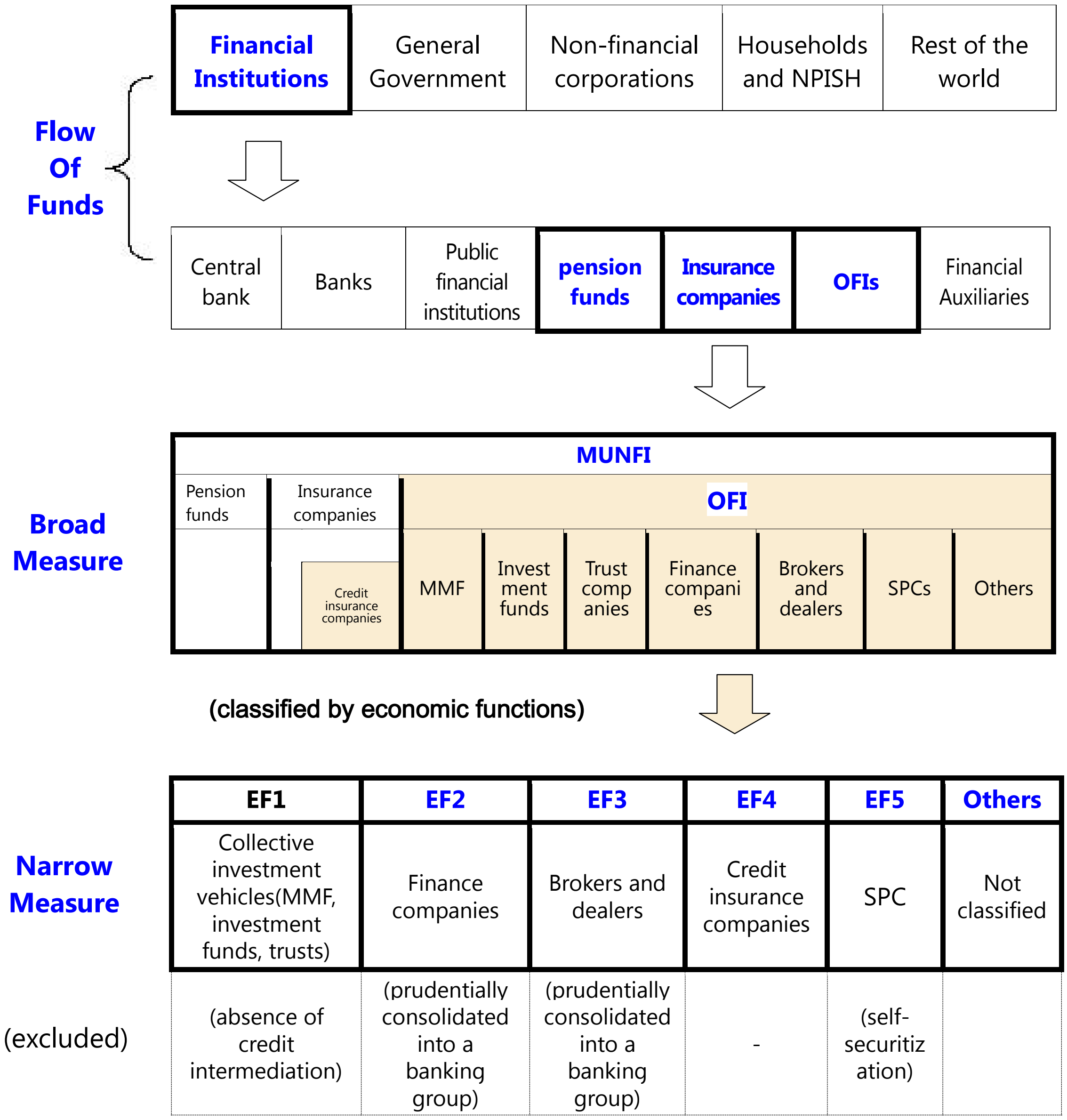
Shadow banking in narrow measure

Chart 2

Box 1

How to derive shadow banking statistics from Flow of Funds statistics

Shadow banking system monitoring exercise led by FSB takes two-step approach to measure shadow banking system. First, authorities cast the net wide to cover all areas where shadow banking-related risks to the financial system might potentially arise. Second, authorities narrow the focus to the subset of non-bank credit intermediation by classifying broad measure into 5 economic functions. In the second step, the narrow measure of shadow banking is measured by excluding self-securitization, absence of credit intermediation, prudential consolidation into a banking group from the broad measure



3.2 Empirical models

We first use the static panel linear model as a preliminary model. Our empirical model is as follows.

$$y_{it} = x_{it}' \beta + \tau_t + \delta_i + e_{it} \tag{1}$$

i and t are the indices of countries and years, respectively. τ_t's denote time effects to capture macroeconomic circumstances. δ_i's are called unobserved country fixed effects, and e_{it}'s are all unobserved idiosyncratic errors(i.i.d). y_{it}'s are the broad measure of shadow banking as a % of GDP of country i in period t. x_{it}'s contain control variables, β is the coefficient vector that we are interested in. Pooled OLS assumes that δ_i is not correlated with x_{it}, that is, $cov(\delta_i, x_{it}) = 0$, which is quite a strong assumption, to get consistent coefficients. Thus, we estimate models with fixed effects estimator allowing for the correlation between δ_i and x_{it}. While there are two fixed effects estimators including LSDV(Least Squares Dummy Variable estimator), Within-group estimator which are numerically identical(Baltagi, 2013), we use LSDV[9]. Also, time effects and country fixed effects are included in all regressions. We estimate various models which are specified in different ways.

Next, we employ the dynamic panel estimation as follows.

$$y_{it} = \sum_{j=1}^{p} \alpha_j y_{i,t-j} + x_{it}' \beta + \tau_t + \delta_i + e_{it} \tag{2}$$

The dynamic model includes lagged dependent variables, $y_{i,t-j}$. It also allows for the correlation between δ_i and x_{it} $(cov(\delta_i, x_{it}) \neq 0)$. We use the generalized method of moments estimator (GMM) developed by Arellano-Bond(1991). We first-difference the model (2) to get rid of country specific effects or any time-invariant country specific variable. Then, we obtain

$$\Delta y_{it} = \sum_{j=1}^{p} \alpha_j \Delta y_{i,t-j} + \Delta x_{it}' \beta + \Delta \tau_t + \Delta e_{it} \tag{3}$$

In the differenced model (3), there still exists a correlation[10] between lagged values of dependent variable $\Delta y_{i,t-j}$ and the differenced errors, Δe_{it}. Due to this correlation, standard fixed effects estimator is not consistent, causing the bias (Nickell, 1981). To eliminate the endogeneity problem due to this correlation, the difference GMM by Arellano-Bond(1991) employs instrumental estimation which utilizes the orthogonality conditions between the differenced errors and lagged terms of dependent variable, $\Delta y_{i,t-j}$[11]. The difference idiosyncratic errors, Δe_{it} may show serial

9 In unbalanced panel data, LSDV may suffer from less losses of data compared to Within-Group Fixed effects estimator.

10 Δe_{it} is a function of $e_{i,t-j}$, which causes the correlation with $\Delta y_{i,t-j}$.

11 As T is getting larger, moment conditions also increase. Too many moment conditions can improve the efficiency, but, introduce bias. So it is suggested that a subset of moment conditions be used to take

correlation which can be addressed by adjusting the AR order p. We can test for serial correlation. In $p = 1$, AR(1) model, α should be a positive value[12] with less than 1 to converge to the steady state. If α is close to 1, System GMM(Blundell and Bond, 1998) would be more desirable. In a dynamic model, time effects and country fixed effects are included in all regressions.

4. Empirical results

4.1 Static panel model

The results in Table 4 display the estimates of the static linear model. The estimated results indicate that the size of long-term institutional investors like pension funds and insurance companies contributes to promoting the growth of shadow banking. It implies that the demand of long-term institutional investors for instruments of shadow banking plays a crucial role in the growth of shadow banking.

In addition, long-term market interest rates(10 year Treasury Bond yields) have a negative impact on the shadow banking growth as anticipated, even though they have weak statistical significance. It is because high long-term interest rate discourages a search for high yield. The coefficients of financial crisis dummies are negative, which means that after the financial crisis, shadow banking activities have remained sluggish.

However, the stock market capitalization and the financial development index have a negative impact on the shadow banking growth counter-intuitively, even though income has a positive effect. It would be possible if the big sized stock market means that there are alternatives for high yield. Financial development index relies on Svirydzenka(2016) who creates indices considering the depth, accessibility, and the efficiency of financial markets and the financial institutions in a more comprehensive manner. Though, the index can be insufficient to represent financial innovations favourable to shadow banks over traditional banks. The depth, the accessibility, and the efficiency are measured by mixing stock market size to GDP, net interest margin, stock market turnover ratio, return on equity, and return on assets.

4.2 Dynamic panel model

Table 5 reports the estimates of dynamic panel estimation. The coefficients of lagged dependent variable produce around 0.5, which displays considerable persistence. It is because the instruments with more-than-one-year maturities issued by shadow banking sectors are considerable, while the size of shadow banking is measured as the size of assets of shadow banking sectors.

Looking at the effects which we are interested in, the size of pension funds that represents the demand has a substantial effect on the growth of shadow banking. An additional increase in pension funds as a % of GDP leads to 2.168~2.459%p increase

advantage of this trade-off (Baltagi et al, 2009)

12 Larger than 1 value of alpha means that it goes to infinity without converging to the steady state.

in OFI to GDP ratio. Insurance companies also have a significant effect on shadow banking in interaction term with financial crisis dummies.

Interestingly, as the Originate-to-Distribute model implies, the estimated coefficients of bank size indicates that the growth in asset size of banks has a positive effect on the growth of shadow banking. A 1%p increase in the size of banks as a % of GDP leads to 0.222~0.289%p increase in OFI to GDP ratio. This provides the evidence that the shadow banking growth is accompanied with the growth of the traditional bank.

Meanwhile, the estimates imply that the long-term effect[13] of a 1%p increase in pension funds to GDP ratio leads to 4.5~7.0%p increase in OFI to GDP ratio. In the long run, a 1 %p increase in the bank size as a %p of GDP leads to 0.51~0.66%p increase in the "steady-state" value of shadow banking. It seems quite a reasonable magnitude relative to the sample means, which are 87.6, 36.4, 277.1 for the size of OFI, pension funds, banks as a % of GDP respectively.

Long-run effects on the size of shadow banking

Table 3

	Dif-GMM1	Dif-GMM2	Dif-GMM3	Dif-GMM4	Dif-GMM5
Pension Fund (as a % of GDP)	4.504	4.483	4.519	5.461	6.991
Bank (as a % of GDP)	0.507	0.543	0.519	0.660	0.663

The AR(2) test and Hansen test indicate that the over-identifying restrictions implied by GMM procedure are not rejected. If the coefficient of lagged dependent variable is close to unity, difference GMM estimator may suffer from weak identification, in that case, a system GMM(Blundell and Bond, 1998) can be a desirable estimation method. However, in our case, the autoregressive coefficient is far from unity. Table 6 and Table 7 report the estimated results in various Model specifications. These results show by and large similar results as before.

4.3 Comparison with earlier studies

Our results can be compared with those of earlier studies. Aramonte et al(2015) suggest that insurance companies, pension funds, in particular, structured-finance vehicles take higher credit risk when investors expect interest rates to remain low. Banks originate riskier loans that they tend to divest shortly after origination, thus appearing to accommodate other lenders' investment choices. This mechanism is supported by our results that the shadow banking growth is accompanied with the growth of the traditional bank as Originate-to-Distribute model implies. These results are also consistent with the presence of a risk-taking channel of monetary policy as Aramonte et al(2015) mention.

13 In dynamic model, β means short-term effects, long-term effects are calculated from $\frac{\beta_k}{1-\alpha}$ in p = 1, AR(1) model.

Estimation results

LSDV estimates Table 4

OFI(as a % of GDP)	LSDV1	LSDV2	LSDV3	LSDV4	LSDV5
Crisis dummy(1 if since 2008)	-36.44***	-32.18**	-38.45***	-32.36***	-17.97**
	(11.32)	(13.11)	(11.11)	(9.191)	(8.955)
Treasury Bond yield(10Yr)	-3.296*	-2.136	-3.201*	-1.603	0.144
	(1.936)	(1.917)	(1.909)	(1.747)	(1.828)
Spread(10yr-3M)	1.66	2.622	1.334	0.0465	0.832
	(2.427)	(2.593)	(2.467)	(2.055)	(1.99)
Bank Capital Ratio	2.874	0.559	2.795		
	(3.326)	(2.994)	(3.37)		
Bank Net Interest Margin	1.593				
	(1.322)				
Pension Fund(as a % of GDP)	3.882***	3.755***	3.851***	3.762***	4.249***
	(0.581)	(0.655)	(0.596)	(0.608)	(0.735)
Insurance(as a % of GDP)	1.163***	0.772*	1.104***	1.190***	0.683*
	(0.384)	(0.393)	(0.373)	(0.376)	(0.377)
Bank(as a % of GDP)	0.041	-0.00898	0.0555	0.0732	0.0126
	(0.0764)	(0.067)	(0.0755)	(0.0785)	(0.0768)
Stock Market(as a % of GDP)	-0.288***		-0.282***	-0.265***	-0.248***
	(0.0993)		(0.1)	(0.0874)	(0.0913)
Financial Development Index	-181.9*	-201.0*	-196.2*	-319.9***	
	(102.3)	(108.4)	(105.1)	(111.4)	
log(GDP per capita)	12.30**	14.44**	11.74**	6.22	9.654**
	(5.258)	(5.67)	(4.971)	(5.156)	(4.326)
Time effect	Yes	Yes	Yes	Yes	Yes
Country effect	Yes	Yes	Yes	Yes	Yes
Observations	140	143	141	168	168
Number of Countries	20	20	20	20	20

1 All regressions include country fixed effects and time fixed effects. Robust standard errors in parentheses.

2 significant levels : *** p<0.01, ** p<0.05, * p<0.1

Estimation results

Difference GMM estimates

Table 5

OFI(as a % of GDP)	Dif-GMM1	Dif-GMM2	Dif-GMM3	Dif-GMM4	Dif-GMM5
OFI(t-1)	0.454***	0.468***	0.468***	0.603***	0.665***
	(0.056)	(0.066)	(0.062)	(0.068)	(0.046)
Crisis dummy				-39.43**	
				(18.490)	
Treasury Bond yield(10Yr)	-0.34	-0.779	-0.915	0.887	1.86
	(1.518)	(1.733)	(1.724)	(1.268)	(1.353)
Spread(10yr-3M)	-0.767	0.00223	-0.604	-0.652	-0.891
	(1.911)	(2.290)	(2.147)	(2.239)	(1.846)
Bank Capital Ratio	5.481	4.755	5.724		
	(3.534)	(3.347)	(3.721)		
Bank Net Interest Margin	3.694*				
	(1.964)				
Pension Fund(as a % of GDP)	2.459***	2.385***	2.404***	2.168***	2.342***
	(0.605)	(0.634)	(0.624)	(0.487)	(0.646)
Insurance(as a % of GDP)	-0.725	-0.932	-0.591	-1.257	-1.311
	(0.924)	(0.983)	(0.926)	(1.030)	(1.084)
Insurance×Crisis dummy	0.535	0.683	0.584	0.620**	0.715**
	(0.386)	(0.484)	(0.410)	(0.275)	(0.340)
Bank(as a % of GDP)	0.277**	0.289**	0.276**	0.262*	0.222*
	(0.123)	(0.135)	(0.128)	(0.146)	(0.118)
Stock Market(as a % of GDP)	-0.136*		-0.108	-0.0263	-0.038
	(0.080)		(0.080)	(0.048)	(0.042)
Financial Development Index	-64.29	-50.8	-45.66	-193.6	
	(100.6)	(101.7)	(96.8)	(156.9)	
log(GDP per capita)	42.25	45.5	37.31	36.05**	37.87*
	(28.210)	(28.100)	(26.030)	(17.750)	(19.620)
AR(2) (p-value)	0.196	0.632	0.396	0.346	0.221
Time effect	YES	YES	YES	YES	YES
Country effect	YES	YES	YES	YES	YES
Observations	94	97	95	134	134
Number of Countries	20	20	20	20	20

1 All regressions include country fixed effects and time fixed effects. Robust standard errors in parentheses.

2 Difference Hansen tests(Null H : Instruments are valid) are conducted for model 1~5, and all of them are not rejected at 5% significant level.

3 significant levels : *** p<0.01, ** p<0.05, * p<0.1

Estimation results

Difference GMM estimates - 1 Table 6

OFI(as a % of GDP)	Dif-GMM1	Dif-GMM2	Dif-GMM3	Dif-GMM4	Dif-GMM5
OFI(t-1)	0.333***	0.349***	0.348***	0.526***	0.585***
	(0.022)	(0.025)	(0.025)	(0.060)	(0.031)
OFI(t-2)	0.298***	0.317***	0.301***	0.240***	0.268***
	(0.077)	(0.085)	(0.082)	(0.078)	(0.104)
Crisis dummy		-27.16*			-15.15*
		(16.040)			(8.285)
Treasury Bond yield(10Yr)	1.275*	0.629	0.462	1.478	2.619
	(0.741)	(0.922)	(0.945)	(1.071)	(1.666)
Spread(10yr-3M)	-3.164	-2.136	-2.569	-1.785	-1.876
	(2.003)	(2.124)	(2.150)	(2.101)	(1.753)
Bank Capital Ratio	4.554	3.911	4.827		
	(3.168)	(2.893)	(3.344)		
Bank Net Interest Margin	4.307*				
	(2.242)				
Pension Fund(as a % of GDP)	1.777***	1.666***	1.726***	1.767***	1.881***
	(0.372)	(0.363)	(0.376)	(0.463)	(0.552)
Insurance(as a % of GDP)	-0.882	-1.008	-0.723	-1.114	-1.093
	(0.869)	(0.930)	(0.892)	(1.261)	(1.318)
Bank(as a % of GDP)	0.312**	0.314**	0.304**	0.309*	0.256*
	(0.141)	(0.149)	(0.144)	(0.178)	(0.148)
Stock Market(as a % of GDP)	-0.124		-0.0968	-0.0378	-0.0535
	(0.079)		(0.079)	(0.045)	(0.053)
Financial Development Index	-58.1	-45.9	-39.39	-210.7	
	(68.550)	(70.040)	(63.990)	(155.800)	
log(GDP per capita)	35.98	38.58	31.49	40.15*	41.98
	(26.730)	(25.840)	(24.490)	(23.910)	(25.760)
AR(2) (p-value)	0.243	0.276	0.245	0.287	0.237
Time effect	YES	YES	YES	YES	YES
Country effect	YES	YES	YES	YES	YES
Observations	94	97	95	120	120
Number of Countries	20	20	20	20	20

1 All regressions include country fixed effects and time fixed effects. Robust standard errors in parentheses.

2 Difference Hansen tests(Null H : Instruments are valid) are conducted for model 1~5, and all of them are not rejected at 5% significant level.

3 significant levels : *** p<0.01, ** p<0.05, * p<0.1

Estimation results

Difference GMM estimates - 2 Table 7

OFI(as a % of GDP)	Dif-GMM1	Dif-GMM2	Dif-GMM3	Dif-GMM4	Dif-GMM5
OFI(t-1)	0.482***	0.513***	0.503***	0.640***	0.727***
	(0.083)	(0.080)	(0.082)	(0.079)	(0.071)
Treasury Bond yield(10Yr)	-0.935	-0.616	-1.466	0.767	1.569
	(3.149)	(2.978)	(3.075)	(2.796)	(2.827)
Spread(10yr-3M)	-1.073	0.299	-0.731	-0.351	-0.414
	(3.669)	(3.523)	(3.608)	(3.090)	(3.144)
Bank Capital Ratio	5.181	3.688	5.645		
	(3.425)	(3.166)	(3.437)		
Bank Net Interest Margin	3.698				
	(2.735)				
Pension Fund(as a % of GDP)	2.229***	2.110***	2.212***	2.018***	2.244***
	(0.440)	(0.428)	(0.439)	(0.411)	(0.407)
Bank(as a % of GDP)	0.254**	0.204*	0.253**	0.194*	0.143
	(0.120)	(0.111)	(0.120)	(0.105)	(0.105)
Stock Market(as a % of GDP)	-0.196*		-0.165	-0.118	-0.139
	(0.110)		(0.109)	(0.092)	(0.093)
Financial Development Index	-77.43	-52.46	-63.13	-225.2**	
	(112.9)	(107.5)	(112.7)	(94.6)	
log(GDP per capita)	21.63	30.25	21.6	21.07	22.08
	(25.18)	(23.76)	(25.21)	(21.77)	(22.17)
AR(2) (p-value)	0.544	0.735	0.652	0.246	0.213
Time effect	YES	YES	YES	YES	YES
Country effect	YES	YES	YES	YES	YES
Observations	98	103	99	138	138
Number of Countries	20	20	20	20	20

1 All regressions include country fixed effects and time fixed effects. Robust standard errors in parentheses.

2 Difference Hansen tests (Null H : Instruments are valid) are conducted for model 1~5, and all of them are not rejected at 5% significant level.

3 significant levels : *** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This paper investigates what determines the shadow banking growth using the shadow banking statistics which are recently published in FSB Global Shadow Banking Monitoring Report. Utilizing unbalanced panel data for mainly G20 countries for 2002-2013 periods, we provide the empirical evidence of the static model with fixed effects estimation as well as dynamic panel estimation.

The estimated results imply that the size of pension funds, which represents the demand, has a considerable effect on the growth of shadow banking. Marginal increase in pension funds as a % of GDP leads to 2.168~2.459%p increase in OFI to GDP ratio.

Interestingly, as the Originate-to-Distribute model implies, the estimate of the bank size indicates that the growth in the asset size of banks has a positive effect on the growth of shadow banking. A 1%p increase in the size of banks as a % of GDP leads to 0.222~0.289%p increase in OFI to GDP ratio. This provides the evidence that the shadow banking growth is accompanied with the growth of the traditional bank.

Meanwhile, the estimates imply that the long-term effect of a 1%p increase in pension funds to GDP ratio lead to 4.5~7.0%p increase in OFI to GDP ratio. In the long run, a 1 %p increase in the bank size as a %p of GDP leads to 0.51~0.66%p increase in the “steady-state” value of shadow banking. It is quite a reasonable magnitude relative to the sample means, which are 87.6, 36.4, 277.1 for the size of OFI, pension funds, banks as a % of GDP respectively.

However, we cannot help pointing out some limitations of our empirical analysis. It falls short of the impact analysis of regulatory arbitrages on the shadow banking. We have difficulties in finding indicators or variables to indicate regulatory arbitrages appropriately, while we should admit that our variables used in estimation are exposed to substantial measurement errors. For example, in case of reserve requirements which are referred as an example of regulatory arbitrages, it is not easy to create the variable to indicate advantages of shadow banking relative to deposits of traditional banks. In addition, the reserve requirement ratio depends on the types of deposits, and has little variation to identify the coefficients in the fixed effects estimation. As one can see, a measurement error causes attenuation bias: then it is necessary to pay attention in interpreting the estimates in the panel fixed effects estimation(Angrist and Pischke, 2009). Griliches and Hausman(1986) provide the measurement error in panel data.

Hereafter, there still remain additional work to investigate how effective reserve requirements ratio, appropriate estimates for deposit insurance burden and proxy for financial innovations have an impact on shadow banking growth if we get them.

In addition, if narrow measure data of shadow banking which is measured by following FSB methodology are accumulated in longer term series, it is thought that additional analysis on the determinants of shadow banking can be experimented in various perspectives.

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Competition indicators for the UK deposit-taking sector[1]

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Bank of England

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Competition Indicators for the UK Deposit-taking Sector

Sebastian J. A. de-Ramon and Michael Straughan [(1)]

Abstract

We use a new regulatory dataset to estimate competition in the UK deposit-taking sector. The novelty of this study is two-fold. First, the dataset allows us to explore trends in competition intensity over an extended, 24 year period from 1989 to 2013 using data for UK regulated firms which encompasses a wider range of firms than for previous studies. Second, we take a portmanteau approach and estimate a number of different performance-based competition measures common in the literature to support conclusions on the intensity of competition over the period. Our estimates of the Lerner index, the Panzar-Rosse H-statistic and the Boone indicator suggest that competition intensity was strong at the beginning of our sample, but became less intense in the early 2000s. However, the deposit-taker business model bundles together activities in several markets simultaneously, so strong competition in some markets can be offset by the extraction of market rents in others. Importantly, competition intensity decreased (and the ability of UK deposit takers to extract market rents from customers increased) in the period immediately ahead of the financial crisis (2003-2007).

Key words: Competition, Banks, Deposit Takers.

***JEL* classification**: D22, D24, G21, L11, N20.

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Contents

1 Introduction

Accurate measures of competition intensity are important in understanding the influence of the banking industry in the wider economy. Anti-competitive practices and other market failures in banking can have negative consequences for productive efficiency and the cost of finance (Goodhart and Wilson, 2004) with implications for consumer welfare and economic growth. Recent studies focus on the way competition can reduce systemic risk (e.g. Schaeck et al., 2009) for which measures of competition are key.

The objective of this paper is to use data on UK banks and building societies (collectively 'deposit takers') to investigate the intensity of competition in this sector over a relatively long time period and using different measurement techniques. Past empirical studies of UK banks competition had narrower focus on either: industry structure (concentration) only; specific (and generally limited) time periods; and individual product types or services offered. For example, Logan (2004) studied concentration in UK bank loans and deposits for the period 1990-2004 and found that concentration in lending increased over the period but is generally more concentrated than retail deposits. Matthews et al. (2007) constructs two (non-structural) measures of competition intensity using an unbalanced panel of 12 large UK bank groups over the period 1980-2003. Using these measures they find that competition in core banking businesses was the same throughout the 1990s as it was in the 1980s and that generally that UK banks are monopolistically competitive. Schaeck and Cihák (2010) measure competition intensity for the period 1995-2005 using a sample of UK and European banks and find that competition between UK banks decreased over the period. Casu and Girardone (2009) use data from 79 UK banks (from a total sample of 2,701 European banks) to study competition and find that competition in the UK improved between 2002 and 2005 although the authors note that there is no evidence of increased competitive pressures across Europe as a whole. Finally, Weill (2013) constructs competition measures for European banks including 56 UK banks over the period 2002-2008 and finds that competition intensity peaked in 2003 and declined for the remainder of the sample period.

The novelty of this work is two-fold. First we use a new UK regulatory dataset of 127 deposit takers covering 24 years from 1989 to 2013. This is a broad dataset covering a period which straddles a number of UK economic cycles and includes the 2008 financial crisis and its aftermath. Second, to draw firm conclusions about the intensity of competition, we take a portmanteau approach by estimating all common measures used in the literature, rather than using a smaller sub-set of measures.

This paper proceeds as follows. First, we review aspects of the literature relevant to this study. Second, we briefly discuss the new regulatory data and highlight the key issues and limitations of using this data. Third, we present our econometric results for the measures of competition. We conclude by reconciling these outcomes with the recent history of the UK deposit-taking sector. Appendices A3 and A4 describe respectively the data and the econometric methodologies to measure competition.

2 Literature review

The structure-conduct-performance (SCP) hypothesis developed by Bain (1951) states that the industry structure determines the competitive conduct and performance of firms within that market. Under this hypothesis, more concentrated industries will be less competitive as the opportunities for collusion improve. The major structural changes in asset composition and market shares of banks and building societies that occurred in the UK following the 'big bang' deregulation of the 1970s and 1980s (Davis and Richardson (2010)) [1] should therefore have signalled changes in the competitive landscape. However, Logan (2004) shows inconsistencies in outcomes for competition between UK banks: between 1989 and 2003 concentration in lending, as measured by the Herfindahl-Hirschman Index, increased (a decline in competition under SCP) while deposit concentration remained unchanged (no change in competition under SCP). But many studies highlight that SCP-based measures fail to consider how firms compete in the markets so they tend to be poor estimates of the intensity of competition (e.g. Claessens and Laeven (2004)).

During the period of our study deregulation freed-up entry in banking services with the 1993 Second Banking Coordination Directive that reduce formal barriers to entry in the EU, allowing European banks to operate in different markets. This increased competition, especially in non-traditional non-interest bearing products, increased efficiency and consolidation (Casu and Girardone, 2006).

Contestable markets theory, now ascendant in the literature, focusses on the influence of both existing incumbents and potential competitors rather than just incumbents on which concentration ratios are focussed (see Baumol et al. (1982)). This theory rejects the mechanistic link from structure to conduct and performance, an outcome borne out in more recent studies of the banking industry (e.g. Bikker et al (2014))[2]. These empirical studies of firm behaviour measure competition directly from performance-based data, such as revenues and costs (e.g. Matthews et al. (2007); Berger et al. (2009); Schaeck and Cihák (2010, 2012 and 2014)). The approaches used in this strand of the literature measure the departure of firms' performance with respect to the outcomes expected under perfect competition.[3] Liu et al. (2013) discuss a range of performance-based measures highlighting that they require careful interpretation to assess competition, and ideally a variety of such indicators should be used.

Appendix 4 review the main measures used in this study: the Lerner index, the Panzar-Rosse H-statistic and the Boone indicator. These performance-based measures are not only theoretically more sound than structural measures but are driven by individual firm behaviour and do not generally require defining a narrow geographic market (Casu and Girardone (2006)). However, there are some caveats when interpreting these measures. The Lerner index assumes that firms are profit maximising but firms do not always operate with perfect technical and allocative efficiency. Koetter et al. (2012) develop adjusted versions of the index to address this problem. The Lerner index is measured with error because they depend on output prices and marginal costs which must be estimated from total cost empirical models (Kumbhakar et al. (2012)). Another problem is that the average mark-up across all

1 Figure 1 in Davies and Richardson (2010) shows the wave of consolidation among large UK banks and building societies, but also shows that the four largest UK groups account for a smaller share of deposit-taking and lending services in 2010 than they did in 1960.

2 Bikker et al. (2014) note that the empirical banking literature shows that concentration is generally a poor measure of competition given that some studies find that competitive conduct is more intense than the industry structure suggests while others find that market power is greater than industry structure suggests. As the authors note, "Since the mismatch can run in either direction, concentration is an extremely unreliable measure of performance."

3 For a description of perfect competition model, see http://www.economicsonline.co.uk/Business_economics/Perfect_competition.html

firms may not capture the degree of product substitutability making difficult to assess changes in competition (Vives (2008)). When measuring firms' mark-ups it is also important to take into account changes in efficiency. This is because firms may fail to minimise their costs introducing an error to empirical measures of the price-cost mark-up (Kumbhakar et al., 2012). New techniques to estimate mark-ups based on the stochastic frontier theory can overcome such limitations. Empirical tests using banking sector data show that these efficiency-corrected measures are highly correlated with return on assets (Coccorese, 2014).

Similarly, the H-statistic also requires careful interpretation. The H-statistic requires additional information about costs and market equilibrium to infer the degree of competition (Bikker et al. (2012)). A joint test of competitive conduct and equilibrium can address some of those problems. However, the test narrows the applicability of the revenue H-statistic to only those periods where the market is in a long-term equilibrium (Shaffer (1982)). More recent research demonstrates that the H-statistic can be sensitive to the way the test is specified, in particular when scaling the regression variables. Bikker et al. (2012) discuss how this problem affects many of the past studies using this technique and explain how to interpret the results in each case. Finally, there are cases when the H-Statistic can fail in which the Lerner index becomes a better indicator of market power (Spierdijk and Shaffer (2015)). Given the novelty of the Boone indicator in the literature, there is less exploration of outcomes than for the H-statistic. One limitation is that the Boone indicator is distorted where firms are not competing to maximise (short-term) profits but rather seek to build market share or where firm outputs are increasingly heterogeneous (van Leuvensteijn et al (2011)).

Table 2.1 below presents a summary of recent empirical studies using the measures discussed above. These studies use a range of methodologies and data, cover UK and non-UK banks and focus on the pre-crisis period.

Most studies include more than one performance-based measure, or combine them with a market concentration index. For example, Matthews et al. (2007) described UK banks as monopolistically competitive based on data from 1980 to 2000. The authors found that competition on core balance sheet activities was the same in the 1990s and 2000s as it was in the 1980s based on estimates of the H-statistic and Lerner index. In contrast, they found that competition in non-core balance sheet activities worsened significantly during the 1990s.

Table 2.1: Recent estimates of competition measures

Study	Region	# UK Banks[1]	Period under study	Measures[2]	Periodicity of estimates
Berger et al (2009)	World	43	2007	HHI, L	Average for period
Bikker et al (2012)	World	73	1994–2004	PRH	Average for period
Carbó et al (2009)	EU	58	1995–2001	HHI, L, PRH	Average for period
Casu and Girardone(2006)[3]	EU	63	1997–2003	CR, PRH	Average for period
Casu and Girardone(2009)	EU	73	2000–2005	L	Annual
Claessens and Laeven(2004)	World	106	1994–2001	PRH	Average for period
Coccorese(2014)	World	116	1994–2012	L	Annual
Fernández de Guevara et al (2007)	EU	45	1993–2000	L	Annual
Goddard and Wilson (2009)	G7	166	2001–2007	PRH	Average for period
Logan(2004)	UK	357	1989–2003	CR, HHI	Annual
Matthews et al (2007)	UK	11	1980–2004	PRH, L	Average for sub-periods
Schaeck and Cihák (2010)	EU	–	1995–2005	B	Annual
Schaeck and Cihák (2012)	EU	43	1999–2005	PRH	Average for period
Schaeck and Cihák (2014)	EU	43	1995–2005	B	Annual
Schaeck et al (2009)	World	–	1998–2005	PRH	Average for period
Weill (2013)	EU	56	2002–2008	L, PRH	Annual
van Leuvensteijn et al (2011)	EU + G2	140	1992–2004	B	Annual

Source: Authors

Notes:
[1] Total number of UK banks reported in the study
[2] Measure(s) of competition used in the study. CR = concentration ratios; HHI = Herfindahl-Hirschman Index; L = Lerner index; PRH = Panzar-Rosse H-statistic; B = Boone indicator
[3] Casu and Girardone (2006) contains a similar table for earlier studies of competition in the banking sector

Fernández de Guevara et al (2007) found that the EU deregulation process did not improve competitive conditions for the period 1993-2000. Their estimate of the Lerner index for the UK shows that market power increased in the late 1990s and early 2000s. Carbó et al. (2009) compared the Herfindahl-Hirshman index (HHI) with the Lerner index for the UK and found these measures are strongly and positively correlated over the period 1995-2001. Girardone and Casu (2006) concluded that the EU financial market is monopolistic competitive based on their study of EU banks for the period 1997-2003. The authors also found that the UK has a low competition score (as measured by the H-statistic) in spite of having a large number of banks compared to other European countries. In addition, they suggest that the banks with highest inefficiencies and costs might also generate the greatest profits in Europe. In a separate study, Girardone and Casu (2009) estimated the Lerner index for a number of European countries over the period 1999-2005 and found that market power in the UK as measured by the Lerner index fell slightly in both 2004 and 2005. They also found that this trend was accompanied by a fall in efficiency from 2000-2005. This is consistent with their main findings that more market power in Europe does not lead to higher inefficiencies.

Schaeck and Cihák (2014) estimated the Boone indicator for several European countries for the period 1995-2005 and found that competition in the UK fell steadily over the period (and consistent with estimates of the Boone indicator for the UK over the period 1994-2004 by van Leuvensteijn (2007)). The authors found that competition improved between 1998 and 2001 but subsequently fell steadily until 2004. The authors concluded that the UK had one of the least competitive banking sectors amongst developed countries. In a separate study, Schaeck and Cihák (2012) estimated the H-Statistic for the UK over the period 1999 to 2005 and found that small banks in the UK were more competitive than large banks over the same period.

Overall these studies suggest that the best representation for UK banks is one of monopolistic competition with firms enjoying some market power. The results also suggest that since the year 2000 competition intensity in the UK deteriorated.

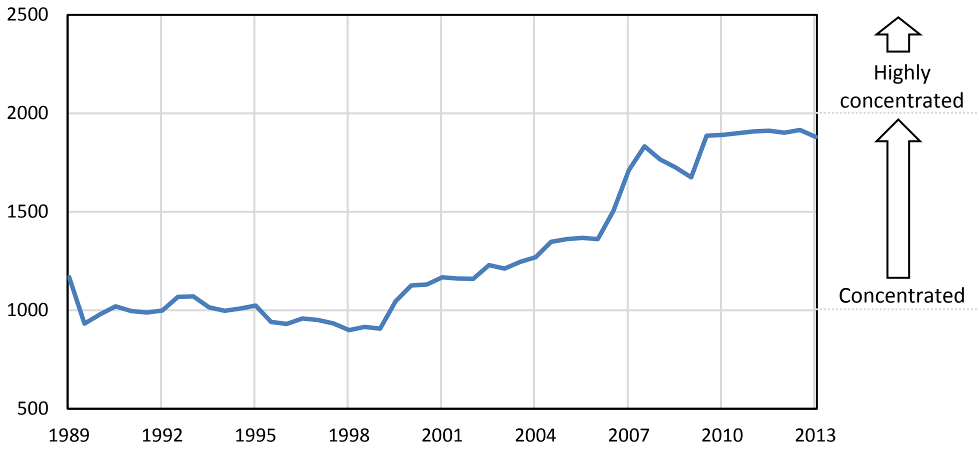
3 Empirical results

In this section, we estimate the performance-based measures discussed in section 2 based on the individual deposit-taker data available in our dataset. Appendices 1 and 3 describe the data used for each indicator and the main characteristics of the database used. All performance-based measures are derived from parameters estimated from panel regressions.

3.1 The Herfindahl-Hirschman Index (HHI)

We calculate the HHI shown in equation (1) (of appendix 4) using data on total assets for traditional model deposit takers. Figure 3.1 below shows the progression of the HHI over the sample.

Figure 3.1: Herfindahl-Hirschman Index – Total Assets[1]



Source: Bank of England, Authors' calculations

Notes:

[1] For deposit-takers using traditional finance model

The value of the HHI for total assets indicates that the deposit taking sector is on the border of being concentrated over the first decade of the sample. Mergers in 2000 (Barclays and Woolwich Building Society; Royal Bank of Scotland and National Westminster Bank) saw the HHI move from 907 at the end of 1999 to 1,130 by end 2000. Concentration then continued to rise steadily reflecting both faster growth by larger banks and the ongoing absorption of smaller banks. The purchase by RBS of the ABN AMRO businesses in 2007 saw the HHI rise by 470 points from 1,362 in 2006 to 1,832 in mid-2008, an increase of more than three times the 150 point increase that competition authorities note could give rise to concerns about competition in an already concentrated ($HHI > 1{,}000$) market. Lastly, the merger of Lloyds Banking Group and HBOS, along with Barclays purchase of Standard Life Bank, increased the HHI by 213 points to 1,887 in the first half of 2010. Concentration subsequently remained high at around 1,900, close to the 2,000 threshold for a highly concentrated industry.

However, the implication of this measure of the HHI for competition are not clear for a number of reasons: the HHI provides no indication of the contestability of the sector; the use of group data means expansion into non-UK markets can distort the measure; and total assets are not representative of any particular banking services market. We calculate the HHI for deposits, total loans, mortgages and unsecured loans in Figure A2.1 of Appendix 2 and find a similar pattern for deposits and total loans (reflecting the selection of the traditional financing model). However, concentration in the unsecured loans sector is considerably higher than for total loans, while concentration in mortgages remained considerably lower than for assets until 2009, after which the increase in concentration reflects a number of mergers (most notably the merger of Lloyds and HBOS in late 2008).

3.2 The Lerner index

We follow Berger et al. (2009) to estimate the marginal cost and output price for the standard approach to the Lerner index (discussed in section 0) and follow Kumbhakar et al. (2012) to measure the Lerner index indirectly using the stochastic frontier approach (see section 0). We estimate a third version of the index using the standard approach which is a market power proxy for credit provision only and excludes other services provided by banks (Kick and Prieto (2013) and Coccorese (2014)). Finally, we provide additional robustness tests by estimating Lerner indices over data sub-periods to help ensure average cost function parameters are well behaved.

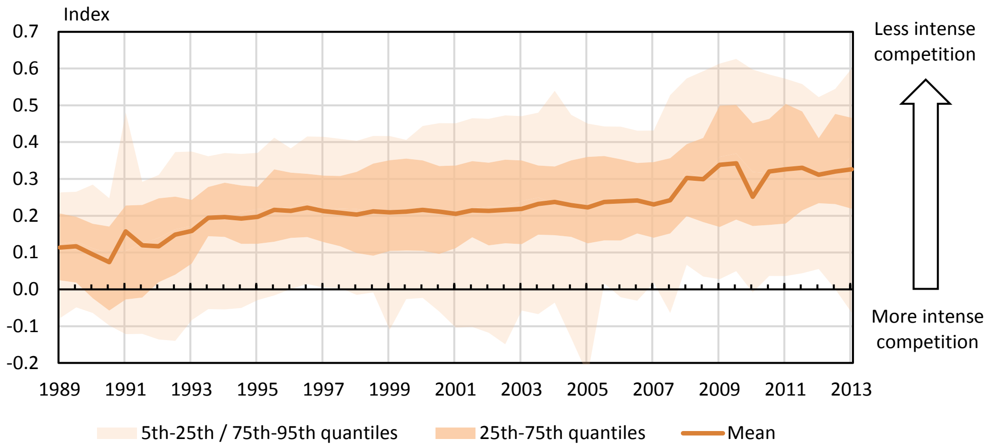
The total cost function in equation (3) (of appendix 4) is estimated using a panel regression with fixed cross-section effects and clustered errors to allow for intragroup effects.[4] We use total expenses related to firms financial intermediation function for total costs ($C_{i,t}$ in equation (3) of appendix 4). For input prices we proxy: staff costs ($W_{1,i,t}$) using the ratio of annual personnel expenses to total assets; physical capital ($W_{2,i,t}$) using the ratio of other operational expenses (non-interest, non-labour) to fixed assets; and average firm funding rate ($W_{3,i,t}$) using the ratio of interest expense to total deposits. We proxy total output ($Q_{i,t}$) by using total assets and use the ratio of total revenue to total assets to proxy banks' output price (P in equation (2) of appendix 4). To ensure linear homogeneity in the input costs, we divide total costs and input prices by the average firm funding rate $W_{3,i,t}$. The Lerner index is calculated for each bank and we take the mean as the aggregate measure. Figure 3.2 shows the evolution of the average Lerner index among all banks and the range measured by the 5th, 25th, 75th and 95th quantiles.[5]

[4] Estimating the Lerner index using other permutations (e.g. time fixed effects) produces similar results.

[5] The Lerner index is calculated for each firm using the estimated relationship. The central estimate of the Lerner index is calculated as the average for all firms at each point in time. The quantiles correspond to the distribution of Lerner index calculations for each firm.

Figure 3.2 shows that the price-cost margin increases steadily over the period, with the average moving from 0.1 in 1989 to just over 0.3 in 2009 at the height of the financial crisis and remains mostly above 0.3 until the end of the sample. The index is stable within a range of 0.21 and 0.24 between 1997 and 2007 suggesting that market power did not change significantly over an extended period of time, although we note that margins were, on average, higher over the second half of this period. Between 1998 and 2007 the values of the index taken by different banks (the quantile range) widens with respect to earlier periods. After the 2008 financial crisis the range widens even further and the average increases.

Figure 3.2: Lerner index – standard calculation



Source: Author's calculations

To check the robustness of the estimated parameters in the marginal cost function, we re-estimate the Lerner index over four sub-periods.[6] The sub-periods are between 6 and 8 years long, overlap slightly and coincide with significant changes in the UK financial and regulatory infrastructure (as described in de-Ramon et al. (2016a) and de-Ramon et al. (2016b)): (1) 1989 to 1996 which covers the first Basel accord; (2) 1996 to 2002 which includes the introduction of the Basel accord market risk amendment to the UK bank regulations, increased trading assets and ends with the bursting of the 'dot.com' bubble; (3) 2002 to 2008 which begins with the creation of HBOS and ends with the onset of the financial crisis; and (4) 2008 to 2013 which includes the post-crisis industry consolidation and subsequent contraction in economic activity.

Figure A2.2 in Appendix 2 shows estimates for each of the four sub-periods along with our central, full sample estimate. We note that the full sample estimate is contained within the 25-75% quantile range of all the sub-period estimates (and coincides exactly with the sub-period (3) estimate). Moreover, while the estimates in sub-periods (1), (2) and (4) do not coincide with the level of the full sample estimate, the patterns within sub-periods (1) and (2) are the same – that is, market-power increases over time. Sub-period (4) also broadly moves in line with the full-sample estimates, although market power starts to decline at the end of this sub-period. One trend to highlight is the drop from 0.29 to 0.21 in the estimated index between sub-

6 Other sub-periods investigated included fixed four and six year averages. The conclusions drawn were the same in all cases.

periods (2) and (3). This change is difficult to interpret as different cost function parameters are estimated for each period and thus different values are predicted for the same data point (e.g. 2002). We could argue that average market power fell as production technology changed between the two sub-periods. However, the trend between 2002 and 2007 is one of increasing market power with the Lerner index back at 0.3 by the end of the period. We can conjecture that the estimates in sub-periods exaggerate underlying changes in technology which are better integrated in the whole period estimates. Alternatively, the differences in the level could simply reflect noise in the data.

We implement further robustness tests on these results following Berger et al. (2009) by adding year fixed effects and robust standard errors to capture the specificities of each firm through time. In addition, following Matthews et al. (2007) we add environmental variables and period dummies to the regression to control for other factors that may evolve over time and affect the cost function parameters. In general, the alternative Lerner index estimates follow a similar trend and increase over the whole period and the conclusion that market power increased steadily over the period remains.

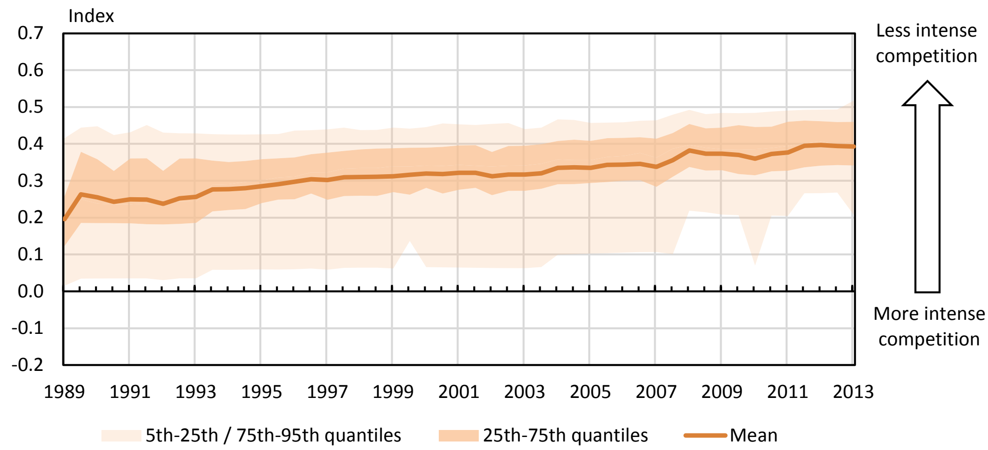
We now estimate the Lerner index using the stochastic frontier approach (discussed in Appendix 4) using: the ratio of total revenue to total costs ($RC_{i,t}$) as the dependent variable and as regressors we use total assets as a measure of output and input prices for labour, funding and fixed capital as before.[7] The results in Figure 3.3 below show that industry margins rose steadily through the period. We note in particular that there is a clear increase in the index over the 4 year period leading up to the financial crisis, with the index rising from 0.32 in the first half of 2003 to 0.36 in the first half of 2008.

As a check on our results, we also estimated an alternative formulation of the Lerner index using the standard estimation methodology. For this estimate, we narrowed the measure of bank output by constructing a mark-up proxy for competition in credit provision only (i.e. excluding other bank services), following Kick and Prieto (2013) and Coccorese (2014). We assume that the appropriate measure of output for the total cost function is total loans and that the price of output is only interest and fee income per loan.[8] The corresponding Lerner index is shown in Figure A2.3 in Appendix 2 and shows two peaks in 1994 and 2004 and two troughs in 2001 and 2008. Otherwise the average index remains fairly stable over the period within a range of 0.39-0.47. The pre-crisis period (2005 to 2008) shows a narrowing of the range of mark-up values suggesting fewer deposit takers were able to maintain higher margins. These results, in combination with the estimates of the Lerner index for all activities, suggest that competition in credit provision was relatively stable but saw periods of stronger competition even as the overall market power of deposit takers increased over the period 1989-2013. This observation is consistent with Matthews et al. (2007) who find that competition in the non-interest element of banking weakened between 1991 and 2004 implying that British banks altered their business models to increase their collective market power.

7 We do not need a proxy for the output price P under this approach.

8 These results need to be interpreted with caution as the price of output includes income from fees and may overstate the true price of loans at different points of time.

Figure 3.3: The Lerner index – stochastic frontier approach



Source: Author's calculations

3.3 The Panzar-Rosse H-statistic

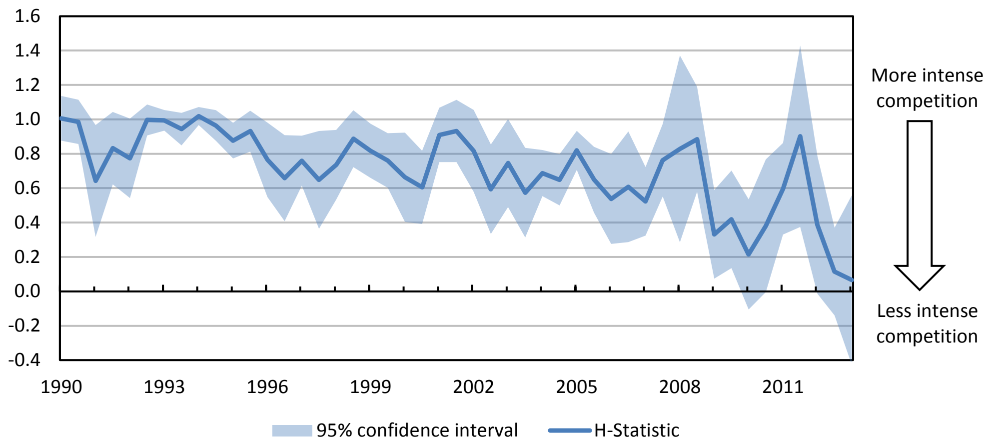
We estimate the Panzar-Rosse H-statistic using an unscaled measure of total revenues[9] ($TR_{i,t}$ in equation (9) of Appendix 4), following the methodology set out in Bikker et al. (2012).[10]. The key financial sector costs for the regression are labour, physical capital and funding,[11] defined as above in the Lerner index calculations. We also included a number of firm-specific factors as control variables that reflect deposit-taker behaviour and risk profile: average risk weights, the ratio of provisions to assets, the ratio of tier 1 to total capital, the ratio of loans to assets, the ratio of non-financial deposits to total deposits, the ratio of non-earning assets to total assets and UK real GDP growth. Finally, we include firm specific and time specific fixed effects. We used a panel regression with fixed time effects and clustered errors (to allow for intragroup effects) to estimate the H-statistic at each point in our time series.

9 The choice of control variables $X_{i,t}$ in equation (9) usually includes some measure of assets which, in effect, acts as a scaling variable for total revenues $TR_{i,t}$. Bikker et al. (2012) review many studies and demonstrate that using a scaled revenue specification yields inconsistent measures of the H-statistic.

10 Bikker et al. (2012) estimate the Panzar-Rosse index for a number of countries between 1994 and 2004 including bank specific effects. For the UK their preferred estimate is significantly below 1 but they also find that UK firms are not in long term equilibrium through the whole of that period.

11 This choice is in line with past Panzar-Rosse applications to banking, for example Bikker et al. (2012), Goddard and Wilson (2009) or Shaffer (2004).

Figure 3.4: Panzar-Rosse H-statistic – rolling period estimates



Source: Author's calculations

Figure 3.4 above shows the central estimates of the H-statistic using rolling fixed time panels of two data periods (one year), with the outcome shown in the second period, and including the 95% confidence interval. Figure 3.4 suggests that there was very strong competition between UK banks up to 1994 but that market power subsequently increased over time bringing the H-statistic significantly below one.

However, the H-statistic needs to be estimated where there is a long-run competitive equilibrium if estimates are to be valid. Shaffer (1982) shows that, where there is a long-run competitive market equilibrium, the return on assets should be equalised across firms regardless of input costs.[12] We follow the test formulated by Shaffer to establish periods when the market was in long-run equilibrium. The test is performed by substituting the ratio of total net income to total assets (a measure of return on assets) for total revenue in equation (9) of Appendix 4 and calculating the modified H-statistic, H^{ROA}, as before. Where we cannot reject the hypothesis that $H^{ROA} = 0$, there is a long-run competitive equilibrium and measures of the H-statistic are valid.[13]

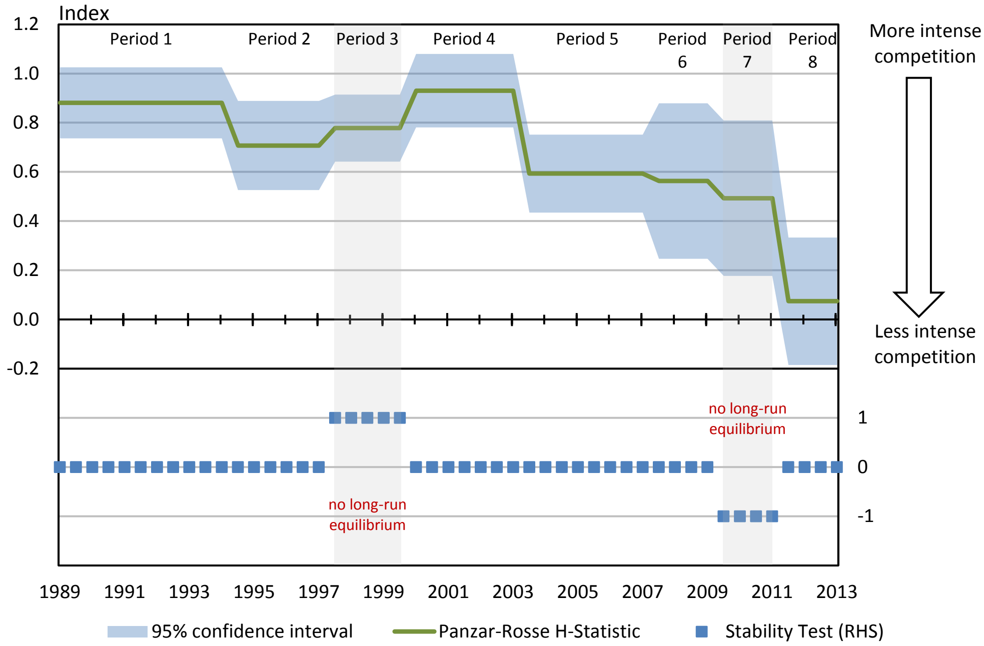
We use rolling time windows of varying size to determine the long-run equilibrium sub-periods within our full sample. The strategy is first to construct the stability test for rolling four-year periods – for example, using all data between 1989 and 1992, then all data between 1990 and 1993, etc. – then increase the size of the window by adding an additional time period and note in which sub-periods and for which window size we reject the long-run equilibrium hypothesis. At the end of the process we were left with the largest possible windows that do not reject long-run equilibrium. We then estimate the H-statistic for each of these periods.

12 Bikker et al. (2012) estimate the H-statistic for a number of countries for the period 1994 to 2004 including bank specific effects. For the UK, their preferred estimate is significantly below 1 but they also find that UK firms are not in long-term equilibrium throughout the estimation period

13 The stability test is a two-sided t-test and H^{ROA} can take negative and positive values. Shaffer (1982) notes that, when $H^{ROA} < 0$, an increase in input prices reduces return on assets with the implication that, in the short run, the firm it cannot immediately pass on higher costs. Where $H^{ROA} > 0$, an increase input prices *increases* return on assets. Shaffer postulates that this may arise if demand pull factors forces the firm to bid up the price of inputs, although this explanation remains conjecture.

This process yields eight separate periods: two separate periods of disequilibrium, the first from 1998 to 2000 ($H^{ROA} > 0$) and the second from 2010 to 2011 ($H^{ROA} < 0$); and six periods where long-run equilibrium is present (1989 to 1994, 1995 to 1997, 2000 to 2003, 2004 to 2007, 2008 to 2009 and 2012 to 2013). The periods of disequilibrium may reflect two disruptive influences in the UK financial sector: the cluster of building society demutualisations in the mid-1990s, and the immediate aftermath of the 2008 global financial crisis.

Figure 3.5: Panzar-Rosse H-statistic and stability test



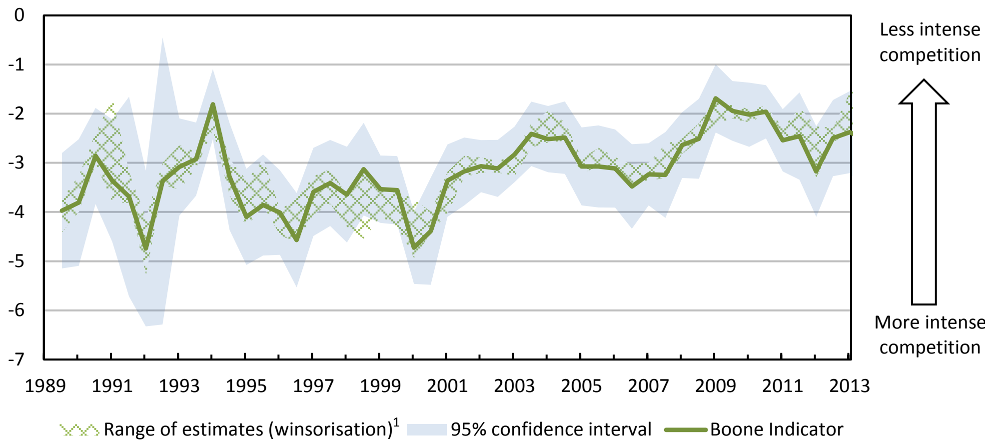
Source: Author's calculations

Figure 3.5 above shows our estimates of the H-statistic including the 95% confidence interval and the outcome of the stability test for the eight periods identified. We find that the H-statistic is close to one for much of the period from 1989 to 2003, excluding only the two years from 1995 to 1997 (and ignoring the disequilibrium period 1998-2000). We then find that the H-statistic moves to a much lower level for the period 2004 to 2009 and lower again for the period 2012-2013 (again ignoring the disequilibrium period 2010-2011). Note also that the 95% confidence interval widens substantially at the end of the sample, most likely reflecting volatility around the time of the financial crisis. One final observation is that the move lower in the H-statistic in the period 2004-2008 suggests that competition intensity between deposit takers declined prior to the financial crisis, consistent with the findings from the Lerner index.

3.4 The Boone indicator

The approach we follow for estimating the Boone indicator is that of Schaeck and Cihák (2014). We use a panel regression with fixed bank-specific effects, robust errors and allowing for intra-group clustering. Variable profits ($\pi_{i,t}$ in equation (11) of appendix 4) are measured as total income reported by deposit takers scaled by total assets, while variable costs ($c_{i,t}$ in equation (11)) are measured as total costs scaled by interest received and income from foreign exchange, investment, fees and other sources. We use similar bank-specific controls as those used for the H-statistic, including average risk weights, the ratio of provisions to assets, the ratio of tier 1 to total capital, the ratio of loans to assets, the ratio of non-financial deposits to total deposits, the ratio of non-earning assets to total assets and UK real GDP growth. To estimate the Boone indicator over the sample, we construct a dummy variable for each time period and include it and the interaction with costs in the estimation. The Boone indicator is extracted as the coefficient in each time period of the interaction variable. Finally, we exclude the largest regression outliers using a standard winsorisation process.[14]

Figure 3.6: Boone Indicator



Source: Author's calculations

Notes:

[1] Hatched area shows the range of winsorised estimates for the Boone indicator, where data points generating largest errors are sequentially removed. The range shows the maximum and minimum estimates for up to 20 iterations of the winsorisation process.

The final estimates for the Boone indicator are shown in Figure 3.6 above. We include in the chart the 95% confidence interval around the central estimates of the Boone indicator, which is relatively stable across the entire period. The Boone indicator is more volatile than the other measures, but nevertheless shows a pattern of less intense competition (exercise of greater market power) from the early 2000s through to end of the period. As a further robustness check, we also show how the winsorisation process changes the central estimates. Successively removing the outliers does not substantially change the estimate, but does has the effect of making the overall upward trend in the Boone indicator more pronounced, particularly over the last decade of the sample where the winsorisation tends to result in higher estimates of the Boone indicator (hatched area in Figure 3.6).

We implement a further robustness check for the Boone indicator using an alternative sub-sample. Following van Leuvensteijn (2011) we exclude specialised deposit takers such as investment banks that do not create loans. This alternative statistic reflects the reallocation of profits from less to more efficient banks that compete more directly on loans. The estimation results are shown in Figure A2.4 of Appendix 2 and show a clear trend over time towards less intense competition.

[14] We calculate the fitted values from the estimated model and exclude observations less that are less than 1% or greater than 99% of the distribution. This process is undertaken iteratively. Our central estimate involves two iterations of the winsorisation process.

Looking at sub-periods, the Boone indicator for lenders during the first half of the 1990s was around -5 suggesting that competition was more intense than in any other period. After 1994 there is a sudden shift towards less intense competition but it is a stable period until 2001 with a value of around -4. Subsequently, the indicator trends towards less intense competition until 2005 with a slight rebound before the financial crisis. In the final period the indicator shifts again towards less intense competition settling around a value of -2.

3.5 Comparison across competition indicators

Table 3.1 below shows the average value for each of the competition measures for the eight periods derived for the H-statistic.

Table 3.1: Combined measures of competition intensity[1]

	Lerner index[2]		H-Statistic[4]	Boone Indicator[5]	*Note*: HHI[6]
	Standard	Efficiency[3]			
Period 1 (1989–1994)	0.14	0.25	0.88	-3.36	1021
Period 2 (1995–1997)	0.21	0.29	0.71	-3.90	969
Period 3 (1998–2000)[7]	0.21	0.31	0.78	-3.46	971
Period 4 (2000–2003)	0.21	0.32	0.93	-3.52	1154
Period 5 (2004–2007)	0.23	0.34	0.59	-2.92	1396
Period 6 (2008–2009)	0.30	0.37	0.56	-2.52	1749
Period 7 (2010–2011)[7]	0.31	0.37	0.49	-2.12	1896
Period 8 (2012-2013)	0.32	0.39	0.07	-2.63	1898

Source: Bank of England, Authors' calculations

Notes:
[1] Periods are derived from the Panzar-Rosse H-statistic stability test used for calculating the long-run equilibrium sub-periods
[2] Lower values of the Lerner index indicate greater competition intensity
[3] Efficiency adjusted measure of the Lerner index
[4] Higher values of the H-statistic indicate greater competition intensity
[5] Lower values of the Boone indicator indicate greater competition intensity
[6] HHI index for total assets.
[7] Periods where the stability test associated with the H-statistic indicates that there is no long-run competitive equilibrium

Estimates of the H-statistic show that, at the beginning of the sample, competition intensity was strong in periods 1 through 4. This is supported by the more negative values for the Boone indicator. The Lerner index suggests competition was more intense early in Period 1. However, periods five and six (highlighted in the table) show a distinct reduction in the intensity of competition from earlier periods across all measures.[15] Most pertinently, this includes the four years immediately prior to the 2008 financial crisis (period 5, from 2004 to 2007) and the period of the crisis itself (period 6, from 2008 to 2009). There is less consensus between the measures for the periods after the crisis (periods 7 and 8, from 2010 to 2013) most likely reflecting

[15] We discuss the possibility of intense competition in credit provision as suggested by the Lerner index on loans in section 3.2

the considerable economic uncertainty and regulatory change undertaken over these periods.

We can quantify the statistical significance of these differences for some measures. From our estimates of the H-statistic in section 3.3 we know that during periods 1 and 4 the statistic is not significantly different from one (the perfect competition outcome), but significantly different from one during periods 5, 6 and 8 (with period 8 being statistically indistinguishable from zero). Table 3.2 below shows statistical tests based on the Boone indicator for periods 1 to 8 identified for the H-statistic. The table reports the probability from a Wald test of the hypothesis that one period (denoted in rows) is statistically different from another period (in columns). The table shows that the average Boone indicator estimated for periods 1 to 4 (1989-2003) is statistically different from those of periods 5 to 8 (2004-13). The estimated average Boone indicators for periods 1 to 4 are not-statistically different from each other and most differences in consecutive periods are not statistically different from zero. However, period 5 (2004-07) is significantly different from 4 (2000-03) and period 8 (2012-13) is significantly different from period 7 (2010-11).

Table 3.2: Boone Indicator – tests for statistical difference between periods[1,2,3]

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
Period 1 (1989–1994)	–	0.920	0.664	0.632	0.100	0.032**	0.001***	0.005***
Period 2 (1995–1997)	–	–	0.341	0.428	0.021**	0.004***	0.000***	0.000***
Period 3 (1998–2000)	–	–	–	0.945	0.052*	0.018***	0.000***	0.002***
Period 4 (2000–2003)	–	–	–	–	0.015**	0.003***	0.000***	0.000***
Period 5 (2004–2007)	–	–	–	–		0.296	0.001***	0.021**
Period 6 (2008–2009)	–	–	–	–	–	–	0.013**	0.125
Period 7 (2010–2011)	–	–	–	–	–	–	–	0.502
Period 8 (2012-2013)	–	–	–	–	–	–	–	–

Source: Bank of England, Authors' calculations

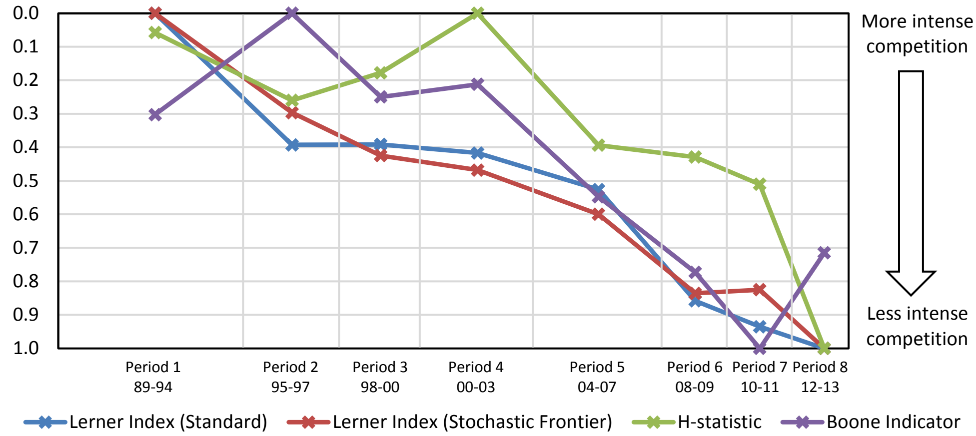
Notes:
[1] Periods are derived from the Panzar-Rosse H-statistic stability test used for calculating the long-term equilibrium sub-periods
[2] Asterisks indicate probability from hypothesis test $H_0\colon Period\ i \neq Period\ j$ for $i \neq j$ where $p < 0.1$ = *; $p < 0.05$ = **; $p < 0.01$ = ***
[3] Test are Wald tests of composite linear hypotheses on the Boone regression estimated parameters and variance-covariance matrix.

Figure 3.7 below provides a visual representation of the combined outcomes of the four performance-based measures. All measures are normalised such that values lie between zero and one[16] with zero indicating the value where competition intensity for each measure is at its maximum and one indicating the value where competition

[16] The measures are normalised using the formula $x^{norm} = (x - \underline{x})/(\overline{x} - \underline{x})$ where x is the average value of the measure in each sub-period, $\underline{x}$ is the minimum value of the averages for the sub-periods and $\overline{x}$ is the maximum average value.

intensity is at its minimum over the sample. The eight periods correspond to the long-term equilibrium sub-periods calculated for the H-statistic[17] (as noted in section 3.3). On this scale, the consistent trend towards less intense competition in general over the entire period is clear.[18]

Figure 3.7: Combined measures of competition[1,2]



Source: Author's calculations

Notes:

[1] Periods are derived from the Panzar-Rosse H-statistic stability test used for calculating the long-term equilibrium sub-periods

[2] Measures are normalised such that zero corresponds to the most competition intensity and one the least competition intensity for each measure

4 Conclusion

The measures of competition intensity calculated in this study suggest that the firms in our dataset are able to extract market rents and earn positive economic profits. The H-statistic, Boone indicator and Lerner indexes indicate that firms, while initially experiencing a period of more intense competition, were increasingly able to extract market rents from customers in the period leading up to the financial crisis and in the post-crisis period.

De-Ramon and Straughan (2016) compare the outcome of these measures with observed trends in the UK deposit-taking sector. They explore in more detail how competition intensity has evolved over time, in particular since the significant reforms enacted in the 1980s and the periods immediately before and after the financial crisis. They find three main sub-periods that more or less corresponds to the empirical findings: consolidation period from 1989 to the early 2000s. post-millennium, pre-crisis period with strong competition in certain market; and the crisis/post-crisis period characterised by banks' ability to extract market rents.

[17] As the H-statistic is not valid for periods 3 and 7, any average that partially included these periods will also be invalid. The average of other measures of competition are valid for these sub-periods.

[18] A similar pattern is observed when the sample is split up into equal periods of 3 years (8 sub-periods) and 4 years (6 sub-periods) although, as noted above, averages for the H-statistic are not valid for averages that include the periods 1998-2000 or 2010-2011

We performed direct tests of the departure from the 'perfect competition' outcomes of UK deposit takers using performance-based measures of competition. Our results indicate that, along with increasing concentration, there was an overall trend of increasing market power / falling competition intensity over the sample from 1989-2013. We note that care needs to be taken when interpreting the performance-based measures, pointing out where the theory and data are ambiguous. In particular, these indicators are less useful in assessing the statistical significance of small movements in competition, especially during small or consecutive time intervals.

The ability to earn super-normal profits by these firms does not necessarily imply that competition is low in all markets which these firms supply products. The performance based measures can be adapted to study competition at a more granular level, e.g. for specific markets such as unsecured loans or mortgages. The differences in the measured price-cost margin for all firm activities (as measured by the Lerner index) versus an inspection of interest rates on individual lending activities suggests that the intensity of competition is higher for some deposit takers' lending activities (and most likely strongest in the market for mortgages than other loans) than for other sources of income (including sales from bundled products, advice and 'investment banking' activities). Using a loan- specialised Boone indicator we show that the competition among those banks may have been more intense during certain periods but also find an overall decreasing trend in competition over time. These more granular estimates are sensitive to a number of assumptions, caveats and uncertainties. We recommend using a battery of indicators also considering the structure of the specific market and existing barriers.

Many studies focus on the number of firms participating in specific financial services markets to proxy the short-term evolution of competition. We show that these structure measures may not be adequate to identify competition outcomes in the UK. In particular, they may not provide a good indicator of how competition affects efficiency and financial stability due to the complexity of the banking business and the many sources of income (and risk). The performance-based measures of competition offer alternative methodologies that take into account the interaction between firm efficiency and competition.

It is also important to complement empirical studies with a good understanding of the regulatory, structural and technological constraints that drive competition. De-Ramon and Straughan (2016) show that UK policy initiatives on those constraints led to mixed long-term outcomes. For example, that lifting barriers between banks and building societies and promoting European banks to compete in a single financial market did not deliver improvements in competition within the UK banking sector. Due to the complex nature of banking business and the possibility of increased market share through consolidation, policy makers need to undertake ex-post assessments of the competition implications of their policies. In addition, changes in competition due to prudential policy may be important for the long-term prospects of financial stability (e.g. an enlarged non-bank sector as a result of capital and funding requirements on regulated banks).

The measures we have calculated also suggest that the relationship between competition in those markets in which deposit takers participate and financial stability is not straightforward. Our results suggest that intense competition in some markets can coexist with an increasing ability of firms to extract market rents when operating across multiple markets. Moreover, our estimated measures of competition intensity suggest periods in which financial instability coincides with both stronger (i.e. early 1990s small banks crisis) and weaker (i.e. 2008 financial crisis) competition.

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Appendix 1 Key Data for Regressions

Table A1.1: Data and assumptions used in regressions[1]

Indicator	Version	Perfect competition outcome	Model assumptions	Dependent variable	Explanatory variables	Environ-mental factors	Reference
Lerner	Standard price-cost margin measure	Output price convergence with marginal cost	Output mix and price, translog cost function, homogeneity	Total Cost	Cost input prices, core Tier 1 capital, total assets	For robustness checks	Casu and Girardone (2009)
	Mark-up adjusted price-cost margin measure	Output price convergence with marginal cost after considering efficiency of each firm	Output mix, translog cost function, homogeneity, half-normal efficiency distribution	Revenue to total cost ratio (revenue per each pound spent)	Input prices, core Tier 1 capital, total assets	For robustness checks	Kumbhakar et al. (2012) Coccorese (2014)
Panzar-Rosse	Test of competitive market equilibrium	Profits correlated with input prices under perfect competition	Translog production function	Profits (return on assets)	Input prices	Yes, for robustness checks	Bikker et al. (2012)
	H statistic of market power	No pricing market-power	Translog cost function	Total Revenue (unscaled)	Input prices	For robustness checks	Bikker et al. (2012)
Boone		Competition increases profit share of most efficient firms	Linear relationship	Profits (return on assets)	Efficiency (proxied by total cost to total revenue ratio)	Yes	Schaeck and Cihák, (2010)

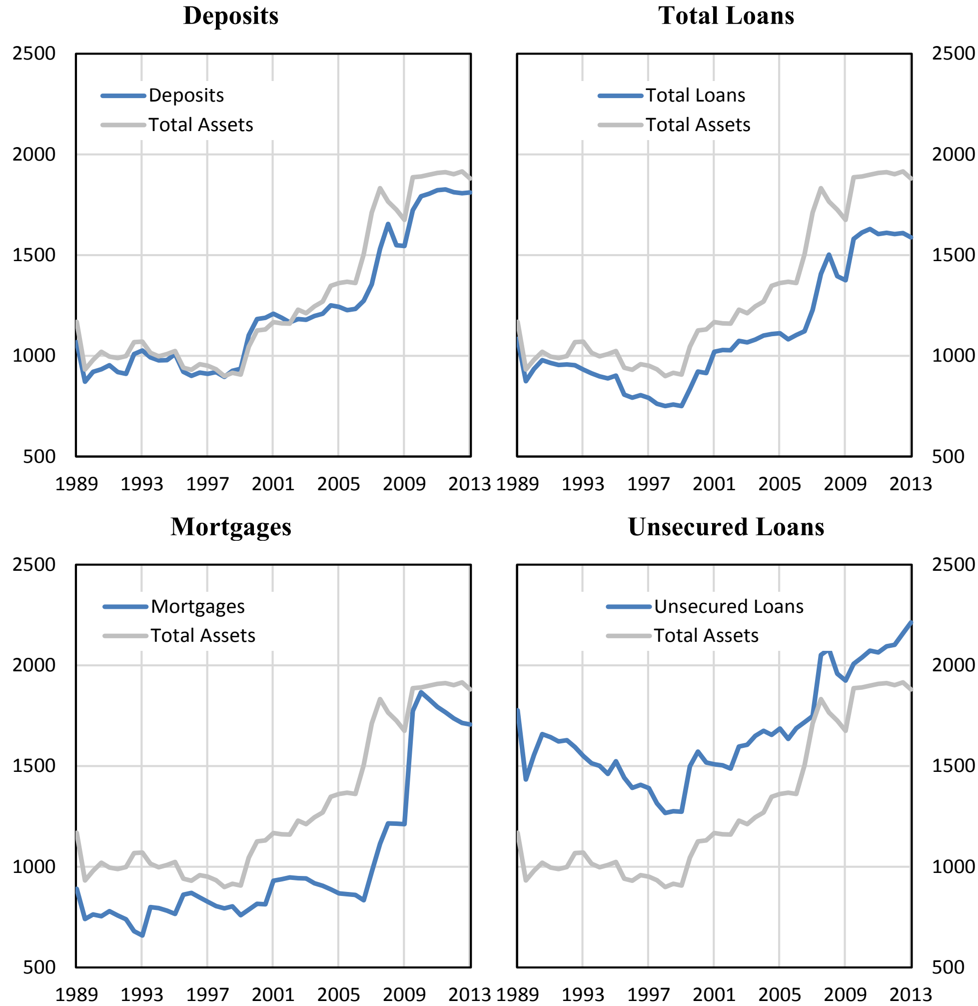
Source: Authors

Note(s):

[1] All five empirical measures are transformation of fixed effects panel regression parameters; fully loaded regressions (time and bank effects) were also implemented. The data panel consists of banking group data regarding UK and non-UK balance sheet exposures and income account information. Environmental factors are: average risk weight, provision ratio, Tie1 capital ratio, loan to assets ratio retail deposit ratio of liabilities other non-earning assets ratio, group size, GDP growth, period dummies.

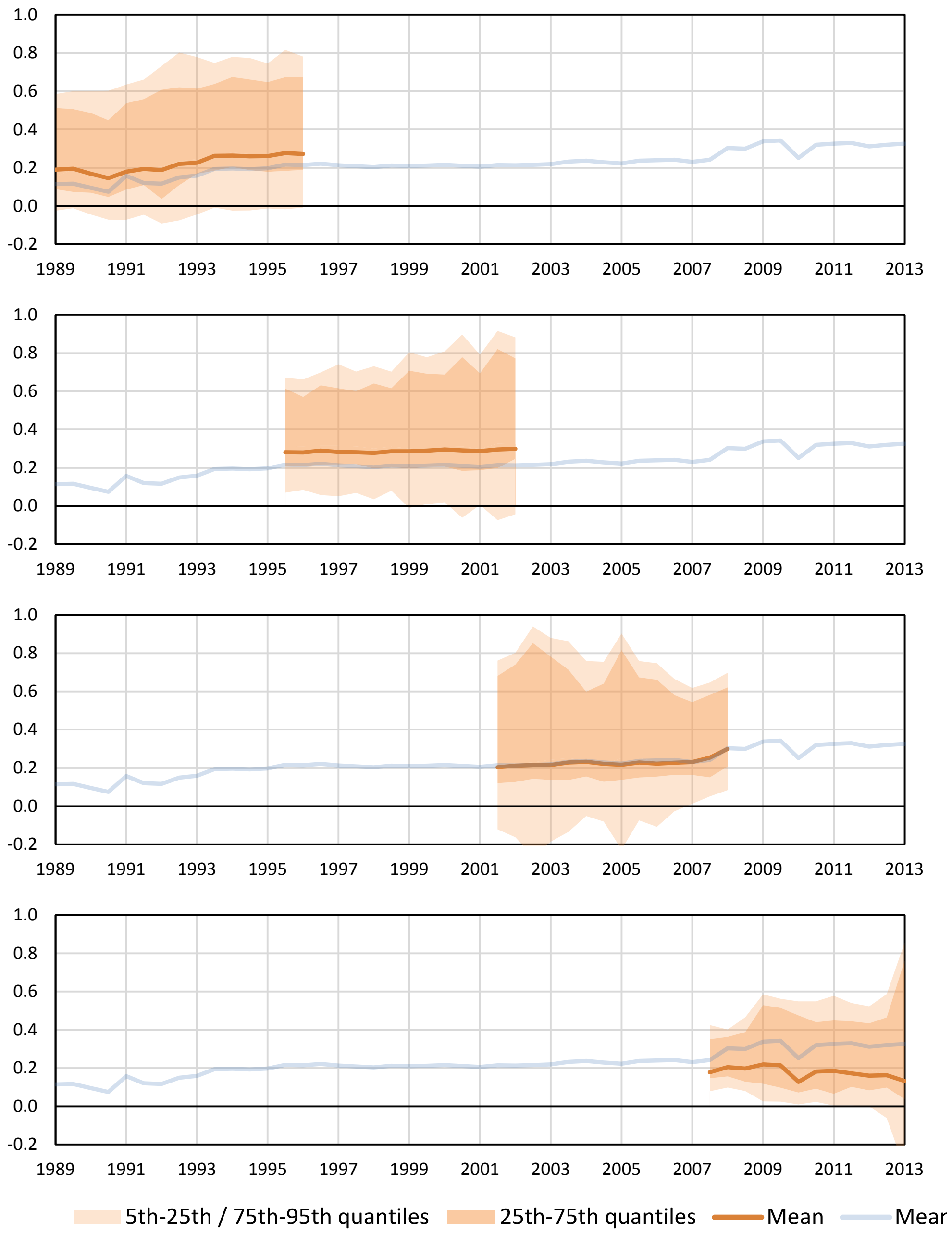
Appendix 2 Additional Indicators

Figure A2.1: HHI Index of sectors – traditional banking model



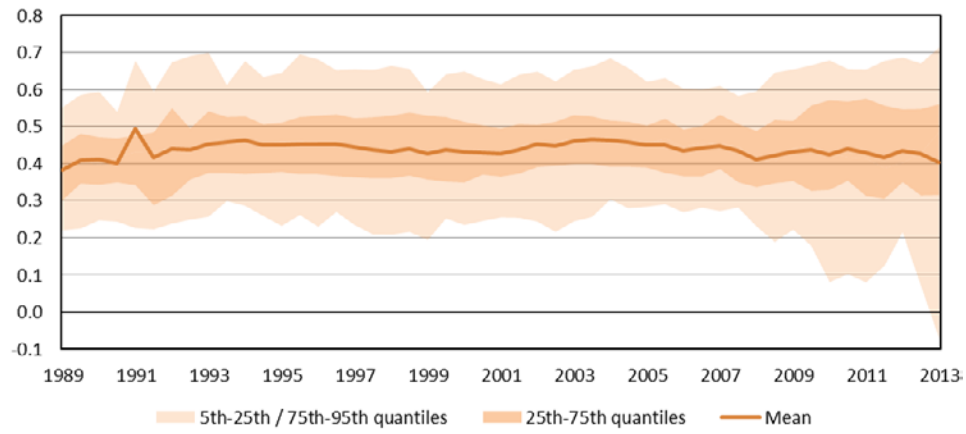
Source: Bank of England, Authors' calculations

Figure A2.2: Estimation of Lerner index over sub-samples



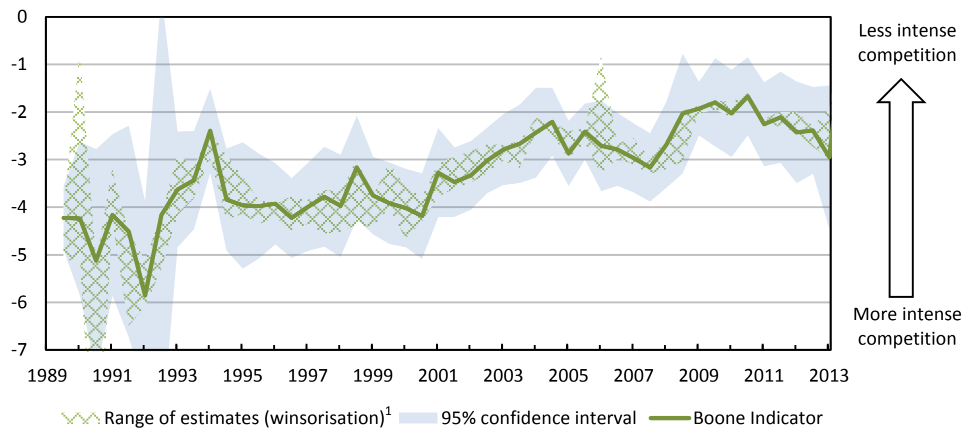
Source: Bank of England, Authors' calculations

Figure A2.3: Lerner index for Total Loans



Source: Bank of England, Authors' calculations

Figure A2.4: Boone indicator for Total Loans



Source: Bank of England, Authors' calculations

Appendix 3 Data for the UK regulated deposit taking sector

We use a newly-compiled dataset of the UK deposit-taking sector in this study (de-Ramon et al. (2016a)). The dataset is drawn from regulatory reports generated by a number of different agencies to produce a large, unbalanced panel dataset that includes all UK-regulated deposit takers. Regulatory data was collected by three different agencies – the Bank of England, the Financial Services Authority (FSA) and the Financial Conduct Authority (FCA) – over the period 1989-2013. In addition, there were a number of changes to the data collected resulting from changes to the regulatory regime, in particular the move from Basel I to Basel II, which needed to be reconciled.

Deposit takers include two distinct business models: banks and building societies. Banks are incorporated and have freedom to undertake a wide range of activities (including non-financial business); building societies have a mutual ownership structure and have restricted funding and lending requirements. Building societies are owned by their deposit holders (members), 75% of business assets must be loans fully secured on residential property and 50% of the funds (liabilities) must be held by members. The data is reported on a semi-annual basis for the period 1989 to 2013 and includes firms' balance sheet and profit and loss data.

We also focus on firms that undertake traditional financial intermediation roles – that is transforming deposits into loans. We have excluded those firms that either do not fund their activities significantly with deposits or use their funding to provide loans. We exclude those firms that have a loan-to-assets ratio of less than 10% and a deposit-to-assets ratio less than 20%, consistent with other studies focussed on competition between deposit takers. The excluded firms are largely focussed on trading activities or other financial market products, and in general are not competing with the more traditional role of financial intermediation. Where firms have operated both traditional and non-traditional models at different points in time, we have excluded only those observations where the non-traditional model was dominant. Table A3.1 provides a summary of the types of firms in the data.

Table A3.1: Regulated firms by business models

	Number of: firms	Observations
By business model		
Banks	105	2967
Building societies	21	545
By activity		
Traditional model[1]	74	2080
Non-traditional model	27	551
Mixed model[2]	25	881
– proportion of traditional activity[3]		55%
Total	126	3512

Source: Bank of England, Authors' calculations

Notes:

[1] The traditional model is defined where firms loan-to-assets ratio is greater than 10% and a deposit-to-assets ratio is greater than 20%

[2] Firms that operated under both traditional and non-traditional models at different points in the sample

[3] Average proportion of observations for which mixed model firms operated under the traditional model

Table 0.2: Selected data[1]

	Mean	Standard deviation	Median	Minimum	Maximum
Key variables[2]					
Total expenses	1609.8	5243.7	199.3	0.8	62527.5
Input costs					
(i) Staff costs	333.8	1437.5	33.9	0.1	14761.5
– ratio to total assets (%)	1.631	3.110	0.941	0.030	54.894
(ii) Physical capital	342.8	1430.8	25.9	0.3	15283.2
– ratio to total fixed assets (%)	340.9	1349.0	126.9	1.3	37194.5
(iii) Funding costs	934.7	2789.0	123.8	0.1	34009.0
– ratio to total deposits (%)	5.686	5.639	4.904	0.060	159.711
Total revenue	2056.4	7023.7	248.8	1.0	91521.4
– ratio to total expenses (%)	124.8	18.8	120.6	16.6	235.8
– ratio to total assets (%)	8.582	6.530	7.418	0.239	111.154
Variable profits	449.9	1963.5	38.4	-336.1	34778.5
– ratio to total assets (%)	0.599	1.055	0.489	-14.303	9.223
Variable costs	1272.9	4011.7	169.9	0.4	61674.5
– ratio to total revenue (%)	66.89	13.19	69.16	34.59	89.13
Control variables[2]					
Total assets	47734	203137	3474	1.7	1925711
Average risk weight (%)	56.08	19.22	52.20	3.88	136.13
Provisions to assets ratio (%)	1.401	3.622	0.655	0.003	53.060
Tier 1 to total capital ratio (%)	83.23	21.25	81.83	34.12	237.62
Total loans to assets ratio (%)	53.82	26.12	58.40	0.00	99.33
Non-financial deposits to total deposits ratio (%)	73.94	26.86	82.76	0.00	100.00
Non-earning assets to total assets ratio (%)	2.593	4.718	0.899	0.001	82.688

Source: Bank of England, Authors' calculations

Notes:

[1] Data is for firms with traditional model defined where loan-to-assets ratio is greater than 10% and deposit-to-assets ratio is greater than 20%

[2] All data in £ million unless otherwise specified

Group consolidated versus solo level data. Regulatory data for deposit takers is collected on both a group consolidated and solo basis for UK regulated firms. Solo level data reflects both the operations of stand-alone firms and of subsidiary level entities within a wider group, including operations within a narrow geographic definition of the UK. In contrast, the group consolidated data includes all global exposures for the group. Using solo data would allow us to focus on the operations within the clearly defined UK geographic boundary. However, groups operating in the UK use their global operations to source funding and otherwise provide competitive advantage to firms. Omitting global operations would exclude this information from the data. One additional advantage of using group consolidated data is that, where two solo-level firms are part of the same group, we can avoid distorting measures of competition where coordination by the group means that these firms may not compete with each other. We have consistently used group consolidated data throughout which means that the data includes both UK domestic and international exposures.

Treatment of mergers. In the regulatory data base, deposit-takers that merge sometimes continue to report data for both entities, using one entity as the merged group and the other as a solo entity, or report both entities on a solo basis and submit data for a third entity as the group. De-Ramon et al (2016a) discuss the reasons why firms were required to continue to report solo data for subsidiaries following a merger. We use the group consolidated data from the point at which the merger is effective and exclude subsidiaries that are included within the group but that continue to report solo data. As with the use of group consolidated data noted above, this can avoid any distortion of competition measures where coordination within the group might affect individual firm behaviour. It is possible that some information on competitive conduct could be excluded where the influence of group decisions does not immediately affect the conduct of newly acquired subsidiaries. Even so, it is not possible to determine subsequently when any influence might be exerted by group management so we use group data from the date of the merger.

Appendix 4 Measures used in this study

In this appendix, we review the measures from the literature that we use in this study to understand trends in competition. We begin with a measure of industry concentration, the Herfindahl-Hirschman index (HHI), and then discuss three performance-based measures: the Lerner index, the Panzar-Rosse H-statistic and the Boone indicator.

The Herfindahl-Hirschman Index (HHI)

The HHI is constructed directly from data and is generally straightforward to calculate. The HHI calculates concentration as the sum of the square of each firms' share in an industry or market, that is:

$$HHI = \sum_{i=1}^{N} s_i^2 \qquad (1)$$

where s_i is the share of firm i in the market and N is the total number of firms. As firm share is calculated on a scale between 0 and 100, the HHI ranges from close to zero (a very large number of firms with very small market shares) to a maximum value of 10,000, in which a single firm holds a monopoly.

The HHI provides background on industrial sectors and/or markets, although it tells us little about the intensity of competition. Competition authorities in the UK (and elsewhere) make use of the HHI as an indicator of the *likelihood* that there could be a competition issue worthy of investigation. For example, an industry with an HHI of greater than 1000 is considered concentrated (and potentially worth of investigating) while an HHI of greater than 2000 is considered highly concentrated (CC (2014)). Competition authorities also use the HHI to signal whether merger activity warrants investigation under competition powers. A horizontal merger generating an increase in the HHI of less than 250 in a concentrated market is not likely to give cause for concern while in a highly concentrated market, an increase in the HHI of less than 150 is not likely to give cause for concern (CC and OFT (2010)). More generally, any event that generates increases in the HHI as noted above could also be worthy of investigation. There are a number of mergers in our dataset so these reference points are worth noting.

The Lerner index

The Lerner index is a measure of price-cost margin and is premised on the outcomes that: in perfect competition the output price (equal to marginal revenue) equals marginal cost (i.e. economic profits should be zero); and in a quantity-setting, Cournot static oligopoly model price rises above marginal cost as firm market power increases. Consequently, divergence of measured price-cost margin from zero should be an indicator of market power (Lerner (1934)).

The standard approach

Under the standard approach used in the literature, the aggregate Lerner index (L) is computed as:

$$L = \frac{P - MC}{P} \tag{2}$$

where P is the output price and MC is the marginal cost, aggregated for all firms.

For the financial sector, the difficulty in measuring prices of output goods and marginal costs is particularly acute. Deposit takers are involved in multiple activities, some of which can be defined as both outputs and inputs. For example, Berger and Humphrey (1997) propose a 'production approach' to banking, where deposits are a product providing services to customers while Freixas and Rochet (1998) propose an 'intermediation approach' in which deposits are an intermediate input in the production of loans. We take the approach common in the literature that deposit-takers predominantly have an intermediation role and that deposits are an input to the production of other products (such as loans). In line with the empirical literature we take a single output approach (Berger et al. (2009), Fernández de Guevara et al. (2007)) using total assets as the output measure while revenue associated with outputs is interest and non-interest income. We also consider total loans as a single output alternative (Kick and Prieto (2013), Coccorese (2014)) on the basis that credit intermediation is the main activity for banks.

Marginal cost MC is not directly observable for a particular firm or for individual products supplied by a firm. Empirically, standard estimates of the Lerner index are therefore derived by estimating the parameters of a total cost function from individual firm data and deriving the marginal costs from the equation parameters. For deposit-taking firms, the Lerner index is commonly calculated by assuming a total cost function of the form:

$$\begin{aligned}\ln(C_{i,t}) = {} & \alpha_0 + \alpha_1 \ln Q_{i,t} + \frac{\alpha_2}{2}\left(\ln Q_{i,t}\right)^2 + \sum_{j=1}^{3} \beta_j \ln(W_{j,i,t}) + \frac{1}{2}\sum_{k=1}^{3}\sum_{j=1}^{3} \alpha_{kj} \ln W_{k,i,t} \ln W_{j,i,t} \\ & + \sum_{j=1}^{3} \delta_j \ln(W_{j,i,t}).\ln Q_{i,t} + \lambda_1 E_{i,t} + \frac{\lambda_2}{2} E_{i,t}^2 + \theta_1 T + \theta_2 T^2 + \sum_{j=1}^{3} \lambda_j T \ln(W_{j,i,t}) \\ & + \Phi' X_{i,t} + \varepsilon_{i,t}\end{aligned}$$

where $C_{i,t}$ is total cost (or expenses) for bank i at time t, $Q_{i,t}$ is total assets, a proxy for bank output, $W_{j,i,t}$ are input prices reflecting labour costs (W_1), physical capital (W_2) and funding costs (W_3), $E_{i,t}$ is bank capital, T is a time trend and $X_{i,t}$ contains a number of control variables which may impact on the firm production technology (e.g., period fixed effects, as in Berger et al. (2009)). Most studies use total assets as an output measure as income by type of bank activity is not always be available. See, for example, Fernández de Guevara et al. (2007), Berger et al. (2009) or Weill (2013). As a robustness check of our results we use total loans as a proxy for output in section 3.2.

The measure of marginal cost used in the calculation of the Lerner index is then derived from the estimates in equation (3) as:

$$MC_{i,t} = \frac{\partial C_{i,t}}{\partial Q_{i,t}} = \left(\alpha_1 + \alpha_2 \ln Q_{i,t} + \sum_{j=1}^{3} \delta_j \ln(W_{j,i,t})\right)\frac{C_{i,t}}{Q_{i,t}} \tag{4}$$

Finally, we follow the empirical literature and measure output price P in equation (2) using the ratio of interest and non-interest income to total assets as a proxy.

The stochastic frontier approach

We also construct an alternative estimate of the Lerner index following Kumbhakar et al. (2012). These authors note that if $P \geq MC$ then $P.\left(\frac{Q}{C}\right) \geq MC\left(\frac{Q}{C}\right) = \left(\frac{\partial C}{\partial Q}\right)\left(\frac{Q}{C}\right) = \frac{\partial \ln C}{\partial \ln Q}$.Therefore, price must be greater than marginal cost, the relationship between price, marginal cost and output can be written as:

$$\frac{P_{i,t}Q_{i,t}}{C_{i,t}} = \frac{\partial\, ln\, C_{i,t}}{\partial\, ln\, Q_{i,t}} + u_{i,t}, \qquad u_{i,t} \geq 0 \tag{5}$$

where $P_{i,t}Q_{i,t}/C_{i,t}$ is the ratio of total revenue ($P_{i,t}Q_{i,t}$) to total costs and $u_{i,t}$ is n alternative measure of the markup applied by the firm over marginal cost.

Assuming a total cost function similar in form to that in equation (3), the mark-up $u_{i,t}$ can be estimated directly from the following relationship using the stochastic frontier methodology:

$$RC_{i,t} = \gamma_1 + 2\gamma_2 \ln Q_{i,t} + \sum_{j=1}^{3} \mu_j \ln\left(W_{j,i,t}\right) + \rho T + \eta E_{i,t} + u_{i,t} + v_{i,t} \tag{6}$$

where $RC_{i,t}$ is the ratio of total revenue to total cost and $v_{i,t}$ is the error term. One advantage of this approach is that it does not require a separate estimate of output prices as for the standard Lerner index in equation (2). However, it requires an additional behavioural assumption for the mark-up term $u_{i,t}$ which can only be positive and is restricted to be the positive half of a normal distribution. Together, the mark-up term $u_{i,t}$ and the error term $v_{i,t}$ make up the compound error term as commonly set out in the stochastic frontier literature. We follow the suggestion in Kumbhakar et al (2012) and assume that $u{\sim}N^{+}(0,\sigma_u^2)$ and $v{\sim}N(0,\sigma_v^2)$ where N^{+} is the normal distribution truncated at zero from below. The error term $v_{i,t}$ is a two-sided random process that does not reflect market power but rather uncertainty on the part of the firm when pricing their products. Kumbhakar et al. (2012) then show that the Lerner index can be calculated using the relationship between the estimated one-sided mark-up ($\hat{u}$) and the elasticity of total cost to output ($\mathrm{E}_{TC,Q}$) as follows:

$$L = \frac{\hat{u}}{\mathrm{E}_{TC,Q} + \hat{u}} \tag{7}$$

where the elasticity of total cost to output term ($\mathrm{E}_{TC,Q}$) is derived from the deterministic element of equation (6) as follows:

$$\mathrm{E}_{TC,Q} = \hat{\gamma}_1 + 2\hat{\gamma}_2 \ln Q_{i,t} + \sum_{j=1}^{3} \hat{\mu}_j \ln\left(W_{j,i,t}\right) + \hat{\rho} T + \hat{\eta}\, E_{i,t} \tag{8}$$

The Panzar-Rosse H-statistic

The Panzar-Rosse H-statistic considers the transmission of input costs through to firms' revenue as estimated by the sum of the elasticities of revenue to the underlying input prices. Weak pass-through of costs to revenues is interpreted as a greater exercise of market power, while full pass-through is indicative of highly competitive markets. To understand the intuition behind the H-statistic, it is useful to consider the two extremes cases of perfect competition and monopoly.

Under perfect competition, each firm in equilibrium earns zero economic profits. Costs are homogeneous of degree one in input prices, so any change in input prices induces an equal change in marginal costs. A sustained increase in input costs will generate negative economic profits in the short term. To restore zero economic profits, some firms exit the market, reducing aggregate supply and raising output prices such that remaining firms' revenues exactly offset the increase. The elasticity of firms' revenue to costs will therefore be unity in the perfect competition case.

In contrast, a monopolist sets prices in the market where demand is elastic as this is where marginal revenue is positive. Total Revenue is equal to price times quantity, $TR = P \times Q$. Marginal revenue can be derived using the product rule as $MR = \frac{\partial(PQ)}{\partial Q} = P + Q\frac{\partial P}{\partial Q} = P\left[1 + \frac{\partial P}{\partial Q}\frac{Q}{P}\right]$. The elasticity of demand is defined as $\mathrm{E}_D = \frac{\partial Q}{\partial P}\frac{P}{Q}$, so marginal revenue becomes $MR = P\left[1 + \frac{1}{\mathrm{E}_D}\right]$. Demand is elastic where $-\infty < \mathrm{E}_D < -1$ which implies a positive marginal revenue, while inelastic demand (where $-1 < \epsilon^D < 0$) implies negative values for marginal revenue. A monopolist will always set production on the elastic part of the demand curve where marginal revenue is positive.

The monopolist responds to an increase in input costs by reducing production and so total revenue falls as demand is elastic and the resulting increase in price is not sufficient to offset the reduction in the output. The elasticity of the monopolists revenue to costs is therefore negative. Intermediate values for the H-statistic reflect varying degrees of monopolistic competition with the intensity of competition diminishing as values move from one (perfect competition) towards zero (increasingly imperfect / monopolistic competition) (see Rosse and Panzar (1977) and Panzar and Rosse (1987)). The H-statistic will be negative for a perfect monopoly, although in practical terms the index generally varies between one (strong competition) and zero (weak competition).

The H-statistic is derived from a fixed effects panel regression of the following form:

$$\ln\left(TR_{i,t}\right) = \alpha + \sum_{j=1}^{J} \beta_j \ln\left(C_{j,i,t}\right) + \theta' X_{i,t} + \eta_{i,t} \tag{9}$$

where $TR_{i,t}$ is the total revenue for firm i at time t, $C_{j,i,t}$ is input cost factor j and $X_{i,t}$ is a vector of exogenous control variables. The H-statistic itself is calculated as the sum of the coefficients on each factor cost, i.e.

$$H = \sum_{j=1}^{J} \beta_j \tag{10}$$

The Boone Indicator

The intuition behind the Boone indicator relies on the output-reallocation effect. When competition intensity increases, more efficient firms are able to expand their output at lower cost than less-efficient firms, leading to higher profits. As competition becomes more intense, less-efficient firms become increasingly unprofitable and leave the market, leaving more efficient firms able to expand output and profitability. An increase in competition intensity can arise from either greater interaction between incumbent firms or lower barriers to entry. Formally, for any three firms in a market with levels of efficiency $n'' > n' > n$, an increase in the intensity of competition benefits more efficient firms such that the ratio $[\pi(n'') - \pi(n)]/[\pi(n') - \pi(n)]$ rises. Boone demonstrates that this relationship between efficiency and output is consistent with a broad set of models of competition which include, but are not limited to, competition based on quantities (Cournot) and price (Bertrand) (e.g. Boone (2008)).

Empirically, the measures of variable profits and efficiency are determined as follows. First, variable profits are defined in terms of total revenues and costs directly related to production but excluding costs such as R&D and capital stocks. This is because R&D and capital stocks are indicative of expenditure that change future efficiency, which will show up in the measure in future periods (see Boone (2008) for discussion of variable definitions). Efficiency is measured in terms of average variable costs, defined as variable cost (as above) divided by a measure of output. For the financial sector, output is usually proxied by revenue derived directly from financial market activities, such as interest and investment income received.

In practice, the Boone indicator is estimated as the time fixed effects coefficient on variable costs using an equation of the form (Boone et al. (2007)):

$$\pi_{i,t} = \alpha + \beta_t \ln(c_{i,t}) + \Phi X_{i,t} + \eta_{i,t} \qquad (11)$$

where $\pi_{i,t}$ are the variable profits, $c_{i,t}$ are average variable costs and $X_{i,t}$ are control variables for each firm i at period t. The Boone indicator is the estimated coefficient β_t derived for each period t, allowing comparisons through time.

Interpretation of performance-based measures

The performance-based measures provide us with different perspectives on the divergence of outcomes from what we would expect from highly competitive (perfectly competitive) markets. Each measure has a different theoretical foundation, focussing on a different aspect of competition outcomes. Table A4.1 sets out the key characteristics of each of the measures we consider in this study.

Table A4.1: Characteristics of measures of competition intensity

Measure	Theoretical Range	Value at perfect competition	Direction indicating increasing intensity of competition	Concept underpinning perfect competition outcome
Lerner index	0 to 1	0	↓	Economic profits driven towards zero
H-Statistic	0 to 1[1]	1	↑	Full pass-through of costs to revenue
Boone indicator	-∞ to 0	Increasingly negative	↓	Output reallocated to more efficient firms

Notes:

[1] The H-statistic can take on negative values for a pure monopoly but for practical purposes is bound between 0 and 1

The theoretical outcomes for perfect competition against which these measures are benchmarked are generally those that arise in the absence of market failures, such as information asymmetries and externalities. These market failures tend to raise entry and exit barriers, introduce sunk costs and limit the propagation of production technologies. Moreover, these market failures are also a key source of instability in the financial sector, which is a key focus of financial market regulators. In this sense, the perfect competition outcomes embedded within the performance-based measures we consider are consistent with the definition of effective competition espoused by the PRA and which can be a relevant indicator for measuring progress against financial stability objectives. In general, competition is considered to be effective when: (i) suppliers compete to offer a choice of products or services on the most attractive terms to customers and appropriately price in the risks associated with their businesses; (ii) customers have the confidence to make informed choices are based on those quality attributes that are easy to observe at a price that allows suppliers to earn a return on their investment commensurate with the level of risk taken; and (iii) effective entry, expansion and exit is possible in the market. See Dickinson et al (2015) for further discussion.

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Statistical implications of evolving monetary policy: the case of Indonesia[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Statistical Implications of Evolving Monetary Policy: The Case of Indonesia

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Abstract

The monetary policy framework of a central bank evolves over time. That evolution process induces changes in the availability of statistics in terms of both scope and depth. In the case of Indonesia, prior to 1999, the overarching goals of monetary policy were price stability, sustainable economic growth and balance of payment soundness. The monetary instruments at that time included Open Market Operations (OMO), Discount Facilities and the Reserve Requirement, using Base Money as the operational target. Therefore, the availability of accurate statistics concerning Base Money (M0), Narrow Money (M1) and Broad Money (M2) was vital for monetary policymaking. However, after enforcement of the Bank Indonesia Act in 1999, monetary policy targeted a single objective, namely achieving and maintaining rupiah stability. To implement monetary policy, since July 2005 Bank Indonesia has adopted the Inflation Targeting Framework (ITF), using the BI Rate as the policy instrument. Consequently, information regarding inflation expectations and output gap became key underlying considerations when formulating monetary policy. This paper will explain the implications of monetary policy evolving for statistics, including for surveys, in Bank Indonesia.

Keywords: Monetary Policy Framework, Central Bank, Statistics, Surveys

JEL classification:

1. Introduction

1.1 Overview

Pursuant to the Bank Indonesia Act (No. 23) of 1999, monetary policy making by Bank Indonesia evolved. Previously, monetary policy had targeted price stability, sustainable economic growth and a sound balance of payments (BOP), but subsequently evolved towards a single objective, which is to achieve and maintain the stability of the rupiah value. In pursuit of its overarching purpose, Bank Indonesia focused on three tasks: (1) to prescribe and to implement the monetary policy; (2) to regulate and to safeguard the smoothness of the payment system; and (3) to regulate and to supervise banks. When the Financial Services Authority (Otoritas Jasa Keuangan - OJK) was established in accordance with the Otoritas Jasa Keuangan Act (No. 21) of 2011, however, banking regulation and supervision function was transferred to OJK and Bank Indonesia was tasked with macro prudential regulation and supervision.

On 1st July 2005, Bank Indonesia applied an Inflation Targeting Framework (ITF), which prioritizes forward-looking monetary policy by publicly announcing projected inflation for the upcoming periods and explicitly states that the single target of long-term monetary policy is low and stable inflation. By announcing the inflation target, the central bank is required to implement disciplined, forward-looking policy. Consequently, public inflation expectations are influenced by the transparent and accountable inflation target that is announced.

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Any evolution of the monetary policy framework applied by Bank Indonesia will require a corresponding change in the available statistics needed in terms of the scope and depth of the data. Prior to 1999, the main monetary policy instruments included Open Market Operations (OMO), Discount Facilities and the Reserve Requirement (RR), with Base Money (M0) used as the operational target or monetary policy signal. Upon application of ITF, however, the Base Money (M0), Narrow Money (M1) and Broad Money (M2) aggregates became critical information to support monetary policy. Furthermore, ITF also required additional information on inflation expectations, which was collected through various surveys conducted by Bank Indonesia. In addition, Bank Indonesia also required supplementary data and information concerning bank lending as well as the lending standards applied by the banking industry to support macro prudential policy.

1.2 Objective of the paper

The objective of this paper is to illustrate the change in the data/statistics required as monetary policy at Bank Indonesia has evolved. The paper also reviews in greater detail the data requirements after application of ITF and "enhanced ITF", primarily in terms of inflation expectations and lending standards, as well as how Bank Indonesia collects the information through the various surveys performed. The structure of this paper is organized as follows. After the introduction, the second section summaries the monetary policy framework implemented by Bank Indonesia prior to and after the Bank Indonesia Act of 1999 was promulgated, focusing on ITF implementation. The third chapter of the paper will elaborate the implications of monetary policy evolution on Bank Indonesia statistics, the role of surveys to capture inflation expectations and lending standards as well as the development of such surveys. The paper will close with the conclusions drawn from the previous chapters.

2. Monetary Policy In Indonesia

Monetary policy is the policy of the monetary authority or central bank in the form of control over monetary aggregates to achieve the desired economic developments (Warjiyo and Juhro, 2003). Monetary policy plays a crucial role in the economy of a country because it influences price stability, economic growth and the balance of payments (BOP).

There are two types of monetary policy, namely expansive and contractive. In general, expansive monetary policy is applied to stimulate economic activity by increasing total demand for money or lowering interest rates in the economy, while contractive monetary policy aims hold inflation by reducing demand for money or raising interest rates.

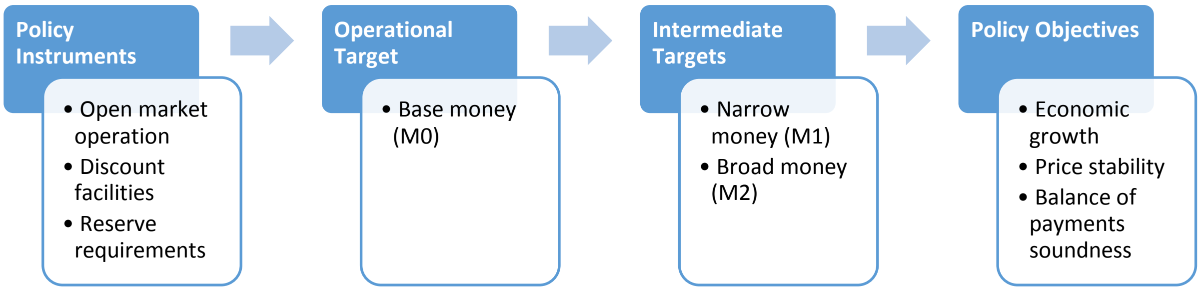
2.1 Monetary Policy prior to ITF

The monetary policy framework of a central bank can evolve over time. Global economic conditions, the domestic economy and financial sector developments are the main determinants of change. In the case of Indonesia, at the beginning of the 1980s, a decline in government revenues from oil exports due to the sliding oil price forced the government to deregulate the banking industry in order to stimulate domestic savings growth from the public as a source of development financing.

In 1983, banks were permitted to determine their own credit policy and interest rates, which precipitated rapid banking and financial sector growth in Indonesia. Thereafter in 1988, the government issued a further deregulation package that simplified the requirements to start up a bank, open branch offices and become a foreign exchange bank. The policy was accompanied in 1990 by refinements to the national credit system that encouraged banks and financial institutions to expand the intermediation function and confirmed Bank Indonesia's role in terms of maintaining monetary stability and banking industry supervision.

As a result of government deregulation in the 1980s, direct monetary policy that had previously limited credit and other assets, coupled with selective credit policy, evolved into indirect market-oriented monetary policy to control base money (M0). Using base money as the operational target, the amount of currency in circulation (M1 and M2) could be influenced to achieve the fundamental target of monetary policy. Monetary policy that uses monetary aggregates (base money and currency outside banks) is known as a quantity-based approach.

Figure 2.1 Monetary Policy Framework prior to ITF



Source: Bank Indonesia

To manage base money, Bank Indonesia controls liquidity in the economy through Open Market Operations (OMO) using monetary instruments, namely Bank Indonesia Certificates (SBI), Money Market Securities (SBPU), Discount Window, and Moral Suasion. Through Open Market Operations, Bank Indonesia could increase the amount of base money by purchasing securities and vice versa. Open market operations also influence short-term interest rates due to changes in bank liquidity predicated on increases or decreases to base money initiated by Bank Indonesia. In addition, the discount window, which allows eligible banks to borrow money from the central bank to meet temporary liquidity shortages, also influences short-term interest rates.

The monetary and banking crisis that befell Indonesia in 1997-1998, due to the Asian Financial Crisis, had a significant impact on Indonesia's economy. Dramatic rupiah depreciation, soaring inflationary pressures and spiraling interest rates severely impeded the bank intermediation function. Such conditions drastically eroded the effectiveness of monetary policy in terms of attaining the inflation target. The crippled bank intermediation function undermined monetary policy transmission through the interest rate channel. To overcome such dire circumstances, Bank Indonesia directed monetary policy towards controlling liquidity on the money market through base money (M0) as the operational target in line with the needs of the real economy.

2.2 Inflation Targeting Framework

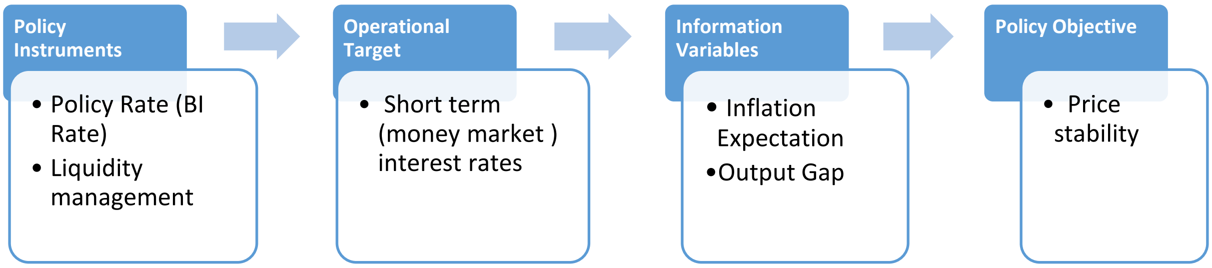
With the promulgation of the Bank Indonesia Act in 1999, the target of monetary policy shifted from a dual target to a single objective, namely rupiah stability against goods and services, as reflected by inflation and exchange rate stability against other currencies. In addition to stipulating the single objective, the Bank Indonesia Act of 1999 implicitly mandated for Bank Indonesia to apply the Inflation Targeting Framework (ITF). Subsequent to the transition period from 1999-2005, on 1st July 2005, Bank Indonesia officially adopted ITF.

The Inflation Targeting Framework is a monetary policy framework signaling the central bank's official position that the overarching goal of monetary policy is to create low and stable inflation, while announcing the inflation target publicly (Warjiyo and Juhro, 2003). Announcing the inflation target is indicative of the central bank's avowed commitment to control inflation and increase transparency.

Warjiyo and Juhro (2003) proposed a number of fundamental concepts of ITF-based monetary policy as follows: (i) inflation target; (ii) forward-looking monetary policy; (iii) transparency; as well as

(iv) accountability and credibility. ITF begins with determining and announcing the desired inflation target by the central bank for a predetermined period. The announced inflation target is also used to anchor the monetary policy of the central bank. Furthermore, ITF-based monetary policy is forward looking, implying that monetary policy includes anticipatory measures to attain the inflation target. ITF application demands central bank transparency and disclosure, thus demonstrating commitment to combat inflation and to anchor public inflation expectations.

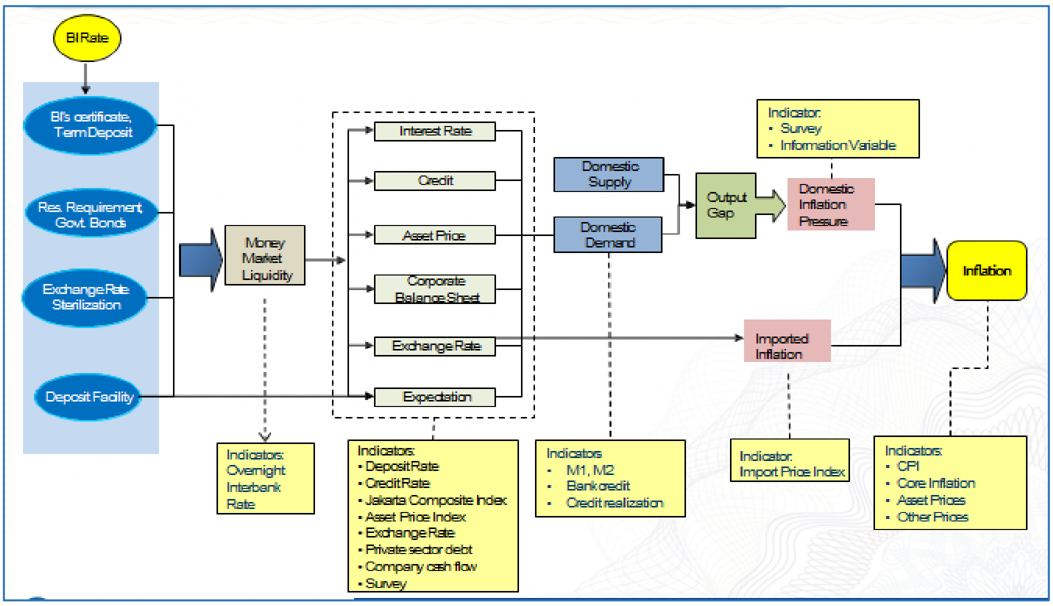
Figure 2.2 Monetary Policy Framework Under ITF



Source: Juhro, S. M. & Goeltom, M. S. (2015), modified

In general, the monetary policy transmission mechanism applied by Bank Indonesia after ITF adoption included various cannels, such as the interest rate channel, bank lending channel, assets prices, balance sheet, exchange rate and expectations. Furthermore, monetary policy transmission differs in each country where it is applied. The monetary policy transmission mechanism in Indonesia, however, is illustrated according to Figure 2.3.

Figure 2.3 Monetary Policy Transmission



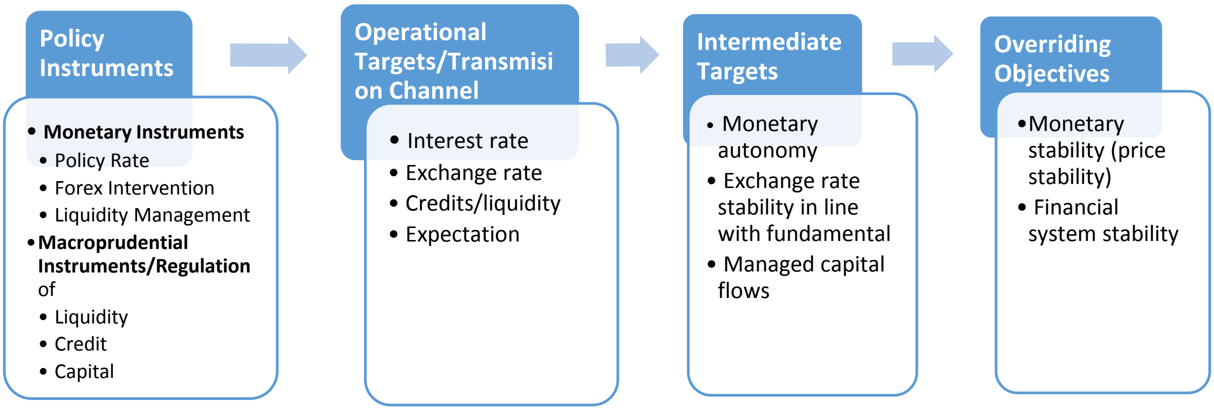
Source: Bank Indonesia, Intermediate Central Banking Certification Materials

Bank Indonesia executes a policy strategy through the implementation of monetary policy, while monitoring other indicators, including interest rates and exchange rates as well as monetary aggregates. Consequently, Bank Indonesia regularly observes a number of real economic variables, both demand and supply-side variables, to detect possible inflationary pressures early. Moreover, Bank Indonesia is also constantly expanding the availability of economic, monetary and banking information along with data on the flows of foreign exchange in order to support monetary policy effectiveness.

Consequently, Bank Indonesia released regulations concerning recurrent surveys to collect and collate comprehensive and up-to-date information on the economy, monetary sector, banking industry and real sector.

The Global Financial Crisis of 2008 prompted a structural change in the Indonesian economy. The Crisis provided an invaluable lesson that macroeconomic stability shall not be achieved without financial system stability. After the global financial crisis, Bank Indonesia paid due consideration to the growing interconnectedness between monetary stability, financial system stability and the payment system. Juhro and Goeltom (2015) explained that ITF, as applied by Bank Indonesia, required further development to incorporate a policy mix in order to mitigate financial system risks. Consequently, the policy rate response was complemented with exchange rate policy, capital flow management, macroprudential policy as well as policy coordination and communication.

Figure 2.4 Monetary and Macroprudential Policy Framework Under "enhanced" ITF



Source: Juhro, S. M. & Goeltom, M. S. (2015), modified

Thereafter, Bank Indonesia applied a new approach to achieve rupiah exchange rate stability through a policy mix comprised of three main policy strategies: (i) credible and consistent monetary policy; (ii) credible and proactive macro prudential policy supported by solid and tested surveillance; and (iii) credible and proactive payment system policy and rupiah management.

Under enhanced ITF, macro prudential instrument in addition to monetary instruments is utilized. Monetary instruments (policy rate, forex intervention and liquidity management) will be utilized to influence monetary variables, such as the exchange rate, credit and expectation. In the other side, macro prudential instrument will be utilized mainly to manage risk potential or perception in financial market. The last picture describes improvement of monetary policy under enhanced ITF.

The discussion above clearly shows that the monetary policy applied by Bank Indonesia has evolved over time to address the changing landscape, while paying due consideration to the overarching purpose of monetary policy.

3. Statistics To Support Monetary Policy

The evolution of monetary policy precipitated a corresponding change in the statistics required in terms of scope and depth. ITF implementation by Bank Indonesia demanded information on inflation expectations. In addition, the application of macro prudential policy also required data to support the monitoring of financial system stability. The new requirement for statistics and information to support monetary and macro prudential policy was met, amongst others, through various surveys.

3.1 Provision of Inflation Expectations Data

As a central bank implementing ITF, Bank Indonesia is required to anchor public inflation expectations within the predetermined target corridor. Consequently, it has become imperative to know the medium and long-term inflation expectations of the public. To that end, Bank Indonesia conducts various surveys that seek to collate information on inflation expectations. For example, the Business Survey (BS) collects information on inflation expectations from the perspective of the business community, while the Retail Sales Survey captures the inflation expectations of retailers and the Consumer Survey probes the inflation expectations of consumers. Bank Indonesia also conducts the Forecasting Macroeconomic Indicators Survey (MIFS) to gauge the inflation expectations of economists and financial market analysts.

Based on an assessment of the various surveys conducted, Bank Indonesia initiated a review in 2015 to redesign the survey questionnaires after it was decided that the information gleaned from the aforementioned surveys was inadequate to formulate medium and long-term policy. The existing questions were sufficiently diverse, incorporating qualitative and quantitative questions, but failed to apply a uniform time horizon, thus undermining in-depth comparisons. In general, comparisons of the questions on inflation expectations contained in each respective survey are presented in Table 3.1.

Table 3.1 Questions on Inflation Expectations in the Existing Surveys

TYPE OF SURVEY	PERIOD	INDICATORS	QUESTIONS	METHODOLOGIES	NOTES
CONSUMER SURVEY	Monthly	- Price Expectation for the next 3 months - Price Expectation for the next 3 months for 7 grups of commodities ((1) Foodstuff, (2) Food, Beverage,s Cigarettes, and Tobacco, (3) Housing, Electricity, Gas and Fuel, (4) Clothing, (5) Health, (6) Transportation, Communication, and Financial Services, (7) Education, Recreation, and Sport)	- How do you estimate the price change in general in the next 3 months compared to this time? (go up, go down, remain the same) - How do you estimate the price change in general in the next 3 months compared to this time by commdity grup? (go up, go down, remain the same)	Weighted Balance Score. The results of a survey using Balance Score method ie Net Balances plus 100. Balance Score = (% Increasing Answer-% Decreasing Answer) + 100	The correlation between the price expectations to the real inflation for the next 3 months, 6 months, and 12 months are 0.35, 0.34, dan 0.45.
		Price Expectation for the next 6 months	How do you estimate the price change in general in the next 6 months compared to this time? (go up, go down, remain the same)		
		Price Expectation for the next 12 months	How do you estimate the price change in general in the next 12 months compared to this time? (go up, go down, remain the same)		
RETAIL SALES SURVEY	Monthly	Price Expectation for the next 3 months	During the next 3 months, what do you expect about prices in general compare to where they are now? (go up, go down, remain the same)	*Weighted Balance Score* .	The inflation expectations SPE correlation of 0.28 (three month period) and 0.26 (a period of 6 months) .
		Price Expectation for the next 6 months	During the next 6 months, what do you expect about prices in general compare to where they are now? (go up, go down, remain the same)		
BUSINESS SURVEY	Quarterly	Expectation for annual inflation	-What is your expectation for annual inflation in 2016? (yoy)	*Simple average*	If using quarterly data I to IV the correlation will be negative 0.07. If using the fourth quarter data only then the outcome is significantly improved 0.82, however deviation still high at 1.78%.
MACROECONOMIC INDICATORS FORECASTING SURVEY	Quarterly	The next quarterly inflation forecast (yoy) The inflation forecasts (yoy) in the current year and the following year (yoy)	- In your point of view , what is the inflation rate forecast upcoming quarters (yoy) - In your point of view , what is the inflation rate forecast in the year x (the current year)? - In your point of view , what is the inflation forecast in the year x+1 ? - If you expect inflation in year x is higher or lower than a year x-1, mention of the main reasons that change according to priority (1, 2, 3)?	Mean point estimate (MPE) is the average response point estimate (level) of the respondents	The correlation between inflation and inflation projections for the coming quarter by 0.66 with deviation of 1.10% .

Source: Redesign of Inflation Expectations Survey, Bank Indonesia

Based on the results of literature studies in various countries, separate surveys could be used to observe indicators of inflation expectations form various economic agents, as had been the case in Indonesia. The questions were generally quantitative in nature, allowing direct processing to calculate the mean and median. Nonetheless, a number of surveys were found to enquire directly the expected "inflation rate" but other surveys favored more indirect questions in the form of "general prices" or "prices you pay" to gauge expected and perceived inflation.

Table 3.2 Comparison of Questions on Inflation Expectations in the Consumer Survey

Countries	Surveys	Questions
USA	*Survey Of Consumers*	*Price in general*
Japan	*The Monthly Consumer Confidence Survey (MCCS)*	*Prices of goods and services that you frequently purchase*
India	*Inflation Expectations Survey of Households (IESH)*	- *Expectation on Prices* - *inflation rate*
England	*Bank of England/Gfk NOP Inflation Attitudes Survey*	- *Prices in the shops generally to change (perceived & expectation)* - *Changes in interest rate (perceived & expectation)*
Australia	*Survey of Consumer Inflationary Expectations*	*Prices of things you buy*
New Zealand	*Household Inflation Expectations (HIE)*	*Inflation rate*
Indonesia	Consumer Survey	*Price in general*

Source: Redesign of Inflation Expectations Survey, Bank Indonesia

Nonetheless, through the questionnaire redesign, indirect questions were favoured in the form of "changes in general prices" in order to overcome any difficulties respondents might have in terms of answering the questions that could potentially erode the response rate.

Subsequently, the questionnaires of the Inflation Expectations Survey were redesigned to include the following points in order to enhance the quality and functionality of the data collected:

- Questions applied a uniform time horizon in order to facilitate comparisons between surveys. Therefore, each survey contained additional questions about inflation expectations in one year and possibly two years. In addition to questions in the form of a moving average for 3 months, 6 months, 1 year and 2 years, questions were also included regarding yearend CPI for the current year and for the following year.
- In order to confirm qualitative answers to inflation expectations (net balance processing and direction), the scope of the questions included the magnitude of price change (inflation/deflation) to facilitate analysis.
- The reasons behind the respondents' answers to questions on inflation were also disclosed/analysed to help explain respondent behavior when forming inflation expectations.
- To anchor the inflation target, questions were included on whether the respondents were aware of the inflation target set by the Government, the level of confidence towards the inflation target and whether the respondent's inflation expectations were forward looking.
- An additional question was also included concerning assumed inflation when formulating corporate budgets.

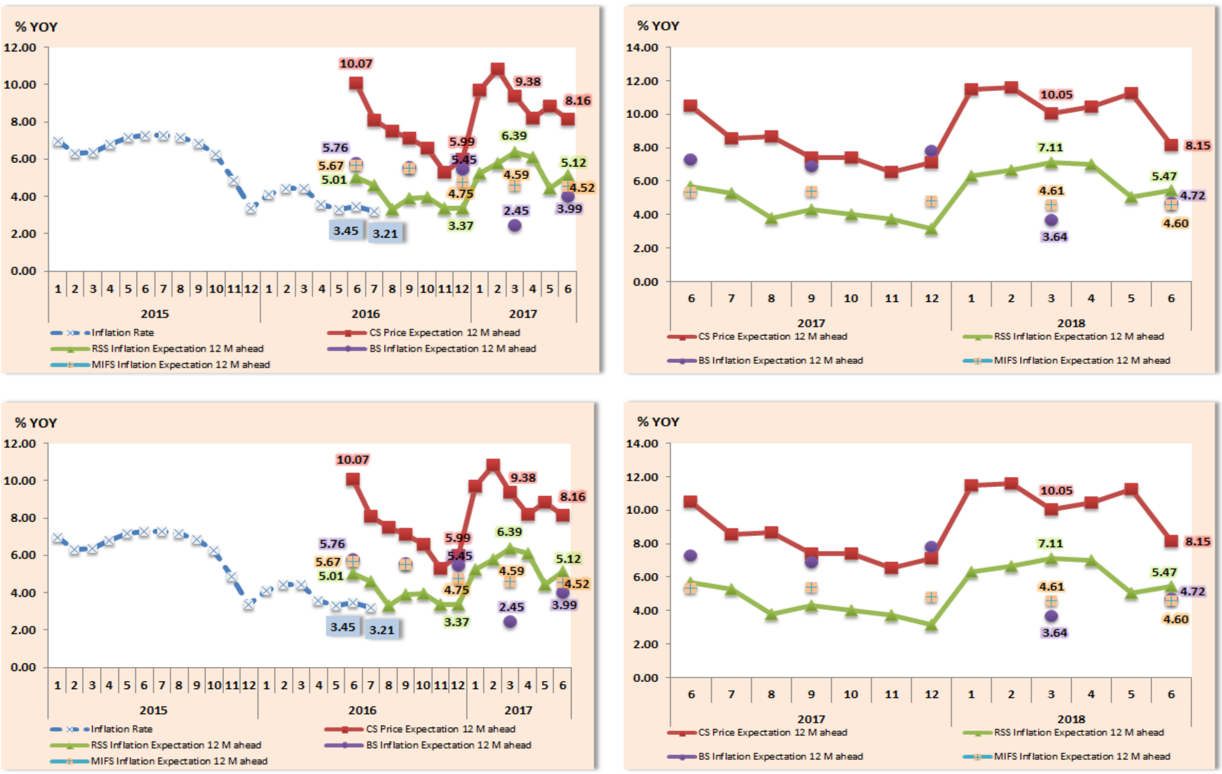
In the subsequent phase, Bank Indonesia initiated an Inflation Expectations Survey pilot project with the respondents of the Business Survey, Consumer Survey, Retail Sales Survey and the Macroeconomic Indicators Forecasting Survey, while adjusting the time horizon to match existing surveys. Therefore, as the Consumer Survey and Retail Sales Survey were conducted monthly, the pilot project for such respondents would also be conducted monthly. Similarly, the pilot project for respondents of the Business Survey and Macroeconomic Indicators Forecasting Survey were conducted on a quarterly basis.

An example of the Inflation Expectation Survey (IES) pilot project in March 2016 could be described as follows:

- Household respondents predicted average (mean) inflation expectations for 3 months, 6 months, 12 months and 24 months at 13.35% (yoy), 9.41% (yoy), 9.38% (yoy) and 10.05% (yoy).
- Retailers predicted average (mean) inflation expectations for 3 months, 6 months, 12 months and 24 months at 8.92% (yoy), 5.38% (yoy) 6.39% (yoy) and 7.11% (yoy).
- Corporate respondents predicted average (mean) inflation expectations for 3 months, 6 months, 12 months and 24 months at 3.62% (yoy), 3.13% (yoy), 2.45% (yoy) and 3.64% (yoy).
- Economic analysts and observers predicted average (mean) inflation expectations for 3 months, 6 months, 12 months and 24 months at 4.44% (yoy), 4.43% (yoy), 4.59% (yoy) and 4.61% (yoy).
- Respondent awareness of the inflation target set by the Government for 2016 was relatively low, particularly amongst consumers. Only 3.95% of consumers were aware of the 2016 inflation target, followed by retailers (24.12%) and corporate respondents (58.3%). Conversely, nearly all economists were aware of the 2016 inflation target.

The latest results of pilot project inflation expectation survey showed that consumer inflation expectations are always higher than other respondents for all time horizon. Inflation expectations of respondents Business Survey (BS) and Forecasting Macroeconomic Indicators Survey (MIFS) within the next 3 months, especially June 2016 was much lower than the results of other surveys. Inflation expectations were also relatively close compare to the inflation rate (3.45%). Meanwhile inflation expectation in 3 months ahead for September 2016 from Business Survey, Forecasting Macroeconomic Indicators Survey and Retail Sales Survey relatively coinciding approximately 3.7-3.9%.

Graph 3.1 Pilot Project Inflation Expectation Survey (IES)



Source: Bank Indonesia

The longer time horizon of the question, the harder for respondents to provide inflation expectations answers (uncertainty inflation). This is also reflected in the increasing number of standard deviations (Table 3.3). For example, when time horizon of question is 12 months ahead, all respondents expected that inflation to June 2016 was greater than 5%. Whereas for the same period and the time horizon of question is 3 months ahead, BS and MIFS respondents expected that inflation rate will be 3.62% and 4.44%, respectively, which were lower than expectation of 12 months ahead.

Table 3.3 The Result of Pilot Project IES – *Standard Deviation (%)*

Survey	3 months	6 months	12 months	24 months
Consumer Survey	9.95	9.80	10.83	12.25
Retail Sales Survey	4.63	4.42	5.49	6.16
Business Survey	4.07	4.03	5.02	6.72
Macroeconomic Indicator & Forecasting Survey	0.91	0.84	0.73	0.86

3.2 Provision of Lending Policy Information

Complementing the lending data submitted by banks through reports, Bank Indonesia also conducts a Banking Survey to collate early information on bank policy to accumulate deposits, to provide credits or loans, to place excess liquidity, to set lending and deposit rates as well as the supply and demand of new loans.

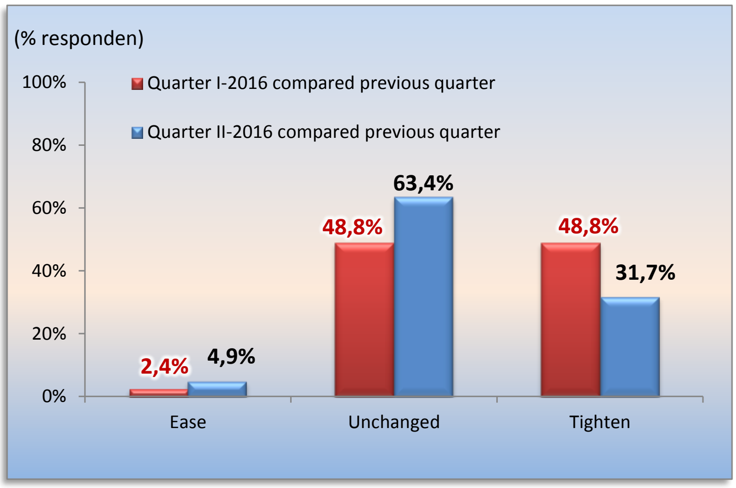
Information on bank lending standards is collected through the Banking Survey as a net balance that merely indicates the direction. Congruent with the pressing need to observe indications of future supply-side shifts in credit and the level of monetary policy/financial sector policy transmission as well as in keeping with international best practices (United States, Europe, the Philippines, Thailand, etc), the Banking Survey was also honed. Additional questions were incorporated into the questionnaire on lending standards, for instance 'How have the lending standards/guidelines on credit lines at your bank changed from the previous quarter?' The question is broken down for loans in general, investment loans, working capital loans, consumer loans, etc. Respondents are only required to answer "tighter', 'slightly tighter', 'unchanged', 'slightly looser' or 'looser'. In addition, a question was added concerning the determinants of the change in lending policy, for example, bank capital, economic projections, real sector conditions, bank liquidity, etc.

Bankers are also asked about other aspects of lending policy, for which they must answer tighter/unchanged/looser, such as the ceiling on credit lines, loan maturity, costs of loan approval, loan agreements, collateral, administrative requirements, etc. For each aspect, respondents are only required to answer "tighter', 'slightly tighter', 'unchanged', 'slightly looser' or 'looser'. All questions on lending standards use a time horizon of the upcoming three months.

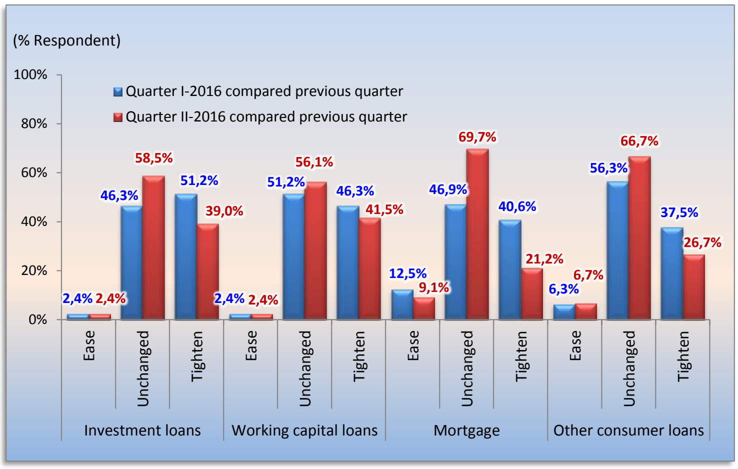
Analysis examples concerning the lending standards contained in the Banking Survey in Q1/2016 are as follows:

- Bank lending policy for Q2/2016 also helped to drive credit growth. As many as 63.4% of respondents stated that lending standards would remain unchanged from the previous quarter. In addition, the percentage of respondents who disclosed that lending standards would be tighter dropped from 48.8% to 31.7% (Graph 3.2)
- By loan type, the majority of respondents also confirmed no change in lending standards from the previous quarter. In Q2/2016, the percentage of respondents who planned to tighten lending standards decreased on the previous period (Graph 3.3).

Graph 3.2 Lending Standards in Q1 and Q2/2016



Graph 3.2 Lending Standards by Loan Type in Q2/2016



Source: Bank Indonesia

The latest Banking Survey (Q3/2016) revealed that the majority (63.4%) of respondents stated that bank policy to extend credit would remain relatively unchanged from the previous period, up from 58.5% last quarter, while the percentage of those who reported a tighter credit policy fell from 39.0% to 36.6%. Based on loan type, more respondents confirmed lending policy would remain relatively unchanged from the previous period, with the exception of working capital loans. A total of 57.5% of respondents stated that lending policy for working capital loans would remain unchanged from the previous period, down from 62.5% last quarter

Both examples of survey refinements made by Bank Indonesia demonstrate that monetary policy evolution ultimately affects the requirement for data/statistics. Data processing through survey activity accommodates the additional requirement for data and information.

4. Conclusion

The monetary policy framework of a central bank evolves over time. Any evolution of the monetary policy framework applied by Bank Indonesia will require a corresponding change in the available statistics needed in terms of the scope and depth of the data. Under quantity-based approach, statistics of Base Money (M0), Narrow Money (M1) and Broad Money (M2) aggregates became critical information to support monetary policy.

The implementation of ITF by Bank Indonesia demanded information on inflation expectations. In addition, the application of macro prudential policy also required data to support the monitoring of financial system stability.

The new requirement for statistics and information to support monetary and macro prudential policy was met, amongst others, through various surveys. By redesigning the questionnaires of some surveys, Bank Indonesia tries to fulfill the new requirement for statistics and information to support monetary and macro prudential policies.

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Measuring bank risk-taking behaviour: the risk-taking channel of monetary policy in Malaysia[1]

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Central Bank of Malaysia

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Measuring Bank Risk-taking Behaviour: The Risk-taking Channel of Monetary Policy in Malaysia

Teh Tian Huey[1] and Daniel Chin Shen Li[2]

Abstract

Using a proprietary micro-dataset on loan defaults in Malaysia, we introduce a simple fixed effects model to extract a measure of bank lending standards from the observed default rates of loan portfolios. We then use this measure to investigate the risk-taking channel of monetary policy in a panel fixed-effects regression. We find limited evidence of the risk-taking channel of monetary policy in Malaysia. This could in part be a reflection of the effects of a pre-emptive monetary policy stance and the implementation of policies from a broader toolkit in leaning against financial imbalances in Malaysia.

Keywords: bank lending, risk-taking channel, monetary policy

JEL classification: E50, E52, G21

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1. Introduction

One of the key roles of the financial system is to intermediate funds efficiently and to allocate resources in a risk-informed manner towards productive uses in the economy. The Global Financial Crisis of 2008-09 highlighted misalignments in the financial system that distorted the incentives of financial institutions from serving this function effectively.[3] Indeed, the softening lending standards of banks has been argued to be one of the contributing factors of the crisis, amid an environment of prolonged loose monetary policy, weak supervision standards and rampant securitisation activity in several major advanced economies.[4] This risk-taking behaviour by banks fuelled unsustainable growth in asset prices and facilitated a build-up in leverage that ultimately unravelled in a disorderly manner.[5] This line of argument gave impetus to new strains of theoretical and empirical literature on the risk-taking behaviour of banks and its interaction with monetary policy.

The 'risk-taking channel of monetary policy', coined by Borio and Zhu of the BIS, refers to the impact of policy rate changes on risk perceptions or risk-tolerance. Under this channel, prolonged low levels of interest rates could lead to higher riskiness of portfolios, mispricing of assets, and looser price and non-price terms in the extension of funding.[6] There are several hypotheses on how bank risk-taking behaviour interacts with monetary policy. This includes through the misperception and mispricing of risks amid excess liquidity and inflated asset prices, sensitivity of bank behaviour to prudential regulatory requirements, exacerbated agency issues, and nominal frictions in expected investment returns leading to 'search for yield' behaviour.[7] On the other hand, some studies argue for the opposite effect of tight monetary policy encouraging bank risk-taking. Reasons for this line of argument include high interest rates increasing the attractiveness of risky assets due to higher opportunity cost of holding cash buffers and high interest rates reducing the net worth of banks, inducing banks to "gamble for resurrection".[8] Given competing theories, the net effect of monetary policy on bank risk-taking is thus an empirical question.

Naturally, there is great interest among regulators to monitor the risk-taking behaviour of banks and to understand the nexus between monetary policy and bank risk-taking. The foremost challenge is to measure banks' risk-taking behaviour, a key aspect of which is the loan underwriting standards (used interchangeably with lending standards) of banks. Bank loans account for more than 60% of private sector domestic debt-based financing in Malaysia, hence bank risk-taking through changes in underwriting standards could have significant implications on financial stability and the broader macroeconomy. This paper makes three key contributions. Firstly, we

3 Misalignments of incentives can arise from financial institutions being "too big to fail" and having "no skin in the game", among others. See Goldstein and Veron (2011) and Taleb and Sandis (2013).

4 See Taylor (2008), Allen and Carletti (2009), Acharya and Richardson (2010) and Rajan (2010).

5 The dynamics of credit-driven cycles are explored in Borio and Lowe (2002) and Schularick and Taylor (2010).

6 Borio and Zhu (2008). See also Adrian and Shin (2009), Brunnermeier et al (2009) and Shin (2009).

7 See Stiglitz and Greenwald (2003), Rajan (2005), Dell'Ariccia and Marquez (2006), Allen and Gale (2007), Diamond and Rajan (2009), Acharya and Naqvi (2012) and Adrian and Shin (2010).

8 See Kane (1989), Hellman et al (2000) and Smith (2002).

introduce a simple and flexible method of computing bank lending standards that could be widely applicable given the relatively light data requirements. Secondly, we provide a measure of Malaysia's retail bank lending standards. Thirdly, we use the estimated measure of lending standards to explore some of the hypotheses on the risk-taking channel of monetary policy for Malaysia.

In the empirical literature studying the effects of monetary policy on bank risk-taking, there are two main approaches to measuring bank lending standards, differentiated by the source of data used. The first approach uses survey data of bank loan officers, most commonly the Federal Reserve Senior Loan Officer Opinion Survey (SLOOS) and the Euro Area Bank Lending Survey (BLS). Survey responses are used to construct indices that capture various aspects of bank lending standards, which are subsequently verified against other proxies of bank risk-taking and regressed against a host of factors to identify the determinants of bank risk-taking behaviour.[9] The second approach utilises large micro-datasets, typically centralised credit registers containing detailed credit information at the individual and account level. This approach is less common due to the unavailability of and restricted access to such datasets. Within this approach, two ex-post performance measures are common - the observed defaults of loans and the time to default of loans, usually analysed within standard probit or logit discrete choice models or hazard-based duration models.[10]

Fewer studies have incorporated and compared both approaches. In a recent study, Vojtech, Kay and Driscoll (2016) are the first to match individual bank responses from the SLOOS with mortgage application information from the Home Mortgage Disclosure Act (HMDA). The authors also use geographical variation in the Lender Processing Services Applied Analytics (LPS) database to study if delinquency rates were correlated with lending standards as indicated by the SLOOS. The results showed that areas with higher exposure to banks with tightening lending standards also had significantly lower delinquency rates two years after the tightening, suggesting that lending standards are an important determinant of the credit quality of bank loans. This finding provides support for our methodology.

Using micro-data from the Central Credit Reference Information System (CCRIS), a credit register database administrated by Bank Negara Malaysia (BNM) containing account-level credit information on all borrowers from all banks in Malaysia[11], we extract a measure of bank underwriting standards for retail borrowers in Malaysia using the observed default rate (ODR) of loans.[12] As this measure is also intended as an indicator for surveillance, our empirical approach is guided by three key considerations. Firstly, as a surveillance indicator, the measure needs to be timely.

9 See Maddaloni and Peydró (2010), Buch et al (2014), Bassett et al (2012) and Koen and Hoeberichts (2013).

10 See Jiménez et al (2008), Ioannidou et al (2009) and Bonfim and Soares (2013).

11 Coverage encompasses all 65 licensed commercial, Islamic, investment and development banks, and 10 large non-bank financial institutions. The system has records on approximately 9 million borrowers and contains details on the profile of the borrower, credit applications and credit accounts.

12 The reason corporate loans are excluded from this study is due to the nature of such loans in Malaysia. Corporate loans are less homogenous in characteristics and tend to display more idiosyncratic behaviour, with long-term corporate-bank relationships playing an important role in financing decisions. This renders the simplifying assumptions in our model less appropriate for corporate loans. To study the behaviour of bank risk-taking in corporate loans, a method that fully exploits account level information is more appropriate.

Secondly, related to the first consideration, we exercised preference for parsimony in the data requirements of the model. Thirdly, the method should be replicable and easily interpreted for difference slices of the data, so as to preserve the flexibility of our measure.

Extending a vintage analysis (VA) framework, we propose a simplified fixed effects model (referred to as the DUMS default rate model[13]). The key assumption is that after controlling for performance year and months-on-book (MOB) fixed effects, variation in ODR between different cohorts primarily reflect differences in underwriting standards. The model meets our key considerations - it requires only the ODR and several time dimensions for estimation; the data is reported on a monthly basis; and given that CCRIS represents the population, the model can be replicated and interpreted for different subsets of the dataset. Using this measure of lending standards, we then investigate the risk-taking channel of monetary policy via a second-stage panel fixed effects regression. We find limited evidence of the risk-taking channel of monetary policy in Malaysia.

The rest of the paper is organised as follows. Section 2 outlines the empirical strategy and data in more detail. Section 3 presents the results and section 4 elaborates on limitations and further work. Finally, section 5 concludes.

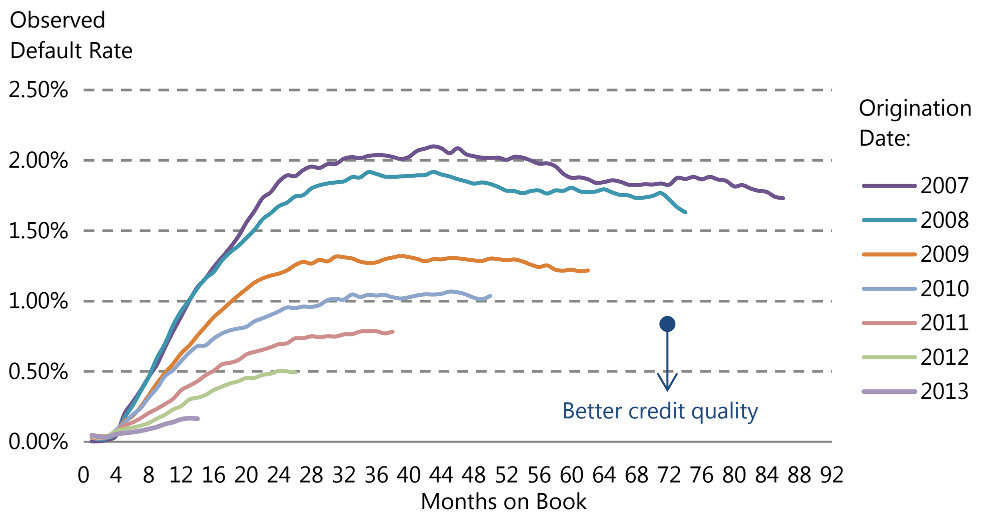
[13] The reason for the name will be apparent in section 2.

2. Empirical Strategy and Data

DUMS Default Rate Model

Our approach begins with a VA framework, based on the underlying premise that there is a direct relationship between ODR and the underwriting standards of banks. In a standard VA, loans are first segmented based on their origination date (vintage). The ODR of each vintage is then tracked over the age of the cohort (MOB) and arranged into a triangular dataset, with origination date on one axis and MOB on the other. Holding constant the age of the loan, a lower ODR for a given cohort is then interpreted as a sign of better credit quality.

Example of Vintage Analysis Figure 1



Beyond MOB effects, if the remaining variation in default rates is driven solely by bank lending standards, then a VA would suffice to measure lending standards. However, there are other factors that affect loan defaults, such as the macroeconomic cycle, the type of loan (e.g. retail vs corporate) and consumer behaviour (e.g. retail mortgages typically default last among all retail loans). Guided by the VA framework, we propose the DUMS default rate model which characterises the default rate as being driven by three main factors, in the following form:

$$D_{ij} = D_0 U_i M_j S_{(j-i)} \varepsilon_{i,j} \qquad (1)$$

where,

D_{ij} is the default rate of origination cohort *i,* at time *j*;

D_o is the cycle neutral default rate;

U_i is the underwriting standards for origination cohort *i,* which capture both borrower and bank characteristics as well as macroeconomic variables such as monetary policy at the point of origination. This factor corresponds to origination date in VA;

M_j captures variation in the macroeconomic cycle at time *j,* including changes in borrower characteristics post-origination;

$S_{(j-i)}$ is the seasoning effect of a loan cohort after being seasoned by *(j-i)* periods. This factor corresponds to the MOB variable in VA; and

$\varepsilon_{i,j}$ is the idiosyncratic error term.

Equation 1 captures the compounding effect that different factors can have on the default rate. For example, if loose lending standards result in low borrower creditworthiness for cohort i (captured by U_i), should there be a negative macroeconomic shock in the period j (captured by M_j), one would expect borrowers in this cohort to be more affected by the shock than borrowers in cohorts with higher creditworthiness. In other words, D_{ij} would decrease, and by more than $D_{i'j}$. We also control for further variation in default rates by applying the model separately for loans of different purposes.

Using a log-transformation, we estimate the DUMS model using ordinary least squares (OLS):

$$\log(D_{i,j}) = D_0 \; + \; \beta U_i + \partial M_j + \gamma S_{(j-i)} + \varepsilon_{i,j} \qquad (2)$$

where U_i, M_j and $S_{(j-i)}$ are vectors of dummy variables, respectively for each individual cohort origination date (i), performance year (j), and MOB (j-i). This specification indirectly accounts for all factors that are unvarying for a given cohort, performance year, and months-on-book, without having to explicitly specify individual factors. For instance, a negative shock to GDP that causes defaults to increase in period 'a' would be captured by dummy variable M_a, while a change in regulation that causes tightening in underwriting standards in period b would be accounted for by dummy variable U_b. In this way, this specification offers a condensed form as a simplified alternative to those in the literature. Our measure of underwriting standards is then obtained from β, the estimated coefficients for the vector of dummies U_i.

A key challenge in measuring bank risk-taking is identification as measures of underwriting standards typically reflect the confluence of both supply and demand factors. To study the risk-taking behaviour of banks, it is often necessary to disentangle changes in the demand for loans from changes in the supply of loans. Specifically, it would be ideal to isolate the component of underwriting standards that reflects only intended risk-taking by banks. To illustrate, when interest rates are low, investments which were previously not financially viable could become profitable given the lower cost of credit, thus increasing the demand for credit. Such loans could have a higher risk profile than the existing loan portfolio, given the relatively lower returns on investment.[14] Similarly, when interest rates are low, the resulting boost to net worth could make an otherwise non-creditworthy borrower appear creditworthy. Both these cases could lead to banks approving loans with relatively higher default rates, yet do not necessarily imply greater intended risk-taking by banks. In cases where loans are observably of higher risks, banks may fully account for these risks in the pricing or terms and conditions of the loan, in line with a consistent level of risk appetite. In cases where higher risks are not observed by banks, including when

[14] However, this is not necessarily the case. Kashyap and Stein (2000) show that lower rates lead to increase in credit demand, but not necessarily only from risky borrowers.

masked by inflated incomes and asset prices, the greater risks taken on by banks could be unintended.

Studies using survey data largely rely on vector-autoregression-based identification strategies to isolate the component of variation in standards that are orthogonal to the determinants of loan demand.[15] For studies using micro-datasets, the common approach is to control for demand factors at the loan level by including a host of variables to capture macroeconomic factors, borrower characteristics, bank variables[16], and loan features. The remaining variations in lending standards are then interpreted as supply-driven. To distinguish between intended and unintended bank risk-taking, these studies also compute corroborating ex-ante measures of bank risk-taking using variation in borrowers' credit history at the time of application.[17]

The DUMS model does not in itself address the issue of identification. As highlighted above, the vector β captures all cohort-specific variables, including demand factors. This means that our measure of underwriting standards could show deterioration due to risks that are either accounted for by banks in the pricing and terms of the loan or unintentionally taken on, or due to banks deliberately increasing their risk appetite, approving loans which they would have otherwise rejected.

The DUMS model also makes the trade-off between data requirements of the model and the scope for direct inference. The model minimises the amount of data required for estimation, at the expense of a limited scope for immediate inference. For example, in contrast to common specifications in the literature, the DUMS model does not allow for immediate comparison of the relative importance of GDP and interest rates in influencing the default rate, as the variables of interest would be subsumed under the relevant fixed effects dummies along with other factors. In this sense, the DUMS model does not replace existing specifications in the literature, rather, it offers a pragmatic midway approach between using banks' ODR directly as the measure of underwriting standards and estimating data-intensive models with full specification of variables of interest.

Second-Stage Panel Regression

To address the two limitations of the DUMS model raised above, we attempt to expand the scope for inference and pursue more rigorous identification of supply-driven changes in standards through second-stage regressions. Using a panel regression with fixed effects for each bank, we regress the estimated underwriting standards of individual banks against relevant cohort-related macroeconomic, loan and bank variables, to partial out demand-driven changes in the series. We do not include time fixed-effects as the variation we want to study - the response of

15 See Lown and Morgan (2006), Ciccarelli et al (2010), and Cappiello et al (2010). Using a different strategy, Bassett et al (2012) utilised variation in individual bank responses to partial out changes in standards that are due to demand factors.

16 Changes in bank-specific characteristics could reflect both purely exogenous reasons (e.g. business decision by banks) and partly endogenous reasons (e.g. economic shocks that influence loan demand). Hence, separating out the effects of bank characteristics from the remaining variation in lending standards could lead to an understatement of the degree of exogenous or supply-driven changes in banks' underwriting standards (Bassett et al, 2012).

17 See, for example, Jiménez et al (2008) and Ioannidou et al (2009).

standards to monetary policy - is time-varying and common to all banks. While identification is conducted at the aggregate level, thus discarding variation at the individual loan level, the loss of efficiency and accuracy in estimation arising from this is muted given the current limitations of the CCRIS database.[18]

Following the empirical approach of Jiménez et al (2008) and Ioannidou et al (2009), our second-stage regression is specified as follows:

$$U_{t,b} = c_b + \theta_1 MP_{t-1} + \theta_2 Macro_{t-1} + \theta_3 Bank_{t-1,b} + \theta_4 Loan_t + \varepsilon_{t,b} \tag{3}$$

where,

$U_{t,b}$ is the measure of bank b's underwriting standards in period t, where t refers to the origination date for each cohort (corresponding to β in the DUMS model);

MP_{t-1} is the main variable of interest, capturing monetary policy in the period prior to the origination of the loan cohort. A negative coefficient would suggest evidence of the risk-taking channel of monetary policy;

$Macro_{t-1}$ are macroeconomic control variables common to all banks in the period prior to the origination of the loan cohort;

$Bank_{t-1,b}$ are bank characteristics for bank b in the period prior to the origination of the loan cohort; and

$Loan_t$ are loan characteristics of the loan cohort.

The existing literature also finds evidence that changes in bank risk-taking behaviour in response to monetary policy could differ depending on bank characteristics such as the liquidity and capital positions of banks. As such, we also include interaction terms between monetary policy and bank characteristics to capture potential non-linear effects.

We estimate the panel regression using a cross-section SUR generalised least squares weights specification, which allows for conditional correlation between heteroskedastic contemporaneous residuals for the cross-section of banks, but restricts residuals to be uncorrelated between different time periods. To estimate the coefficient covariance, we use the cross-section SUR panel corrected standard error (PCSE) methodology without the leading degree of freedom correction term.

18 While the CCRIS database is information-rich in many dimensions, there are gaps in key identifying characteristics, most crucially for this study, the income of the borrower and the pricing of loans at the time of approval. This poses a challenge to model the determinants of default rates at the individual loan level as the income of the borrower would constitute a significant omitted variable. At best, borrower income can be accounted for by an aggregate proxy measure, which is what we do in the second-stage panel regressions. Efforts are currently underway to close these gaps, either through the expansion of the scope of CCRIS or by merging CCRIS with granular income databases of other institutions.

Data

Our sample spans nine years, from January 2007 to December 2015. While data is submitted monthly, extraction was based on quarterly cohorts in view that underwriting standards are structural and not expected to change frequently. The performance of each cohort is then tracked monthly. Separate extractions are carried out for each loan purpose - residential property, personal use, passenger cars and non-residential property.

The definition of default follows the international standard of loans with repayment in arrears of more than 90 days.[19] The computation of the ODR is based on count, is static and allows for repeated defaults. ODR increases when the number of defaults during the period is larger than number of cures, and vice versa.

To avoid missing values for periods where the ODR is zero, we create an index from the ODR series, with 0% and 1% ODR corresponding to 100 and 101 respectively, before taking logs. This gives the resulting estimated coefficients an approximately additive interpretation. For the estimation to be econometrically feasible, we drop the dummy variables corresponding to the 1Q 2007 cohort, first month-on-book and macroeconomic periods October, November and December 2015.

For the second-stage regression, the description and sources of variables included are laid out in Table 1.

Summary of Variables used in Second-Stage Panel Regression — Table 1

Variable	Abbreviation	Definition	Source
Underwriting standards	U	Individual bank underwriting standards by loan purpose	Authors' estimation
Policy Rate	OPR	Overnight policy rate (%)	Bank Negara Malaysia
Monetary Policy Shock	SHOCK	Exogenous monetary policy shocks in Malaysia (%)	Tng and Kwek (2015)
Output	GDP	Annual growth in gross domestic product (%, yoy)	Department of Statistic Malaysia
Prices	CPI	Annual growth in consumer price index (%, yoy)	Bank Negara Malaysia
Capital flows	FLOW	Net capital flows from the balance of payments (RM billion)	Bank Negara Malaysia
House Prices	MHPI	Annual growth in Malaysian House Price Index (%, yoy)	National Property Information Centre
Liquidity Position	LD	Individual bank loan-to-deposit ratio	Bank Negara Malaysia
Capital Position	CAP	Individual bank equity over total assets ratio	Bank Negara Malaysia
Lending Rate Spread	ALROPR	Difference between the average lending rate by loan purpose and the OPR (%)	Bank Negara Malaysia

[19] However, there is some variation in the interpretation of this standard among banks, with some interpreting this as 3 months in arrears and others as 4 months.

Summary of Variables used in Second-Stage Panel Regression (Cont)		Table 1
Variable	Abbreviation	Definition
Macroprudential Measures	MPP	Dummy variable for periods following the introduction of macroprudential measures by loan purpose
Crisis Periods	GFC	Dummy variable for the periods 3Q08-2Q09
Time Trend	TREND	Time trend over the sample period

3. Results

The estimated measures of aggregate bank underwriting standards are shown in Figure 2. An increase in the measure corresponds to looser underwriting standards and higher default rates. With the exception of non-residential property loans, which underwriting standards have largely remained stable, most loan purposes see a general downward trend in the measure, suggesting general improvement in underwriting standards over the sample period. The measure for personal loans has the largest variation in magnitude, implying that variations in bank underwriting practices have a larger impact on personal loan default rates than other loan portfolios.

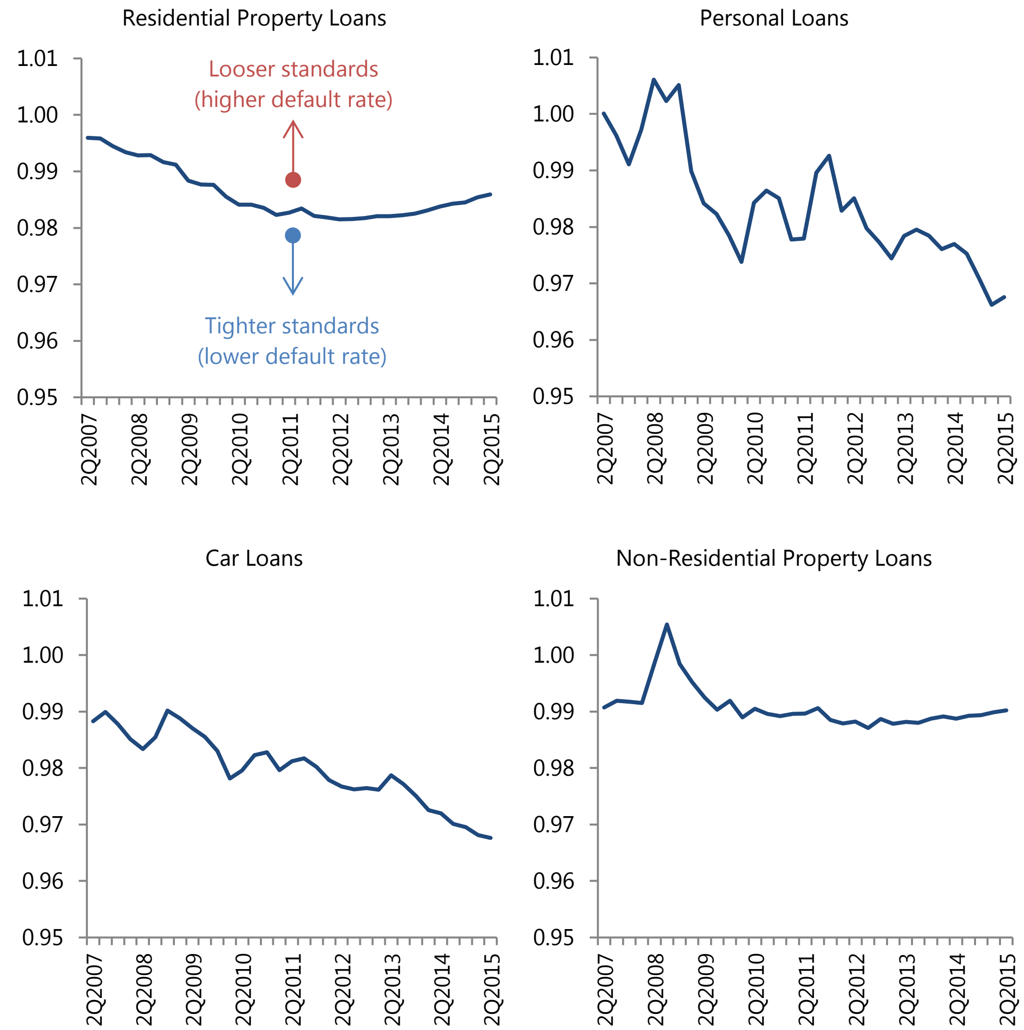
The measure for personal loans appears to correspond with the relevant macroprudential measures. Observing unsustainable rapid personal financing growth in the periods prior to 2012, BNM released the Guidelines on Responsible Financing which took effect from 1Q 2012. In 3Q 2013, BNM further imposed a maximum tenure of 10 years for personal financing and prohibited the offering of pre-approved personal financing products. These measures resulted in a marked slowdown in the growth of personal financing, especially among non-bank financial institutions.[20] Correspondingly, we see the underwriting standards for personal loans deteriorate in the run up to 2012, after which the trend reversed.

We do not observe a similar depiction for residential property loans, for which macroprudential measures were also imposed, along with microprudential and fiscal measures. This potentially reflects the targeted nature of the housing loan measures[21], which were aimed narrowly at speculative activity that accounted for a small share of total housing financing. The dynamics for housing loan defaults appear instead to correspond with movement in house prices. Following the implementation of measures, the rapid increase in average house price growth stabilised in 2012 before moderating after 3Q 2013, roughly corresponding to the turning points of the estimated series.[18] This suggests that the mild uptrend in the series could be an artefact of slowing house price growth (demand-driven) rather than deteriorating bank underwriting standards (supply-driven).

20 For more details on the effects of macroprudential measures on personal financing, housing loans and house prices, refer to Chapter 1 of the BNM Financial Stability and Payment Systems Report 2014.

21 To curb speculative purchases, in Q4 2010, BNM introduced a maximum LTV ratio of 70% for the third and above outstanding housing loan per individual. In the following quarter, BNM increased the risk weights on loans previously disbursed with LTV ratios over 90%, from 75% to 100%. In 3Q 2013, BNM imposed a maximum tenure of 35 years for housing loans. Fiscal measures included the prohibition of Developer Interest Bearing Schemes (DIBS) starting 2014 and a series of increases in real property gains tax (RPGT) from 2010 to 2014.

Aggregate Bank Underwriting Standards for Retail Loans — Figure 2



For car loans, while the trend of underwriting standards is generally an improvement, the pace of improvement increased after 2013. This corresponds with the release of the Risk-informed Pricing guidelines in December 2013[22], which contributed to the alleviation and reversal of continued lending rate compression (a symptom of risk-taking) in car loans that had occurred due to stiff competition among banks.

With the exception of a large spike during the Global Financial Crisis, underwriting standards for non-residential property loans have remained relatively stable. Given the timing, magnitude and idiosyncratic nature of the spike, we suspect that similar to the measure for residential property, this spike could be picking up factors other than bank underwriting standards. One possibility is that in these

[22] The Risk-informed Pricing guidelines sets out standards for banks to adopt a risk-informed approach in the pricing of retail loan products, to ensure consistency with an approved risk appetite.

periods of crisis, distressed business owners could have resorted to obtaining funds by refinancing their commercial premises, which for many small and medium enterprises are owned by the individual rather than the business entity. Such a hypothesis remains to be validated.

Overall, the aggregate measures of bank underwriting standards appear in line with our priors and understanding of the evolution of bank lending over the sample. For further validation, we examine the correlation of our measure with loan approval rates. Dell'Ariccia et al (2008) found that rising delinquency rates were linked to lower loan denial rates. We find a similar relationship, between a loosening in our measure of underwriting standards and higher approval rates, as shown in Table 2. Interestingly, with the exception of personal loans, this correlation does not hold for credit growth, suggesting that higher than average credit growth in itself may not necessarily be a sign of weakening underwriting standards. In particular, the large negative correlation for residential property underwriting standards and credit growth could be confounded by property price movements, as discussed above.

Correlation of Underwriting Standards with Approval Ratio and Credit Growth

Table 2

	Residential Property (RP)	Personal Loan (PL)	Car Loan (CL)	Non-residential Property (NRP)
Approval Ratio	0.82	0.63	0.52	0.55
Credit Growth	-0.89	0.67	0.11	-0.24

In the second-stage panel regressions, we find limited evidence of the risk-taking channel of monetary policy across loan purposes, as shown in Table 3 by the positive coefficients on the OPR. This lack of evidence holds when we replace the OPR with Tng and Kwek's (2015) estimate of exogenous monetary policy shocks[23], with the exception of personal loans, which negative coefficient suggests that negative monetary policy shocks lead to looser underwriting standards and the origination of loans with higher default rates.

[23] Technically, identification requires exogenous monetary policy changes. As such, where results diverge, we tend to the estimation which uses exogenous monetary policy shocks as the measure of monetary policy.

Result from Second-Stage Panel Regression								Table 3
Specification	RF		PL		CL		NRP	
	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK
Number of Banks	25		24		21		17	
Number of Observations	850		816		714		578	
Monetary Policy $(MP)_{t-1}$	0.522***	1.463***	1.004***	-0.555***	0.561***	-0.147	0.004	-0.117
GDP_{t-1}	0.004	0.016***	0.008*	0.048***	-0.011***	-0.001	0.006**	0.006***
CPI_{t-1}	0.008	0.017	-0.001	-0.055***	0.001	-0.022	0.015	0.025***
$FLOW_{t-1}$	0.001***	0.001***	0.002***	0.000	-0.001***	-0.002***	0.002***	0.003***
$MHPI_t$	-0.046***	-0.034***	-	-	-	-	-0.025***	-0.029***
LD_{t-1}	-1.044***	-1.593***	-5.501***	-4.666***	0.671***	-0.540***	2.118***	1.600***
CAP_{t-1}	0.071***	0.065***	0.247***	0.072***	0.038***	0.040***	0.026**	0.021
$ALROPR_t$	-0.351***	-1.103***	-0.128***	0.014	-0.030	-0.351***	-0.152**	-0.147***
MPP*TREND	-0.014***	-0.009***	-0.040***	-0.022***	-0.036***	-0.040***	0.006***	0.130***
GFC	0.005	0.404***	-0.012	0.411***	-0.162**	0.243**	0.088*	0.009***
Unweighted R^2	0.66	0.68	0.66	0.73	0.68	0.68	0.62	0.70

* indicate statistical significance at the 10% level; ** indicate statistical significance at the 5% level; *** indicate statistical significance at the 1% level

Note: Coefficients presented have been multiplied by 100. A coefficient of 1 implies an approximately 1ppt difference in default rates.

Broadly, the results suggest that loans originated during periods with higher GDP growth, net capital inflows and lower house price growth tend to observe higher default rates. Banks with a better perceived liquidity position and higher capital buffer approve loans with higher default rates. A lower credit spread in the pricing of loans is also associated with higher default rates. Loans originated after the implementation of macroprudential measures displayed lower default rates while loans originated during the financial crisis of 2008 saw higher default rates.

To investigate potential non-linear effects between bank characteristics and banks' response to changes in monetary policy in terms of underwriting standards, we interact banks' loan-to-deposit ratio and equity ratio with the monetary policy variable. The estimated coefficients of interest are reported in Table 4. In order to interpret the net effect of a change in monetary policy on bank underwriting standards, we apply the coefficients to the actual data series and compute the proportion of our sample that corresponded with an overall negative monetary policy effect on our measure of underwriting standards.

Result from Second-Stage Panel Regression with Interaction Terms Table 4

Specification	RF		PL		CL		NRP	
	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK	OPR	SHOCK
Monetary Policy $(MP)_{t-1}$	1.435***	14.37***	-0.251	-23.01***	-0.283***	3.205***	0.442	-1.310
$MP*LD_{t-1}$	-0.414***	-6.430***	0.489***	12.97***	0.141***	-1.478***	-0.265	0.648
$MP*CAP_{t-1}$	-0.018***	-0.085***	0.039***	-0.284***	0.066***	-0.060***	0.009	-0.003
Net negative MP effect (% observations)	1.14	5.26	74.9	68.9	81.7	50.1	11.1	97.1

* indicate statistical significance at the 10% level; ** indicate statistical significance at the 5% level; *** indicate statistical significance at the 1% level

Note: Coefficients presented have been multiplied by 100. A coefficient of 1 implies an approximately 1ppt difference in default rates.

Allowing for non-linear effects, the personal and car loan specifications emerge with statistically significant coefficients and a sizeable proportion of observations corresponding to an overall negative monetary policy effect on our measure of underwriting standards. Focussing on the specifications using exogenous MP shocks, the results suggest that banks with larger capital buffers take on more risks in response to loose monetary policy compared to banks with relatively lower capital ratios. The corresponding estimates for banks' liquidity positions are inconsistent across the loan purposes, thus is inconclusive.

Overall, the empirical evidence in this study on the risk-taking channel of monetary policy is at best mixed, but mostly limited. While controlling for non-linear effects lead to slightly stronger evidence, the general finding is inconclusive.

4. Limitations and Further Work

One of the main complications of the DUMS model arises from the regressors comprising entirely of dummy variables. The use of close to 250 dummy variable series could easily result in multi-collinearity between the regressors, especially for subsets of the data with sporadic missing entries. This issue complicates estimation in two ways. The first complication occurs at the point of estimation. It could be difficult to detect and adjust for the source of multi-collinearity given the scale of the dataset and the various permutations of estimations. The second complication arises at the point of inference. In certain cases, estimation results, and hence our measure of standards, can be sensitive to which dummy variables are dropped as the base case, in particular which cohort dummy forms the base case. While the variations in the resulting measure are mostly quantitative, qualitative differences involving changes to the trajectory of the measure could occur.

A second limitation arises from the triangular nature of the dataset used, resulting in our measure of standards being less reliable for more recent loan cohorts. Due to there being fewer observations of loan performance, the measure of standards estimated for recent cohorts tend to be sensitive to the addition of new data points. Thus far, we have yet to compute standards error bands for our measure, which is an avenue for further work going forward.

Beyond robustness issues, while we attempt to control for demand-driven risk-taking by including loan and macroeconomic controls in our second-stage regression, our estimation could still suffer from omitted variable bias if there remains unobservable factors that correlate with the variables included. Further work can improve identification in two ways. First is to further exploit the data available in CCRIS, deploying more control variables, including loan characteristics such as loan tenure, collateral pledged, and the loan-to-value ratio, where applicable. These data items exist within the system and can potentially add value once sanitised. Second is to validate our findings using ex-ante measures of bank risk-taking, such as those constructed by Jiménez et al (2008) and Ioannidou et al (2009).

Admittedly, the empirical strategy in this paper does not fully resolve all the highlighted issues. It is thus important to appreciate the limits of the method, to complement the measure with corroborating indicators where possible, and to conduct robustness checks for sensitivity before drawing inference. Going forward, this simple measure should be complemented by more explicitly specified or granular methods, for instance, binary response models or hazard-based duration models that are better suited for censored datasets.

5. Conclusion

Using a proprietary micro-dataset on loan defaults in Malaysia, we introduce a simple fixed effects model to extract a measure of bank lending standards from the observed default rates of loan portfolios. In a second-stage panel fixed effects regression, we use this measure to investigate the risk-taking channel of monetary policy. We find limited evidence of bank risk-taking arising from low policy interest rates.

While we do not find significant evidence of the risk-taking channel of monetary policy in this study, it does not imply that the channel does not exist. Rather, it may be the case that this channel has not manifested strongly in Malaysia, possibly in part due to Malaysia's policy approach towards financial stability and the build-up of financial imbalances. In the formulation of monetary policy, BNM has always been cognisant of the risks of financial imbalances.[24] Beyond monetary policy, policies from a broader toolkit, including microprudential, macroprudential and fiscal measures have been implemented pre-emptively in Malaysia to guard against the risks of financial imbalances. It is possible that such concerted policy, regulatory and supervisory efforts have helped to curb any potential manifestations of underlying risk-taking behaviour, including among banking institutions.

[24] For example, refer to BNM's Monetary Policy Statement of July 2014.

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Quantifying the tightness or looseness of monetary policy in South Africa[1]

Johan Van den Heever, Danie Meyer,
South African Reserve Bank

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Quantifying the tightness or looseness of monetary policy in South Africa

Johan van den Heever[1] and Danie Meyer[2]

Abstract

The central bank's accommodation rate, the repurchase rate, is the key policy instrument through which monetary policy finds expression in South Africa. Since the global financial crisis the relationship between the central bank policy rate and several other key interest rates in the financial system has changed. This paper describes this development and presents a number of alternative benchmark interest rates and indicators of the tightness or looseness of monetary policy that are relevant to South Africa.

Contents

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Introduction

In South Africa the central bank's accommodation rate, the repurchase rate, is the key policy instrument through which monetary policy finds expression. Since the global financial crisis the relationship between this policy rate and several other key interest rates in the financial system has changed. This paper describes this development and presents a number of alternative benchmark interest rates and indicators of the tightness or looseness of monetary policy that are relevant to South Africa.

In the next section of the paper attention is given to the basic framework that guides monetary policy in South Africa, before turning to alternative interest rate barometers that may be used to augment the repurchase rate as indicator of the monetary policy stance. Subsequently attention is given to quantity-based indicators of the stance of monetary policy. In the penultimate section the focus shifts to the impact of regulatory changes on lending behaviour; while not monetary policy decisions, such changes can have a major influence on key variables that monetary policy focuses on. This is followed by a concluding section.

The monetary policy framework in South Africa

Since February 2000 the South African authorities have formally adopted an inflation targeting framework for monetary policy. The target is set by government in consultation with the South African Reserve Bank (the SARB). It has for almost all of the past 16 years been set at between 3 and 6 per cent inflation per annum, and relates to the twelve-month rate of increase in the consumer price index. This framework is applied with flexibility – which practically means that if exogenous shocks cause a deviation of actual inflation from the target range, the SARB can use a gradual approach rather than shock treatment to get inflation back within the range. The SARB has instrument independence and can therefore apply its monetary policy instruments as it deems fit to pursue the inflation target.

The workhorse instrument of monetary policy in South Africa is the SARB's accommodation rate, the repurchase rate. The accommodation rate is made effective through a system in which the central bank routinely provides short-term financing to banks with a temporary liquidity shortfall. The central role of the accommodation rate goes back to the early 1980s, when the authorities adopted a more market-oriented approach to monetary policy and decided that the price of credit should be the kingpin of monetary policy implementation. Previously the authorities used credit ceilings as an important element of monetary policy implementation, but when the ceilings were abolished in September 1980 the interest rate mechanism came to its full right as the main channel through which monetary policy works.

In practice the interest rate mechanism has therefore since the early 1980s involved that the private- sector banks set their lending and deposit rates in alignment with the central bank's key accommodation rate. The level of lending rates moderates the quantity of credit demanded; in simplistic terms the quantity of credit and the size of the banking sector's balance sheet is demand-driven, with such demand for credit being established at the level of lending rates that is congruent with the central bank's policy interest rate. (Of course other variables also enter the demand-for-credit function, but that is not the focus of this paper.) Credit in turn influences aggregate expenditure, and expenditure influences inflation. (There are more mechanisms at work through which monetary policy is transmitted to inflation, but again that is not the focus of this paper.)

Interest rate barometers

The first interest rate barometer of monetary policy is obviously the central bank's policy interest rate itself. It is central in the announcement of the monetary policy stance – in South Africa, as in many other countries, this communication follows after each meeting of the central bank's Monetary Policy Committee. Simultaneously it measures the cost of wholesale credit at the central bank's accommodation window. This measure of monetary policy tightness is quite clear and statistics on it go back to the establishment of the SARB in 1921. In the strictest sense the series is not fully comparable over the period of 95 years: the rate quoted at times was a discount rate and at times (as at present) a yield, and the period over which it applied was also not uniform (weekly at present, daily in some of the earlier sets of arrangements). Accordingly, when converting the announced policy rate to a compound annual yield rate to make it strictly comparable over time, there would be small differences between the various sets of arrangements at the accommodation window. However, these would be of such minor magnitude that for macroeconomic analysis they could safely be disregarded. (Of course for the people managing the accommodation window and the private-sector banks' staff managing the financing of their short-term liquidity shortfalls these details are important, since they really have an impact on the relevant cost centre's bottom line.)

There are no formal regulations or legislation compelling banks, when lending to clients, to charge an interest rate that is a specific quantum above or in a specific ratio to the SARB's policy rate. In fact that would clash with the market-oriented approach adhered to in the conduct of monetary and financial policy. However, there are constraints on lending rates in the form of maximum rates formally set by government to protect vulnerable consumers from abuse. These maximum rates are quite high – high enough to be well beyond the lending interest rates usually established in the normal course of bank business in South Africa. Yet it should be noted that at least some bank lending to households takes place at these maximum rates; this would largely be relatively risky unsecured loans. While the total amount of such lending is small relative to other types of lending such as mortgage loans and instalment sale loans, the number of such loans is large (and the average amount per loan therefore fairly small). In these instances the relevant interest rate is mechanistically linked to the SARB's repurchase rate; for instance, since 6 May 2016 the maximum interest rate on unsecured credit transactions is the SARB's repurchase rate (currently 7 per cent per annum) plus 21 per cent per annum, therefore capping rates at 28 per cent per annum. The accompanying table illustrates the maximum interest rates that may legally be charged on a number of key categories of loans.

Maximum prescribed interest rates in South Africa from 6 May 2016		Table 1
Sub-sector	Maximum prescribed interest rate	
	Formula	Value with RR = 7%
Mortgage agreements	RR + 12% per annum	19% per annum
Credit facilities	RR + 14% per annum	21% per annum
Unsecured credit transactions	RR + 21% per annum	28% per annum
Developmental credit agreements:		
- For small business development	RR + 27% per annum	34% per annum
- For unsecured low-income housing	RR + 27% per annum	34% per annum
Short-term credit transactions:		
- First loan	5% per month	5% per month
- Subsequent loans within a year	3% per month	3% per month
Other credit agreements	RR +17% per annum	24% per annum
Incidental credit agreements	2% per month	2% per month

RR is the repurchase rate of the South African Reserve Bank, and amounted to 7% at time of writing

Source: Republic of South Africa. Government Gazette No 39379, 6 November 2015

The bulk of lending in South Africa, however, takes place at rates well below these maximum interest rates. A benchmark interest rate of particular importance is the banks' prime lending rate, since it is used as reference rate in numerous credit agreements. Based largely on risk considerations, the most creditworthy borrowers would typically be charged a rate at a fixed margin below the prime rate, while riskier clients would typically have to pay interest at a fixed margin above the prime rate. Since in value terms most lending is conducted at variable interest rates, when the prime rate changes, the interest rate charged on the lion's share of the banking sector's lending book changes by a similar quantum.

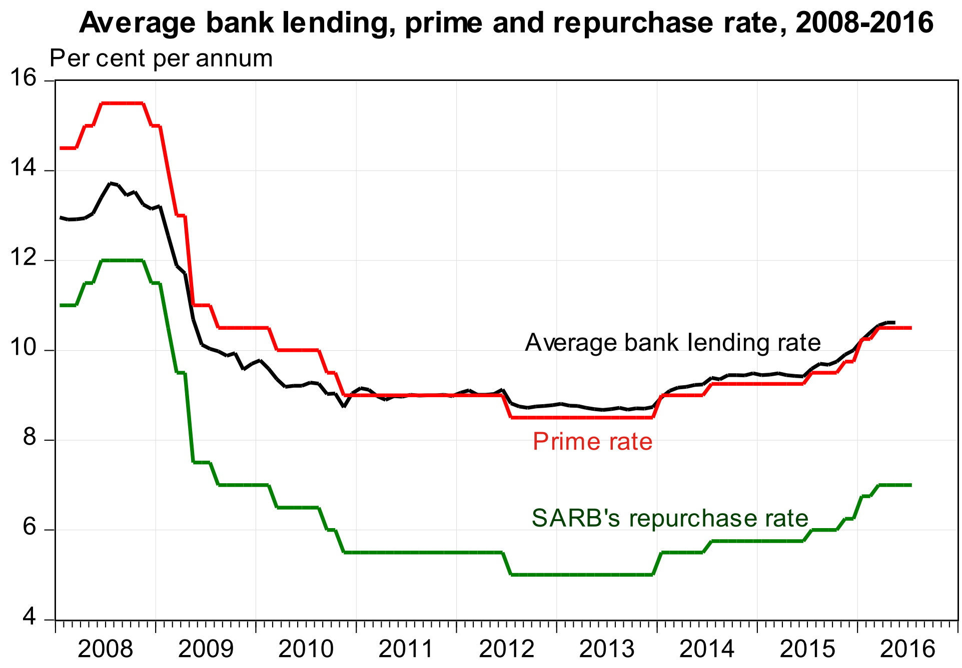
While banks are not forced to maintain a constant margin between the SARB's repurchase rate and their prime lending rates, by convention that margin has for many years been 3,5 percentage points; the current repurchase rate of 7 per cent per annum gives rise to a prime rate of 10,5 per cent. This convention-driven margin has not been altered by the global financial crisis and its aftermath.

Generally from a borrower's perspective the prime interest rate is likely to be closer to the rate actually charged to him or her by the bank than the SARB's repurchase rate. The prime rate is accordingly often used as a proxy for bank lending rates in South Africa.

While the repurchase rate and prime rate have traditionally been used to capture the monetary policy stance in a nutshell, it is clear that the average interest rate actually charged on lending would add valuable information when formulating or analysing monetary policy. In this connection various options present themselves.

Firstly, the average lending rate across all bank lending may be calculated. This can readily be done using information submitted by the banks in their monthly regulatory returns. The average lending rate deemed most relevant when focusing on monetary policy refers to domestic currency-denominated arms-length lending to the private sector, which includes both households and companies. Lending in other currencies, albeit only a small fraction of total bank lending in South Africa, is therefore excluded since the relevant interest rate is not influenced by the domestic monetary policy stance. Staff loans and lending to associated businesses are not considered arms-length transactions and are also excluded. Lending to the government sector is also excluded, since this type of lending is usually not the target of monetary policy and since different disciplines apply to government.

The graph below shows the average interest rate on bank lending to the private sector, along with the prime and repurchase rate.

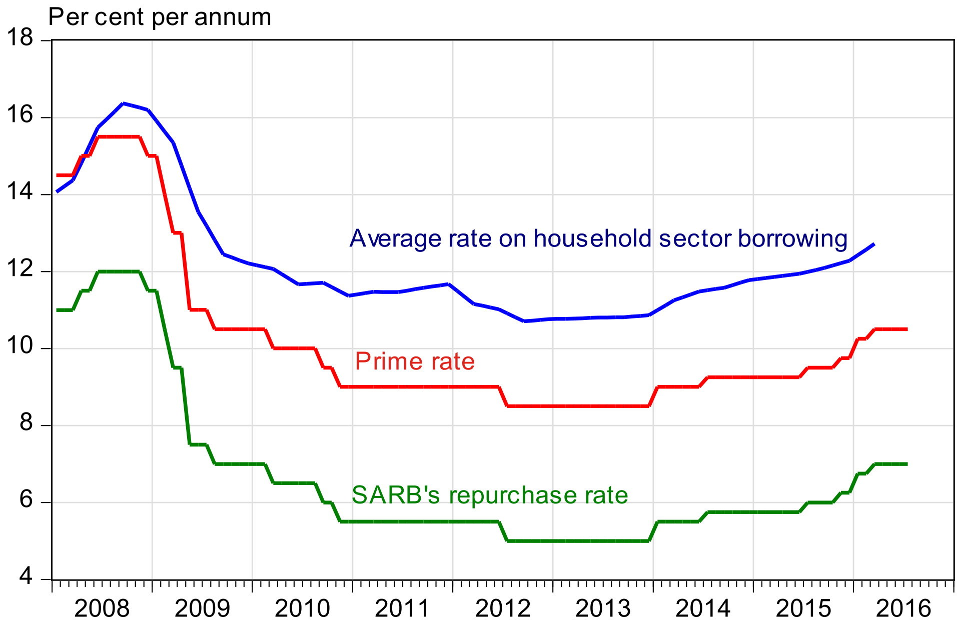


Whereas in 2008 the average lending rate was almost 2 percentage points below the prime rate, the differential narrowed thereafter, partly as a reflection of higher risk premia being included in lending rates after the surge in debt writeoffs in the wake of the financial crisis. In 2011 and the first half of 2012 the two rates essentially fell right on top of each other, while from mid-2012 the average bank lending rate has generally been slightly higher than the prime rate. Changed patterns of borrowing, described in the paragraphs below, also contributed to the reversal of the differential.

Secondly, the average interest rate paid by household sector borrowers on their borrowing may be used to proxy monetary policy tightness. Although most credit extension to the household sector originates with the banking sector, it should be kept in mind that some household borrowing is sourced from other institutions such as nonbank car finance companies and nonbank microlenders. Estimating the average interest rate on household borrowing is a laborious task, involving a matrix of loan types and lending institutions. Appendix A shows the components of household borrowing used to calculate the average interest rate on household borrowing. A different interest rate, relevant to each loan type and lending institution, is applied to each component to derive the average interest rate on household borrowing.

The graph below shows how the gap between the average interest rate on household sector borrowing, on the one hand, and the prime rate and repurchase rate, on the other, has widened over time.

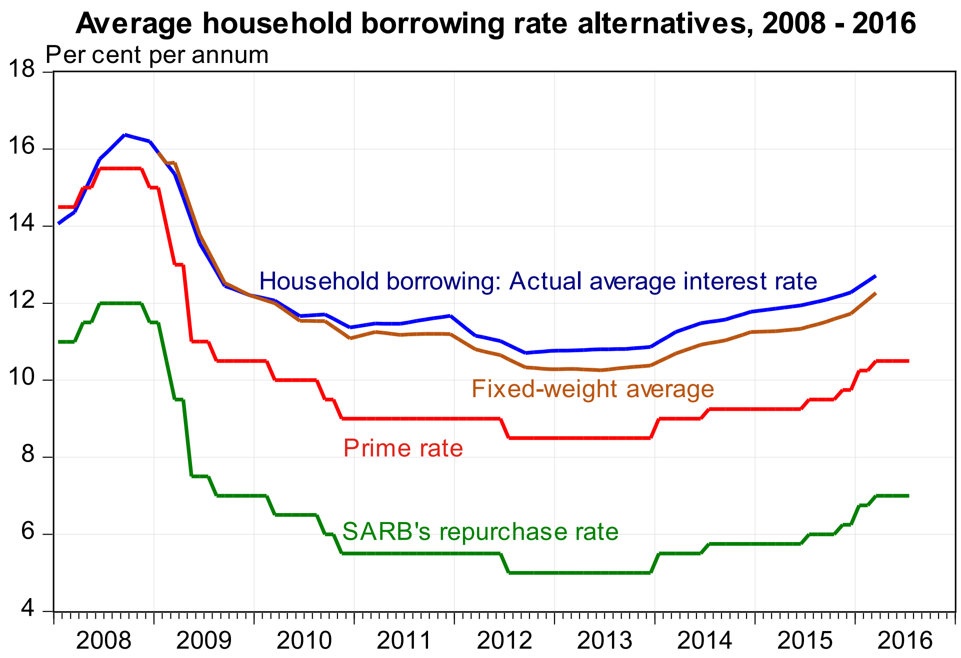
Household borrowing, prime and repurchase rates, 2008-2016



There are at least two reasons why the gap has widened since 2008. Firstly, in the wake of the global financial crisis the frequency of borrower defaults rose sharply and to unexpected heights, suggesting that lending rates should incorporate a higher risk premium than had been the case previously. Lenders accordingly raised their lending margins on new business. On existing business this could generally not be done since lending rates had contractually been linked with a fixed margin to a benchmark rate such as the prime rate; repricing could only be effected if a client applied for a re-advance or a new loan. Secondly, mortgage finance fell from grace following the bursting of the bubble in the real-estate market. Both the demand for and supply of mortgage loans therefore dwindled. However, the average interest rate on mortgage loans is lower than that on most other types of lending, so that a shift in loan demand and supply towards non-mortgage loans immediately implies a higher average rate on overall credit extension.

The second phenomenon highlighted in the previous paragraph is not really a de facto tightening of monetary policy but a shift in preference between loan types. To isolate the impact of higher risk premia only on margins above the prime and repurchase rate, fixed weights (based on the relative importance of each type of loan in the base year – say 2008) may be applied to the interest rates actually charged on the various types of loans. This will yield an indication of the average increase in lending rates assuming no shift between loan types has taken place. The fixed-weight average actual interest rate paid by households on their debt is a third barometer of actual monetary policy tightness at the coalface, and is depicted in the graph below. It was calculated using the fixed weights shown in Appendix A. The resulting fixed-weight average series is shown in Appendix B, along with the actual average series.

As can be seen from the graph, the fixed-weight alternative remained very close to the actual average interest rate that was charged on household borrowing until late in 2010, and only thereafter started drifting lower. The margin between the two has in recent years typically been between 0,4 and 0,7 percentage points. This is limited in magnitude, but certainly not insignificant. While the fixed-weight alternative is therefore noteworthy, the value it adds is comparatively limited in the current South African environment since average lending rates to households are not testing the zero lower boundary but are rather around 12 per cent per annum. The "pain reduction" associated with the alternative measure is not large, relative to the overall burden of household debt service costs.



A final point which can be made in this connection is that the ideal measure of the tightness of monetary policy through interest rates should measure how the interest rate faced by a borrower with a specific set of risk-related characteristics (indebtedness, inflation-adjusted income, time in current job, inflation-adjusted assets owned, etc) and borrowing for a specific purpose and inflation-adjusted amount has changed over time. Against this ideal, the measures which are available or within reach are relatively crude. Nevertheless, improved access to large datasets covering comprehensive information on loan applications and outcomes may bring economic statisticians closer to that ideal.

Quantity-based indicators

In the South African setting monetary policy has since the discontinuation of credit ceilings in 1980 focused on the price of credit – the interest rate – as the primary channel through which monetary policy works. This was the case despite the adoption of money supply targets in the mid-1980s and of money supply guidelines for most of the 1990s. The targets or guidelines for growth in the broad money supply were never pursued in a mechanistic way, and the authorities refrained from making aggressive use of open market operations to achieve a specific quantitative outcome for the money supply. The chain of command ran from policy interest rates to bank lending rates to credit and expenditure, and through that to money supply and inflation. With the adoption of formal inflation targeting in 2000, moreover, the attention paid to the money supply dwindled further.

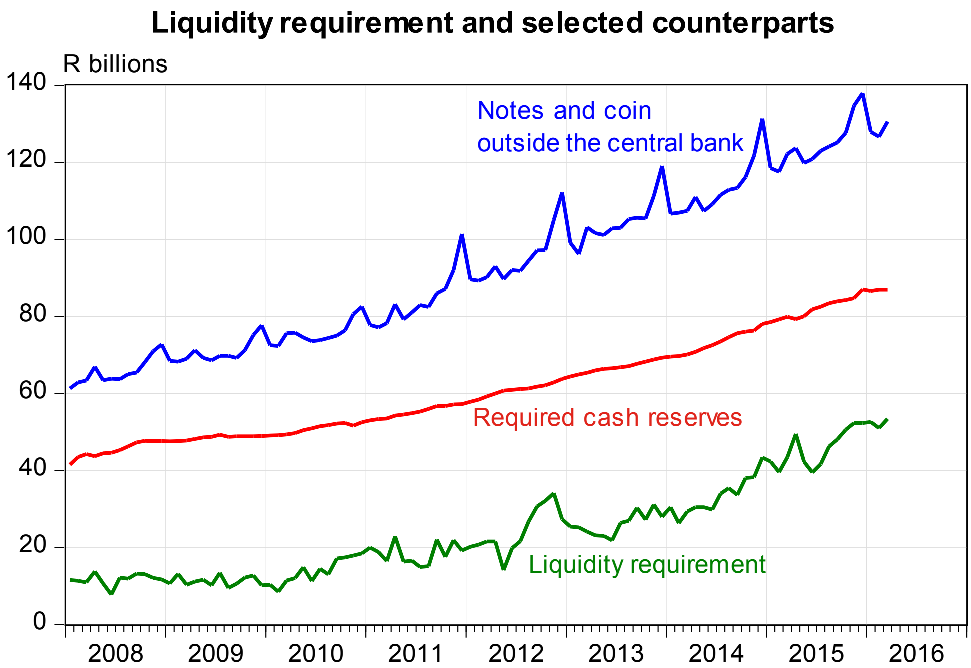
With the targeted rate of inflation fluctuating around an average of 6 per cent per annum over the past 16 years, no testing of the zero lower boundary for interest rates and no appetite among the policy-makers to artificially push down long-term interest rates, South Africa has not adopted a policy of quantitative easing at any point in the wake of the financial crisis – and neither did it do so at any earlier point before the financial crisis.

Monetary policy has therefore not come to a strict quantity-based approach at any point since late 1980. The interest rate mechanism has remained central. However, to ensure sound transmission of the SARB's repurchase rate to the general level of interest rates, the SARB has had a preference for maintaining a "money market shortage" or "liquidity requirement" of adequate size. By making sure that the banks have to borrow sizeable amounts at the accommodation window, the SARB's repurchase rate is made effective.

In this context, the nearest that the country has come to quantitative easing has been a by-product of the considerable efforts made to build up the gross international reserves of the SARB. As the SARB purchased foreign exchange in the market it created rand and increased liquidity in the domestic money market. Had this been fully sterilised (for instance by issuing SARB debentures) the domestic money market shortage would have continued to trend higher, driven by the rising amount of rand banknotes and coin in issue as well as higher cash reserve deposits that banks are required to hold with the central bank as their balance sheets expand. However, up to 2013 the central bank often did not fully sterilise the rand liquidity injected as it purchased foreign exchange. The liquidity injections were often simply offset by the draining effect of higher required cash reserve deposits and currency in circulation. On balance the money market shortage therefore did not rise by much during this period – this dimension of monetary conditions remained relatively easy in the wake of the Great Recession.

A systematic programme to gradually increase the banks' liquidity requirement (and thereby reinforce the effectiveness of the SARB's policy interest rate) was adopted in 2013. This essentially entailed allowing the liquidity requirement and therefore the amount of accommodation granted (on the asset side of the central bank's balance sheet) to reflect the organic growth in (1) the value of notes and coin supplied to the economy by the SARB; and (2) the value of required reserve balances that banks have to keep with the SARB (both on the liability side of the central bank's balance sheet). Tracking the amount of liquidity provided therefore supplements the standard information on policy interest rates; the higher the liquidity requirement of the banks, the more funding they receive at the SARB's repurchase rate and the clearer the need to fully reflect the repurchase rate in their lending and deposit rates. That said, the banks have since the transition to market-oriented monetary policy in the early 1980s consistently and to a fair degree reflected the repurchase rate or its predecessor accommodation rates in their lending and deposit rates. Some tightening of spreads has however followed in the wake of the tighter liquidity conditions in the money market brought about since 2013. For instance, the spread between the South African Benchmark Overnight Rate on deposits (Sabor) and the prevailing repurchase rate has narrowed over this period as banks were forced to become more competitive for short-term funds. This is evident from the higher rates that banks are willing to pay for overnight funding from their top 20 clients; these rates are included in the Sabor calculation.

The graph below illustrates the gradual upward trend in the SARB's note and coin liability and liability arising from cash reserve balances, and in the amount of liquidity provided to the banks by the SARB.



Other quantity-based indicators of the tightness or looseness of monetary policy include the rate of growth in aggregate bank credit extended to the domestic private sector, the pace of growth in various subcomponents of total bank credit, and the rejection rates recorded when prospective borrowers apply for loans. Needless to say that these indicators all warrant close scrutiny.

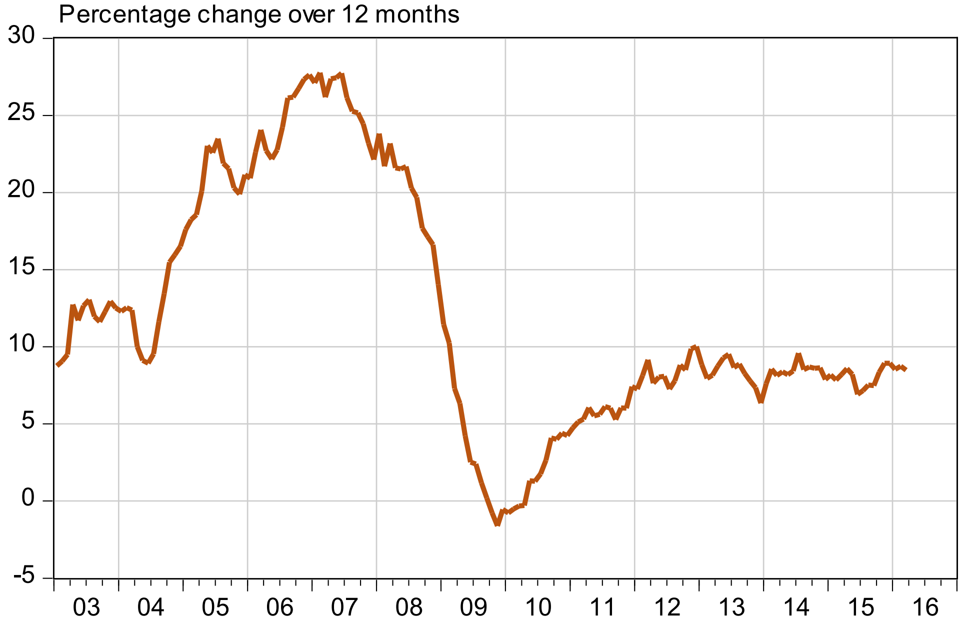
Regulatory changes

Regulatory changes often have a significant impact on lending and deposit-taking behaviour. While such changes are not monetary policy decisions, they can have a major impact on key variables that monetary policy focuses on – although such impact can be difficult to measure and disentangle from the effects of other developments.

Over the past ten years the South African government has focused considerable energy on the protection of the consumer, inter alia taking steps to reduce over-indebtedness and eliminate reckless lending practices. On 1 June 2007 the National Credit Act replaced the Usury Act, the Credit Agreements Act and the Exemption Notice to the Usury Act, the latter being specifically applicable to microlenders. The National Credit Act controls and regulates all credit agreements, therefore governing key aspects of the activities of institutions engaging in the provision of credit.

Upon the implementation of key provisions of the National Credit Act, lending institutions were inter alia required to undertake more rigorous screening of loan applications before granting credit to consumers. The end result was a rapid deceleration in the rate of growth in credit extension – but since at the same time the real-estate market in South Africa started to run out of steam after several boom years, and the global financial crisis started to unfold, the exact contribution of the Act cannot be pinpointed. The accompanying graph shows how quickly bank loans and advances lost momentum during that episode.

Bank loans and advances to the domestic private sector



More recently, in September 2015 regulations for loan affordability assessment were implemented, as part of the revisions to the National Credit Regulations. Previously the regulations only prescribed that a loan affordability process has to be followed. A more detailed approach is now followed: The criteria in the new regulations stipulate certain norms for minimum living expenses per income category. The regulations require credit providers to ensure that the consumer has sufficient income available to fund the proposed credit instalment. Amounts to be deducted from gross income include statutory deductions such as income tax and unemployment insurance contributions, maintenance payments as well as all other committed payment and debt service obligations, including such obligations as may appear from the credit applicant's credit records as held by any credit bureau. After the above-mentioned subtractions, the amount available to the consumer from his or her income must be enough to service the new debt being applied for and he or she must still have enough left to cover the stipulated necessary expense norm.

South Africa is one of a number of countries phasing in the Basel III global reforms to strengthen bank supervision and regulation. Banks have inter alia been focusing on the gradual build-up of high-quality liquid assets to ensure compliance with the phasing in of the Liquidity Coverage Ratio disclosure framework, which became effective on 1 January 2015. They have also been devoting energy to the implementation of the Basel III Net Stable Funding Ratio, promoting a more stable funding profile and enhancing overall liquidity risk management. However, all these regulatory reforms are perceived by banks as affecting their ability to support credit growth. Increased capital buffers and the minimum liquidity requirements affect costs, raising the cost of providing credit.

Conclusion

The SARB's repurchase rate is the first port of call when describing and analysing the monetary policy stance in South Africa, for good reason. It anchors short-term interest rates in the economy. However, it is not the Holy Grail, and the focus on this central variable should be augmented by a number of other barometers and analyses in order to obtain a comprehensive picture of the stance of monetary policy. A suite of indicators is therefore appropriate.

In the post-crisis period the margin of average lending rates above the repurchase rate has increased significantly, suggesting that borrowers are experiencing more pressure than suggested when studying just the repurchase rate and prime rate. Various regulatory developments are also inserting some sand into the wheels of finance.

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Appendix A: Composition of South African household debt underpinning household debt interest calculations

	Percentage of total in final quarter of 2008	
Mortgage loans		61.0
Housing mortgage loans from banks	56.3	
Farming mortgage loans from banks	0.3	
Other mortgage loans	4.4	
Other loans		16.0
Cash credit and long-term advances from the Land and Agricultural Bank	0.1	
Overdrafts and other loans and advances from banks	8.1	
Credit card advances	4.8	
Loans to individual farmers	0.4	
Loans against policies - Insurers	0.3	
Total micro-lending	1.6	
Loans from non-bank financial companies and financial public corporations	0.6	
Other loans	0.1	
National Student Financial Aid Scheme student loans	0.3	0.3
Leasing and instalment sales		18.4
Leasing finance from banks	2.4	
Leasing contracts issued by non-bank financial companies	0.4	
Instalment sale finance from banks	9.7	
Instalment sale finance from commerce sector	5.8	
Other accounts		4.3
Open accounts	2.4	
Indebtedness to local authorities	1.9	
Total household debt.		100.0

Note: Components may not add to totals due to rounding

Source: South African Reserve Bank

Appendix B:
Average interest rate on South African household debt

Quarter	Actual interest rate	Fixed-weight interest rate
4th qr 2008	16,2	16,40
1st qr 2009	15,3	15,65
2nd qr 2009	13,6	13,77
3rd qr 2009	12,5	12,52
4th qr 2009	12,2	12,21
1st qr 2010	12,1	11,99
2nd qr 2010	11,7	11,54
3rd qr 2010	11,7	11,53
4th qr 2010	11,4	11,08
1st qr 2011	11,5	11,25
2nd qr 2011	11,5	11,18
3rd qr 2011	11,6	11,21
4th qr 2011	11,7	11,20
1st qr 2012	11,2	10,80
2nd qr 2012	11,0	10,65
3rd qr 2012	10,7	10,34
4th qr 2012	10,8	10,28
1st qr 2013	10,8	10,29
2nd qr 2013	10,8	10,26
3rd qr 2013	10,8	10,33
4th qr 2013	10,9	10,38
1st qr 2014	11,3	10,69
2nd qr 2014	11,5	10,92
3rd qr 2014	11,6	11,04
4th qr 2014	11,8	11,25
1st qr 2015	11,9	11,27
2nd qr 2015	12,0	11,33
3rd qr 2015	12,2	11,52
4th qr 2015	12,4	11,73
1st qr 2016	12,9	12,26

Fixed-weight interest rate calculated using 4th qr 2008 as base

Source: South African Reserve Bank

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Measuring wage and price stickiness using firm-level data and potential implications for monetary policy in Macedonia[1]

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National Bank of the Republic of Macedonia

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Measuring wage and price stickiness using firm-level data and potential implications for monetary policy in Macedonia

Gani Ramadani♣

Abstract

The aim of this paper is to measure wage and price stickiness in Macedonia based on evidence on firms' price and wage adjustment. It uses a dataset collected through a firm-level survey covering various sectors and firm sizes. We find that firms in Macedonia adjust wages less frequently than prices. Wages tend to remain unchanged, on average, for about 13 months, while prices for around 5 months. The other aspect of rigidity related to time-dependent strategies of wage and price changes, show that time-dependent wage adjustment is more widespread as a rule adopted by firms in Macedonia than time-dependent price adjustment. In some aspects wages and prices in Macedonia feed into each other at the micro level and that there is some relationship between wage and price rigidity. We conclude that the presence and degree of nominal rigidities are somewhat lower in Macedonia compared with the average of surveyed EU countries.

Keywords: survey data, wage and price stickiness, time dependent, Macedonia

JEL classification: C83, D21, E30, J31

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The views expressed in this paper are those of the authors and do not necessarily reflect those of the NBRM.

Contents

1. Introduction

Wage and price stickiness are important parameters for macroeconomic analyses, and their appropriate measurement is essential in the policy-making process. The literature has shown that the nature of nominal rigidities determines the response of the economy to shocks and has several implications for the conduct of monetary policy. This paper focuses its attention on firms' price and wage adjustment in Macedonia, emphasising the presence and degree of nominal rigidities. For this issue we concentrate on three aspects: the frequency of wage and price adjustment; the mechanism of adjustment and its timing; and the degree to which wage and price changes feed into each other. All this dimensions are analyzed based on survey data at firm-level in Macedonia.

The survey on wage and price setting behaviour at firm level in Macedonia was conducted in the first half of 2014, while in selected EU countries the survey was carried out between the end of 2007 and the first half of 2008. The survey uses the harmonized survey questionnaire and design applied within the Wage Dynamics Network (WDN)[1] of Eurosystem. The network consists of 23 central banks from the EU and is coordinated by the European Central Bank. The network developed the WDN Survey on wage and pricing policies at the firm level and was carried out by 17 national central banks.

In writing this paper and analysing the wage and price rigidity in Macedonian using survey data we have consulted research papers that have analysed WDN survey results, as well as the Final Report of the Wage Dynamics Network which summarises the results of the network.

In the literature we can find studies on price stickiness for EU countries based on micro quantitative data and survey data (Alvarez et al., 2006; Dhyne et al., 2007; Vermeulen, et al., 2007; Fabiani et al., 2006). By this type of survey data we are able to study price stickiness in Macedonia, having in mind that disaggregated micro consumer price data are limited (Petrovska and Ramadani, 2010). Moreover, survey data allow us to measure the extent of price and wage rigidity simultaneously.

Following Druant et al., 2009, several dimensions of wage setting are explored in this paper, which focuses explicitly on how firms set and adjust prices and wages and on the relationship between the two policies. In particular, the paper aims at providing answers to the following questions: (i) How often are prices and base wages changed in Macedonia? (ii) Are adjustments synchronized or not and do they tend to take place in specific months of the year? (iii) Are there significant differences across sectors, firms and average of EU regarding the frequency and timing of wage and price changes and their relationship?

The paper shows that firms in Macedonia adjust wages less frequently than prices. The other aspect of rigidity related to time-dependent strategies of wage and price changes, show that time-dependent wage adjustment is more widespread as a rule adopted by firms in Macedonia than time-dependent price adjustment. Different

1 The WDN is an ESCB/Eurosystem research network studying the features and sources of wage and labour cost dynamics in EU countries.

pieces of evidence confirm that in some aspects wages and prices in Macedonia feed into each other at the micro level and that there is some relationship between wage and price rigidity. From the results of different aspects of wage and price adjustment we find that presence and degree of nominal rigidities are somewhat lower in Macedonia compared with the average of surveyed EU countries. There is ongoing project of building a standard DSGE model in central bank of Macedonia, and these findings will be useful for more effective calibration of model parameters.

The remaining structure of the paper is as follow. Section 2 briefly presents the survey and the data collected. Section 3 focuses on evidence on the frequency and timing of price and wage changes at the firm level, their relationship and the variation across sectors, firms and EU average. Section 4 summarizes the main findings.

2. Survey data and sample

In this paper, we use dataset of survey results for Macedonia. The survey contains questions on wage and price-setting behaviour at the firm level. It was conducted by National Bank of the Republic of Macedonia for the first time during the first half of 2014 using outsourcing global market research company. The survey uses the common harmonized questionnaire and sample design, drawn up by European Central Bank for EU countries within the Wage Dynamics Network (WDN).

Sample composition by sector and size — Table 1

Number of firms

	1-4 employees	5-19 employees	20-49 employees	50-199 employees	>200 employees	Total
Manufacturing	12	32	30	64	23	161
Construction	7	14	10	15	3	49
Trade	51	72	19	18	4	164
Market services	25	67	17	20	11	140
Total	95	185	76	117	41	514

Percentages

	1-4 employees	5-19 employees	20-49 employees	50-199 employees	>200 employees	Total
Manufacturing	2.3	6.2	5.8	12.5	4.5	31.3
Construction	1.4	2.7	1.9	2.9	0.6	9.5
Trade	9.9	14.0	3.7	3.5	0.8	31.9
Market services	4.9	13.0	3.3	3.9	2.1	27.2
Total	18.5	36.0	14.8	22.8	8.0	100.0

Source: Survey on wage and price setting in Macedonia (2014).

Table 1 presents the sample composition by sector and firm size. The sample covers 514 firms in Macedonia with different size in regard to employees that operate in manufacturing, construction, trade and market services. In order to make our results representative for the whole workforce in the sectors covered, we use employment adjusted sampling weights. A detailed description of the Macedonian survey sample and the results can be found in Ramadani and Naumovski (2015).

An advantage of this survey is that firms in Macedonia were directly asked about a number of features referring to the institutional setup within the firm or to the environment where it operates (e.g. the existence of a policy at the firm level that adjusts wages to inflation or the degree of competition). Information on these features is rarely available in administrative and other datasets. On the other hand, the survey has disadvantages inherent in ad hoc surveys, such as potential misunderstandings in interpreting the questions. Moreover, results may be influenced by the specific economic situation. As we noted above, the Macedonian survey was conducted in 2014, the period of sluggish economic recovery from the global economic and financial crisis and low consumer price inflation. In this paper, some of the findings for Macedonia we compare with surveyed EU countries, where interviews were carried out around the end of 2007 and the beginning of 2008, when the economic environment was perceived as quite favourable.

3. Wage and price adjustment

The way firms in Macedonia adjust their wages and prices plays an important role on the transmission of economic shocks. In particular, the degree of wage and price stickiness determines the speed of adjustment of the economy and the amount of the related costs. A deeper knowledge of the extent of rigidity is uncommonly useful for evaluating the performance of monetary policy and building and calibrating more effectively a macroeconomic model to be used for policy analysis and forecast.

To our best knowledge, empirical evidence on the stickiness of wages and prices in Macedonia for the whole economy and across sectors is rather scarce. One paper which deals with price dynamics in Macedonia is that by Petrovska and Ramadani (2010), which findings are based only on quantitative consumer price data. Moreover, because of unavailable micro consumer price data, the evidence is based on aggregate price data or only on consumer price categories rather than on more detailed consumer price product categories. Hence, findings form this paper are less relevant and incomparable. Correspondingly, inaccessible quantitative disaggregated consumer price data is an additional reason and motivation to conduct the study based on survey data, which covers both price and wage adjustments simultaneously. Another empirical study that uses same survey data with this paper is that by Huber and Petrovska (2015), but their focus is on determinants of nominal price and wage rigidities.

The rich information on wage and price adjustment collected by the survey contributes to fill the gap related to the lack of data on wage setting at the firm level and micro consumer price data. In addition, it makes possible to measure the degree of wage and price stickiness at the same time. Next, below we present some descriptive evidence on three different aspects related to this issue: i) the frequency of wage and price changes; ii) the prevailing mechanism of adjustment (time vs. state dependence) and its timing; and iii) the extent to which wage changes feed into price changes and vice versa.

3.1 Frequency of wage and price adjustment

The frequency of price and wage changes provides an indication of the degree of price and wage stickiness or delivers a rough measure of the extent of nominal rigidities. Price and wage rigidity are important parameters for macroeconomic analyses and represent essential element in the calibration of standard DSGE models that are widely used for monetary policy analysis (see Sbordone et al., 2010 and Christiano et al. 2010).

The survey delivers information on the frequency of both wage and price changes at the firm level. It explicitly asked firms in Macedonia about the frequency of price changes for their main product (see Appendix 1, question 31) and of wage changes for their main occupational group (question 9). For the case of price adjustment, firms could choose between the following range of options: daily, weekly, monthly, quarterly, twice a year, once a year, less frequently than once a year, other. The frequency of wage adjustment was captured through three separate questions taking different types of wage changes: those due to factors unrelated to tenure and/or inflation, those due to tenure and those due to inflation. Respondents in Macedonia could choose from the options: more than once a year; once a year; once every two years; less frequently than once every two years; never / don't know.

To make survey results more comparable, in the analysis of the responses concerning frequency of price adjustment, we aggregate the first three options, on the one hand, and the fourth and fifth, on the other, and end up with four categories: daily to monthly, quarterly to half-yearly, yearly and less frequent than yearly. Similarly, for wages we aggregate the third and fourth options into a single one, which we label "less frequently than once a year". In order to simplify the description of results, in the rest of this paper we consider a composite measure, defined as the highest frequency of wage change for each firm among the three factors described above.

The results derived from the surveyed firms in Macedonia show that in general firms change prices more frequently than they change wages (Table 2). Around 29% of firms report that they change prices once a year or less frequently, about 31% do it more often, while the remaining ones do not have any particular pattern. Base wages of workers are changed less frequently. Around 73% of firms change wages once a year or less often, only 21% of wages change more often, while the remaining ones do not report any change (option "never/don't know" was chosen).

The disaggregation by sector reveals that there is higher cross-sectoral variation in the frequency of price adjustment than in the case of wage adjustment in Macedonia. Firms in manufacturing and market services[2] change prices much less frequently than those in trade and construction sector (Table 2). Market services sector is with the highest proportion of firms reporting no regular pattern in price adjustments. Regarding wage adjustment, they are least frequent in construction and market services, more frequent in trade and most frequent in manufacturing sector.

[2] The lower frequency of price changes for services could reflect the lower volatility of consumer demand for them (see Clement, D. 2003). Another factor could be cost structure, which in services sector labour costs are more important than raw material costs. Hence, volatility of raw material prices has limited impact in the frequency of price revisions in services sector.

However, even in manufacturing, the base wages of around 60% of workers are adjusted with a yearly frequency and only 25% are adjusted with a higher frequency. A comparable analysis has been done by firm size, as defined in Section 2, and differences in frequencies of price and wage changes turn out to be negligible.

Frequency of price and wage changes across sectors

(percentages) Table 2

	PRICES				
	daily to monthly	quarterly to half yearly	Yearly	less frequently than once a year	no pattern
Total	**10.2**	**20.7**	**11.4**	**18.0**	**39.7**
Manufacturing	3.0	31.0	14.0	18.0	34.0
Construction	40.0	15.0	3.0	7.0	34.0
Trade	21.0	18.0	9.0	3.0	48.0
Market services	1.0	4.0	13.0	31.0	49.0
Standard deviation	*18.2*	*11.1*	*5.0*	*12.6*	*8.4*

	WAGES (for any reason)			
	more frequently than once a year	yearly	less frequently than once a year	never/don't know
Total	**21.3**	**56.3**	**16.2**	**6.2**
Manufacturing	24.6	59.6	8.2	7.5
Construction	17.1	76.7	4.0	2.2
Trade	21.3	31.5	38.9	8.3
Market services	17.1	53.1	25.5	4.3
Standard deviation	*3.6*	*18.7*	*16.1*	*2.8*

Source: Survey on wage and price setting in Macedonia (2014).
Notes: Figures weighted by employment weights.

The evidence on the frequency of price and wage changes presented above can also be summarised through an alternative measure of nominal rigidity, i.e. the number of months for which prices and wages remain unchanged ("duration"). Moreover, this measure helps to simplify the comparison of results. The computation of the duration indicator is still based on the firms' answers to questions regarding the frequency of price and wage changes but requires additional specific assumptions. In particular, whereas most of those answers directly translate into durations (e.g. "once a year" translates into a duration of 12 months), a few of them refer to intervals (e.g. "less frequently than once every two years").[3] A proxy for the average duration of wage and price spells was computed by simply multiplying each point category by its respective frequency. Following the approach of Martins (2011), for those categories expressed through intervals, the mid-point was assumed.

[3] We need to put assumption for three interval categories. Two for wages: duration shorter than one year and duration longer than two years; and one for prices: duration longer than one year.

Other more complex approach is that from Druant et al. (2009). In order to impute expected durations for those categories expressed through intervals, this approach assumes lognormal distribution of durations (with different moments for prices and wages). Then, it estimates the parameters of the distributions from the other answers, and in the end compute the conditional expectations for these categories.[4] We use imputed conditional expectations as given and calculate price and wage durations for Macedonian firms using both approaches. To save on space or for its simplicity, in our analysis we report the results about price and wage duration from the first approach only, as results show that differences are qualitatively of minor significance.

The results on duration should, therefore, be regarded as approximations. The impact of assumptions for interval categories on the estimates presented below is, however, quite negligible, as they concern only a minority of firms' answers. Another important qualification is that price durations are not computed for more than one-third of firms that report "no pattern" to the question on the frequency of price changes. A similar omission applies to wage changes, since wage durations are not computed for firms that choose the option "never/don't know" to the question on the frequency of wage changes. However, in the case of wages it is much less relevant since it contains only 6 percent of the firms.

Results in Table 3 show that wages in Macedonian firms remain unchanged, on average, longer than prices. Prices tend to remain unchanged on average only for about 5 months. Looking at sectorial differences, our results reveal that prices set by manufacturers and services firms tend to remain unchanged above average, whereas those set in construction and trade sector are more flexible (with duration up to 2 and 3 months, respectively). As expected, durations are longer for wages, as they remain unchanged on average for almost 13 months. There is evidence of some variation across sectors, but when looking to firms' size the variation becomes smaller.

When comparing the results with surveyed EU countries as a part of WDN, average price duration in Macedonia is shorter, which can be attributed to the high share of firms that experience severe or strong competition and follow competitor's price changes (see Ramadani and Naumovski, 2015). Also, average wage duration is somewhat shorter in Macedonia compared with average EU countries, which can be related to tenure rather than inflation as the most important factor producing frequent wage adjustment in Macedonia (more details in subsection 3.3). Moreover, if we look at individual EU countries, higher duration recorded for EU aggregate is mainly due to Italy, where wages remain unchanged for 2 years, consistently with the wage bargaining institutional setup (see Du Caju et al. 2008), whereas for most other countries wage duration is around 12 or 13 months, except for Italy (20.3). Also, differences for Macedonia with those from EU average might be related to the different period in time to which survey data refer.

4 For details, see Druant et al. 2009, Appendix 3.

Estimated average duration of wage and price spells

(months) Table 3

	Prices	Wages
Total	5.2	12.5
Manufacturing	6.6	10.9
Construction	1.9	11.3
Trade	2.8	16.2
Market services	5.4	14.0
Standard deviation	2.2	2.5
Very small firms	6.6	11.9
Small firms	7.8	13.7
Medium-sized firms	7.7	10.7
Large firms	5.4	11.6
Very large firms	4.1	13.2
Standard deviation	1.6	1.2
Memo:		
Total EU	9.6	14.9
Euro area	9.6	15.0
Non-Euro area	9.6	14.7

Notes: Figures weighted by employment weights.

Source: Survey on wage and price setting in Macedonia (2014) and Druant et al. (2009)

3.2 Timing of wage and price changes

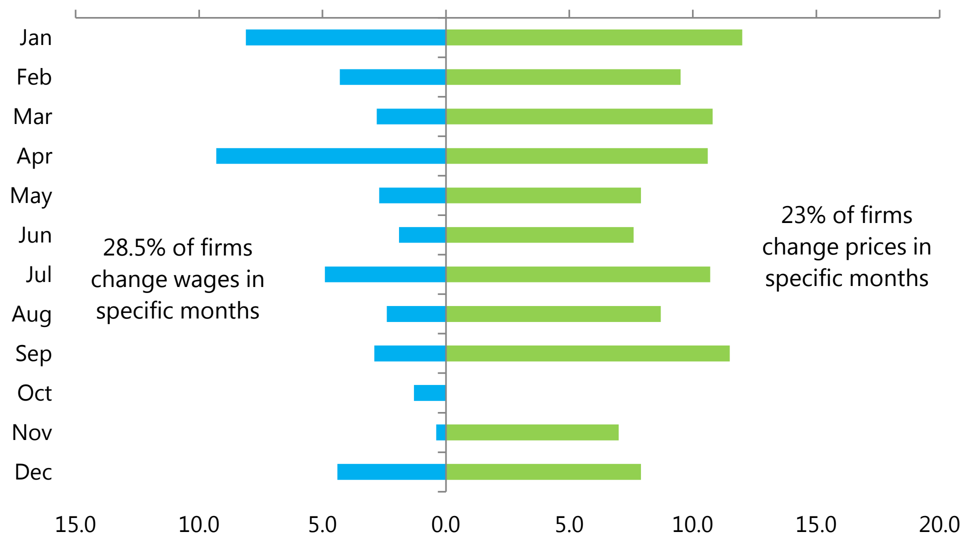
Another relevant indicator that signals the presence and extent of nominal rigidities, apart from the frequency of price and wage changes, is the nature or timing of adjustment itself. In order to account for the fact that firms do not change their prices and wages in response to every shock, the literature has modelled firms' strategies either as a time-dependent process, where the timing of the adjustment is exogenously given and does not depend on the state of the economy, or as a state-dependent one when it does. In the presence of shocks, time-dependent rules typically lead to greater price and wage rigidity.

Firms' behaviour whether time or state dependent, has important implications for monetary policy decision makers. In particular, the degree of time concentration of wage setting decisions may have an impact on the transmission of monetary policy decisions to the real activity. For example, Olivei and Tenreyro (2007) find for the U.S., where wage changes concentrate at the turn of the year; that monetary policy shocks that take place in the second half of the year have insignificant effects on aggregate economic activity. Same authors in 2008 derive similar results for Japan, where most firms set their wages between February and May, and find that monetary policy shocks occurring in the first part of the year produce a smaller impact on real economy.

In order to obtain more empirical evidence on these issues, firms in Macedonia were asked to specify whether their wage and price changes are concentrated in particular month(s) or they take place with no predefined pattern (see Appendix 1, questions 10 and 32). Figure 1 reports the results and show that time-dependent wage adjustment is more widespread as a rule adopted by firms in Macedonia than time-dependent price adjustment. The proportion of surveyed firms in Macedonia that typically change wages in specific months is 29 percent, whereas in the case of prices it amounts to 23 percent that declare such a "time-dependent" pattern. Among these firms in Macedonia, there appears to be some degree of synchronisation in the timing of both price and wage change, with significant clustering in January and April.

Concentration of price and wage setting decisions at the firm level

(percentages of firms reporting to change wages/prices in a particular month) Figure 1



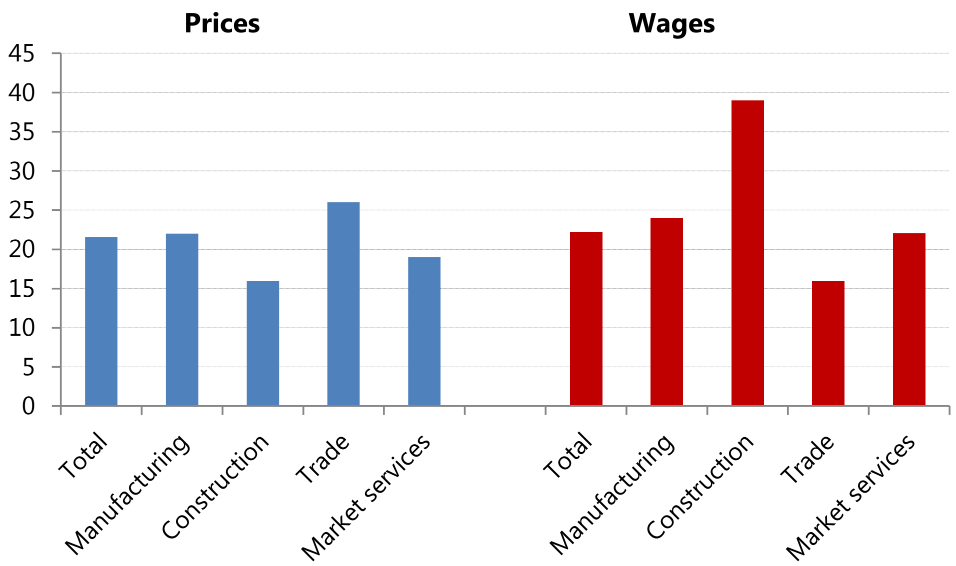
Notes: Figures weighted by employment weights.

Source: Survey on wage and price setting in Macedonia (2014). The sum of percentages exceeds the proportion of firms that change wages or prices in specific months as they could choose more than one month.

The sectorial analysis shows that firms in construction sector tend to concentrate more often their wage decisions in a particular month, while the concentration in particular months is least common in trade sector (Figure 2). Firms' operations in construction sector depend on seasonal factors, and their time concentration of wage decisions come exactly from seasonality, which particularly occur in the peak of construction works. Conversely, the pattern of concentration of price changes across sectors is with less variability compared with the pattern of wage adjustment. In this case, trade sector is above average and with highest concentration of price changes in particular month, while firms in construction report lowest time dependent price adjustment rules.

Time-dependent price and wage adjustment across sectors

(percentages of firms reporting to change wages/prices in a particular month) Figure 2



Source: Survey on wage and price setting in Macedonia (2014).

The finding that time-dependent wage adjustment mechanism is more widespread than time concentration of price changes might be related to the existence of wage indexation mechanisms, as well as to the presence of collective wage agreements. Data comparisons between Macedonia and EU countries show that the degree of concentration of wage and price changes is significantly lower in Macedonia.[5] The lower degree of concentration of wage changes can be explained by considerable low automatic indexation of wages and by the fact that tenure is main factor driving wage changes which are assumed to occur throughout the year (more details in subsection 3.3). The possible explanation of the concentration of price changes could be shorter price duration in the obtained results for Macedonia and larger share of firms that operate in highly competitive pressures.

3.3 The interaction between wage and price changes and indexation

After assessment the degree of rigidity of wages and prices gauged by the frequency and the timing of the adjustment process, now we focus explicitly on the interaction between wage and pricing decisions at the firm level. In this background we address both the issue of whether firms' wage and price change are related (and the causal link between the two) and how wages feed into prices. The very rich survey database allows us to find direct information on different aspects of wage and price relationship. For instance, the link between price and wage changes at the firm level,

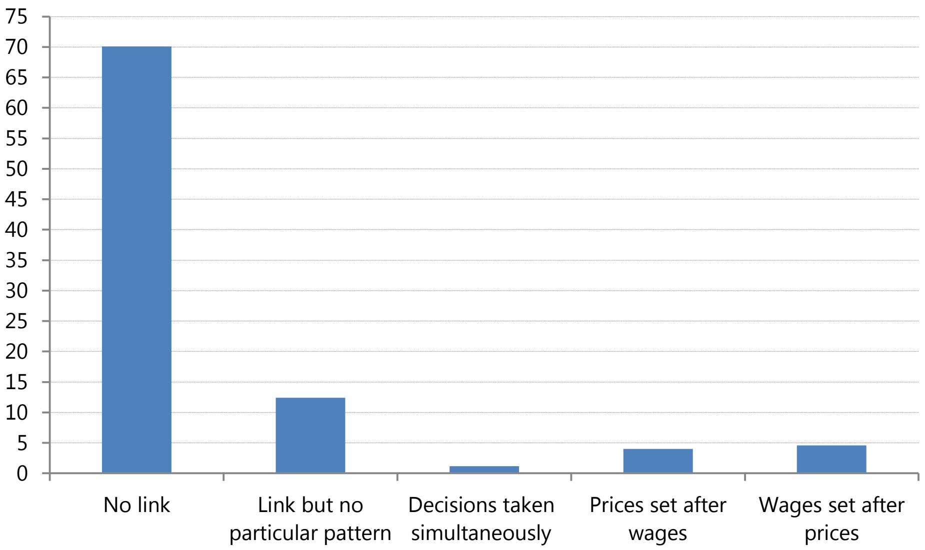
[5] 54% of firms in EU change wages in a typical month, whereas 35% change prices in a typical month

the response of prices to wage shocks, the existence and nature of internal policies of indexation and the frequency of wage changes due to inflation.

In order to analyse the link between price and wage changes, the survey questionnaire asks firms about the possible connection between the timing of their price setting and wage setting decisions (see Appendix 1, question 33). The intensity and direction of this relationship is illustrated in Figure 3. The results suggest that there is weak degree of interaction between the timing of price and wage changes, with around 22% of firms in Macedonia recognising that a connection does exist.[6] However, from 22% of Macedonian firms, only 10% admit that the link is relatively strong: in 1%, the decisions are taken at the same time; in 4%, changes in prices are taken only after wages are set; and in 5%, changes in wages occur only after prices are set. The patterns with respect to intensity and direction of the relationship are very similar across sectors. In contrast, in around 70% of the firms there does not seem to be any link between the timing of both decisions. The weak price-wage link in Macedonia corresponds with results that inflation is the lowest important factor driving wage changes and this is striking difference from the EU, where inflation is the main driving factor of frequent changes in wages.

The relationship between wage and price changes at the firm level

(percentages) Figure 3



Notes: Figures weighted by employment weights, rescaled excluding non-responses.

Source: Survey on wage and price setting in Macedonia (2014).

The finding that the majority of firms in Macedonia (70%) do not explicitly recognise a direct relationship between their price and wage adjustment decisions, it does not automatically imply that these two policies are not related. Indeed, other pieces of evidence arising from the survey suggest that wages and prices feed into each other at the micro level. The existence and extent of the pass-through of wages

6 This percent in surveyed EU countries is much higher, where 40% report synchronisation in adjustment of prices and wages.

into prices can be captured by examining the firms' adjustment strategies as reaction to shocks. Indeed, when asked to assess the relevance of different adjustments strategies to a common permanent unexpected increase in wages (see Appendix 1, question 25), about half of firms in Macedonia reported that they would increase prices (see Table 4). This represents the second most relevant policy used after reduction of other costs as adjustment strategy when firms face unanticipated wage shock.

In a study also based on the same survey database, Ramadani (2016) finds that firm's technology or labour intensity in production process makes firms in Macedonia more likely to increase prices after wage shock. In other words, the pass-through of wages into prices is particularly strong in firms with a high labour share.[7] This evidence is in line with the findings of Bertola et al. (2010) carried out in the context of WDN focused on EU surveyed firms. With this, we confirm previous evidence from section 3.1 that prices are stickier in sectors typically characterised by a high incidence of labour costs, such as market services or manufacturing sector.

Adjustment strategies to shocks

(percent of firms answering relevant or very relevant) Table 4

	EU			Macedonia		
	Demand shock	Cost-push shock	Wage shock	Demand shock	Cost-push shock	Wage shock
Adjust prices	50.5	65.6	59.2	68.8	62.5	**50.1**
Reduce margins	56.6	53.5	49.8	56.4	54.3	40.7
Reduce output	49.9	21.4	22.5	60.5	44.6	34.1
Reduce costs	78	67.6	59	78.9	71.5	65.7

Source: WDN Final Report 2009, Survey on wage and price setting in Macedonia (2014).

Turning back to the wage and price relationship, an important aspect is the existence and nature of indexation policies or the extent to which wage changes in Macedonian firms are related to inflation. The existence and strength of this relationship is determined by the presence or not of indexation rules. Hence, of extreme relevance from a policy perspective is the nature of these mechanisms – specific to automatic or not, formal or informal, and forward or backward looking. Regarding this issue, two questions were included in the survey (see Appendix 1, questions 6 and 7). First, firms in Macedonia were asked whether or not they have a policy that adapts changes in base wages to inflation. If so, firms had to report whether the adjustment is automatic or not, is subject to a formal rule, and whether adjustment is "backward" or "forward" looking (take into account past or expected inflation).

On average almost 30% of 514 firms surveyed do have an internal policy that adapts base wages to inflation, which put Macedonia in group of countries with low level of indexation (Table 5). Of these 30%, nearly 91% has a policy that adapts wages to inflation without applying any formal rule and mostly based on past inflation, while the remaining of them adopt an automatic indexation mechanism, and adjustment is mostly of a backward looking nature. There is some variability across sectors, the

7 Results are based on multivariate probit regression models.

existence of an internal indexation policy is more widespread in construction and less common in market services. Predominant cases across each sector are the ones where the link of indexation of base wages to inflation is not formal and tends to be backward looking.

Firms' policies of adjusting base wages to inflation are somewhat less common in Macedonia, when compared with the surveyed firms in the EU countries. The differences are more evident in the mechanisms of indexation, where nearly half of EU surveyed firms that adapt base wages to inflation they adopt an automatic indexation mechanism.

Policy of adjusting base wages to inflation — Table 5

Firm-level policy of adjusting base wages to inflation

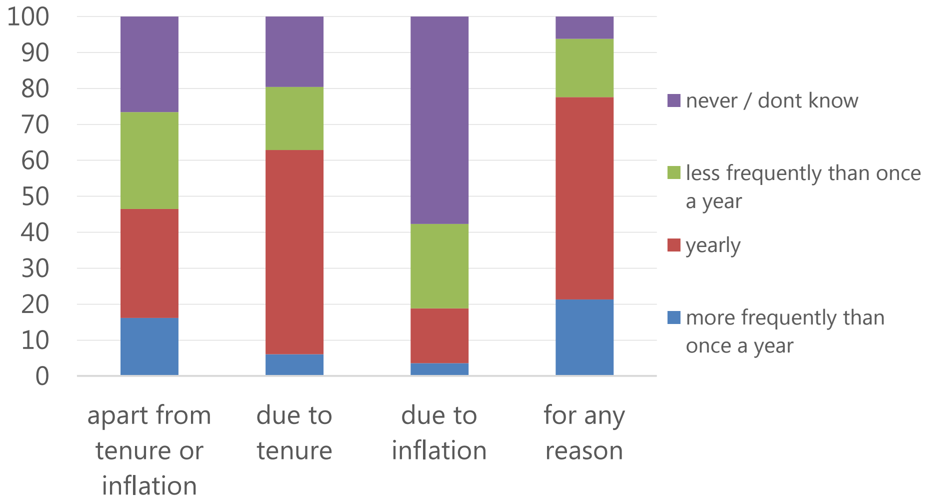
	Automatic		Informal		Total*
	Past	Expected	Past	Expected	
Total economy	2.2	0.5	23.0	3.7	29.4
Manufacturing	1.3	1.0	23.4	7.3	33.0
Construction	0.0	0.0	49.0	0.0	49.0
Trade	7.3	0.3	20.3	0.9	28.7
Market services	1.8	0.0	10.7	0.5	13.0
Very small firms	5.3	0.0	15.0	3.0	23.2
Small firms	6.8	0.8	15.3	2.3	25.0
Medium-sized firms	1.1	0.0	13.7	3.2	18.0
Large firms	2.6	1.3	23.4	5.6	33.0
Very large firms	1.5	0.0	24.9	2.6	29.0
Memo:					
Total EU	13.2	3.9	12.7	6.9	36.7
Euro area	16.3	4.1	9.7	5.5	35.6
Non-euro area	5.5	3.2	19.8	10.2	38.7

Figures weighted by employment weights. Source: Survey on wage and price setting in Macedonia (2014) and Druant, et al. (2009). (*) Percentage of workers covered by wage indexations clauses: Very low: 0-25%; Low: 26-50%; Moderate: 51-75%; High: 76-100%.

A last piece of evidence on how inflation affect firms' wage decisions is captured by survey question about the frequency of wage adjustments due to inflation, tenure or other factors. It is remarkable that tenure stands out as the most important factor producing frequent wage adjustment (on an annual or infra annual basis). The frequency of wage changes driven due to inflation is the lowest (see Figure 4). These results are somewhat different from the WDN Final Report results for the surveyed EU countries where inflation is the most important factor driving the frequent wage adjustment for the most EU countries. One possible explanation for this is the relatively low share of firms in Macedonia applying wage indexation, symbolic number that use automatic mechanism and lower presence of collective wage agreements compared to the surveyed firms in the EU.

Factors affecting the frequency of wage changes

(as a percentage of total employment in the sample) Figure 4



Source: Survey on wage and price setting in Macedonia (2014).

4. Conclusions

Appropriate measurement of wage and price stickiness is essential in the policy-making process. This study provides evidence on firms' price and wage adjustment in Macedonia, and particularly emphasis the presence and degree of nominal rigidities. It focuses on specific aspects related with frequency, timing and interaction of wage and price changes across sectors and firms in Macedonia and compares them with EU average. The main conclusions are the following.

As to the frequency of adjustment, the paper shows that firms in Macedonia adjust wages less frequently than prices. Wages tend to remain unchanged, on average, for about 13 months, while prices for around 5 months. Wage and price durations in Macedonia are shorter than those observed in EU.

The other aspect of rigidity related to time-dependent strategies of wage and price changes, show that time-dependent wage adjustment is more widespread as a rule adopted by firms in Macedonia than time-dependent price adjustment. The fraction of surveyed firms in Macedonia that typically change wages in specific months is 29 percent, whereas in the case of prices it amounts to 23 percent. The finding that time-dependent wage adjustment mechanism is more widespread than time concentration of price changes might be related to the existence of wage indexation mechanisms, as well as to the presence of collective wage agreements. Comparing the results with EU, the directions of time-dependent wage and price adjustment are in line with EU surveyed countries, but the intensity of the degree of time-dependent adjustments in Macedonia is lower, delivering in general lower rigidity.

Different pieces of evidence confirm that in some aspects wages and prices in Macedonia feed into each other at the micro level and that there is some relationship between wage and price rigidity. First, around 22% of the firms in Macedonia admit a relationship (formal or informal) between the timing of their wage and price adjustment decisions. Second, when asked to assess the relevance of different adjustments policies to a common permanent unexpected wage shock, about 50% percent of firms report that they would increase prices as adjustment strategy. Third, firm-level wage changes appear to be related to inflation developments, although the level of indexation is low, and tenure rather than inflation produce more frequent adjustment. Fourth, firms with a high labour cost share report a tighter link between price and wage changes. All these evidences are with lower intensity in Macedonia compared with the average of surveyed EU countries.

From the results of three aspects of wage and price adjustment we can conclude that presence and degree of nominal rigidities are somewhat lower in Macedonia compared with the average of surveyed EU countries. Less sticky prices and wages, in turn might potentially make more effective monetary policy transmission mechanism.

The findings in this paper about wage and price stickiness are important and can help building and calibrating more effectively macroeconomic models that are widely used for monetary policy analysis and forecast.

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Appendix

Appendix 1: Survey questions

6 — Does your firm have a policy that adapts changes in base wages to inflation?

Definition of base wage - direct remuneration excluding bonuses (regular wage and salary, commissions, piecework payments).

No	☐ → **GO TO QUESTION 8**
Yes	☐

7 — If "yes" in question 6, please select the options that best reflects the policy followed:

Wage changes are automatically linked to:	
- past inflation	☐
- expected inflation	☐
Although there is no formal rule, wage changes take into account:	
- past inflation	☐
- expected inflation	☐

9 — How frequently is the base wage of an employee belonging to the main occupational group in your firm (as defined in question 1) typically changed in your firm?
<u>Please tick an option for each of the three types of wage changes listed below.</u>

	more than once a year	*once a year*	*once every two years*	*less frequently than once every two years*	*never / don't know*
Wage changes apart from tenure and/or inflation	☐	☐	☐	☐	☐
Wage changes due to tenure	☐	☐	☐	☐	☐
Wage changes due to inflation	☐	☐	☐	☐	☐

10 — Under normal circumstances, are base wage changes concentrated in any particular month / months?

No ☐
Yes: Jan. ☐ Feb.☐ Mar.☐ Apr.☐ May☐ June☐ July☐ Aug.☐ Sept.☐ Oct.☐ Nov.☐ Dec.☐

25 — How relevant are each one of the following strategies when your firm faces an unanticipated permanent increase in wages (e.g. due to the renewal of the national contract) affecting all firms in the market?
<u>Please tick an option for each line.</u>

	not relevant	*of little relevance*	*relevant*	*very relevant*	*don't know*
Increase prices	☐	☐	☐	☐	☐
Reduce margins	☐	☐	☐	☐	☐
Reduce output	☐	☐	☐	☐	☐
Reduce other costs	☐	☐	☐	☐	☐

31 — Under normal circumstances, how often is the price of the firm's main product typically changed?
<u>Please choose a single option, the one that best describes the situation in your firm.</u>

More than once a year:	
- daily	☐
- weekly	☐
- monthly	☐
- quarterly	☐
- half-yearly	☐
Once a year	☐
Once every two years	☐
Less frequently than once every two years	☐
Never	☐
There is not a defined pattern	☐

32 — Under normal circumstances, are these price changes concentrated in any particular month / months?

No ☐
Yes: Jan. ☐ Feb. ☐ Mar. ☐ Apr. ☐ May ☐ June ☐ July ☐ Aug. ☐ Sept. ☐ Oct. ☐ Nov. ☐ Dec. ☐

33 — How does the timing of these price changes relate to that of wage changes?
<u>Please choose a single option.</u>

There is no link between the two	☐
There is a link but no particular pattern	☐
Decisions are taken simultaneously	☐
Price changes tend to follow wage changes	☐
Wage changes tend to follow price changes	☐
Don't know	☐

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Recent ECB experience of rapidly evolving monetary policy and its statistical implications[1]

Jean-Marc Israël, Antonio Colangelo, Rodrigo Oliveira-Soares,
European Central Bank

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Recent ECB experience of rapidly evolving monetary policy and its statistical implications[1]

Jean-Marc Israël, Antonio Colangelo and Rodrigo Oliveira-Soares

Abstract

Since the onset of the financial crisis, the ECB has adopted several unconventional monetary policy measures to promote the correct functioning of the monetary policy transmission channel. This paper reviews some initiatives developed in the area of monetary and financial statistics to support the design and implementation of these measures, as well as the analysis of their impact. Alongside new aggregated data on bank loans to the private sector, the ECB is now collecting and sharing across the Eurosystem individual banks' reports – protecting data confidentiality, as required – to better support monetary policy conduct. In addition, two major projects have been launched aiming at collecting granular data to monitor the wholesale money market (Money Market Statistical Reporting) and to assess in greater depth supply and demand factors in credit developments (Analytical Credit). Moreover, statistical concepts and measurements constitute the basis for implementation of the Targeted Long Term Refinancing Operations (TLTROs) launched by the Eurosystem in 2014 with the first series, and revamped in 2016 with the TLTRO-II programme.

Keywords: euro, European Central Bank, central banking, statistics, monetary policy, unconventional, transmission channel, credit, bank loans, money market.

JEL classification: E43, E51, E580, G21

[1] The paper has benefited from useful input and suggestions from Orestes Collazo Brananova, Violetta Damia, Augusto Fasano, Karine Feraboli, Sarah Frost, Hanna Häkkinen, Josep Maria Puigvert, Ronald Rühmkorf and Patrick Sandars. The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank.

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Introduction

As a response to the financial crisis, the ECB expanded its operating framework by including non-standard monetary policy measures. In a first phase, before June 2014, these measures focused on a more flexible provision of liquidity to the banking system and on the outright purchase of assets targeting malfunctioning market segments. After June 2014 new credit easing measures were introduced with the final aim to improve monetary policy transmission, including negative interest rates on the deposit facility, targeted refinancing operations - the TLTROs, and new asset purchase programmes.[2]

The design and implementation of those tools as well as the need to monitor their impact on the monetary policy transmission have created new challenges for analysts, which have translated into new demands for monetary and financial statistics. Without being exhaustive, this paper provides an overview of some of the initiatives which were developed. First, users have faced the need to keep the headline aggregates fit for monetary policy, e.g. by taking into account financial innovation. This has resulted into new statistics on bank loans, which are reviewed in Section 1. In addition, the challenges arising from unconventional monetary policy measures have introduced new dimensions in the analyses, leading to a need for higher data granularity and timeliness. For monetary and financial statistics this has meant new user requests for access to data on banks on an individual level. Section 2 presents balance sheet and interest rate statistics which have been shared since 2012 across the Eurosystem at the level of individual Monetary Financial Institutions (MFIs) – protecting data confidentiality, as required; while the data were already available at

[2] For further insights, see ECB (2010, 2015*a* and 2015*b*).

Eurosystem national central banks (NCBs) for the purposes of compiling national and euro area aggregated MFI statistics, they had not been shared at Eurosystem level beforehand. In addition, new projects were initiated aimed at the collection of money market transactions and granular credit data; these projects are briefly introduced in Sections 3 and 4. Moreover, the design of the TLTROs represented a major challenge as the methodological framework of the programme was developed entirely on statistical concepts; this is discussed in Section 5, while Section 6 concludes.

1. New data on bank loans to the private sector

In 2015, the ECB released new data to improve the economic content of its statistics on bank loans. The first significant enhancement related to MFI balance sheet items (BSI) statistics,[3] which represent the primary source for the ECB monetary analysis. When a bank sells part of its loan portfolio to a third party (for instance in the context of securitisation activities) and removes those loans from its balance sheet, it reports a reduction in lending. At an aggregated level, to the extent loans are not transferred to another euro area bank, this will translate into a reduction in MFI lending, although the actual amount of financing received by the real economy remains unchanged. A need thus arises to construct measures of bank lending which are not affected by loan transfers off and onto banks' balance sheets.

With the aim of providing a measure of bank lending from the perspective of the lender, the ECB has been publishing loan series adjusted for sales and securitisation since December 2008. This method was based on the adjustment of loan transactions reported in a given month by the amount of loans removed from the MFI balance sheet (i.e. derecognised) owing to securitisation or outright sales to non-MFIs; the resulting adjusted transactions would then be used to derive growth rates.[4] This method, however, did not take into account the repayments of those loans that are no longer recorded on banks' balance sheets (derecognised loans), nor the outstanding amounts of derecognised loans in the calculation of the adjusted growth rates. In September 2015 the ECB released new data on loans adjusted for sales and securitisation based on a refined method which is taking into account these two effects, insofar as data are available.[5] The new data offer a more comprehensive view of all lending to the real economy originated by banks whether or not the loans are recorded on banks' balance sheets at the time of the reporting and ensure better comparability across countries.

3 The statistical requirements of BSI statistics are specified under Regulation (EU) No 1071/2013 of the ECB of 24 September 2013 concerning the balance sheet of the monetary financial institutions sector (recast) (ECB/2013/33), OJ L 297, 7.11.2013, p. 1.

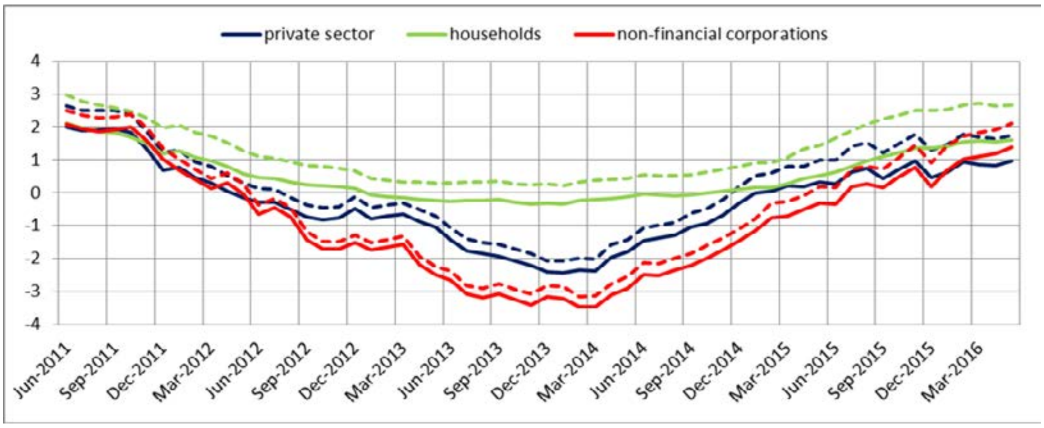
4 See ECB (2009).

5 See ECB (2015*c*).

Chart 1

MFI loans to the euro area private sector adjusted for sales and securitisation

(annual growth rates, seasonally adjusted)



Source: ECB

Note: The solid lines represent the new method and the dashed lines represent the former method. The last observation is for May 2016.

Chart 1 shows that the method of adjustment introduced in 2015 resulted in steady lower growth rates than using the former method. This difference is explained by flow and stock effects. First, repayments of derecognised loans result in somewhat lower adjusted flows of loans compared with the former method. Second, the inclusion of the stocks of derecognised loans increases the base on which the growth rates are computed, thereby reducing the growth rates in absolute value terms. In other words, the stock effect contributes to making positive growth rates lower, and negative growth rates less negative, under the new method than under the former method.

At the request of users, additional data were also introduced in the context of MFI interest rate (MIR) statistics,[6] which provide information on interest rates applied by banks to deposits and loans vis-à-vis households and corporations, relating to both new business and outstanding amounts. In particular, the data on new business comprise information laid down in new agreements between banks and their customers, thus reflecting the supply and demand conditions at the time of the agreement. These statistics enable an assessment of the pass-through of changes in policy rates to the lending and deposit rates faced by households and corporations. However, data on new business of loans have thus far not distinguished between new agreements related to renegotiations and pure new loans, while the distinction can be relevant for analysis. In 2015 new indicators were published that allow disentangling renegotiations of loans to households (broken down by purpose of the loan) and corporations.[7]

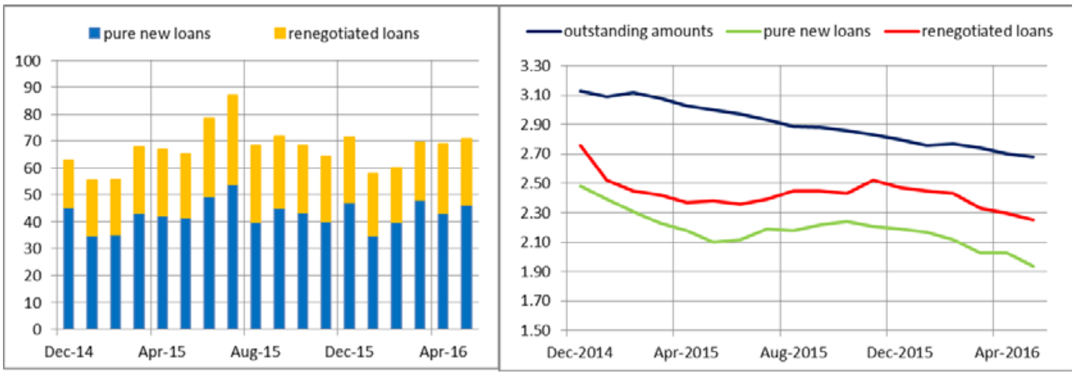
[6] MIR statistics are collected under the requirements of Regulation (EU) No 1072/2013 of the ECB of 24 September 2013 concerning statistics on interest rates applied by monetary financial institutions (recast) (ECB/2013/34), OJ L 297, 7.11.2013, p. 51.

[7] See also ECB (2015*d*).

Chart 2

MFI loans to the euro area households for house purchase: new business volumes (left-hand side) and interest rates (right-hand side)

(EUR billions (left-hand side), percentages per annum excluding charges (right-hand side))



Source: ECB

Note: The last observation is for May 2016.

Chart 2 (left-hand panel) shows that in the euro area from December 2014 to May 2016 over a third of the loans to households for house purchase recorded as new business were actually renegotiations of existing loans. Chart 2 (right-hand panel) also compares interest rates on loans to households for house purchase, showing that interest rates on true new loans were consistently lower than those on renegotiated loans between December 2014 and May 2016. Over the period, both interest rates were significantly lower, on average, than interest rates on outstanding loans for house purchase.

2. Use of individual banks' balance sheet and interest rate statistics

Data on euro area MFIs have been collected by the Eurosystem under the BSI and MIR statistical framework on an individual basis since 1999 and 2003 respectively. Traditionally, NCBs would share the data with the Eurosystem based on national aggregates only. While these aggregates remain a key component for the euro area indicators, granular BSI and MIR data have also become important for analysis to better analyse the monetary policy transmission channel and disruptions caused by fragmentation in the markets. Hence, the ECB has established since September 2012 a regular transmission of individual MFI data, with a view to sharing the dataset across the whole Eurosystem for monetary policy as well as macro-prudential and financial stability analysis, in line with the legal framework underlying the collection of statistical information by the ECB.[8] Tools and processes needed to be adapted so as to handle microdata. In addition, data confidentiality had to be protected.

Originally, from September 2012, the dataset was limited to the main items of the MFI balance sheet and covered a panel of about 250 MFIs representing 70% of

8 Council Regulation (EC) No 2533/98 of 23 November 1998 concerning the collection of statistical information by the European Central Bank, OJ L 318, 27.11.1998, p. 8.

the euro area MFI sector in terms of total assets. The dataset then was gradually extended both in terms of indicators and institutions. Since October 2015, the coverage has increased to about 300 MFIs (representing 80% of the euro area MFI sector in terms of total assets) and the granularity of the indicators has also been extended.[9] For instance, for the balance sheet indicators a total of about 130 indicators on outstanding amounts and over 30 on transactions are made available to users. In particular, the dataset covers cash, loans, debt securities, money market fund (MMF) shares/units, non-MMF investment fund shares/units, equity, non-financial assets and remaining assets. On the liability side, deposits, debt securities, capital and reserves, and remaining liabilities are presented. Data are split by residency and sector of the counterparty, maturity (where relevant), purpose (for loans to households) and type (for deposits). Regarding interest rates, the dataset covers loans and deposits to euro area households and non-financial corporations (NFCs), and distinguishes between interest rates on outstanding amounts (13 indicators) and interest rates on new business (30 indicators, with the corresponding business volumes). The breakdowns broadly match those available for the balance sheet indicators in terms of maturity (or fixation period for the new business) and instrument type for deposits or purpose for loans to households. Loans to NFCs are additional made available with a split for the amount of the loan.[10]

Since its establishment, this rich dataset has enabled to enhance monetary analysis with cross-sectional studies, as the responses of individual MFIs to monetary policy easing and unconventional measures became much affected by their individual characteristics. The standard ECB tool sets for assessing money and credit has thus been complemented with distributional analyses and cross-sectional studies using individual data. Besides the monetary policy transmission mechanism, the microdata can also be used to study the funding conditions of banks, not least as a consequence of prudential or regulatory changes, their profitability (e.g. interest rate margins) or balance sheet structure, allowing for analyses across business models, bank types and countries.[11]

9 The latest extension has also introduced micro-prudential supervision as one of the purposes for which the data can be used.

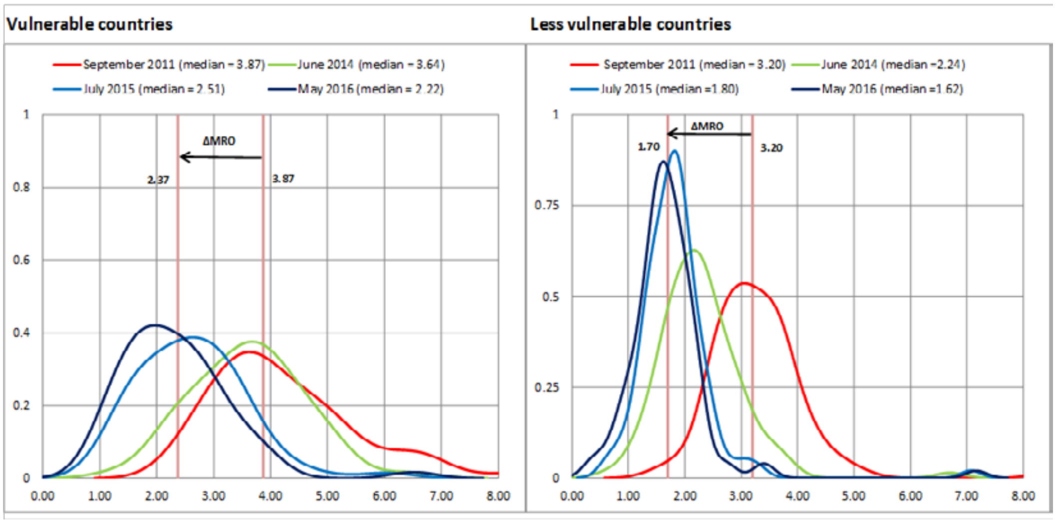
10 For a more comprehensive description of the dataset and the technical challenges that were faced (especially in relation to the latest extension), see Bojaruniec and Morandi (2016).

11 For instance, see ECB (2014*a*, 2015*b*, 2015*e* and 2016). Much academic research has also been performed in this context; for example, see Altavilla *et al* (2016) and Holton and Rodriguez d'Acri (2015).

Chart 3

Composite lending rates for NFCs: distribution of individual MFIs

(percentages per annum)



Source: ECB

Note: The charts show the density of the lending rate distribution obtained from a sample of 56 MFIs in selected vulnerable countries (Ireland, Spain, Italy and Portugal) and 106 MFIs in less vulnerable countries (Belgium, Germany, France, the Netherlands and Austria) in four different periods (September 2011, June 2014, July 2015 and May 2016). The chart also shows that if the reduction in the MRO rate since September 2011 (i.e. 145 basis points) had been fully passed on to the median lending rates of that period (i.e. 3.87% for vulnerable countries and 3.20% for less vulnerable countries), the lending rate in May 2016 would have been 2.37% for vulnerable countries and 1.70% for less vulnerable countries.

Chart 3 extends the analysis of ECB (2015b) and shows that the pass through of successive cuts in the MRO rate to lending rates applied to NFCs was much slower for vulnerable countries than in less vulnerable ones. Comparing the distributions of lending rates of September 2011 (i.e. shortly before the first of a series of cuts in the rate of the ECB main refinancing operations (MRO) starting in November 2011) and June 2014, it appears that vulnerable countries did not experience a significant drop on the median rate (23 basis points) despite the 125 basis point reduction in the MRO rate. In contrast, this reduction was better reflected in the median rate for less vulnerable countries (96 basis points). Since the launch of the TLTROs[12] and the new asset purchase programmes in June 2014, the reduction in borrowing costs in vulnerable countries was significant, supporting the view that the measures have helped aligning the price of credit with the intended stance of monetary policy.

3. New daily granular data on money market transactions

Monitoring money markets is crucial for the analysis of the monetary policy transmission (as well as for macro- and micro-prudential supervision), especially in a situation of high market fragmentation. In a situation where such fragmentation was expected to remain very high, in 2014 the Eurosystem decided to establish a legal

[12] See Section 5 for further details.

framework to collect statistical data on money market transactions.[13] This dataset provides the Eurosystem with daily, accurate, timely (in the early morning on the working day following the deal) and comprehensive data on transactions concluded by the reporting credit institutions, which will allow an improved monitoring of the transmission of monetary policy decisions in money markets, as well as on market expectations for the future evolution of policy rates. This new granular dataset covers four segments of the euro money markets, namely unsecured, secured, foreign exchange swaps (FX swaps) and overnight index swaps (OIS) transactions denominated in euro. The new collection framework requires the daily reporting of transaction-by-transaction information on unsecured and secured lending and borrowing transactions in euro with a maturity of up to one year. All FX swap transactions involving euro and OIS transactions denominated in euro must also be reported. The detailed trade data to be provided include the volume, rate, counterparty type and collateral type, together with the time at which the transaction was conducted.[14]

Following the adoption of the relevant legal act, the ECB started on 1 July 2016 to collect statistical data from the 52 euro area credit institutions with the largest market share in money market segments. With a view to limiting the impact of teething problems and ensuring full automation from 1 July 2016, credit institutions started to send data on 1 April 2016. This three-month interim period was deemed necessary to fine-tune the reporting process before the legal obligation came into force on 1 July. As shown in Chart 4, the number of transactional records already reached ca. 35,000 per day by mid-July 2016. The data are available at 07:30 in the morning of the next working day, allowing an early assessment to be used as input to the daily monitoring of liquidity by the ECB. The data granularity will also allow more in-depth analysis of market developments. This granularity and timeliness requires that the statistical analysis, e.g. on consistency and plausibility, is run with highly effective and automated processes, part of which will need to be developed and enhanced while gaining experience. In this regard, a full standardisation of the underlying taxonomy and data transmission format based on the ISO 20022 standard has been introduced by the Eurosystem. A set of four reporting messages and a status message containing feedback information have been jointly submitted by the ECB, the Deutsche Bundesbank, the Banco de España and the Banque de France and subsequently been approved by the ISO Registration Authority.

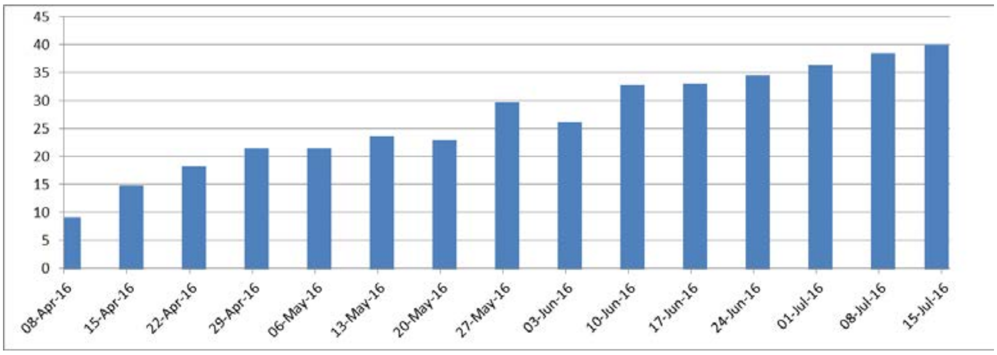
13 Regulation (EU) No 1333/2014 of the European Central Bank of 26 November 2014 concerning statistics on the money markets (ECB/2014/48), OJ L 359, 16.12.2014, p. 97.

14 For further information, see ECB (2016*b* and 2016*d*).

Chart 4

Transactional records collected

(Weekly averages, thousands)



4. The Analytical Credit datasets

The ECB has adopted a strategy to develop and produce new ESCB granular statistics on credit and credit risk with the aim to support the Eurosystem in the performance of its tasks, including those related to monetary policy analysis and operations, risk management, and financial stability surveillance. The granular data will also be used to produce new indicators of credit intermediation and increase the quality of existing statistical datasets.

To this end, a new statistical regulation was adopted in May 2016,[15] according to which granular credit and credit risk data are to be collected based on harmonised ECB statistical reporting requirements, with a view to establishing a common granular credit dataset (i.e. "AnaCredit") shared between the Eurosystem members and comprising input data for all euro area countries. The AnaCredit dataset will cover credit and credit risk information to broadly monitor the performance of the whole euro area credit market; it is therefore essential for the ECB that the relevant database contains complete, accurate and timely information on the credit situation in the financial system. The new legal framework calls upon a first stage of implementation with a focused scope, namely lending and credit lines by credit institutions to all legal persons, in particular NFCs. The scope may later on be extended to other lenders and other instruments. A phased-in approach makes the overall endeavour more manageable, while the data model, definitions and granularity of data allow any future enrichment to be processed in a non-disruptive manner.

Covering loans to NFCs in the initial phase, the AnaCredit dataset will allow a better understanding of the monetary policy transmission channel, particularly regarding small and medium-sized enterprises (SMEs) – the backbone of the economy in terms of investment and employment opportunities. AnaCredit should provide high-quality and timely information on debtors and the different credits they were granted (i.e. type of credit, outstanding debt, number of days past due date, date of origination and contractual maturity, type of interest rate and currency of the credit). This will help assessing their indebtedness and creditworthiness. Furthermore,

[15] Regulation (EU) 2016/867 of the European Central Bank of 18 May 2016 on the collection of granular credit and credit risk data (ECB/2016/13), OJ L 144, 1.6.2016, p. 44.

on the lenders' side information on any risk mitigation measures securing the credits (e.g. credit derivatives, guarantors, financial collateral received) is useful to estimate the severity of losses in the event of default. Finally, the dataset should support reliable debtor identification (e.g. full name and unique ID number, address or location, type of obligor (SME or corporate obligor)) as unique identification is essential for capturing the total indebtedness of debtors accurately, especially if there are cross-border exposures.[16] In this respect, such a credit dataset also calls for an accurate business register. The entities in the financial sector are already covered within the European System of Central Banks' "Register of Institutions and Affiliates Dataset" (RIAD). RIAD is foreseen to be expanded to also cover the non-financial entities that will be reported in AnaCredit.

5. The statistical basis of the TLTROs

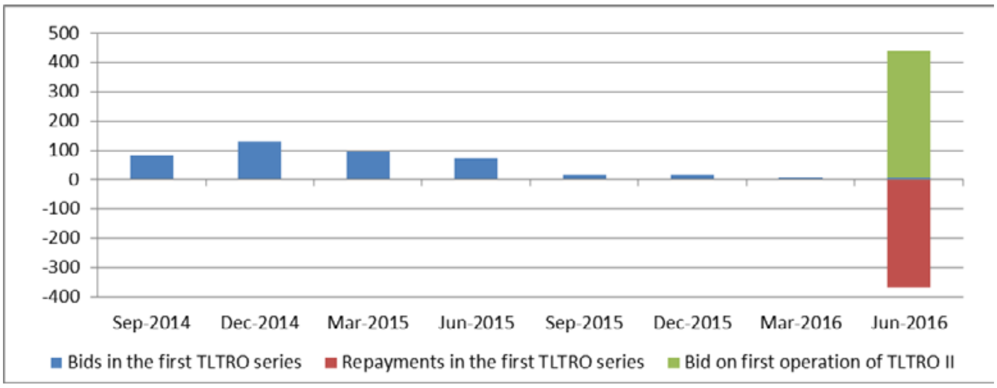
In June 2014 the Eurosystem decided to introduce the TLTROs, a new type of monetary refinancing operations targeted to support bank lending to NFCs and households. The idea underlying the operations is to provide incentives to credit institutions to use the liquidity obtained from the Eurosystem for lending to the non-financial private sector. The first TLTRO programme, conducted from September 2014 to June 2016 with eight quarterly operations (maturing in September 2018), entitled monetary policy counterparties to borrow in the first two operations 7% of the total amount of their loans eligible for the programme (i.e. loans to the euro area non-financial private sector, excluding loans to households for house purchase) outstanding on 30 April 2014. Additional amounts could be borrowed in the subsequent operations depending on the banks' lending activities. The second TLTRO series (TLTRO-II) was launched in March 2016 to reinforce the Eurosystem's accommodative monetary policy stance, and consists of four additional quarterly operations (maturing four years after settlement) to be conducted between June 2016 and March 2017. Counterparties are entitled to borrow in the operations a total amount of up to 30% of their loans eligible for programme outstanding at 31 January 2016, less any amount still outstanding from the first two TLTRO operations conducted in 2014. The incentive scheme of TLTRO-II is based on a pricing mechanism where the interest rate to be paid depends on the lending pattern of the counterparties. Under the two programmes, eligible counterparties could choose to participate either on an individual basis or as part of a "TLTRO group" through a "lead institution", which conforms to Eurosystem eligibility criteria.[17] Chart 5 shows the bids under the first and second TLTRO series.

[16] For further information, see ECB (2015*f*).

[17] See ECB (2014*b* and 2016*c*) for further information on the two series of operations.

Chart 5
Liquidity provisions under the TLTROs

(EUR billions)



Source: ECB

Note: In June 2016 many counterparties decided to repay the amounts borrowed under the first series of TLTROs in favour of TLTRO-II.

The design of the TLTROs represented a major challenge for statisticians as it required the development of a dedicated statistical reporting for TLTRO participants which allows the measurement of the loan variables to be used for the calculation of the allowances and the evaluation of the banks' performance. In fact, data already collected by the Eurosystem in the context of BSI statistics were not sufficient as, e.g., small MFIs can be granted derogations. In addition, some important indicators for the TLTROs are not covered in BSI statistics. Still, the TLTRO dedicated reporting was anchored to the BSI methodological framework, so as to ensure common definitions and understanding by the credit institutions, comparability of data and, most notably, to enable the Eurosystem to carry out some consistency checks on the received data.

The reporting template was structured trying to guarantee an equal playing field across participants, for instance taking into account the impact of securitisation on the development of eligible loans and not fully harmonised reporting practices across the euro area. Specifically, the concept of "eligible net lending" used in the programme to monitor the lending behaviour of TLTRO bidders considers new MFI loans and repayments of principal in the reporting period, excluding the impact of loan acquisitions and disposals (including in a securitisation). In terms of national recording practices, the derecognition from the balance sheet of loans securitised in a traditional securitisation is not fully harmonised and loans may be reported net of provisions in some countries; the TLTRO template thus had to reflect these aspects as well.

Statisticians were also given a very active role in the implementation of the programmes, especially in the light of their experience to handle the data flows and guarantee the proper level of confidentiality protection for the exercise as a whole. In particular, Statistics Departments of NCBs are collecting the data from counterparties, verifying their consistency and, in many NCBs, also performing the calculation of the variables relevant for the programme. In this context, a focused data exchange of individual BSI data across NCBs concerned allowed the validation of the TLTRO reporting of cross-border TLTRO groups.

6. Conclusions

The financial crisis gave rise to an unprecedented market fragmentation which impaired the smooth functioning of the monetary policy transmission mechanism. Policy makers have responded by introducing a broad range of new monetary policy instruments whose design and implementation has required the development of more complex analyses going beyond traditional aggregated datasets.

The statistics function of the Eurosystem was, thus, required to meet new resource-intensive demands under high time pressure. Value for analysis of the data has further much increased.

These demands have translated into significant operational challenges, which in turn also allowed strengthening statistical processes. For instance, the richness of the AnaCredit dataset may in the near future allow rethinking the way aggregated statistics are compiled and collected from reporting agents and, going forward, could possibly lead to a decrease in data requirements in the context of BSI and MIR statistics. In addition, the interaction and cooperation among business areas has become much closer than before, enhancing the awareness of statistical producers on the use of their datasets and, ultimately, the scope of their efforts.

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Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

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Unconventional monetary policy – is there a call for unconventional statistics?[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Unconventional monetary policy – is there a call for unconventional statistics? [1]

Filipa Lima and Sónia Mota

Central banks across the world have been progressively adopting "unconventional" monetary policy measures which include, among others, zero or negative reference rates and expanded assets purchase programmes, aimed at pursuing price stability, easing the funding conditions for households and firms and ultimately promoting economic growth. In order to monitor the impacts from these measures it is essential the provision of good quality and timely statistics. In light of the current international statistical data requirements, namely in terms of the banks' balance-sheets and interest rates, financial accounts and public debt data, we will assess if these "conventional" statistics are fit for that purpose.

Keywords: unconventional monetary policy; central-bank balance sheet; credit aggregates; public debt.

JEL classification: E52; E58; G21; H63

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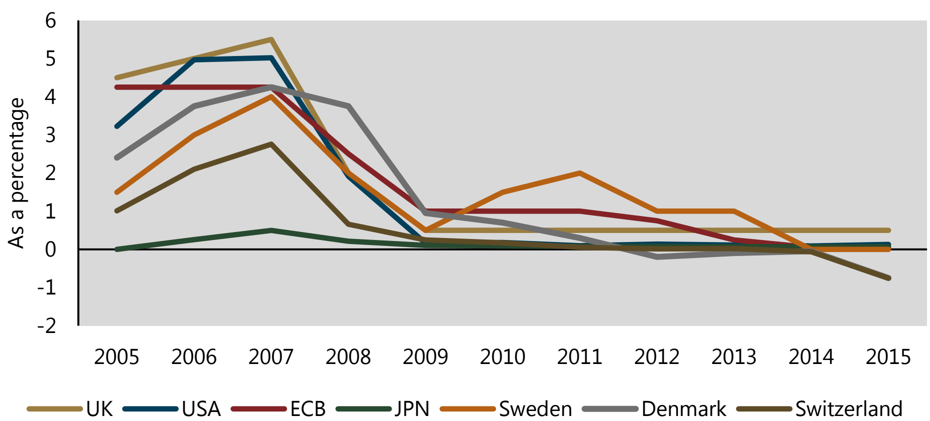
1 The opinions expressed here are those of the authors and not necessarily those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors. The authors are thankful to the comments and suggestions provided by André Dias, Lígia Nunes and Sérgio Branco.

Contents

1. Introduction

Central banks conduct monetary policy to achieve the goals they are mandated to by means of an attempt to influence broad financial and macroeconomic conditions. One of the most traditional ways to do this is through the injection of reserves into the banking system according to the banks' demand in order to indirectly steer the interbank interest rate. Throughout the financial crisis that started in 2007-2008 this traditional tool proved to be insufficient to provide additional monetary policy accommodation in light of the combined effect of: i) liquidity shortages and market impairments, resulting from elevated liquidity and credit risk premia, which impeded the transmission of the intended monetary policy stance; and ii) a further easing of the stance was needed at times when short-term nominal interest rates were at their effective lower bound. Reference interest rates declined sharply from 2007-2008, becoming progressively very close to zero or even negative; indeed, at the end of 2015, reference interest rates in Switzerland and Denmark were negative (Graph 1).

Graph 1 | *Reference interest rates*



Source: European Central Bank; Bank of England; Board of Governors of the Federal Reserve System; Bank of Japan; Riksbank; Danmarks Nationalbank; Swiss National Bank and Swiss Exchange.

Central banks around the world moved thus beyond their traditional operating framework to make use of their balance sheets as a monetary policy tool. According to the ECB (2015), faced with the strains and risks of the financial crisis, central banks began using their balance sheets taking one or more of the following actions:

- increasing liquidity provision to their banking systems elastically, i.e. accommodating banks' increased demand for liquidity, and modifying the modalities of liquidity provision to give funding reassurance, in some cases by also providing term lending;
- launching direct lending operations for the non-bank private sector or purchasing private sector assets;
- starting to purchase medium and long-dated public sector securities, or securities guaranteed by governments, on a large scale;
- offering explicit verbal guidance on the evolution of policy in the future, including indications about the future use of the central bank balance sheet if specific developments materialise.

As the ECB (2015) puts it, the provision of term funding combines liquidity support and credit easing. The idea is that by lowering banks' funding costs and credit spreads it will translate into looser financing conditions for final borrowers in the economy. This is also often referred to as quantitative easing (QE).

Accommodating the banking system's increased demand for liquidity and providing term funding will result in a larger central bank balance sheet. In the case of central bank interventions targeted at credit easing, it is the composition of the balance sheet's asset side that is of primary importance, in the sense that the assets on the balance sheet reflect the monetary authority's intention to ease conditions in specific markets. To do so, the monetary authority makes more active use of its balance sheet to improve upon or substitute for private financial intermediation, as well as to enable or enhance the transmission of the intended degree of accommodation. Credit easing measures are targeted at market segments that are closely linked to private non-financial sector borrowing conditions. This link may be direct – for example in the case of interventions that ease conditions in commercial paper markets – or indirect, where the central bank's action influences market prices of assets that, in turn, affect the price applied to the underlying credit – as in the case of interventions in markets for products securitised on loans to households or companies. The measures taken by the central bank will depend on the specific characteristics of the impairment and the idiosyncrasies of the markets targeted, as well as more broadly on the financial structure of the economy and the set of tools available to the central bank.

In the words of Ms. Sabine Lautenschläger, Member of the Executive Board of the ECB and Vice-Chair of the Supervisory Board of the Single Supervisory Mechanism, at the Eighth ECB Statistics Conference, Frankfurt am Main, 5 July 2016, "conducting this kind of unconventional monetary policy is rather difficult when decisions have to be taken on the basis of conventional data, i.e. traditional aggregate statistics. Mitigating systemic risk in very turbulent times on that same basis is equally difficult." She added that "(…) even when policy decisions are taken on the basis of aggregate statistics, as is usually the case, moving towards granular data offers the big advantage of timeliness and flexibility: raw information can be organised and aggregated in different ways depending on the specific policy question at hand."

There is thus a call from monetary policy makers for unconventional data, which is not aggregate but granular, i.e., micro data. In fact, on the same occasion, Mr. Yannis Stournaras, Governor of the Bank of Greece, argued that "micro data firstly improve our understanding of the transmission mechanism of monetary policy and secondly allow us to better understand the aggregate data and thus better forecast their evolution." and that "having a richer set of granular data can help internalize the impact of monetary policy actions on wealth distribution and ultimately lead to a more precise modelling of the transmission mechanism."

In this paper, we start by looking at the evolution of central banks' balance sheets, using information available on the Bank of Japan, Bank of England, the Federal Reserve of the United States (Fed), the Eurosystem and Banco de Portugal. We will complement this analysis with statistical data concerning: new business interest rates, corresponding credit amounts and credit growth rates granted to households and non-financial corporations. Additionally, we will use financial accounts and public debt data, in order to assess the impact of these QE measures on the public debt holder structure. The case of Banco de Portugal will serve to illustrate the multiple uses of micro data given the variety of databases managed by the Statistics Department as documented by Drumond and Lima (2016).

2. Unconventional monetary policy around the globe

Japan was a front-runner of unconventional monetary policy actions, embarking on a policy of quantitative easing in 2001, nowadays followed by major industrialized countries to tackle the recessionary turbulence after the recent global financial crisis (Kimura and Nakajima, 2013). Japan adopted quantitative easing measures in March 2001, in order to control deflation (Shirakawa, 2002). The central bank set the reference interest rate close to zero and increased liquidity in the financial system, purchasing government bonds and asset-backed securities (Pelin Berkmen, 2012), aiming at encouraging the banks to grant loans to the private sector.

In the United States, according to the Federal Reserve Monetary Policy Releases, there were essentially three unconventional monetary policy programmes: the first, which started in November 2008, was the purchase of agency debt, agency mortgage-backed securities and long-term Treasury securities; the second consisted in additional purchases of long-term Treasury bonds (November 2010, as announcement date) and the third comprised a purchasing programme of agency mortgage-backed securities and long-term Treasury securities (September 2012, as announcement date) (Rosengren, 2015). Similarly, these measures have been taken while interest rates were kept close to zero. When the economy showed signs of improvement the Fed decided to decelerate the quantitative easing programmes, in terms of purchasing assets, while maintaining low interest rates. At its December 2015 meeting, the Federal Open Market Committee (FOMC), the Federal Reserve's monetary policy committee, raised its target range for the federal funds rate by 25 basis points, marking the end of an extraordinary seven-year period during which the federal funds target range was held near zero to support the recovery of the U.S. economy from the worst financial crisis and recession since the Great Depression.

In the United Kingdom, the Bank of England decided, in March 2009, to lower interest rates to levels close to 0.5% in order to stimulate the economy. Since this reduction did not have the desired results, it was further created an asset purchase programme, specifically of public debt securities. Through this programme, the Bank of England succeeded in reducing the yields on government bonds and encouraged investment by investors to whom the central bank had acquired the securities (Joyce et al., 2011).

In the case of the European Central Bank (ECB) and the Eurosystem, three types of unconventional monetary policies have been carried out: LTRO (longer-term refinancing operations), TLTRO (longer-term refinancing operations targeted) and APP (Asset Purchase Programme). The APP includes the following programmes: Covered Bond Purchase Programme (CBPP – securitized bonds of mortgage loans and of the public sector), Asset-Backed Securities Purchase Programme (ABSPP – securitized bonds of loans granted to non-financial corporations), Public Sector Purchase Programme (PSPP for bonds issued by governments and international or supranational institutions located in the euro area) and, introduced in June 2016, the corporate sector purchase programme (CSPP). This programme aims at consolidating the pass-through effects of asset purchases to the real economy. In March 2016, before pursuing this new programme, the ECB announced a new series of targeted long-term refinancing operations (TLRO II). The ECB decided to keep these programmes with progressive reductions in interest rates, cutting the benchmark interest rate to a new record in 2016, namely, to levels close to or at zero.

Monetary policies known as LTROs and TLTRO are open market operations, in which the ECB lends money to banks, requiring assets as collateral. The aim is to encourage banks to facilitate lending to the private sector. According to DeMertzis and Wolff (2016), on a study on the effectiveness of the ECB's asset purchase programme, the LTRO programmes have been successful, while the TLTRO programme did not have the expected success, constraining the ECB to adopt new quantitative easing programmes in particular the APP. Since the creation of the APP, national central banks of the euro area and the ECB significantly increased the weight of public debt on their balance sheets (see Chapter 3).

3. Evidence from statistical data

3.1 Central banks's balance sheet

Accommodating the banking system's increased demand for liquidity and providing term funding has resulted in larger central banks' balance sheet. In the case of central bank interventions targeted at easing the credit conditions, it is the composition of the balance sheet's asset side that is of primary importance, in the sense that the assets on the balance sheet reflect the monetary authority's intention to ease conditions in specific markets. In this section we analyse the evolution and the impact of these measures in the balance sheets of the selected monetary authorities involved in setting this new type of monetary policy. Graph 2 illustrates the evolution of the assets, between 2005 and 2015, for the Bank of Japan, the Fed, the Bank of England and the Eurosystem.

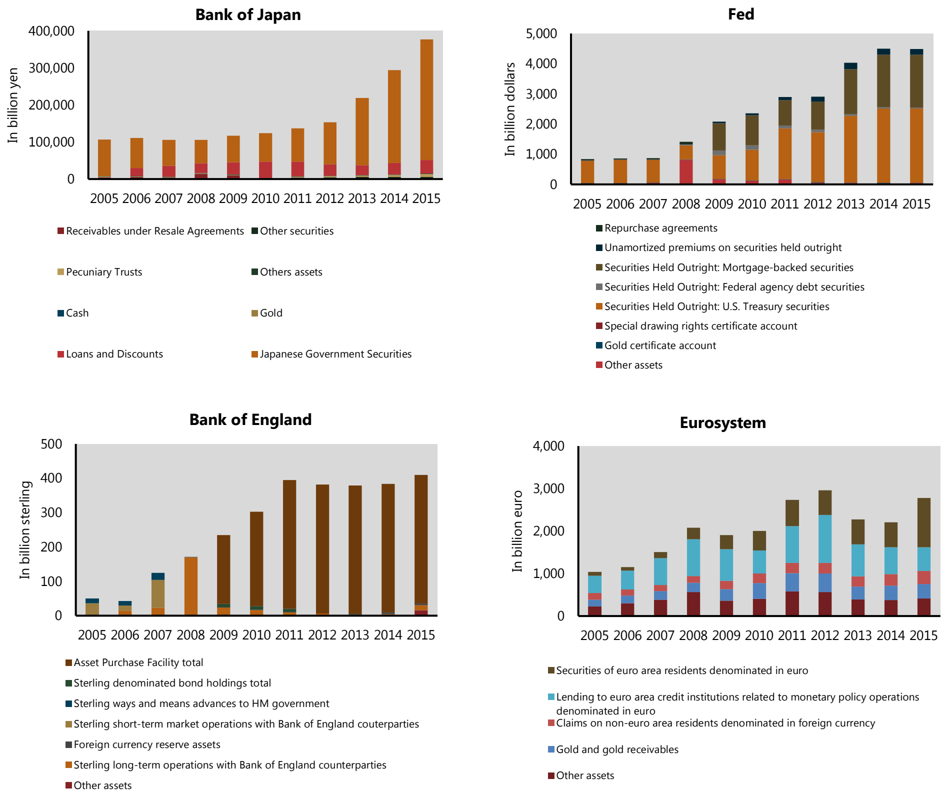
Starting with Japan, the balance sheet mirrors the massive purchases of securities issued by the Japanese government. The purchase of public debt securities reached the amount of 325 002 billion yen in 2015, which represented an increase of 361% when compared to 2007, around 75% of the Japanese GDP in 2015

In the United States, from 2009 onwards, the Fed's balance sheet reflects the effect of unconventional monetary policies measures adopted, namely the purchase of mortgage-backed securities, as well as US Treasury securities, reaching respectively 1 747 billion dollars and 2 462 billion dollars in 2015. When compared with 2009, the stock of Securities Held Outright (mortgage-backed securities) increased 92% and the purchase of US Treasury securities 217%.

For the Bank of England, it is noteworthy the impact of the Asset Purchase Facility programme starting in 2009. At the end of 2015, the amount held in the portfolio of the central bank was 375 billion pounds, representing an increase of 88% when compared to 2009[2].

2 For the purpose of the analysis, from 2009 to 2012, it was considered in the instrument "Asset Purchase Facility Total" the amount not covered by the Bank of England weekly report regarding quantitative easing.

Graph 2 | *Balance sheets – assets side*

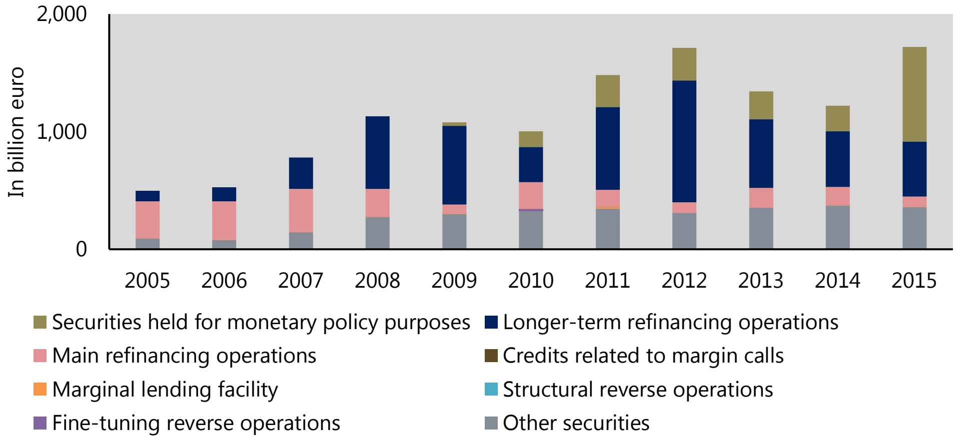


Source: European Central Bank; Board of Governors of the Federal Reserve System; Bank of Japan; Bank of England

In the case of the Eurosystem, we can observe the impact of LTRO in 2008, 2011 and 2012, also observed in graph 3, through the increase of long-term refinancing operations, which was reduced in 2013 and 2014, with the repayment made by banks.

In 2008, the component *"Lending to euro area credit institutions related to monetary policy operations denominated in euro"* amounted 860 billion euros, an increase of approximately 111% over 2005. Similarly, in 2008, it is visible the purchase of euro-denominated covered bonds under the Covered Bond Purchase Programme by the ECB, which contributed to an increase of 179 billion euros in *"Securities of euro area residents denominated in euro"* compared to 2005. In 2014, the ECB undertook additional policy measures, namely the TLRO and a new purchase programme of covered bond and asset-backed securities purchase programme. However, the impact on the balance sheet of the Eurosystem was not significant as shown in Graph 2. In 2015, the ECB's balance sheet increased significantly again, as a result of the new debt purchase programme, which further raised the item *"Securities of euro area residents denominated in euro"*, which includes government bonds purchased under the PSPP, by 571 billion euros from 2014 to 2015. Graph 3 details the monetary policy operations denominated in euro carried by the Eurosystem by type.

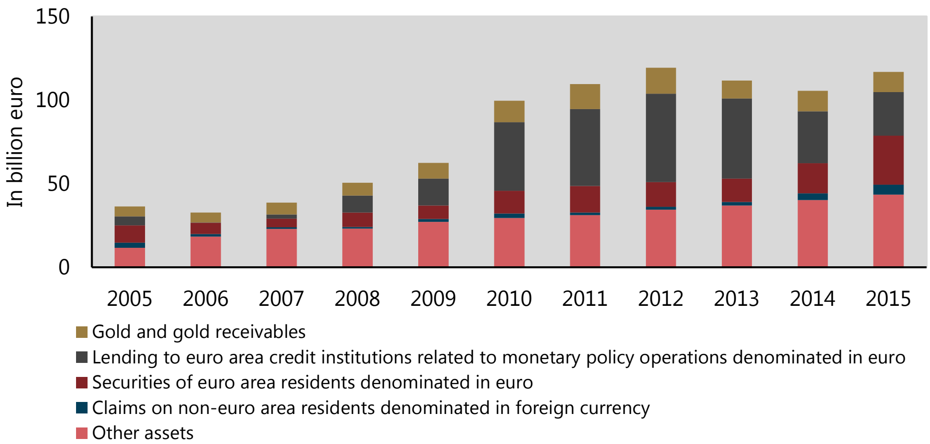
Graph 3 | *Monetary policy operations denominated in euro – Eurosystem*



Source: European Central Bank

In the case of Banco de Portugal, it is noteworthy the trend observed since 2009, with a sharp increase in component *"Lending to euro area credit Institutions related to monetary policy operations denominated in euro"* (Graph 4). In 2015, it is worth noting the increase in *"Securities of euro area residents denominated in euro"* held by Banco de Portugal compared with 2005 (182%), which was strongly influenced by the purchase of government bonds under the PSPP.

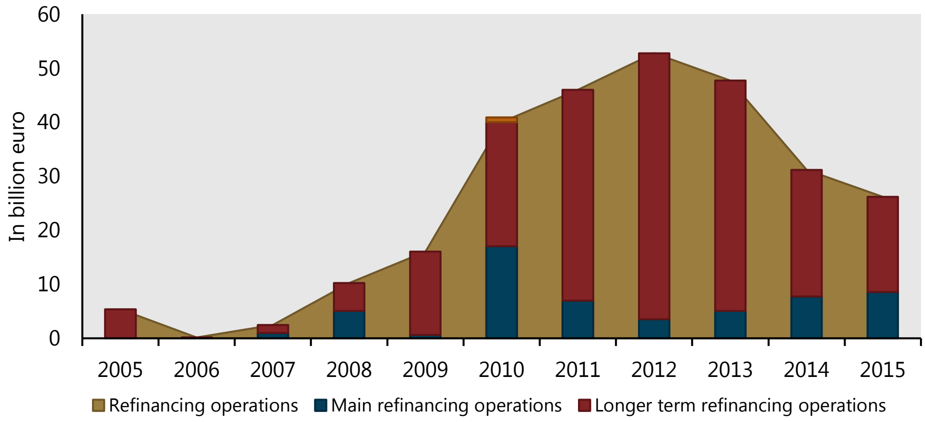
Graph 4 | *Banco de Portugal – assets side*



Source: Banco de Portugal

Graph 5 details the refinancing operations carried by Banco de Portugal by type, where it can be observed the predominance of long-term refinancing operations.

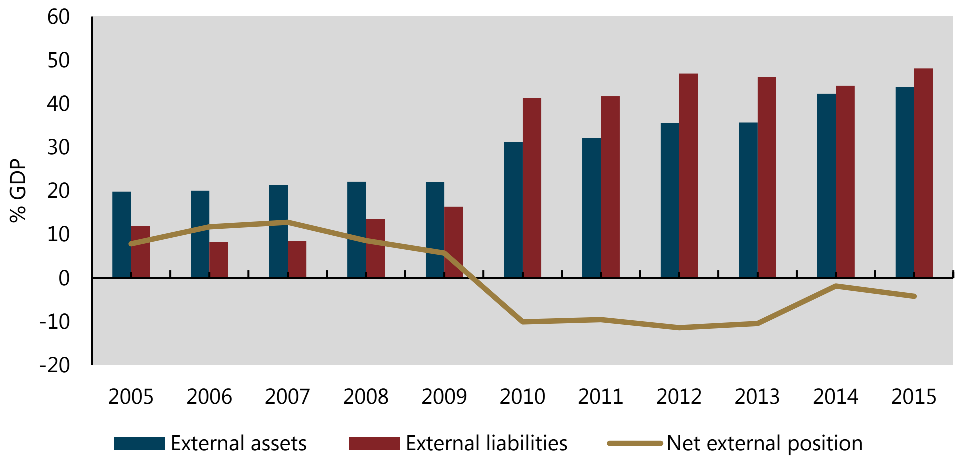
Graph 5 | *Banco de Portugal – refinancing operations*



Source: Banco de Portugal

The monetary policy operations conducted by Banco de Portugal in the context of the Eurosystem also had a significant impact in terms of the Bank's net external position, as measured in the framework of external statistics and the international investment position data. As Branco *et al.* (2015) illustrate, until 2009, Banco de Portugal exhibited a positive net external position; from 2010 onwards the net external position is negative (Graph 6). Nonetheless, it is possible to identify two distinct phases: first, 2010-2012, where the growth of external liabilities is not accompanied by an increase in the external assets at the same pace, thus leading to a deterioration of the net external position; and second, 2013-2014, where we can observe a decrease of external liabilities, thus contributing to an improvement of the net external position, reaching towards the end-2014 a relatively balanced record, which, in 2015, deteriorated a bit further.

Graph 6 | *Banco de Portugal – net external position*

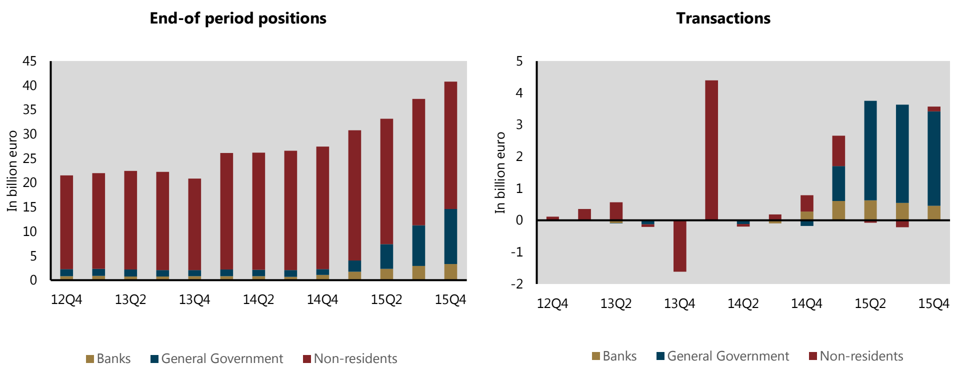


Source: Banco de Portugal

This evolution reflects the role of the central bank as an intermediary in the Eurosystem in financing resident banks – which is recorded as a liability of Banco de Portugal against the Eurosystem and as an asset against the resident banks. In fact, according to the Banco de Portugal's Annual Reports (2010-2013), "*In 2010 there was an increase in positions relating to monetary policy operations. This reflects the current market situation, which is marked by a continued increase in the demand for liquidity in the money market. In a context of financial market instability, liquidity management by Portuguese credit institutions, like in other countries, continued to be translated into* *high primary liquidity demand throughout the whole year, evidenced by a sharp rise in the relative value of the main refinancing operations and longer-term refinancing operations. The increase in claims related to monetary policy operations during the review period also reflects a rise in the portfolio of securities held for monetary policy purposes. The growth of claims related to monetary policy operations causes a very sharp rise in the Bank's intra-Eurosystem liabilities."* As for 2013, "*The total (net) balance of monetary policy operations, carried out within the framework of the Eurosystem, recorded a significant reduction in 2013 compared with 2012 (€-5 956 million), reversing the growth trend seen in the past few years. The significant decline in the amount outstanding of these operations was chiefly due to the decrease in the provision of liquidity to domestic credit institutions (€-4 920 million) in the context of the deleveraging process of their balance sheets.*"

As mentioned earlier, from the analysis of Graph 4 it is noteworthy an increase of debt securities held by Banco de Portugal in 2015. Graph 7 illustrates that this resulted from the purchase of domestic government bonds. These securities were acquired under the Eurosystem's PSPP. These data is available from the financial accounts dataset, with counterpart data published by Banco de Portugal since April 2016, from 13Q4 onwards (see also section 3.3). It remains to be seen the impact stemming from the CSPP launched in June 2016.

Graph 7 | *Debt securities held by the Banco de Portugal by counterpart sector*



Source: Banco de Portugal

3.2 Interest rates and credit growth

In a context of historically low interest rates and monetary policy measures aiming at promoting credit easing, statistical data on banking interest rates and credit developments are key to assess the impact of such measures. With aggregate data alone, policy makers miss lots of valuable information, namely the underlying distribution "hidden" behind the simple average.

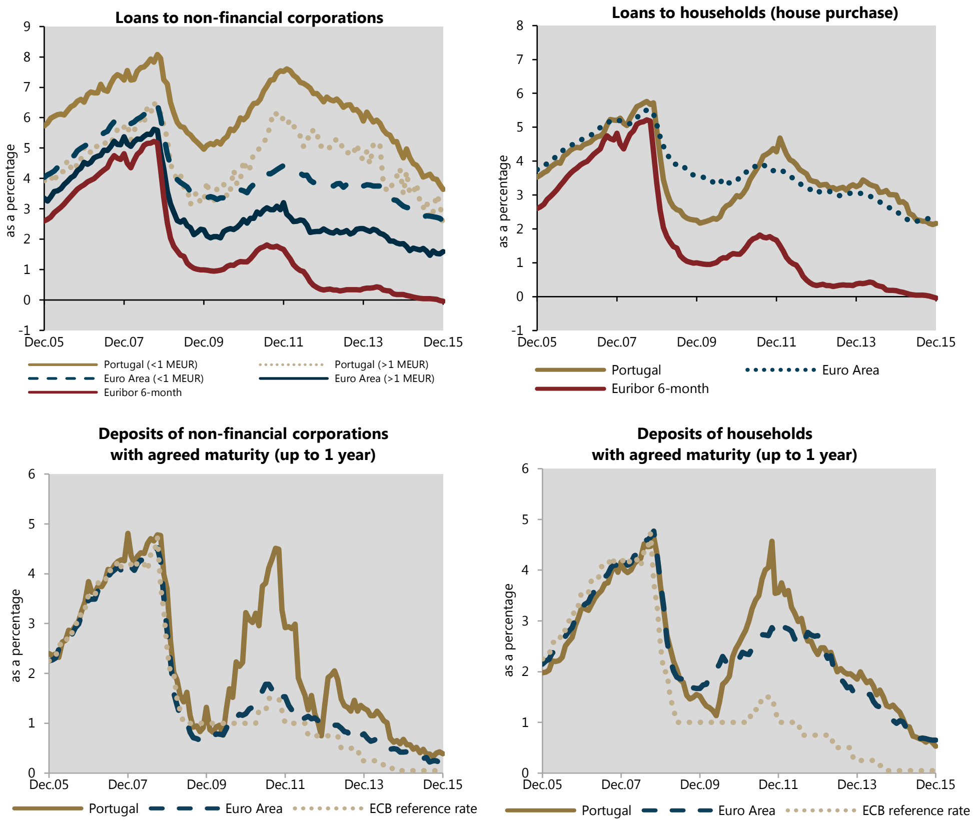
In this section, we use "MFI interest rate statistics" that cover all interest rates that monetary financial institutions (MFIs) resident in the euro area – except central banks and money market funds – apply to euro-denominated deposits from and loans to households and non-financial corporations resident in the euro area, both for new business and outstanding amounts[3].

3 The legal requirements for MFI interest rate statistics were originally laid down in Regulation ECB/2001/18, which was recast by Regulation ECB/2013/34 (amended by Regulation ECB/2014/30). MFI interest rate statistics refer to interest rates individually agreed between a bank and its customer and are converted to an annual basis taking into account the frequency of interest payments, while being quoted

In the case of Portugal, the cost of loans to households has slightly decreased since 2012. At the end of 2015, interest rates (house purchase) were below the levels of the euro area. Similarly, since 2012, the cost of loans to non-financial corporations (NFCs) has been gradually decreasing (Graph 8). In December 2015, interest rates on new loans to NFCs were the lowest since the start of the data collection. In turn, spreads implied in these rates, using the six-month Euribor as the reference rate, stood at levels close to those of the period immediately before the sovereign debt crisis, but above those prevailing until 2008.

The decline in interest rates on new loans mainly reflects the monetary policy pursued by the ECB. In addition, the spread between average interest rates on new loans to NFCs in Portugal and the euro area has narrowed, although it remains considerably above the levels seen before 2008 (Graph 8). This convergence reflects, at least partly, decreased constraints on corporate financing – which had been the result of tighter policies on the supply of bank loans during the crisis period – and a gradual improvement in economic activity, contributing to a higher credit quality for firms (Banco de Portugal, 2016).

Graph 8 | *Banking interest rates – Loans and deposits (new business) – Portugal*



Source: Banco de Portugal and European Central Bank

Following a data request in the context of the Economic and Financial Assistance Programme to Portugal and, to better assess current credit conditions of the non-

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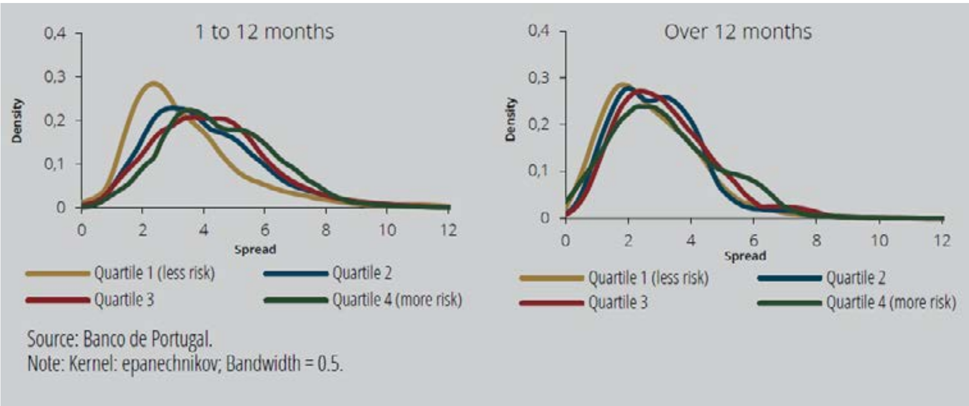
in percentages per annum. New business is defined as any new agreement between a household or non-financial corporation and the bank. These comprise all financial contracts in which the terms and conditions of the interest rate on the deposit or loan are specified for the first time, and all new negotiations of existing deposits and loans. Prolongations of existing deposit and loan contracts which are carried out automatically, i.e. without any active involvement of the household or non-financial corporation, and which do not involve any renegotiating of the terms and conditions of the contract, including the interest rate, are not considered as new business.

financial corporations and monetary policy transmission, Banco de Portugal started collecting individual data on new bank loans and respective interest rates. This database covers all new operations starting with reference period December 2014 (in its initial stage it was limited to banks with volumes of €50 million or higher). Combining these individual data with reference data and data available in other databases, we are able to study how interest rates vary according to the characteristics of the firms. In this respect, one of the main determinants of the interest rate applied to each firm is the credit risk associated to it. In fact, Banco de Portugal has recently taken decisive steps towards further exploring the informational potential of its own Central Credit Register (CCR) and balance sheet databases in an ongoing project that aims at creating an in-house credit assessment system, thus attributing a credit notation to each firm (Neves, 2014).

The relation between risk and interest rates on new loans to non-financial corporations was analysed in the latest Financial Stability Report, published by Banco de Portugal in May 2016. In order to assess the relationship between the level of risk of NFCs and the spreads on new loans, NFCs were divided into four classes according to their risk of default. From this breakdown, by comparing the distribution of spreads on new loans by risk class for the 2013-15 period, it was possible to assess the differentiation of rates between levels of risk. The analysis concludes that in 2015, the highest rates were generally associated with higher-risk firms (Graph 9).

Graph 9 | *Average spreads on new bank loans to NFCs – Loans by maturity and risk quartile in 2015 – Portugal*

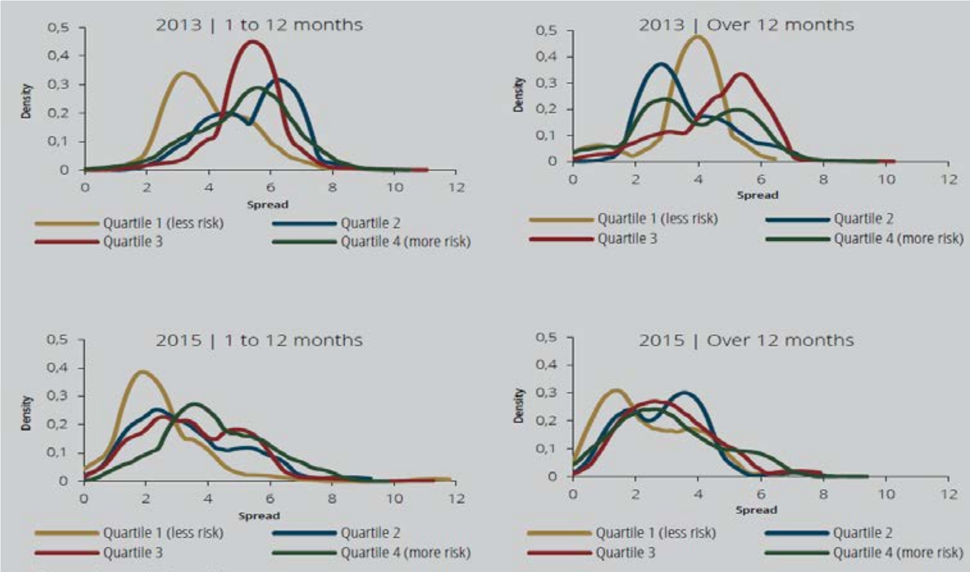


Source: Banco de Portugal, Financial Stability Report, May 2016

The degree of differentiation seems smaller for longer maturities. Additionally, recent data point to a decline in interest rates on new loans for NFCs with both low and high credit risk, as suggested by the shift to the left of interest rate distributions.

Graph 10 illustrates that for new loans of over €1 million, the differentiation between risk classes in 2015 was greater than in 2013. This effect is particularly relevant in loans with longer maturities, where the apparent absence of differentiation in 2013 is in contrast with the risk differentiation observed in 2015.

Graph 10 | *Average spreads on new bank loans to non-financial corporations – loans of over 1 million euro by maturity and quartile in 2013 and 2015 – Portugal*



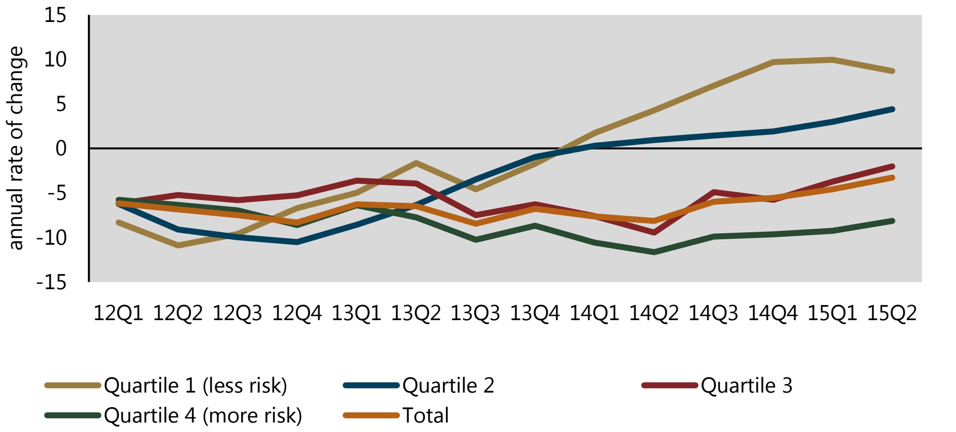
Source: Banco de Portugal.
Note: Kernel: epanechnikov; Bandwidth = 0.5.

Source: Banco de Portugal, Financial Stability Report, May 2016

Given that underlying the definition of quartiles is a credit risk assessment that already takes into account enterprise size, large enterprises alone do not justify the pattern observed. An analysis of loans of up to €1 million shows an apparent risk differentiation in 2013 and 2015, but also a gradual blurring of the distinction between quartiles with lower risk, which corroborates the indicators that have more recently pointed to greater competition by medium-risk firms. Summing up, evidence points to the existence of a differentiation in risk premia on new loans to NFCs. Risk differentiation is more noticeable in loans with a maturity of up to one year, particularly those of over €1 million.

Turning the attention to annual growth rates for loans (in terms of end-of period positions), Drumond and Lima (2016) conclude that, on aggregate, Portuguese banks are granting credit mostly to less risky firms (see Graph 11), suggesting that the overall reduction in the credit supply, confirmed by the negative year-on-year growth rates for NFCs as a whole, may have been part of a “flight to quality” in lending. Ferrando et al. (2015), on an investigation of the effect of sovereign stress and of unconventional monetary policy on small firms’ financing patterns during the euro area debt crisis, found that after the crisis started, firms in stressed countries were more likely to be credit rationed, both in the quantity and in the price dimension, and to increase their use of debt securities. However, unlike the evidence suggested from Portuguese data, the authors concluded that more transparent and creditworthy firms in the euro are experienced a relatively larger decline in credit access, suggesting that the overall reduction in the credit supply was not part of a “flight to quality” in lending.

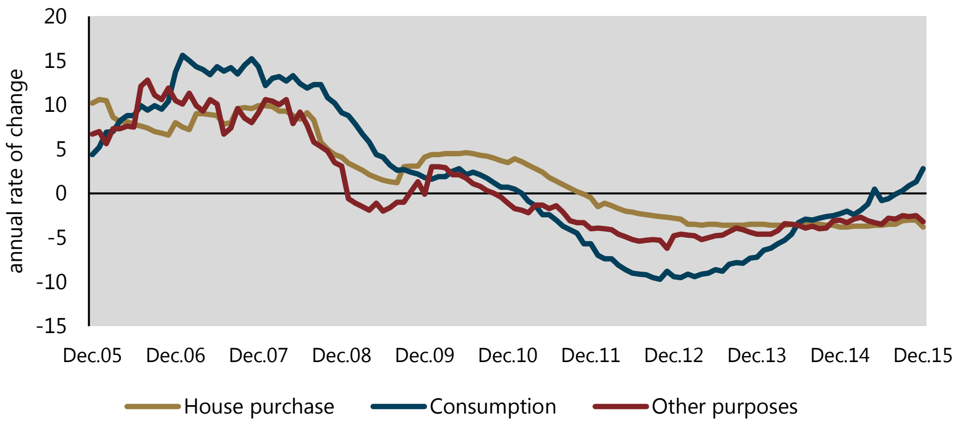
Graph 11 | *Loans to NFCs by risk category – Portugal*



Source: Banco de Portugal

Also in the case of households, micro data can be of use in order to better understand the driving forces behind the aggregates. Graph 12 shows the growth rate of loans to households; after several years of negative growth across all purposes, it is noticeable that consumption loans are picking up at a relatively steady pace, exhibiting already a positive annual rate of change, while housing loans are still decreasing. In this respect, we could consider an additional breakdown of the data presented, according, for example, to the main characteristics of the borrowers: age, education, occupation, source of income, indebtedness, wealth, etc. So far, this data is not available at Banco de Portugal.

Graph 12 | *Bank loans to private individuals by purpose – Portugal*



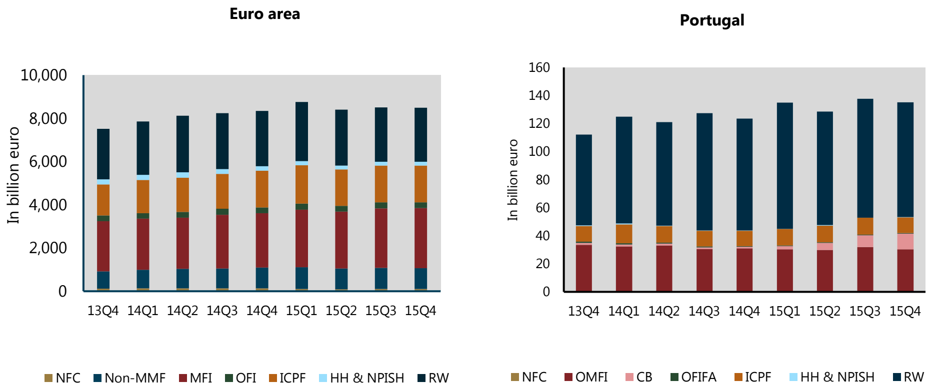
Source: Banco de Portugal

Complementarily, Household Survey Data can also be relevant to better understand the impact of unconventional monetary policies on income distribution. Frost and Saiki (2014) find evidence that, in the case of Japan, the impact of the portfolio channel of unconventional policies have increased income inequality. According to the authors the mechanism is straightforward: an increase to the monetary base (through purchases of both safe and risky assets) tends to increase overall asset prices, which will benefit primarily upper incomes, who hold a larger amount and share of overall savings in equities, and thus benefit from greater capital income.

3.3 Public debt holder structure

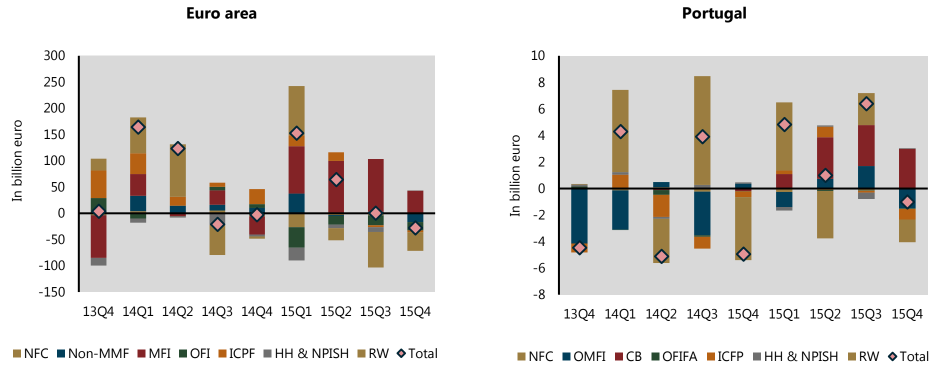
Following the introduction of public sector purchase programmes, central banks emerge as key investors in government debt. The availability of detailed statistical data, not only from the perspective of the assets of the central bank, but also from the perspective of the liabilities of the general government – the so-called from-whom-to-whom approach – becomes thus extremely relevant.

Graph 13 | *Debt securities issued by general government, breakdown by holder (end-of period positions)*



Source: Banco de Portugal and European Central Bank

Graph 14 | *Debt securities issued by general government, breakdown by holder (transactions)*



Legend: NFC - Non financial corporations; MFI - Monetary financial institutions; CB – Central Bank; Non-MMF - Non MMF investment funds; OFI - Other financial institutions (Financial corporations other than MFIs, insurance corporations, pension funds and non MMFs investment fund); OFIFA - Other financial institutions (Financial corporations other than MFIs, insurance corporations and pension funds); ICPF - Insurance corporations and Pension Funds; HH & NPISH - Households and non-profit institutions serving households; RW – Rest of the World.

Source: Banco de Portugal and European Central Bank

In Graphs 13 and 14 we use data available in the framework of the quarterly financial accounts, Guideline (EU) 2016/66 of the ECB of 26 November 2015 amending Guideline ECB/2013/24 on the statistical reporting requirements of the ECB in the field of quarterly financial accounts (ECB/2015/40). Starting with data from end-2013 onwards, it is possible to breakdown of debt securities issued by the general government according to the ESA2010 sector classification of the holder. However, given that the banking sector is considered as a whole, it is not possible, in the context of the current guideline, to separate the holdings of the central bank from those of the other banks. Nevertheless, this detail is currently published by Banco de Portugal. In addition, for holdings by the non-resident sector, it is not possible to identify the share held by other central banks. Possibly, this is a limitation that can be overcome in the context of the Securities Holdings Statistics Database, a European System of

Central Banks (ESCB)-wide project with the objective of collecting security-by-security holdings by institutional sectors of euro area/EU reporting countries for both direct holdings and indirect holdings (third party holdings).

This type of data will also be instrumental to assess the impact of the CSPP launched in June 2016 by the ECB.

4. Concluding remarks

In the aftermath of the financial crisis that started in 2007-2008, central banks around the world moved beyond their traditional operating framework to make use of their balance sheets as a monetary policy tool. The quantitative easing transmission channels are very diverse: confidence, policy signalling, portfolio rebalancing, market liquidity and money/lending (Joyce et al., 2011).

In order to thoroughly understand these transmission mechanisms and better define the monetary policy measures, there is thus a call from monetary policy makers for unconventional data, which is not aggregate but granular, i.e., micro data. As highlighted by a Member of the Executive Board of the ECB, "conducting this kind of unconventional monetary policy is rather difficult when decisions have to be taken on the basis of conventional data, i.e. traditional aggregate statistics.".

Furthermore, the degree of interconnection and integration of the economies and the markets worldwide calls for the extension of such initiatives at the international level. In this respect, the following cases are worth mentioning:

1. The Analytical Credit Dataset (AnaCredit). Efforts of conceptual harmonisation and convergence across the EU have already started regarding the CCRs. In order to get a better overview of the level of indebtedness of the borrowers in an environment of increasing financial integration across European Union Member-States, the overarching aim of this ESCB project is the setting up of a long-term framework for the collection of harmonised granular credit data.

2. The Securities Holdings Statistics Database (SHSDB). SHSDB is an ESCB-wide project with the objective of collecting security-by-security holdings by institutional sectors of euro area/EU reporting countries for both direct holdings and indirect holdings (third party holdings).

3. The Legal Entity Identifier (LEI). LEI is a 20-character, alpha-numeric code, to uniquely identify legally distinct entities that engage in financial transactions. The LEI code is associated with reference data for each entity, currently including core identification information, such as the official name of the legal entity, the address of its headquarters and address of legal formation. As a result of joint public and private sectors efforts, the LEI supports authorities and market participants in identifying and managing financial risks.

In statistics, like in many other areas, there is the need for continuous improvement and innovation. A stepwise approach is not only wise but the most realistic to be followed.

5. References

[1] Banco de Portugal (2013), Annual Report.

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Real dollarization and monetary policy in Peru[1]

Alex Contreras, Zenón Quispe, Fernando Regalado,

Central Reserve Bank of Peru

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Real dollarization and monetary policy in Peru

Alex Contreras[1], Zenón Quispe[2] and Fernando Regalado[3]

Summary

Despite the average inflation levels of 2.8 percent between 2002 and 2015, within the range of the price stability goal, partial dollarization remains as the main vulnerability of the Peruvian economy. Although financial dollarization has already been importantly reduced, in the case of lending, from 82 percent at the end of 1990's to 29 percent in June 2016; the dollarization of transactions persists at high levels such as 58 percent imposing important challenges to monetary policy, principally in events of higher volatility of the exchange rate which passes-through to domestic inflation. In this scenario, measuring the real dollarization at the sectorial level and at the level of the structure of costs of the non-financial firms becomes crucial to understand it and to contribute to the design of the monetary policy in the presence of dollarization.

JEL classification:
C43, E52, E58, F31
Keywords:
Dollarization, financial dollarization, real dollarization
Monetary policy

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1. Introduction

Partial dollarization remains as the main vulnerability of the Peruvian economy.

During the 1970s, households were induced to store assets in the form of foreign currency due to prevailed persistent high inflation (27 percent of annual inflation on average). This phenomena was further enhanced by the hyperinflation of 1988-90 (3 850 percent of annual inflation on average). Since the third quarter of 1990 and in the following years, the reforms in the financial system and in the conduct of monetary and fiscal policies, brought a halt to the hyperinflation and stabilized the prices reaching 3.7 percent of annual inflation in 1999.

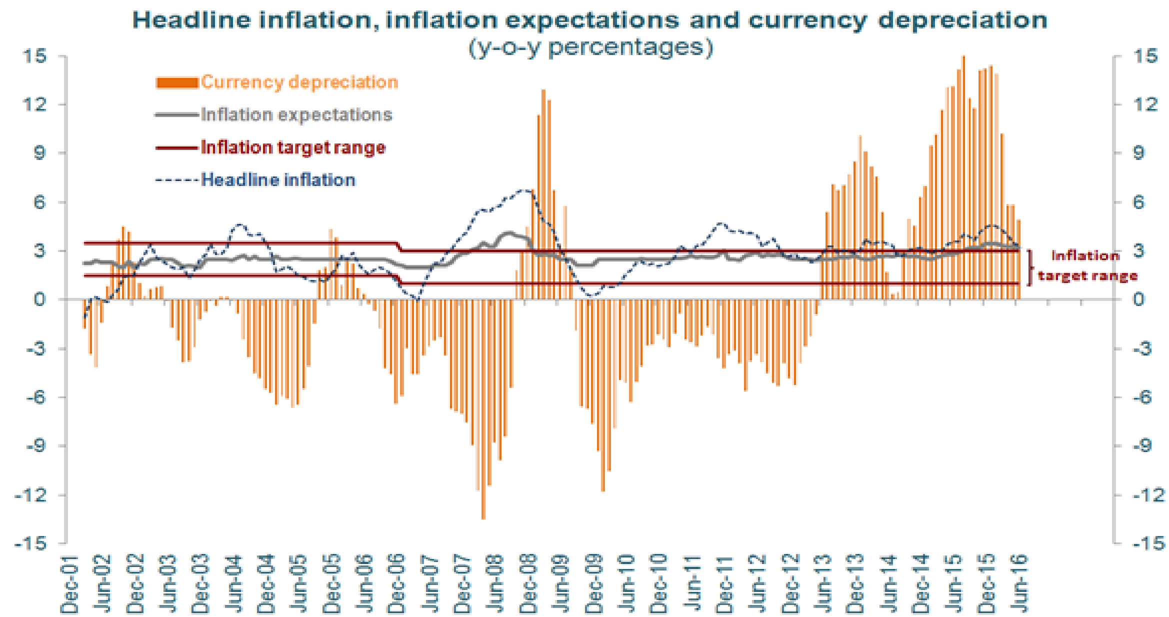
The inflation targeting regime implemented by the Central Bank since 2002 consolidated the stability of prices with an annual inflation of 2.8 percent on average between 2002 and 2015. The important reduction of inflation complemented with Central Bank de-dollarization policies reduced importantly the financial dollarization, particularly the credit, from 82 percent by the end of the 1990's to 29 percent in March 2016.

Peru was the first country in implementing a successful Inflation Targeting (IT) scheme for monetary policy in a context of partial dollarization of the economy. In 2002, when this monetary policy framework was adopted, the dollarization of deposits and loans was 67 and 77 percent, respectively. Although dollarization can create some frictions in the transmission mechanisms of the monetary policy, the evidence from Peru shows that it is possible to implement an IT regime with dollarization, complementing the regular design of monetary policy which uses the short term interest rate as its operational target, with an active use of macro-prudential tools such as reserve requirements and foreign exchange interventions, among other instruments.

However, despite the important reduction of financial dollarization (which is still high at the international standards), events in the foreign exchange market poses challenges to monetary policy through the pass-through of exchange rate to domestic prices, implying the persistence of real dollarization (dollarization of transactions: using the dollar as unit of account and medium of exchange); and may affect the formation of inflation expectations. Figure 1 shows that although the fluctuations of the inflation and inflation expectations are much more lower than those of the currency depreciation, however these dynamics signal a special character of the exchange rate pass-through.

Consequently, to better understand the implications and challenges for monetary policy, in this paper, after a brief revision of the stylized facts of financial dollarization, we address measurement issues of real dollarization: first we will identify the dollarization of transactions at a sectorial level; second we will look for the level of dollarization in the structure of costs (labor costs, financial costs, operational costs and prices of inputs), distinguishing the traded or non-traded character of the final output of the surveyed firms which will also provide us an indirect measurement of the possible balance sheet effects of changes in the exchange rate due to currency mismatches. Finally, we will discuss the challenges for monetary policy posed by real dollarization.

Headline inflation, inflation expectations and currency depreciation
(Y-o-y percentages) Figure 1

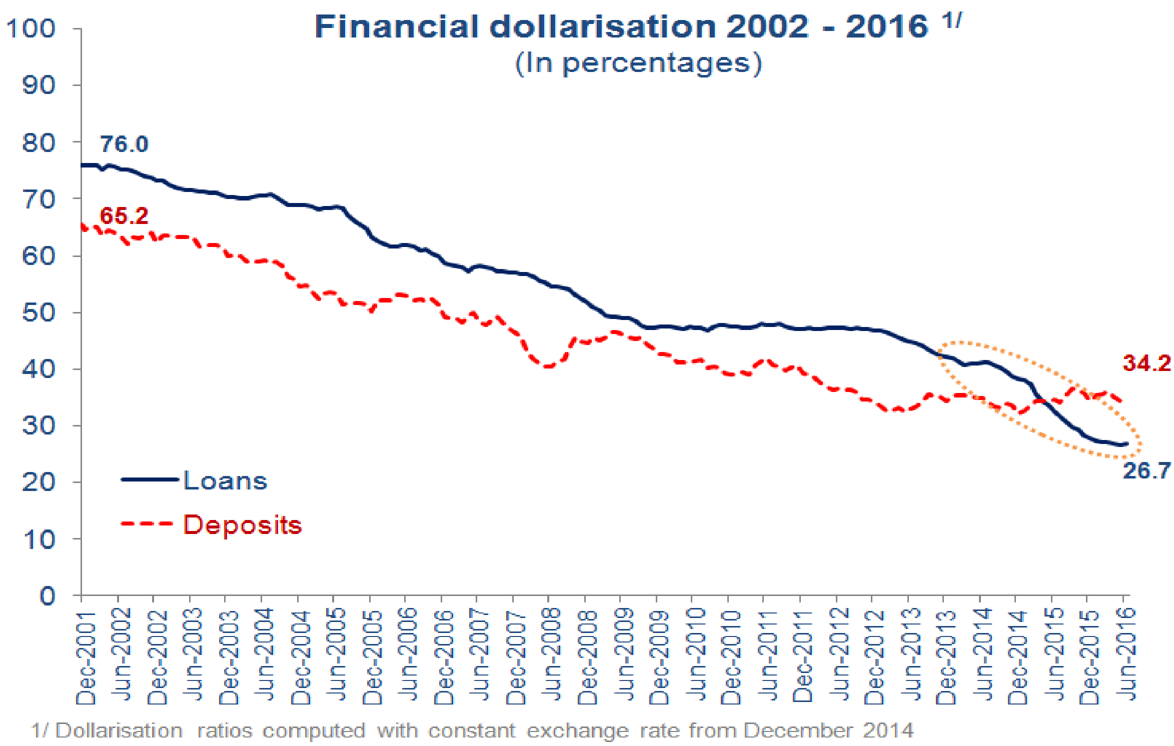


2. Stylized facts of financial dollarization

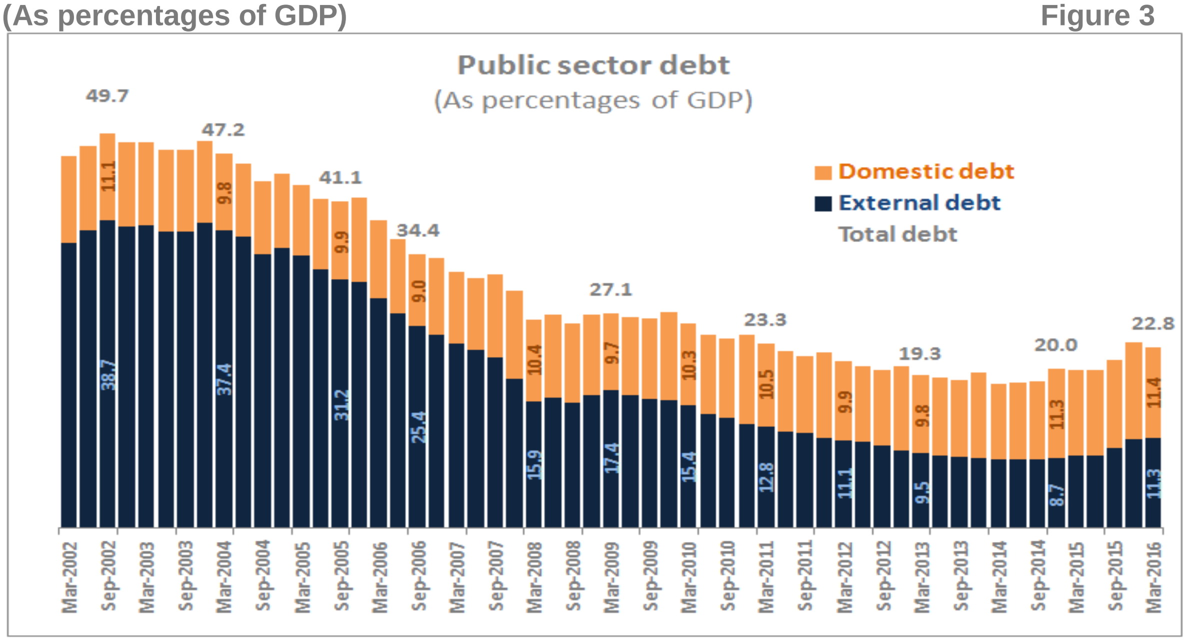
Since the implementation of the IT monetary policy framework in Peru, the financial dollarization of the economy has been importantly reduced, both in the assets and the liability sides of the balance sheet of the financial system. The loans dollarization decreased from 76.0 percent in January 2002 to 26.7 percent in June 2016, and the deposit dollarization has been reduced from 65.2 to 34.2 percent during the same period. (See figure 2).

The main drivers that contributed to the de-dollarization process include the sustained macroeconomic stability of the Peruvian economy reflected in inflation levels at the price stability range, 2.8 percent during the last 15 years (Figure 1), and a disciplined management of the fiscal accounts reflected in an important reduction of the public sector debt which averaged 29.6 percent of GDP during the same period (Figure 3). The de-dollarization process has been further enhanced by macro-prudential policies aimed to strengthen the stability of the financial system, which allowed financial institutions to internalize the currency risks. The progressive development of the capital markets with trading of assets in domestic currency also played an important role. (García Escribano, 2010).

Lending and deposit dollarization[1/]
(Percentages) **Figure 2**



Public debt
(As percentages of GDP) **Figure 3**

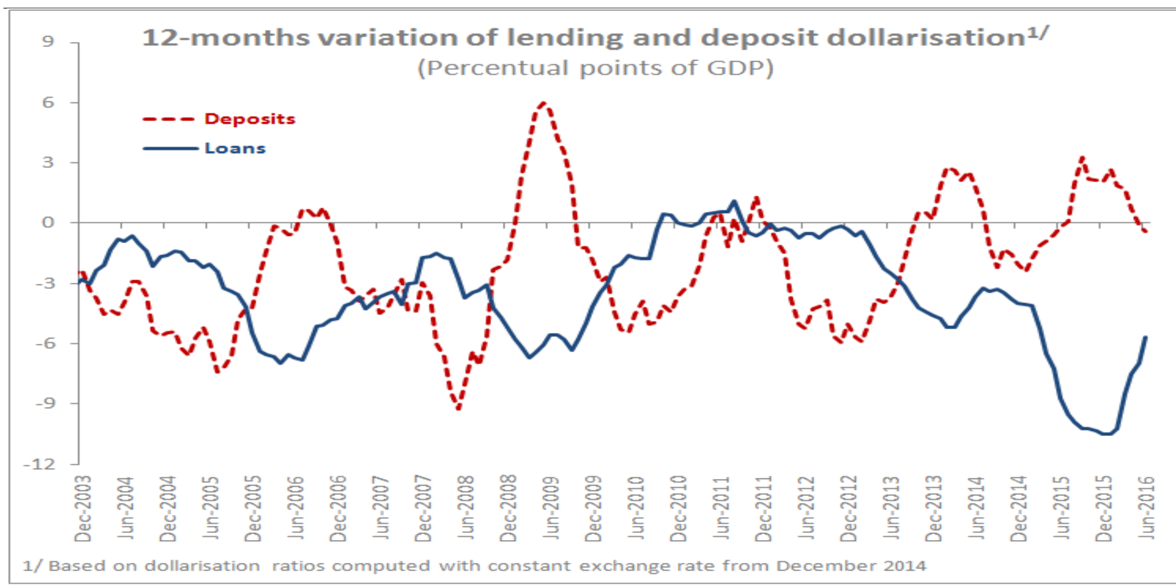


Although the financial de-dollarization process of the economy shows a clear long term downward trend of the lending and deposit dollarization ratios, reflecting the increasing confidence of economic agents in the domestic currency; however, this process has shown periods of rigidity, or upward shifts of the ratios. This behavior may reflect strong dependence on the global and domestic uncertainties faced by the financial system.

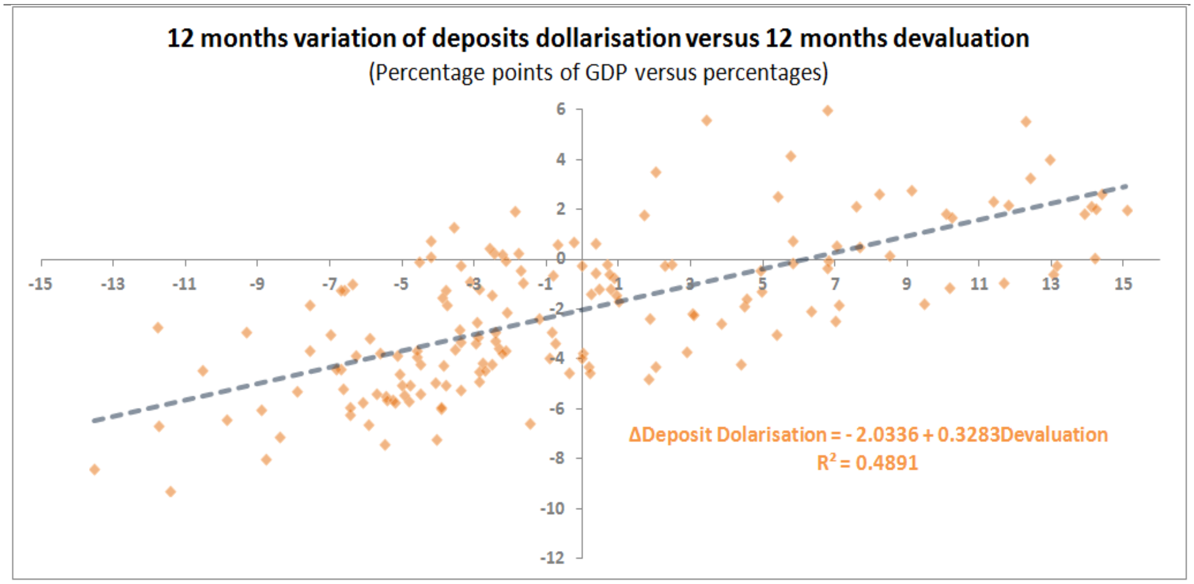
Figure 4 shows that the process of de-dollarization of loans to the private sector has been persistent over the long-term, with negative variations between December 2003 and June 2016, with the exception of one episode during the period October 2010 to September 2011, in contrast to the process followed by the de-dollarization of deposits which represents up to six episodes of positive variations of its dollarization ratio, with the period from February 2009 to September 2009, during the sub-prime financial crisis, as the most critical episode reaching an increase of 6 percentage points of GDP.

The evolution of the deposits dollarization ratio reflects quick adjustment in the currency composition of the assets of depositors due to changes in the financial conditions influencing its opportunity costs. A depreciation of the domestic currency induces them to increase the deposit dollarization in order to protect the value of their savings. Figure 5 reflect the depositor's behavior by increasing their deposit dollarization in response to depreciations of the domestic currency. Similarly, due to the credit risks associated to loans in foreign currency, the variations in loans dollarization is negatively correlated to the devaluation rate of the domestic currency, reflecting changes in the structure of liabilities of the economic agents in order to prevent important losses due to the exchange rate variability. (See Figure 6)

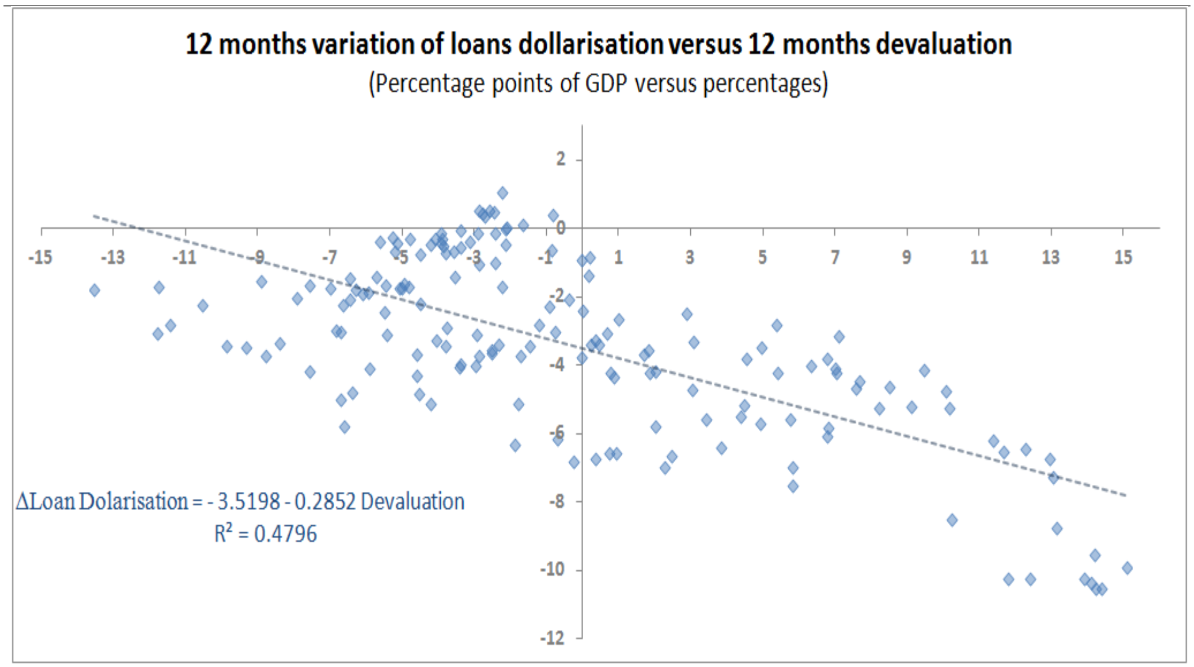
12-months variation of lending and deposit dollarization[1/]
(Percentage points of GDP) **Figure 4**



Deposit dollarization and depreciation
(12 month variations, in percentages) **Figure 5**



Lending dollarization and depreciation
(12 month variations, in percentages) **Figure 6**



The dynamics of the financial dollarization shows clear signals of persistency in the degree of dollarization. As Rossini et.al (2016), mentioned, “the high degree of dollarization inertia can be attributed to transactional costs associated to contract revisions, or due to insufficient incentives to change market practices. The dollarization literature mostly emphasizes the financial risks involved with dollar liabilities with the local banking system. However the existence of an extended practice of keeping prices in dollars generates important complications to the objective of price stability, given the greater uncertainty about the pass-through of depreciation to the inflation and the feedback loops of these variables with the inflation expectations". Consequently, measuring the real dollarization in terms of the structure of costs of the non-financial firms, classifying them according to their industrial sector will provide important insights for the design of monetary policy.

3. Measuring real dollarization

The persistency of the partial dollarization led to the Peruvian economy to adapt their transactional technologies and market practices to the coexistence of two currencies. Actually, Peru allows holdings of any form of deposits in the financial system with no restrictions to foreign currencies such as the US Dollar. The automated Teller Machines (ATMs) are adapted for cash withdrawals in Soles and Dollars, the public can easily access to the foreign exchange market in both, the formal financial system and the informal market. Most of the durable goods (such as real state, automobiles, machinery, etc.) are traded in US Dollars. Furthermore, the trade openness of the economy together with the higher trade growth are factors which may induce to dollarization.

This section presents a series of qualitative and quantitative indicators characterizing the degree of dollarization of the main components of the costs and revenues of non-financial firms. The qualitative indicators allow us to evaluate the evolution of dollarization at microeconomic level. All information included in this section results from specially added questions to the Survey of Macroeconomic Expectations of the Central Bank of Peru (SME) implemented in 2015 and 2016. In the Annex 1, we explain the characteristic of the regular SME, and the Annex 2 presents the main results of the survey for September and December 2015 and for June 2016. The following section presents the currency composition of sales contracts of the non-financial firms.

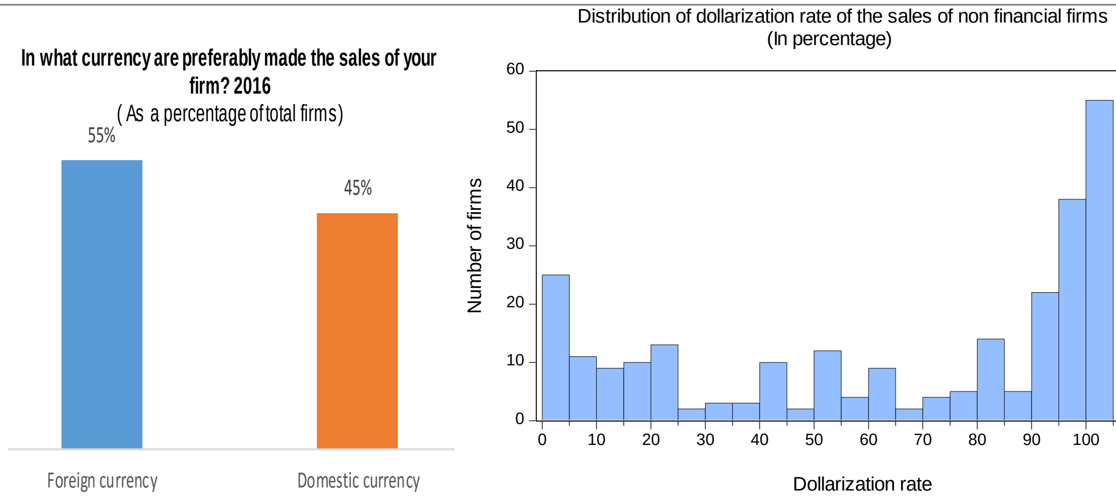
3.1. Currency composition of sales

According to the 2016 SME, 55 percent of non-financial firms base their sales contracts preferably in foreign currency and almost all of them prefer the US Dollar.

However, the distribution of the dollarization of non-financial firms according to their economic sector is asymmetric. The energy sector (including electricity, gas and water) shows the lowest level of dollarization. The services sector presents a 51 percent of dollarization. Mining and fishing, sectors whose productions are mainly oriented to exports, present a 92 percent of dollarization (Figure 8).

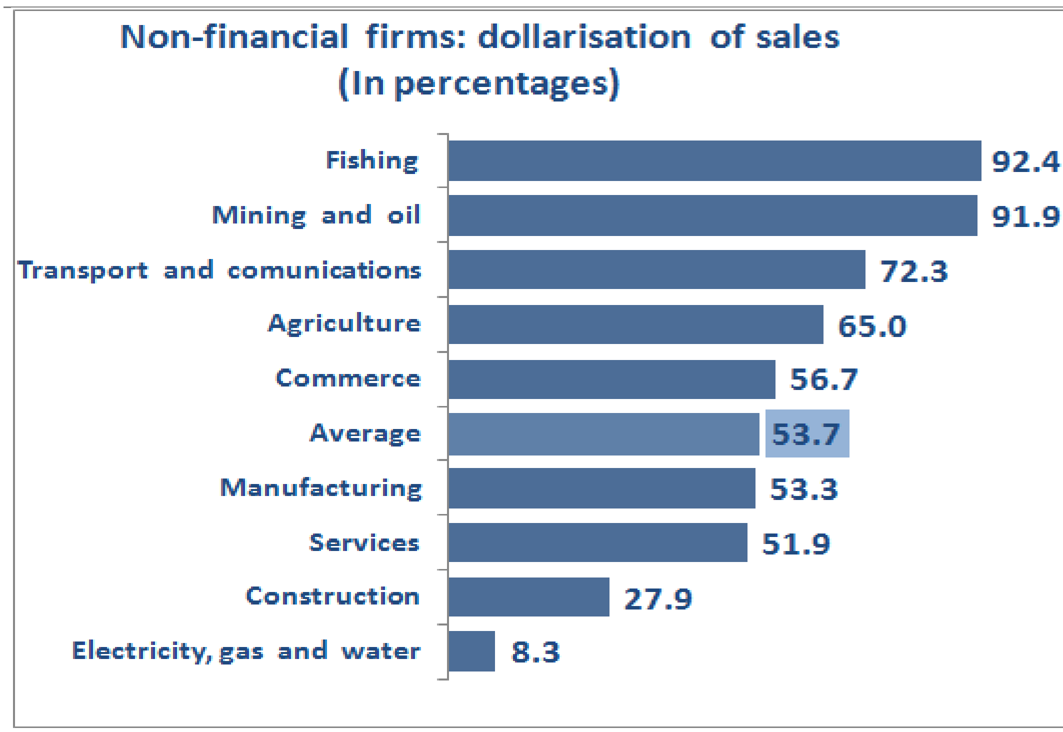
Dollarization of sales
(In percentages)

Figure 7



Dollarization of sales, by sectors
(In percentages)

Figure 8



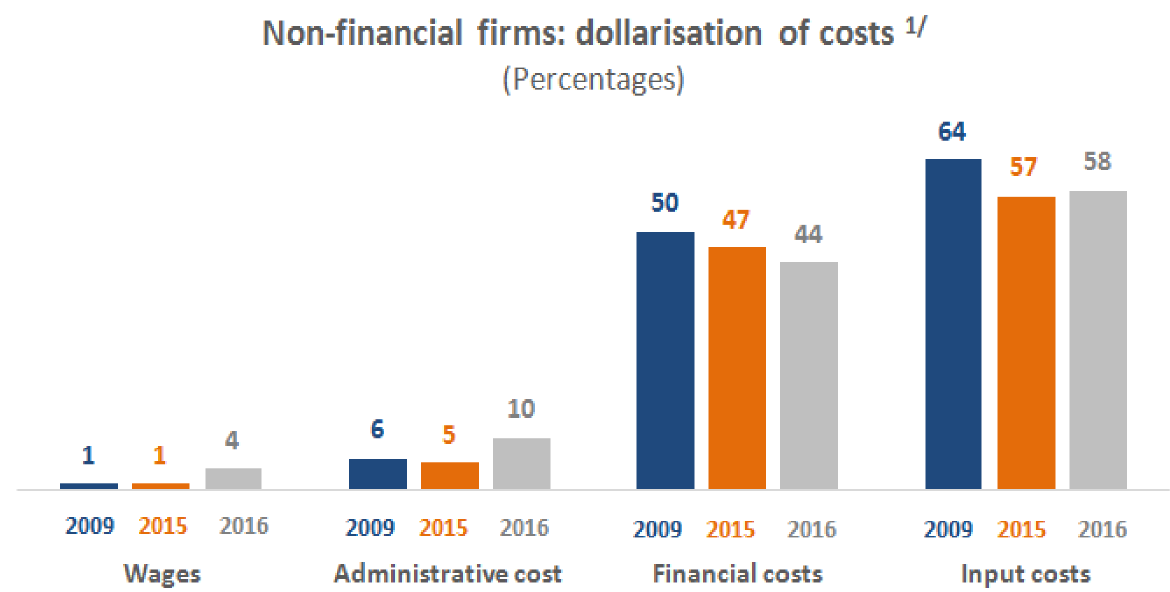
3.2. Currency composition of costs

Evaluating the cost structure of non-financial firms, more than 90 percent of firms reveal that salaries and administrative costs are mainly denominated in domestic currency and the degree of dollarization are 3.9 and 15.9 percent respectively; although in 2016 there is evidence of an increase in the role of dollar in these segments.

Concerning the financial costs, 44 percent of firms reveal the predominance of dollars although the domestic currency started to prevail in this segment. This evolution shows the impact of the de-dollarization policy implemented by the Central bank in order to reduce the vulnerabilities implied by higher levels of dollarization.

In December 2014 the Central Bank introduced a set of measures in order to enhance its de-dollarization policy which started in December 2013 with additional reserve requirements conditional to the growth of loans in dollars. The focus of the new measures are: a) provide liquidity in domestic currency in order to allow substitution of lending in dollars, b) ensure a declining tendency in the volume of loans in dollars, c) prevent the dollarization of deposits, and d) reduce the exchange rate volatility. These set of measures were introduced with exception to those operations associated to international trade and long term financing. One characteristic of these measures were the introduction of a specific period of time for a de-dollarization target; however, the goal has been accomplished even before the elapse of the specific period of time. Moreover, the de-dollarization process has been enhanced with an important downward break in the dollarization tendency of the lending to the private sector since 2014 (Encircled area of figure 2).

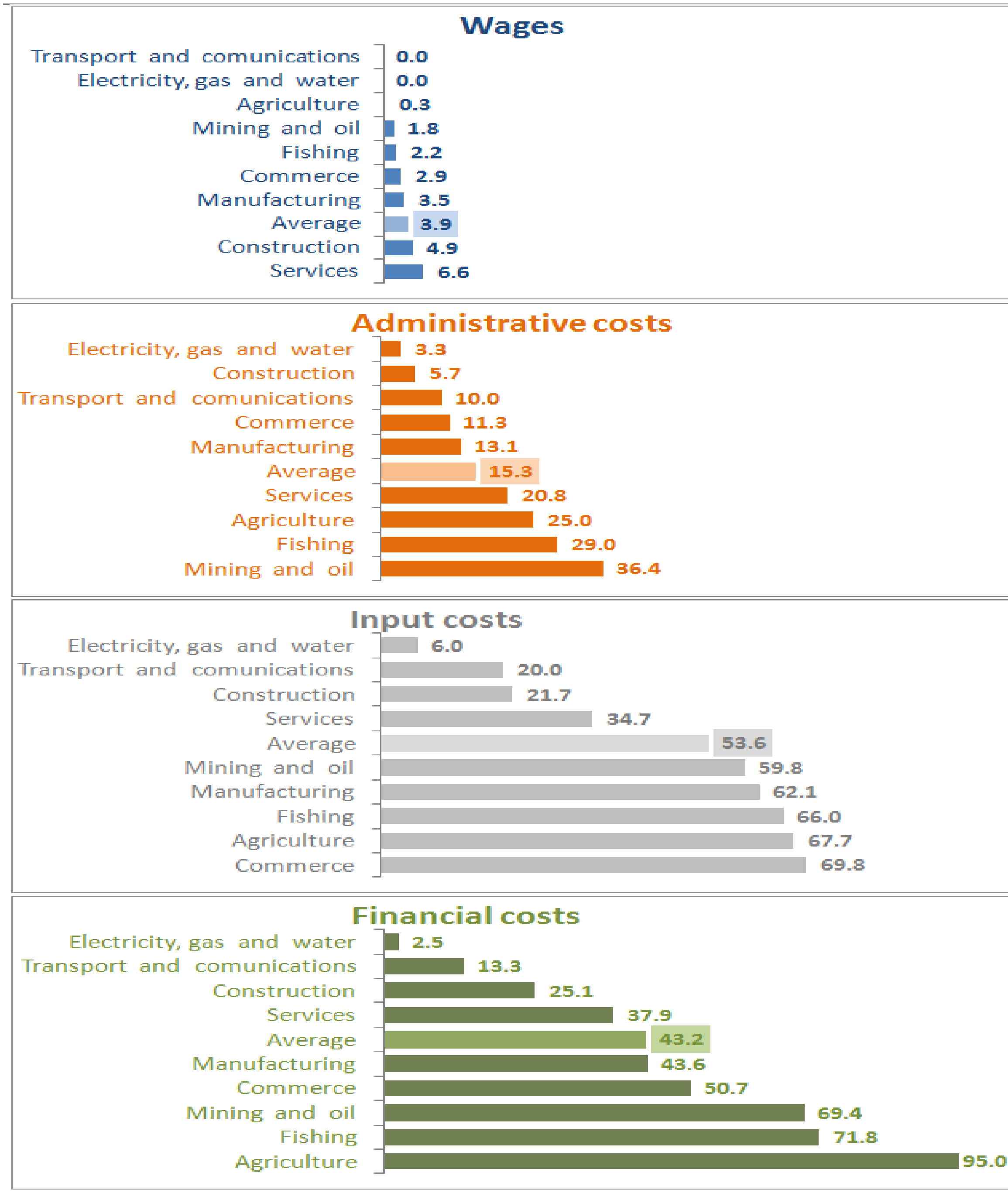
Non-financial firms: dollarization of costs
(In percentages) **Figure 9**



1/ The dollarisation of costs corresponds to surveyed firms acknowledging that most of their costs are denominated in foreign currency

Figure 9 shows that despite important accomplishments in the goal of de-dollarization in all segments of expenditure of non-financial firms, the degree of dollarization of their input costs is still high; 58 percent of firms acknowledge that their input purchases are denominated in foreign currency, and the average degree of dollarization is 53.6 percent.

Non-financial firms: dollarization of costs by sectors
(In percentages) **Figure 10**



At the economic sector level, Figure 10 shows that wage dollarization is very low in most of the economic sectors, a maximum of 6.6 percent in the services sector; regarding the administrative expenditures, the mining and fishing industry are the sectors with higher level of dollarization in this segment, which may reflect a certain natural matching with the revenues given that the currency denomination of their sales are mostly in dollars. In the case of the financial dollarization, the mining, fishing and the agricultural sectors present higher levels of dollarization. In the case of input costs, most of the economic sectors present a degree of dollarization close or higher than 60 percent.

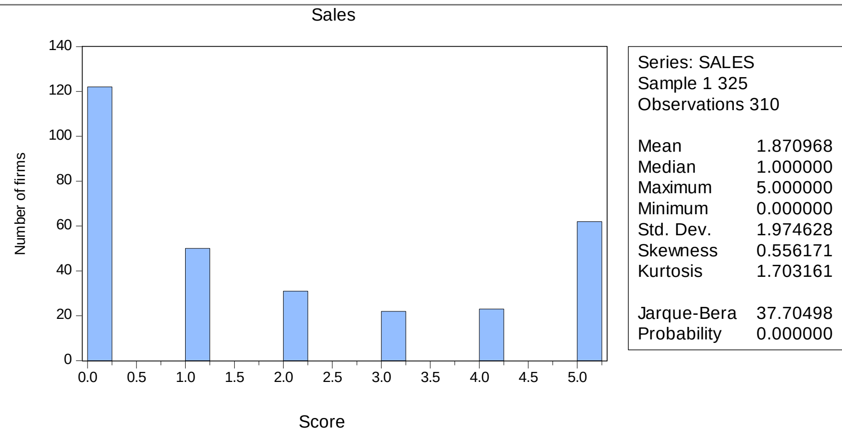
3.3. Dollarization rigidity

There are many hypotheses on the persistency of dollarization and in this section we will evaluate the difficulties faced by firms in changing from foreign currency to domestic currency some of the components of their income statements. We asked to the non-financial firms to grade from 0 to 5 their degree of difficulty of changing from foreign to domestic currency with 5 as the most difficult case (Table 1). In general, there seems to be not that difficult to move between currencies in most of the categories. However, in the case of purchases and sales of inputs the degree of difficulty is higher (this category also presents the higher degree of dollarization). This rigidity may explain the persistency in the dollarization of input costs and reflect some structural microeconomic characteristics.

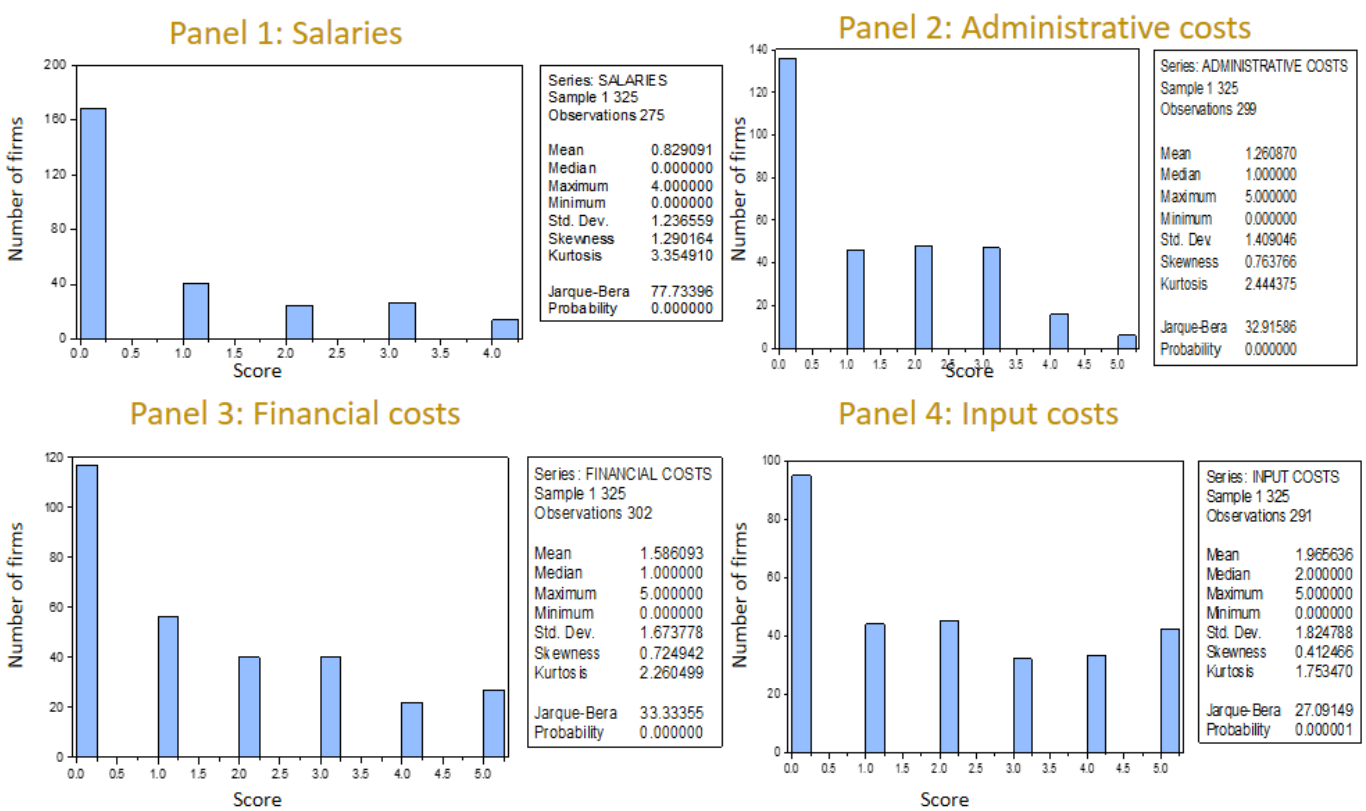
Non-financial firms: dollarization of costs by sectors
(From 0 to 5, 5 the most difficult) **Table 1**

Sectors	Sales	Costs			
		Wages	Administrative costs	Financial costs	Input costs
Agriculture	1.7	2.0	2.3	2.0	2.0
Commerce	2.0	0.9	1.4	1.7	2.3
Construction	1.1	0.5	0.8	1.1	1.6
Electricity, gas and water	1.4	0.4	1.4	1.6	0.6
Manufacturing	1.8	0.9	1.2	1.6	2.2
Mining and oil	2.4	0.4	1.2	1.5	1.6
Fishing	3.8	1.2	2.3	3.3	3.2
Services	2.0	1.1	1.4	1.5	1.6
Transport and comunications	2.4	1.0	1.0	1.5	2.0
Average	1.9	0.9	1.3	1.6	2.0

Degree of difficulty for changing currency denomination of sales (From 0 to 5, 5 the most difficult) **Figure 11**



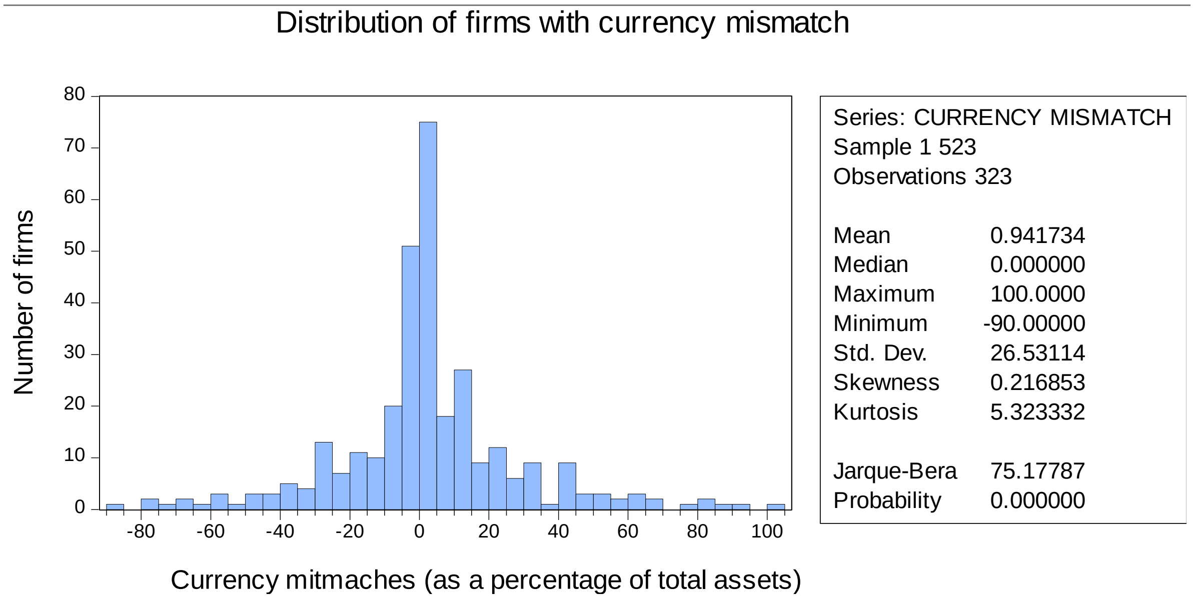
Non-financial firms: distribution of the degree of difficulty for changing currency denomination of costs (From 0 to 5, 5 the most difficult) **Figure 12**



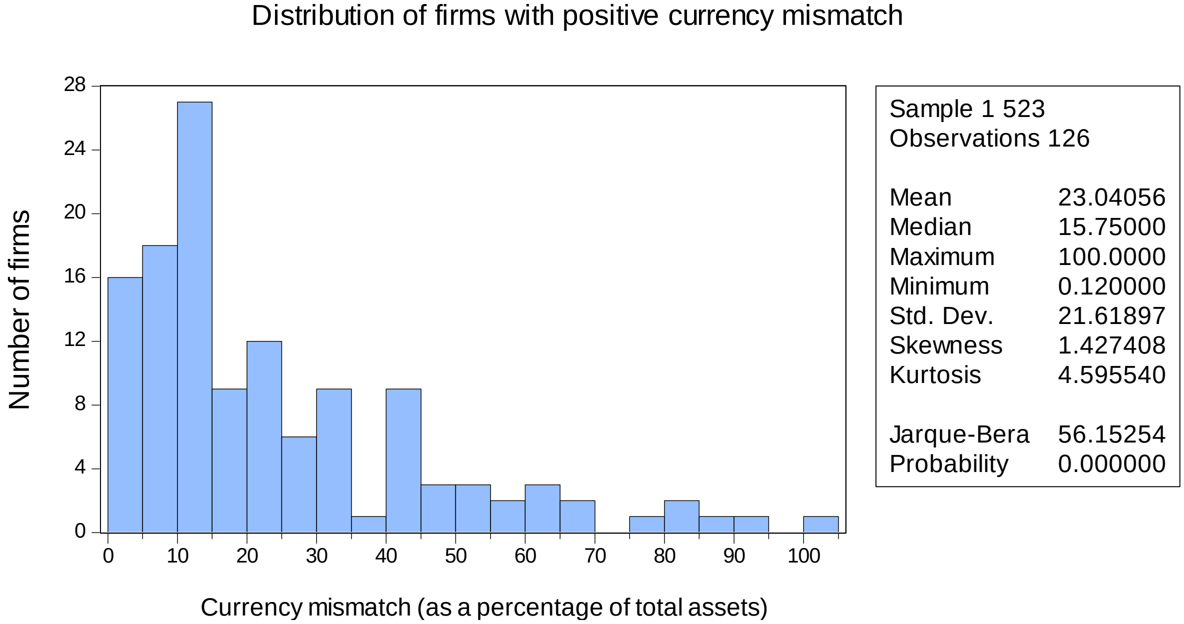
3.4. Dollarization of assets and liabilities

Defining currency mismatch as the difference between assets and liabilities in foreign currency as a percentage of total assets, in this section we evaluate the degree of dollarization of the balance sheet of firms. In Figure 13, from a sample of 323 non-financial firms, 18 percent of surveyed firms present a currency matched balance sheet, 39 percent of firms have a positive mismatch (more assets in dollars) and 43 percent of firms present negative currency mismatch (more liabilities in dollars), presenting a higher vulnerability to exchange rate fluctuations. From the sample, the average currency mismatch represent 23 percent of total assets in the case of firms with positive currency mismatch (Figure 14), while it depicts 18.8 percent of total assets of the firms with negative currency mismatch. (Figure 15)

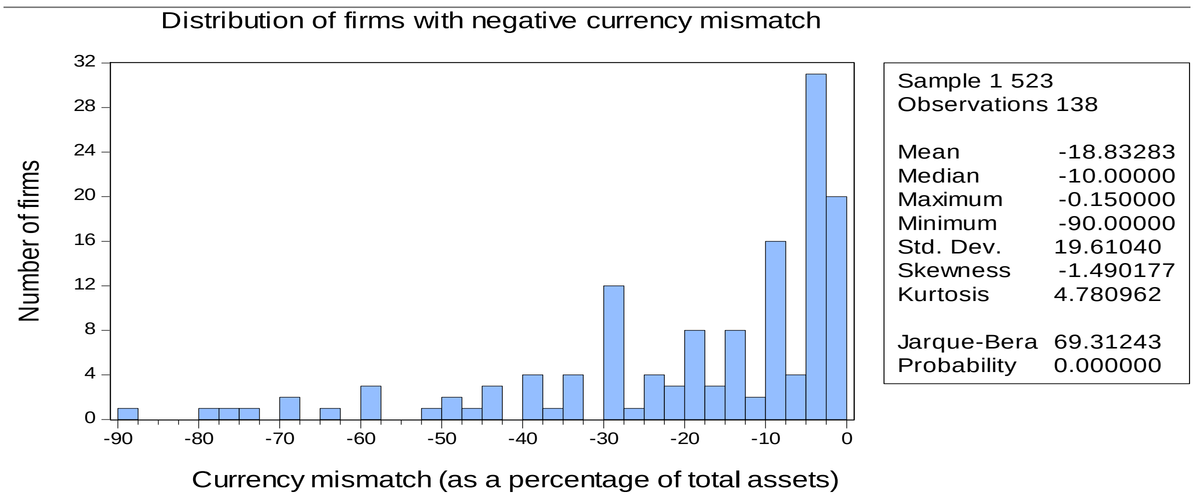
Non-financial firms: Distribution of firms with currency mismatches (Percentages of total assets) **Figure 13**



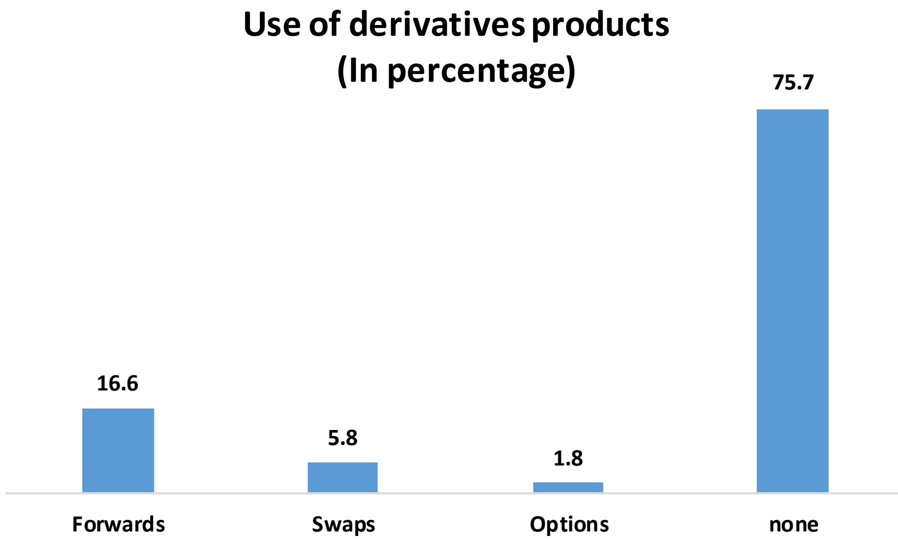
Non-financial firms: Distribution of firms with positive currency mismatches (Percentages of total assets) **Figure 14**



Non-financial firms: Distribution of firms with negative currency mismatches (Percentages of total assets) **Figure 15**

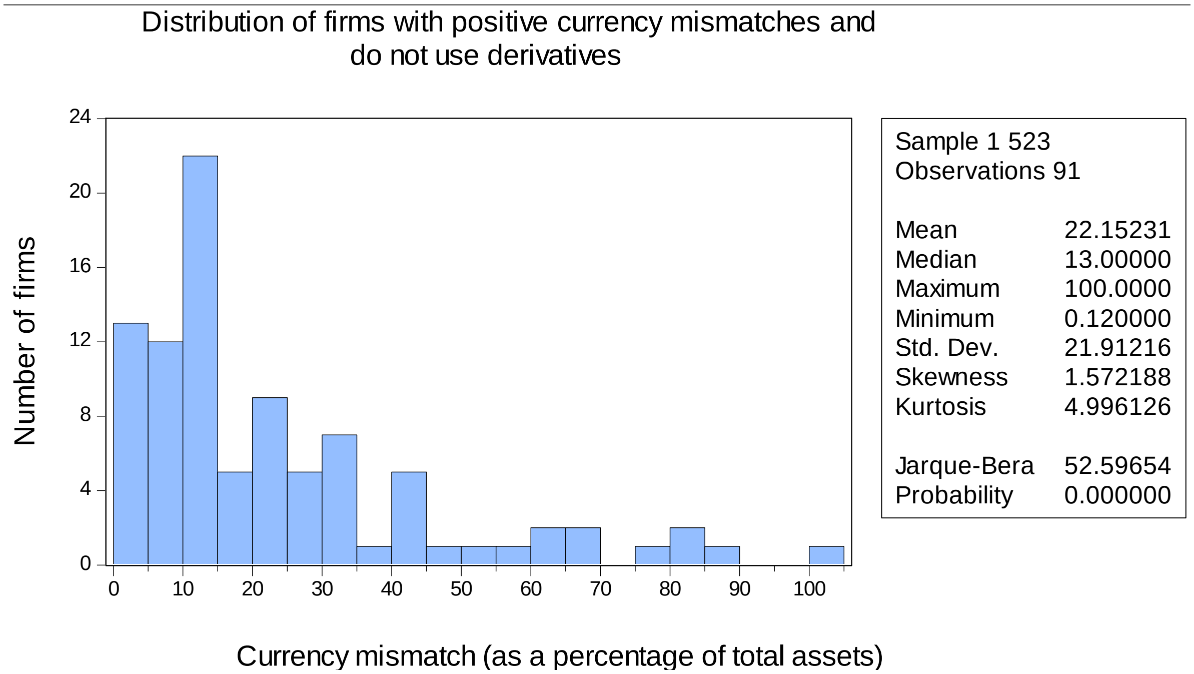


Non-financial firms: use of hedging derivatives products
(Percentage of firms) **Figure 16**

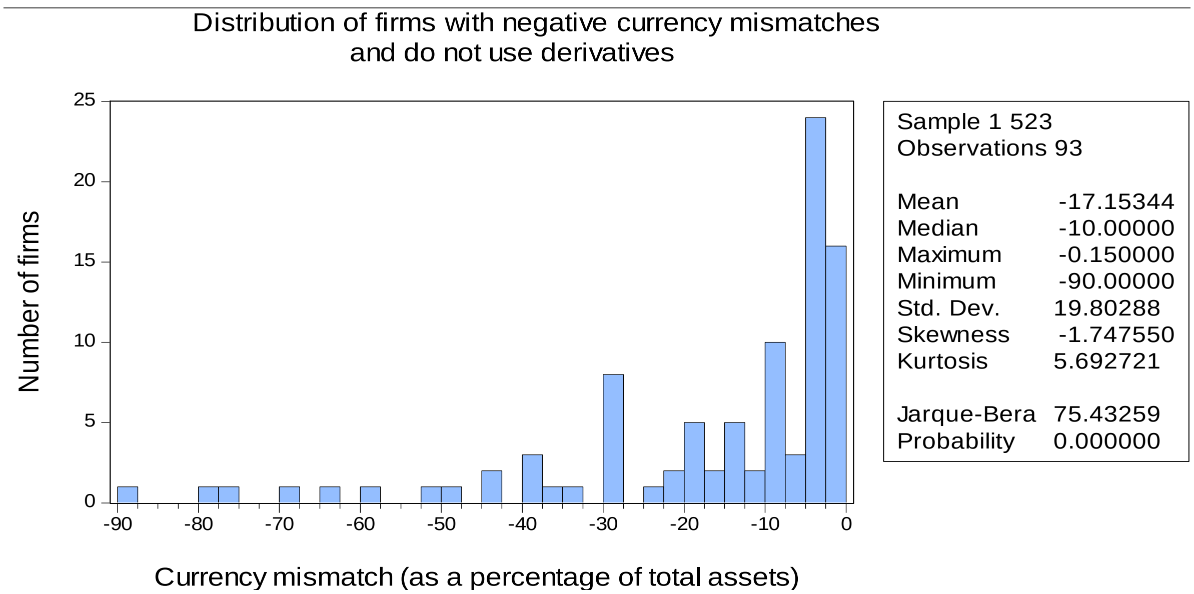


Another characteristic of the Peruvian economy is the scarcity of hedging instruments which combined with information problems leaves the firms vulnerable to currency fluctuations. Figure 16 shows that 75.7 percent of the surveyed firms acknowledged that they do not use derivatives for hedging purposes. Excluding from the sample the firms with currency mismatch but covered by any form of financial derivative (options, swaps or forwards), the average mismatch is only slightly smaller reaching 22.2 percent for positive mismatch cases (Figure 17) and 17.2 percent for negative cases (Figure 18).

Non-financial firms: Positive currency mismatches and use of derivatives (Percentage of total assets) **Figure 17**



Non-financial firms: Negative currency mismatches and use of derivatives (Percentage of total assets) **Figure 18**



3.5. A simple model of currency mismatches

Following Calvo and Rodriguez (1997) and Mwase and Kumah (2015), for the evaluation of the main determinants of currency mismatches we use a simple dynamic linear model of the form $CM_{i,t} = \alpha + \rho CM_{i,t-1} + \beta EERST_i + \gamma EERLT_i + \lambda SIZE_i + \theta EXP_i + u_i$, where $CM_{i,t}$ denotes the currency mismatch (as a percentage of total assets), $CM_{i,t-1}$ denote the currency mismatch in the previous year (as a percentage of total assets), $EERST_{i,t}$ is the expected level of exchange rate for the next year, $EERLT_{i,t}$ is the expectation of Exchange rate for the next 2 years, $SIZE_i$ denotes the size of the firm, measured as the total sales of the previous year and EXP_i represent the exports as a percentage of total sales of the previous year.

We find evidence of persistency in the currency mismatch of firms. Table 2 shows that the previous period mismatches affect significantly to actual currency mismatch. There are also some indications of rigidity of the currency mismatch of firms given by the important explanatory power of the size. However, this may be the case of firms with positive mismatches considering that the biggest firms operate in sectors where the main proportion of their output is exported (i.e. mining, fishing etc.). The evidence also shows that expectations of exchange rate, as a proxy of the returns of taking bets in a direction of exchange rate are not a determinant of currency mismatches.

Determinants of currency mismatches of non-financial firms
(Percentage of total assets) **Table 2**

Determinats of currency mismatches

Dependent Variable: CM
Sample: 1 523
Included observations: 143

Variable	Coefficient			
CMit-1	0.462*	0.50*	0.498*	0.514*
log(SIZE)	2.905**	2.69**	2.573**	2.87*
LOG(EERST)	-1.574	-1.419	-1.375	
LOG(EERLT)	-2.337	5.155		
EXP	0.066			
R-squared	0.244	0.26	0.24	0.243

* Significant at 5% level
**Significant at 10% level

4. Conclusions

Information gathered at the micro level shows that non-financial firms are still vulnerable to currency fluctuations due to currency mismatches at the level of the structure of their costs and at the level of their balance sheets. The persistency of the dollarization urges the Central Bank to maintain its efforts to de-dollarize the economy. The characteristics of non-financial firm's transactions and the structure of their costs may impose certain limits to the de-dollarization process. Further research is needed in order to measure the limits of the de-dollarization.

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The Survey of Macroeconomic Expectations of the BCRP in Table 6 collects information from entrepreneurs, bankers and analysts, with respect to their perception on the future behaviour of the main macroeconomic variables such as inflation, GDP growth, exchange rates and interest rates, and also seeks information on the principal drivers of the production cycle and the business environment.

The expectations of the behaviour of the main macroeconomic variables, resulting from the survey, are among the main indicators analysed and used by the central bank for the design and implementation of its monetary policy.

The survey of Macroeconomic Expectations implemented by the Central Reserve Bank of Peru (BCRP by its initials in Spanish) since July 1999, initially had the purpose of collecting information on the forecasts of inflation, exchange rate and GDP growth, from the financial entities. Since September 2001 the sample was extended to include firms from the different sectors of the economy; and since April 2002, the survey amplified the questionnaire to include aspects of the business confidence. The Survey allows us two groups of indicators: Diffusion indexes and Indicators of Macroeconomic Expectations.

Diffusion index: Survey based index applied to non-financial firms. The Questionnaire follows the methodology formulated by the OECD in its Business Tendency Surveys: A Handbook, where, the diffusion index is computed as the percentage respondents who expect a better situation (above normal) minus the percentage of respondents who expect worse scenario (below normal) plus one (which represents normal), the resulting number is multiplied by 50, such that the diffusion index will tell us, if greater than 50, that more survey respondents expect a better situation than normal. If below 50, the diffusion index tells us that more survey respondents expect a worst situation than normal.

Expectation of Macroeconomic Variables: Macroeconomic expectations (inflation, rate of growth of GDP and exchange rate) are computed based on the median of the answers provided by financial system entities, economic analysts and non-financial firms to the survey on their projections for the macroeconomic variables. In the case of expectations for the short term interbank interest rates, the information used corresponds to the median of the information provided by the financial system entities and economic analysts. Using the median as the indicator of the expectations allows us to separate the extreme values bias.

The sample framework: The survey uses two formats, according to the characteristics of the respondents. One format is for non-financial firms, the other for financial entities and economic analysts. For the sample of non-financial firms the population objective are the Peru’s top 10 000 firms from all the economic activity sectors. For the financial entities and economic analysts, the population are the main banks and other financial entities, consulting firms, the main economic research departments, and universities.

In theory, with a confidence interval of 95 percent, 5 percent of marginal error, the minimum sample size representative of the population would be 368 firms. The actual sample size for the Macroeconomic Expectations Survey in Peru is 400 non-financial firms, 26 economic analysts and 26 financial entities. The non-financial firms are grouped in different sectors of the economy: Agriculture and fishing; mining and oil; manufacturing; electricity, water and gas; construction; transportation and communications; commerce; and services.

The frequency of the survey is monthly, and its implementation begins in the second week of every month. In addition to the monthly survey, the central bank implements two surveys of quarterly frequency: On special survey applied to the construction sector and another survey implemented in the regions of the country.

The economic indicators obtained from the Survey of Macroeconomic Expectations, in particular those corresponding to the diffusion index, are published in the Studies Notes (Notas de Estudios) on a monthly basis in the web page of the Central Bank, according to a schedule published in the Weekly Notes (Nota Semanal). The indicators of the Expectations of Macroeconomic Variables obtained from the survey are published in the Informative Summaries (Resumen Informativo) together with the data of the actual inflation corresponding to the previous month, during the first week of every month.

Survey of Macroeconomic Expectations

	Sep-2015	Dec-2015			Jun-2016			Correlation
General Economic Situation, present								
Business Situation, present	55.4	57.9	↑	>	58.9	↑	>	0.57
Sales situation	48.0	50.0	↑	>	52.5	↑	>	0.60
Purchase orders, in comparison to previous month	45.5	45.1	↓	<	50.6	↑	>	0.62
Output level	49.5	50.7	↑	>	52.1	↑	>	0.52
Demand level, in comparison to expected level	40.6	41.1	↓	<	44.8	↑	>	0.69
Inventories, in comparison to previous month	51.5	51.0	↓	>	51.2	↑	>	0.35
Employment situation	45.5	46.4	↑	<	48.5	↑	>	0.74
Expectations								
Firm's Expected demand for the next 3 months	55.9	51.5	↓	>	58.6	↑	>	0.75
Expected employment for the next 3 months	47.8	45.5	↓	<	49.9	↑	>	0.74
Expected Business Situation of the firm for the next 3 months	55.3	54.4	↓	<	58.6	↑	>	0.64
Expected Business Situation of the sector for the next 3 months	48.1	47.7	↓	<	56.0	↑	>	0.75
Expected Situation of the Economy for the next 3 months	43.2	44.6	↑	>	54.3	↑	>	0.73
Expected Business Situation of the sector for the next 12 months	55.7	57.6	↑	>	66.6	↑	>	0.50
Expected Situation of the Economy for the next 12 months	50.6	56.0	↑	>	68.0	↑	>	0.58
Confidence								
Expectation of economic situation for the nex 12 months (APOYO)	62.0	68.0	↑	>	66.5	↓	<	0.10
Finances								
Financial condition of the firm	61.1	62.4	↑	>	63.2	↑	>	0.48
Situation of credit availability for the firm	63.4	64.3	↑	>	66.9	↑	>	0.16
Prices								
Expectations of the inputs avarage prices fo the next 3 months	50.7	52.5	↑	>	53.8	↑	>	0.64
Expectations of the sales avarage prices fo the next 3 months	53.5	55.3	↓	<	58.2	↑	>	0.65

> : Greater than 50

< : Lower than 50

* Correlations computed from December 2007 to September 2015. For the General actual business and financial situations we show the contemporaneous correlation, for the rest the correlation is with the 3 months ahead GDP

** For the indicators for the present and future economic situation of the household, the likelihood of finding job and the level of prices, we only consider the expectations of the future economic situation of the household.

Source: Central Reserve Bank of Peru, Survey of Macroconomic Expectations, December 2015 and June 2016.

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Gauging market dynamics using trade repository data: The case of the Swiss franc de-pegging[1]

Olga Cielinska, Andreas Joseph, Ujwal Shreyas,
John Tanner, Michalis Vasios,
Bank of England

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Gauging market dynamics using trade repository data: The case of the Swiss franc de-pegging

Olga Cielinska[1], Andreas Joseph[2], Ujwal Shreyas[3], John Tanner[4] and Michalis Vasios[5]

Abstract

The Bank of England ("the Bank") has access to some of the granular transaction level data resulting from EMIR trade reports. The velocity, granularity and richness of this dataset puts it in the realm of big data in the derivatives market, which brings with it its own set of challenges. These data have a number of potential uses in monitoring the market and helping to set policy. But these uses are only possible if the data are both accurate and complete on the one hand and we are able to analyse them effectively on the other. To help determine the status of these factors, we carry out a study of an external event to see how it was represented in the data. A suitable event was identified in the decision of the Swiss National Bank to discontinue the Swiss franc's floor of 1.20 Swiss francs per euro on the morning of 15 January 2015. This was expected to show a number of effects in the Swiss franc foreign exchange over-the-counter (FX OTC) derivatives market. The removal of the floor led to extreme price moves in the forwards market, similar to those observed in the spot market, while trading in the Swiss franc options market was practically halted. We find evidence that the rapid intraday price fluctuation was associated with poor underlying market liquidity conditions, in particular the limited provision of liquidity by dealer banks in the first hour after the event. Looking at longer-term effects, we observe an increased level of illiquidity, associated with an increased level of market fragmentation, higher market volatility and an increase in the degree of collateralisation in the weeks following the event. It is worth noting that whilst we analyse the impact of the event on the market, we are not commenting on the SNB's policy decision itself.

Keywords: Market Microstructure, FX Derivatives, Swiss franc, EMIR, Trade Reporting

JEL classification: G15 G18

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Contents

1. Introduction

Background

The OTC derivatives market has historically been decentralised and opaque. There has been no central source for trade information, for example on prices and trade sizes, either pre- or post-trade, let alone any information about counterparty identities and the network of exposures. This has been true not only for investors, but also for regulators. But this is changing.

In response to the 2008 global financial crisis, a number of reforms have been implemented to improve the functioning of OTC derivative markets, including increasing transparency. Most notably, in September 2009 G20 leaders agreed to make it mandatory for counterparties to derivatives transactions to report details of such contracts to trade repositories (TRs).[6] This initiative, known as the reporting obligation, aimed to open the black box of OTC derivatives by making it possible for regulators to access, for first time, granular transactional data.

In the European Union (EU), the reporting obligation has largely been implemented by the European Market Infrastructure Regulation (EMIR).[7] Under EMIR, all OTC and exchange-traded derivatives transactions undertaken by EU counterparties since August 2012 (or open at that point) have had to be reported by the following business day to a TR. The definition of counterparties covers primarily the activity of clearing houses, financial counterparties and non-financial counterparties that are EU legal entities.

The post-trade disclosure of derivatives transactions opens up a whole new range of possibilities for policy analysis, supervision and research. For example, the ability to observe trading activity and the network of exposures not long after the trades are executed could allow policy makers to identify the build-up of systemic risk within the financial system, as well as idiosyncratic risk to individual institutions for micro-prudential supervision purposes. But these uses require that the data are accurate and complete on the one hand and that we can analyse them effectively on the other. The evidence on these aspects is, however, limited so far, a gap we aim to fill. This is the first in-depth study in Europe to utilise the EMIR TR data relating to the FX market in an attempt to determine their strengths and limitations, as well as to showcase examples of policy analysis and research that can be conducted with them[8].

We do so in two ways. First, we provide a first look at the second largest OTC derivatives market, the FX derivative market. By analysing its structure we gain some novel insights into a previously unexplored market. We then look at the market dynamics around a recent policy event that was not anticipated by FX market

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[6] The 2009 G20 reform agenda also included the increase in pre-trade transparency by the introduction of multilateral trading venues for certain derivative markets as well as reducing risk in the market through measures including the push towards central clearing and the exchange of collateral more generally.

[7] Regulation (EU) No 648/2012 of the European Parliament and of the Council, of 4 July 2012 on OTC derivatives, central counterparties and trade repositories; commonly known as “EMIR”.

[8] Another study that uses the EMIR TR data is the September 2016 ESRB published Occasional paper no. 11: Shedding light on dark markets: First insights from the new EU-wide OTC derivatives dataset, which provides a description of the data. (https://www.esrb.europa.eu/pub/pdf/occasional/20160922_occasional_paper_11.en.pdf?c067e1f68ae0fe23925b88c613c546a8)

participants: the decision by the Swiss National Bank (SNB) to remove the Swiss franc-euro exchange rate floor at 10:30 AM CET on 15 January 2015. The exogenous nature of this event and the speed and scale of subsequent intraday currency movements makes it well-suited for an event-study analysis. It is worth noting that whilst we analyse the impact of the event on the market, we are not commenting on the SNB's policy decision itself.

For such an analysis to be meaningful, it would require the use of transaction data and information about counterparty identities in order to analyse how different market players responded to the removal of the floor. This is exactly the type of information contained in the EMIR data. TR data provide us with a unique insight into the functioning of the FX derivatives market, going significantly beyond what other data sources can tell us. To fully exploit this highly granular trade-level data we make use of analytical techniques from empirical finance and network science.

Analytical Results

Of all the reported transactions to European TRs, the Bank is entitled to see trades where one of the below criterion are satisfied, i.e. at least one of the counterparties is a UK entity, the trade is cleared by a UK CCP, and the asset traded is either denominated in Sterling or has a UK underlying. In our analysis we use reports for outright forwards, FX swaps (the forward leg) and options, which we obtained from the largest trade repository, DTCC. Given the focus on the SNB announcement, we limit our analysis to just the Swiss franc (CHF) segment of the market. In practice, this means that we only look at reports where one leg of the trade is denominated in Swiss franc.

The raw data used in the paper included about 100 million reports consisting of new FX derivative trades (not all of which were unique) as well as valuation updates and 300 million outstanding FX positions between November 2014 and March 2015. The length of the period was chosen to cover the Swiss FX market before and after the de-pegging event so that meaningful comparisons would be possible. After filtering and cleaning we were left with about 400,000 new CHF trades executed by over 9,000 counterparties and 3 million outstanding CHF positions. Despite using data from only one TR and other limitations[9], we estimate that we are able to observe more than half of the market (by comparing with OTC derivatives data from BIS (2015), perhaps because of the role of London as a global financial centre for FX markets. This ensures to some extent that any observed patterns in the data reflect the whole global market.

Before conducting any in-depth analysis, we report some basic statistics. The Swiss franc market is a medium-sized FX market. We see trades accounting for around US$100 billion notional traded daily, of which more than three quarters are forwards (outrights and the forward leg of FX swaps) and the remainder are options. The average maturities are short (<1 year) and we observe some bunching around three-, six-, nine- and twelve-month maturities. The most actively traded currency pair is the US dollar/Swiss franc (USDCHF) followed by the Euro/Swiss franc (EURCHF). The market structure is highly concentrated, with trading by a small number (about 11) of big dealers accounting for more than 90% of the market, of which almost half represents interdealer activity. This is consistent with the commonly held view that OTC trading is dominated by a few large dealers.

[9] The data does not include any trades for the counterparty pairs such as Swiss – Swiss, US-US and Swiss-US

We look at the structure of the Swiss franc market in more detail using network topology techniques, which allows us to identify three distinct segments of the market: an inner core of big liquidity providers, an outer-core of medium-sized active counterparties, and a periphery of small end-users, who are characterized by more directional trading. We demonstrate how the three-tier structure can have interesting implications for network stability and fragmentation and the analysis of liquidity provision, which we regard as a methodological contribution of the paper.

We next move to the analysis of the de-pegging, first, by reconstructing the event using the available transaction data and analysing the response of different market counterparties to the SNB announcement, and, second, by looking at the longer-term impact on market liquidity, trading positions and the structure of the network.

Intraday analysis:

We provide evidence of a rapid V-shaped price movement in the EURCHF OTC forward market similar to the one observed in the spot market. The Swiss franc appreciated by nearly 41% against the euro in the first 20 minutes after the announcement, before stabilising at around 1.05 (an appreciation of around 14%). We find that in the first 15 minutes after the announcement, the provision of liquidity was limited, as evidenced by the low dealer-to-client trading, the small average trade size of EURCHF forwards trades, and the fact that dealers were initially buying Swiss francs, which suggested they were consuming liquidity instead of providing it. After 15 minutes, dealers gradually started to play the role of liquidity provider, even if this activity was potentially loss-making as it coincided with the Swiss franc price reversal (i.e. depreciation). Collectively, our analysis provides some evidence that the rapid V-shaped Swiss franc price fluctuation on 15 January was associated with underlying market liquidity conditions. This demonstrates the value of the granular nature of the TR data and that it can be used to analyse intraday market dynamics.

Longer term impact:

Looking at the two-and-a-half-month period following the announcement we find that: a) the trading network became more fragmented compared to a similar period before the announcement, in part due to a reduction in inter-dealer activity, b) liquidity in the market decreased, indicated by an increase in measures of volatility and illiquidity as well as a decrease in average trade sizes, and c) the amount of collateral exchanged by the different counterparties increased. The more volatile prices in the new regime might explain some of the drop in liquidity, due to a higher degree of information asymmetry and inventory holding costs, both of which are expected to have impaired market liquidity. The drop in liquidity might also relate to the finding that the trading network has become more fragmented, thus making it harder for dealers to match supply and demand.

2. Trade Repository Data

Reporting framework

In September 2009, in response to the financial crisis G20 Leaders agreed that OTC derivatives transactions should be reported to trade repositories so that they could be collected and analysed by the respective regulatory authorities. The trade reporting framework was part of a larger package of reforms aimed at mitigating systemic risk, improving transparency in an opaque market and protecting against market abuse. This reporting obligation has been implemented in different ways across jurisdictions, e.g. EMIR in the EU and the Dodd-Frank Act in the U.S. In Europe, trade reporting to the TRs began in February 2014.

The structure of the data and cleaning process

We analyse five months of OTC FX data between November 2014 and March 2015, provided by DTCC. The data contain reports for forwards and options, with the forward category including both outright forwards and the forward leg of FX swaps. These two types of products account for about 80% of the global FX OTC derivatives market (BIS 2015). The missing 20% consists of mainly currency swaps, which are reported separately as interest rate derivative products, which we did not analyse for this study. We do not observe spot transactions, since these do not fall under EMIR reporting requirements.[10]

The TR data can be broadly divided into two types of reports: a) activity reports, which contain trade information on flows, for example new trades, modifications, and valuation and cancellation updates; and b) state reports, which contain trade information on stock, i.e. all end-of-day outstanding transactions between individual counterparties. The state and activity reports are generated each day and are available for the Bank to see with a one-day lag. [11] The DTCC TR data, the one used for this study contained more than 100 fields, of which 85 were EMIR fields and the remaining were TR introduced fields. These fields include information on trade characteristics and more importantly counterparty identities. However, not all of them contain information relevant to FX derivatives

Given the decentralised nature of OTC markets, EMIR data come with certain limitations and data processing can be time consuming and challenging. We went through several stages of data cleaning to make the raw data suitable for analysis. The steps involved filtering, deduplication and group consolidations, partial outlier detection and the dropping of missing values. The process of filtering and deduplication is described in Chart 1. The raw activity and state reports contained about 100 million and 300 million rows of trades, respectively between November 2014 and March 2015, not all of which contained new trade information or involved the Swiss franc. After filtering the data as per the steps outlined in Chart 1, we were left with a sample of 380,000 activity reports and around 3 million state reports. Importantly, these are single records for each relevant trade, thus avoiding double-counting[12] that could have biased our trading activity analysis.

The TR data used for the analysis might introduce certain biases due to the fact that we make use of data from just one TR and the Bank is entitled to only a subset of trades where one of the counterparties is an UK entity.[13] To get a better idea of the degree of potential bias we compared the aggregates obtained from our data to

[10] Nonetheless, we did get access to anonymised spot transactions executed on 15 January from EBS BrokerTec, an electronic FX platform provider. We used this data to visualize the intraday price movement in the spot market on the event day.

[11] EMIR requires reports to be made to TRs either on the day of an event or the day after. The resulting data is made available to the Bank on the day after it was reported. The precise timing of the reporting was not significant to this analysis because it was carried out well after the event being analysed.

[12] A) EMIR is a double-sided reporting regime, so the Bank would see two copies for a single executed trade when both the counterparties are UK entities (and, in this case, where they are both reporting the trade to DTCC). B) As per the EMIR regulation, the activity reports could contain several copies of the same trade to reflect each of the modification, correction and valuation updates.

[13]The FX market being largely uncleared means that the jurisdiction of the counterparty is the primary reason why the Bank would see a particular report.

BIS (2015) OTC derivative statistics. According to DTCC EMIR TR data available to the Bank on 31 December 2014 there were US$0.9 trillion of Swiss franc forwards and swaps outstanding, as well as US$0.8 trillion Swiss franc options. According to semi-annual BIS data, on 31 December 2014 the notional outstanding of Swiss franc OTC FX derivatives was about US$4.2 trillion.[14] Of this, US$2.1 trillion was accounted for by forwards and swaps, and US$0.9 trillion by options.[15] Although there might be some noise in this comparison due to differences in methodology, the findings in Chart 2 indicate that we see a significant portion of the global Swiss franc FX derivatives, especially in options, as a result of London's status as a global centre for FX trading.

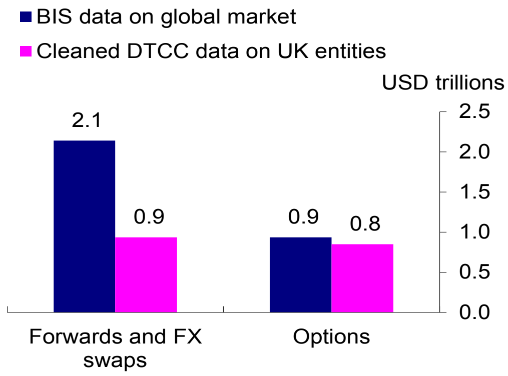
Summary of the data cleaning process for activity and state reports

Chart 1

Activity:100 million rows *State: 300 million rows*	Trade activity and state reports for FX OTC contracts from November 2014 till March 2015
Activity:3.5 million rows *State: 10 million rows*	Filter data to only include contracts where one of the legs is Swiss-franc denominated
Activity: 2.5 million rows *State: 10 million rows*	Filter the resulting trades to include those that were executed between November 2014 and March 2015 (only for Activity reports)
Activity: 380 thousand rows *State: 3 million rows*	For activity reports, select a single copy from multiple reports. For state reports we filtered to leave only EURCHF trades.

Share of global Swiss franc market that we can see in cleaned DTCC data

Chart 2



Source: BIS, DTCC and Bank calculations.

[14] This made up 5.5% of the whole USD 75.9 trillion OTC FX derivatives market, which in turn accounts for 12% of overall OTC derivative activity measured by notional size.
[15] According to BIS estimates, its semi-annual survey captures 90% of global OTC derivatives market.

3. The Swiss franc market

Summary statistics

In this section we provide a first insight into the Swiss franc segment of the OTC FX derivatives market using new trades executed between November 2014 and March 2015, as well as data on counterparties' positions.

- **The size of the market.** The total outstanding notional of Swiss franc derivatives in our data on 31 December 2014 was US$900 billion and US$800 billion for forwards and options, respectively (Chart 2). We observe nearly 3,700 Swiss franc trades per working day, with an average daily traded notional of US$118 billion. 88% of notional represented trading in forwards and the rest in options (Chart 3).

- **Currencies.** The majority of Swiss franc derivatives trades we see were against the US dollar, accounting for 82% of all Swiss franc forward trades and 64% of all options trades in the market (Charts 4 and 5). When looking at the Swiss franc trades against the euro, a greater share is accounted for by options i.e. of all option trades 33% were against the euro compared to 14% for forwards. This seems intuitively sensible if some of the market participants wanted to position/hedge against sharp changes in the Euro to Swiss franc exchange rate.

- **Maturities.** The average maturity of forwards is very short. Over half of all forwards have a maturity of no more than a week, and over 96% no more than four months (Chart 6). The maturity for options is slightly longer, although the most common maturity for options is between one week and two months. We can observe some bunching around three-, six-, nine- and twelve-month maturities (Chart 7). This pattern is indicative of higher liquidity at certain tenors, in line with market convention.

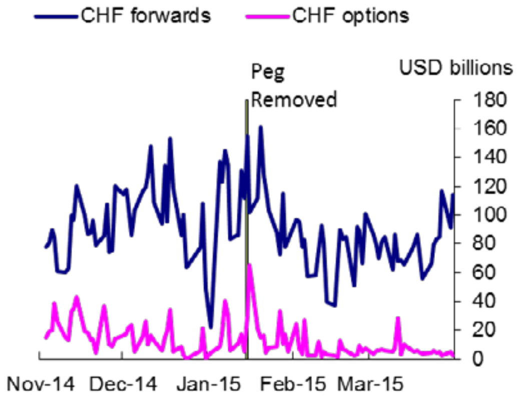
- **Counterparties.** Chart 8 decomposes traded notional by counterparty[16]. G16[17] dealers make up a significant majority of trading in both forwards and options (75% and 80%, respectively). The rest of trading in the forwards market is split between banks, buy-side firms, service providers to institutional clients, corporates and others. Trading in the options market is more homogeneous, with most non-dealer activity coming from hedge funds. In fact, trading in options makes up 37% of all Swiss franc FX derivative activity done by hedge funds, by far the highest share of any of our categories (Chart 9). One potential reason for this could be that speculative activity was more likely to be present in the options market, while hedging activity by corporates and various funds was done in the forwards market. It is worth mentioning, that although the percentage of 'Others' is large, these entities are typically very small and collectively account for a relatively small fraction of the traded notional in the Swiss franc market - around 5%.

[16] Majority of the sector classification used for the analysis was carried out manually; hence some of the classification would be imprecise. However, this has been invaluable to bring out some of the broader trends in the market.

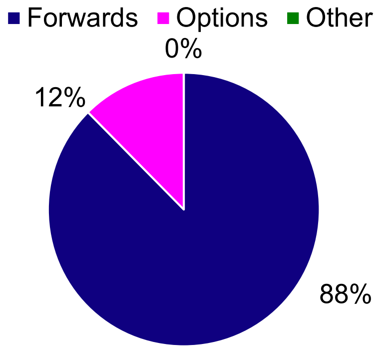
[17] The biggest 16 dealers in our subset of the TR data arranged in alphabetical order are: Bank of America, Barclays, BNP Paribas, Citigroup, Crédit Agricole, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JP Morgan, Morgan Stanley, Nomura, Royal Bank of Scotland, Société Générale, Standard Chartered and UBS. This choice is not arbitrary on our part as most of these banks are also classified as "Participating Dealers" in the OTC Derivatives Supervisors Group, chaired by the New York Fed: https://www.newyorkfed.org/markets/otc_derivatives_supervisors_group.html

Daily volume of notional traded in the Swiss franc market between November 2014 and March 2015 split by product type

Chart 3



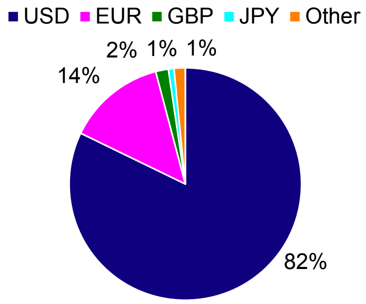
Source: DTCC and Bank calculations.



Source: DTCC and Bank calculations.

Volume of Swiss franc forward trades split by counter currency

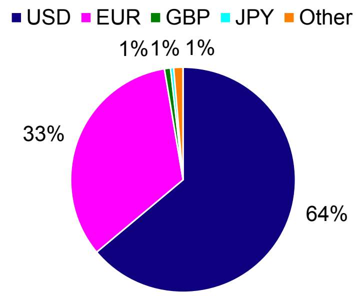
Chart 4



Source: DTCC and Bank calculations.

Volume of Swiss franc option trades split by counter currency

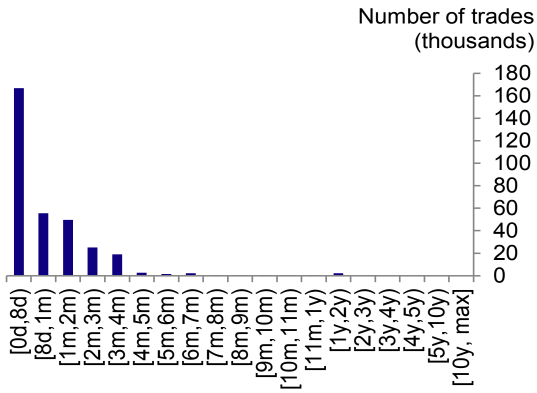
Chart 5



Source: DTCC and Bank calculations.

Maturity distribution of Swiss franc forwards trades between November 2014 and March 2015

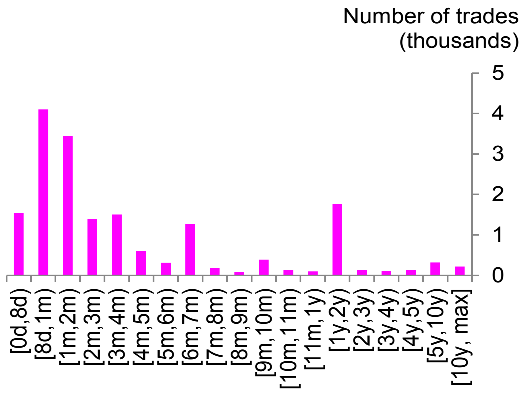
Chart 6



Source: DTCC and Bank calculations.

Maturity distribution of Swiss franc options trades between November 2014 and March 2015

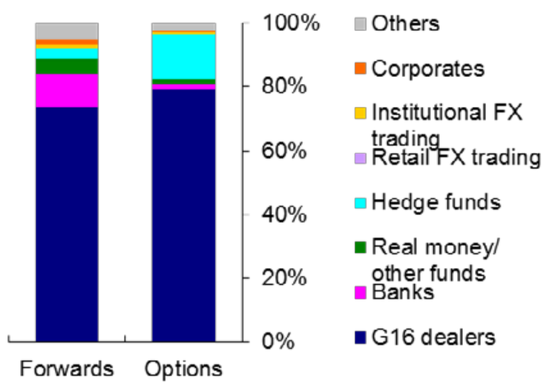
Chart 7



Source: DTCC and Bank calculations.

Notional traded between November 2014 and March 2015 in Swiss franc forwards and options by counterparty type

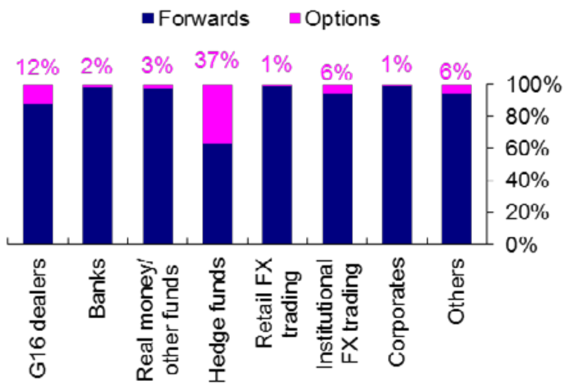
Chart 8



Source: DTCC and Bank calculations.

Forward-option split in Swiss franc notional traded between November 2014 and March 2015

Chart 9



Source: DTCC and Bank calculations.

Market structure - a two tier market classification

The granularity of the TR data allows us to describe in great detail the composition and structure of the FX OTC derivatives market – a first in the literature. Charts 8 and 9 showed that trading activity in the Swiss franc segment of the market is dominated by G16 dealers, which is consistent with the commonly-held view that a small number of big counterparties dominates OTC markets.

We dig into this result by reporting the shares of traded notional by dealer-client type in Chart 10. More than 90% of trading involves a dealer as counterparty, i.e. only 2% of the trades did not involve any of the G16 dealers. The interdealer market accounts for a little over 49% of the total notional traded. The findings suggest that the CHF derivatives market is representative of a typical[18] two-tier dealer-centric OTC market consisting of a top tier of inter-dealer trading and a second tier for end users to trade with the dealers.

We next look at the network of exposures using the two-tier dealer-to-client approach. Chart 11 presents the network diagram of the EURCHF forward market.[19] In this Chart, node sizes are proportional to the number of links a counterparty has, while arrow thickness reflects the aggregated notional outstanding amount between two market participants. Dealers are depicted in red and clients as blue nodes. The first observation is the pronounced core-periphery structure. G16 dealers are central to the network, forming a densely connected backbone of the core. Dealer banks are surrounded by 'clouds of clients', typically small- and medium-sized banks, real money investors and corporates. There are also some centrally located clients (but not as big and as connected as dealers) in the middle which are served by several dealers. Gross exposures tend to be larger for dealers, while higher net exposures are

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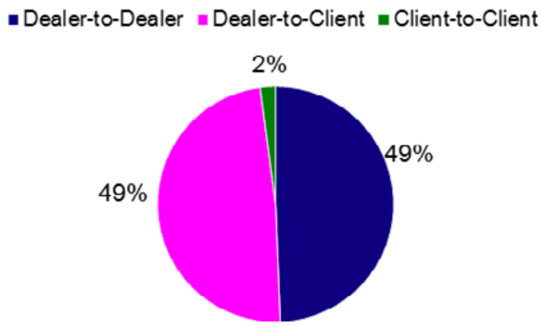
[18] This emerging FX derivative structure is similar to that of other OTC markets. For example, Benos, Payne and Vasios (2016) and Benos, Wetherilt and Zikes (2013) report that the share of interdealer activity in OTC interest rate swap (IRS) and credit default swap (CDS) markets is about 55% and 60%, respectively. One difference is the share of client-to-client trading in our data. The 3% that we observe is slightly smaller than that of the IRS market (about 6-12%), but bigger than that of the CDS market (about 1%).

[19] We focus on the forwards market, because the smaller and less dynamic option market makes it less suited for a network description.

more profound in the dealer-to-client segment. One exception is a particularly large gross exposure between a dealer and a large client (a hedge fund), the big pair of arrows in the bottom left part of the network. More generally, the analysis of the network of exposures can be a useful tool for identifying financial vulnerabilities and the build-up of systemic risk (see Joseph (2014)).

Notional traded between November 2014 and March 2015 in Swiss franc forwards and options by dealer-client type

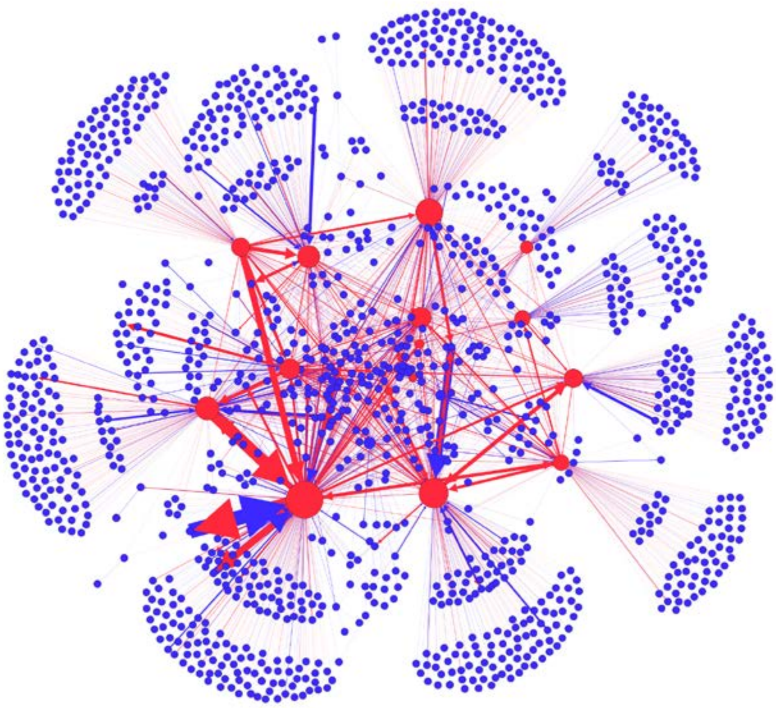
Chart 10



Source: DTCC and Bank calculations.

Visualisation of the traditional two-tier structure of the EURCHF forwards market on 14 January 2015

Chart 11



Red = G16 dealers, blue = clients

Source: DTCC and Bank calculations.

A network topology approach - a three tier market classification

One of the limitations of the traditional two-tier market classification is that it does not distinguish between the different types of clients (the non-dealers). However, as Chart 11 demonstrated, clients in the middle of the network diagram are more connected and more active than the clouds of clients in the periphery. In other words, the client segment can be very heterogeneous.

One way to better capture this property of the network of exposures is by using techniques from network science (see Appendix and Barabási (2016)). Using the network topology, that is the shape of the network, we can split the EURCHF forwards market into three tiers: the inner core, the outer core and the periphery. More importantly, this approach only requires information about the properties of each node, such as the number of connections. Hence, we do not need to make any arbitrary assumption about who is a dealer or a client.

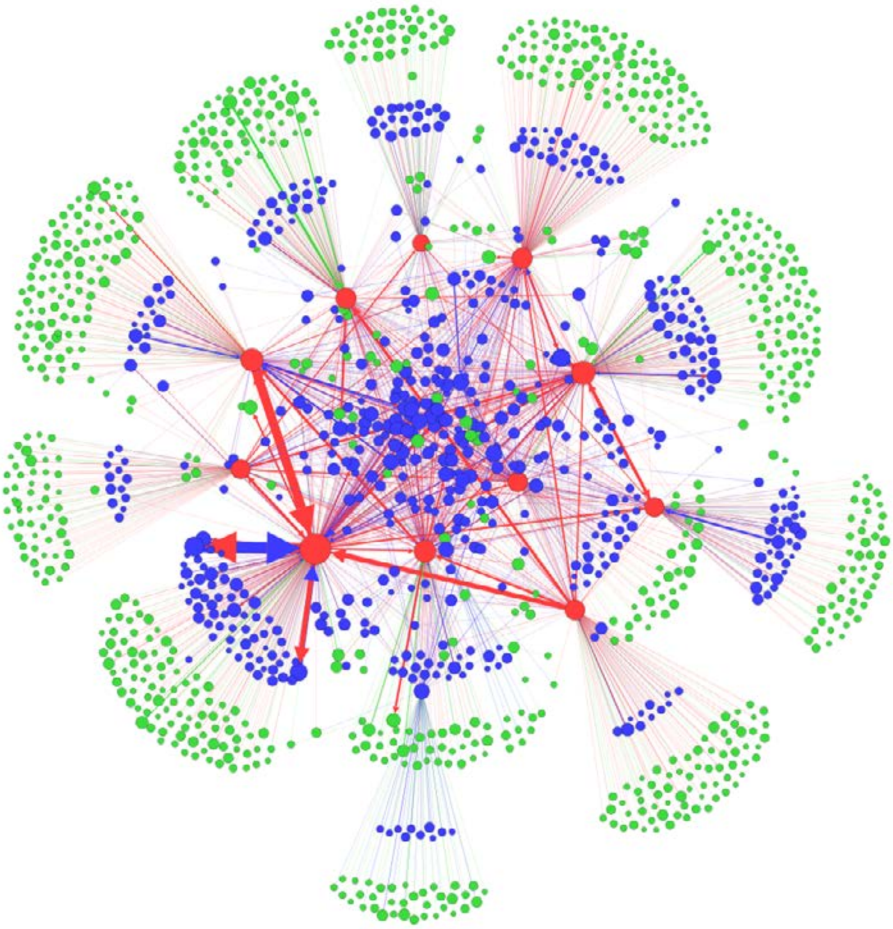
Charts 12 and 13 present the three-tier network classification and the breakdown of each tier by counterparty type, respectively. The node sizes are proportional to the Swiss franc gross position of individual counterparties (logarithmic scale). We can see that constituents of the three-tier structure are as follows. The inner-core, shown in red, consists of dealer banks which exhibit the largest number of connections to other counterparties. The outer core, shown in blue, largely contains banks, corporates and hedge funds. The remaining nodes, shown in green, represent the periphery, largely consisting of smaller banks, real money investors and other counterparties.[20]

The three-tier classification is stable during the whole observation period, i.e. there are no major changes in composition of the layers, although individual counterparties may occasionally move between the outer core and the periphery or leave the periphery (i.e. the market as a whole). The core nodes persistently hold more than 90% of notional position between them, while only constituting about 40% of counterparties. The three-tier classification may be helpful for assessing which firms are particularly important to the functioning of a market, or to identify potentially risky firms and constellations among them.

[20] The "other" counterparties could not be identified due to missing data and the lack of external data sources for cross reference, i.e. they should fit into one of the specific categories and "other" is not a true separate category. These counterparties represent less than 5% of gross positions.

Visualisation of the three-tier structure of the EURCHF forwards market on 14 January 2015

Chart 12

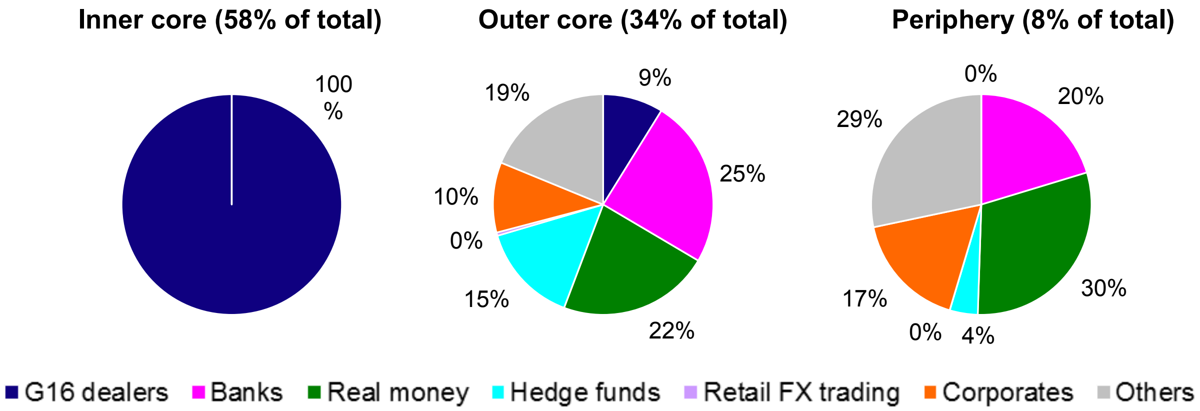


Red = inner core, Blue = outer core, green = periphery

Source: DTCC and Bank calculations.

Composition of different layers on 14 January 2015 by counterparty type

Chart 13



Source: DTCC and Bank calculations

4. Market impacts from de-pegging the Swiss franc

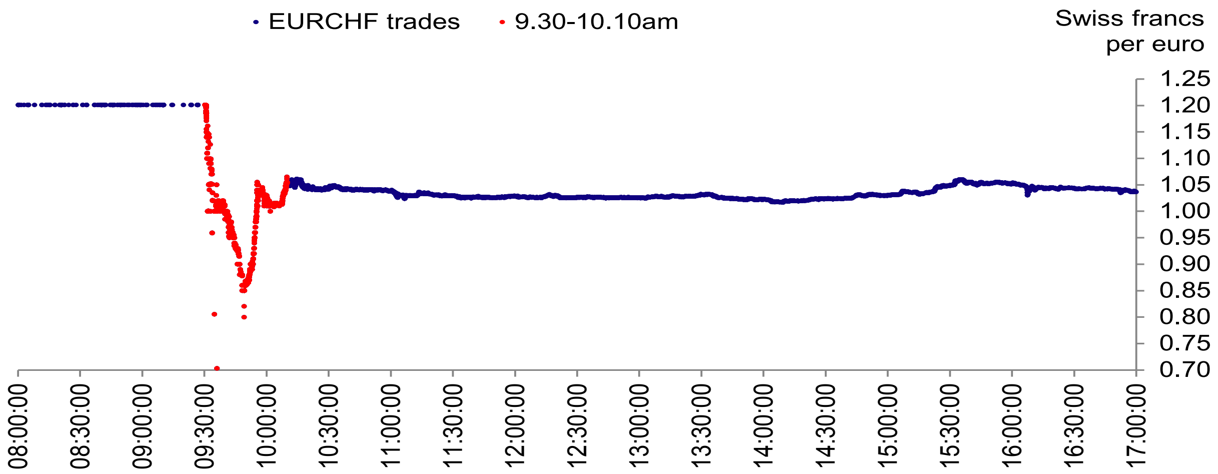
The surprise change in SNB policy is one of the key events that took place in the FX market in 2015. One of the key features that distinguishes the event is the fact it was almost completely unexpected by market participants as far as we can determine from the data. In this section we describe the events on 15 January, first, by reconstructing the intraday activity trade-by-trade. We then examine the immediate impact of the SNB announcement, as well as its longer-term effects on market activity, liquidity, and structure of the network of counterparty positions.

The SNB announcement and its impact on the Spot FX market

At 9.30am UK time the SNB surprised the markets by announcing it was discontinuing the 1.20 EURCHF floor that had been in place since September 2011.[21] The SNB also announced it was lowering the interest rate on sight deposit account balances that exceed a given exemption threshold by 50 basis points to -0.75% and moving the target range for the three-month CHF Libor further into negative territory (from between -0.75% and 0.25% previously to between -1.25% and -0.25%).

Spot EURCHF trades executed on EBS platform on 15 January 2015

Chart 14



Note: We have removed one EBS trade at 9.32 am with a price of just 0.0015. EBS confirmed on the day that the highest value of the Swiss franc traded on the day was 0.85 franc per euro.

Source: EBS and Bank calculations.

The speed and scale of the subsequent currency moves was unprecedented, as shown in Chart 14, which uses spot FX data on individual transactions from EBS. Shortly before the announcement, EURCHF was trading slightly above 1.20. The exchange rate dropped below the 1.20 floor for the first time 47 seconds after the announcement. Two minutes after the announcement, the Swiss franc had appreciated by 11% against the euro. After seven minutes, it was 19% higher. It continued to appreciate to reach a peak of 0.85 francs per euro at 9.49 am, an unprecedented 41% appreciation. It subsequently eased back, falling nearly as fast as in the initial upward move. By around 10.10 am, 38 minutes after the announcement, the franc was 'only' up 15% from its pre-announcement level at around 1.05, where it remained for most of the day. The franc ended the day 14% higher against the euro,

[21] You can find the SNB press release on discontinuing the 1.20 EURCHF minimum exchange rate here: https://www.snb.ch/en/mmr/reference/pre_20150115/source/pre_20150115.en.pdf

and 12% higher against the US dollar, representing 23- and 15-standard-deviation moves, respectively, compared to daily changes in the last eight years, although it is important to note that the standard deviation would have been artificially lower during the period the EURCHF floor was in place.

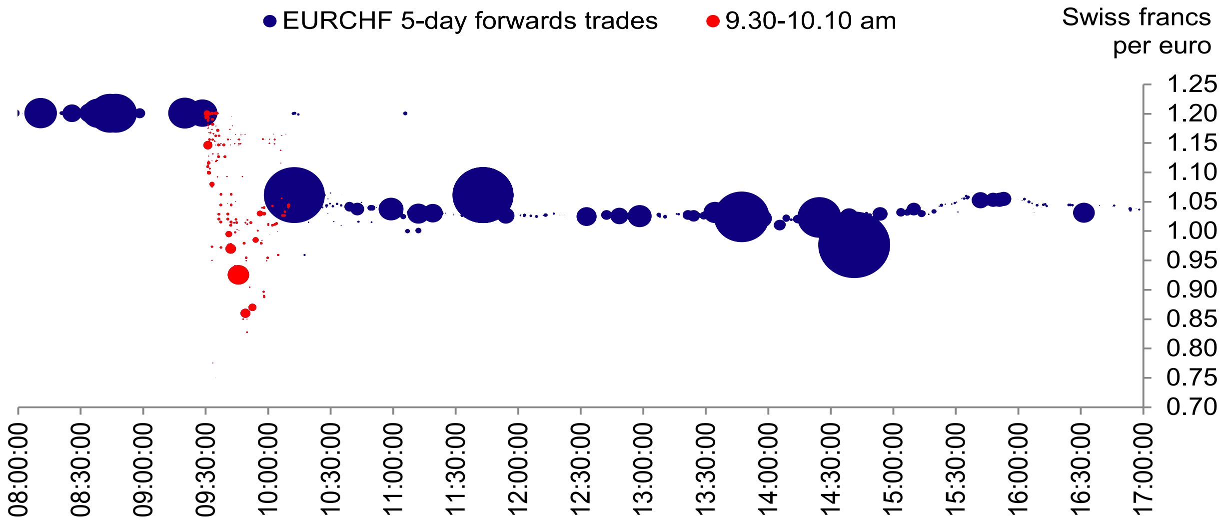
Reconstructing the SNB event trade-by-trade using EMIR TR data

We next use the TR data and reconstruct the trading book on the 15 January 2015. We start with traded prices and notional for the five-day EURCHF forward market. This segment accounted for nearly half (49%) of all EURCHF forwards traded on that day, hence it is a good representation of the whole market. Chart 15 shows all executed trades on the event day, each trade represented by a bubble whose size is proportional to the notional. Trades executed in the interval between 9.30 am and 10.10 am, when prices crashed before recovering to the new equilibrium price, are shaded in red.

The pattern is similar to what we observe in the spot market in Chart 14, yet with much higher price dispersion. The price of five-day forwards fell sharply following the SNB announcement. We observe three trades executed at forward rates below 0.80, one at 9.33 am and two at 9.34 am. The lowest price was 0.65, but the notional traded was extremely small (for this market) at less than USD 1,000. Apart from these three small trades, the price troughed at the same exchange rate as in the spot market (0.85), at the same time (just before 9.50 am). We do observe a small number of trades executed within an hour after the announcement at prices which seem substantially higher than the prevailing price, around 1.15. These might be genuine trades or there might be some issues with the reported execution timestamp. Since these trades have relatively small notional values they do not have a significant impact on the analysis.

EURCHF five-day forwards trades executed on 15 January 2015

Chart 15



Source: DTCC and Bank calculations.

The SNB announcement appears to have taken markets by surprise and made investors to rush into the market to adjust their portfolios, take new hedges or engage in speculative activity. Hence, the sharp price decline to what seemed to be the new EURCHF fair value was expected to some extent: prices adjusted through the trading process. It is the V-shaped price movement, which is highlighted in red, which makes

Chart 15 interesting. If markets were efficient, as economic theory suggests, we should not observe such an exchange rate fluctuation and divergence from fundamentals. One explanation might be the limited provision of liquidity between 9:30 am and 10:10 am. In what follows we examine if this is the case by looking at the different phases of the intraday price movement in conjunction with the trading behaviour of different types of counterparties. We describe each of these in turn, focusing on the building-up of inventories, i.e. the cumulative net positions, and the structure of the trading network. We are particularly interested to see how dealers and the inner-core of the trading network, who are believed to provide liquidity in OTC markets, responded to the SNB announcement. We decompose the events of 15 January into three parts:

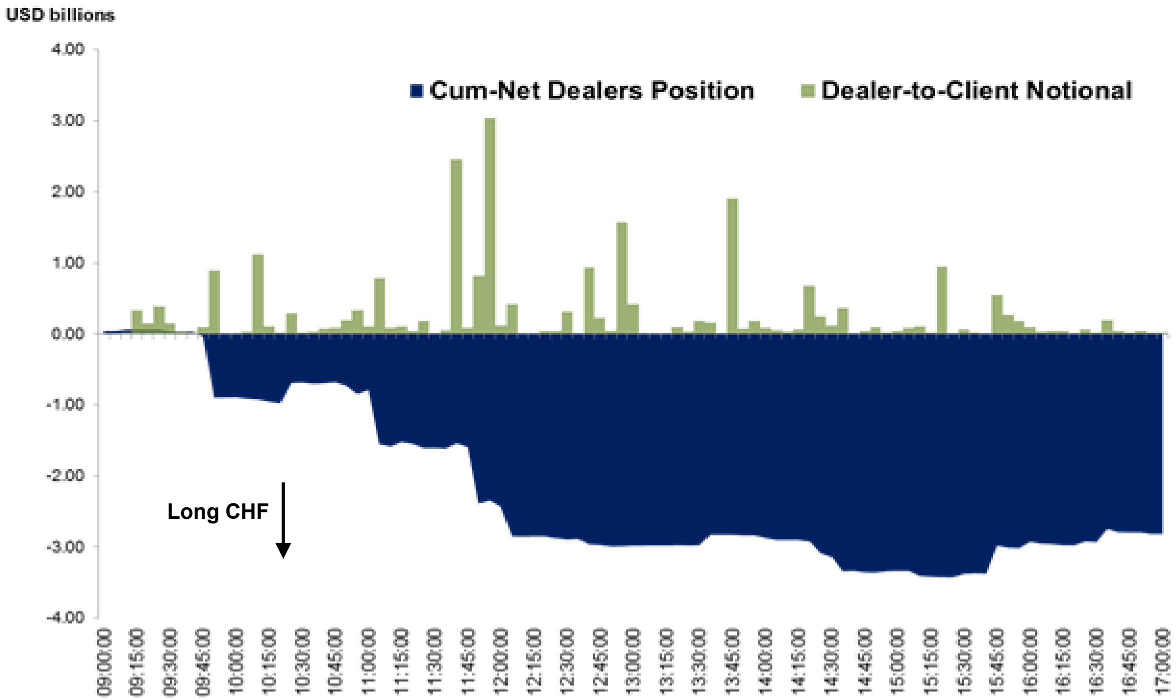
- 9.30-9.50 am, when the Swiss franc was appreciating from 1.20 to a low of 0.85
- 9.50-10.10 am, when the franc was depreciating from 0.85 to around 1.05
- 10.10 am onwards, when the franc stabilised and activity in the market picked up.

9.30-9.50 am: Swiss franc appreciation

Chart 16 shows that the number of Swiss franc forwards trades surged in the minutes after the announcement. Between 9.30 and 9.35 am alone there were 268 EURCHF forwards trades, which was nearly 60 times the average trading for a given five-minute interval between 9.00 am and 3.00 pm before the change in SNB policy in our dataset. The number of trades remained above average for the rest of the day. Despite this increase in the number of trades executed between 9.30 and 9:50 am, the total notional traded remained low. This means that the average size of trades executed in this time period was small, which can be seen in the small size of the red bubbles in Chart 15

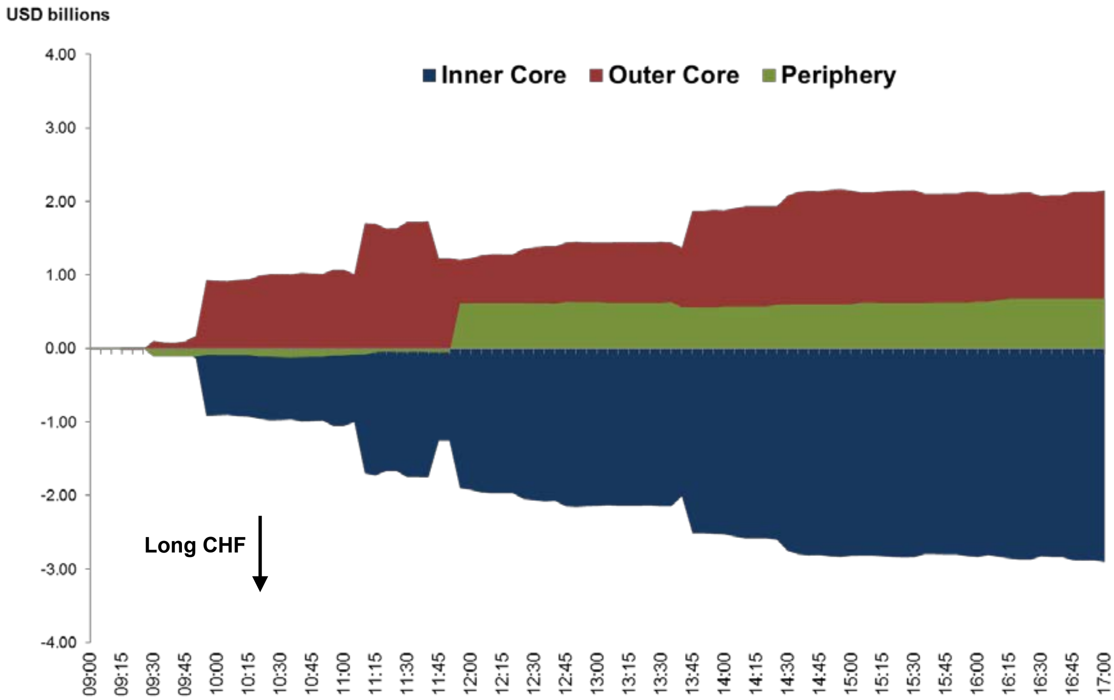
We next look at the behaviour of different counterparties immediately after the SNB announcement. Charts 16 and 17 present the cumulative net positions, i.e. the difference between aggregate long and short positions, of dealers and the different tiers, respectively. Chart 16 also reports the total notional traded in the dealer-to-client market in 5-minute intervals. A first observation is that the dealer-to-client market was very thin in terms of notional traded in the 20 minutes after the event, while dealers' net position was close to zero. A similar picture emerges when we use the 3-tier classification instead, where we see that the inner-core net positions were small too. The observed limited provision of liquidity is surprising given that many market participants wanted to buy the Swiss franc in this time period to capitalise on profits from the expected currency appreciation (i.e, buy low – sell high strategy). On the contrary, we observe that the key liquidity providers were unwilling to build-up any potentially loss-making positions by selling the currency to the interested parties. In fact, immediately after the SNB announcement dealers were net buyers of the Swiss franc. This suggests they were initially consuming liquidity instead of providing it, potentially exacerbating the sharp rise in the franc.

EURCHF forwards cumulative dealer position and dealer-to-client notional traded. Chart 16



Source: DTCC and Bank calculations.

EURCHF forwards cumulative position by tier. Chart 17

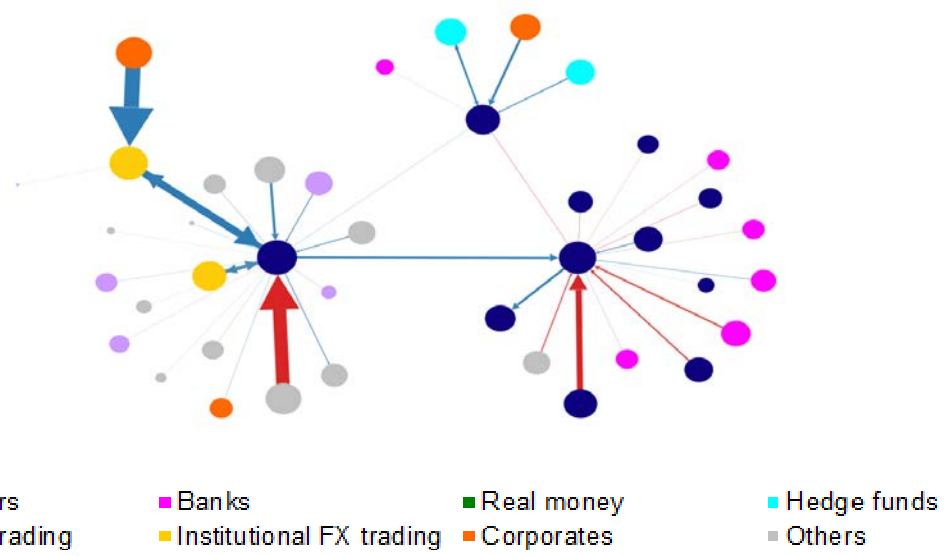


Source: DTCC and Bank calculations

In Chart 18, we zoom in on trading behaviour using more granular data. Here each bubble represents a counterparty that was present in the market, with the size of the bubble proportional to the gross notional traded by the given counterparty in this time period.[22] Arrows pointing away from a counterparty mean this counterparty was selling the Swiss franc, while the width of the arrows represent the size of the trade. The arrows are also coloured according to the weighted average price at which trades were executed between given counterparties. Blue arrows represent trades with forward exchange rates close to 1.20, while red arrows are trades executed below parity. So for instance a blue arrow pointing away from a counterparty means the counterparty had sold the Swiss franc at a cheap price (a high EURCHF exchange rate), presumably leading to a loss. Similarly, a red arrow pointing to a counterparty means the counterparty in question bought the Swiss franc at an expensive price (a low EURCHF exchange rate), also seemingly at a loss.

The network diagram shows that eleven of the G16 dealers were present in the market during the first twenty minutes, but with limited dealer-to-client trading. Only three dealers appeared to provide liquidity to non-dealers (upper centre and bottom left), whereas the rest were active only in the inter-dealer market. The clients who managed to find liquidity were mainly banks, hedge funds and few corporates. A few dealers started providing liquidity after 9.45 am when the exchange rate fell below parity against the euro, in the sense that, they were buying Swiss franc at unfavourable prices, even if this activity was potentially loss-making.

Trading activity by counterparty type in EURCHF forwards market between 9.30 am and 9.50 am (Swiss franc appreciation) Chart 18



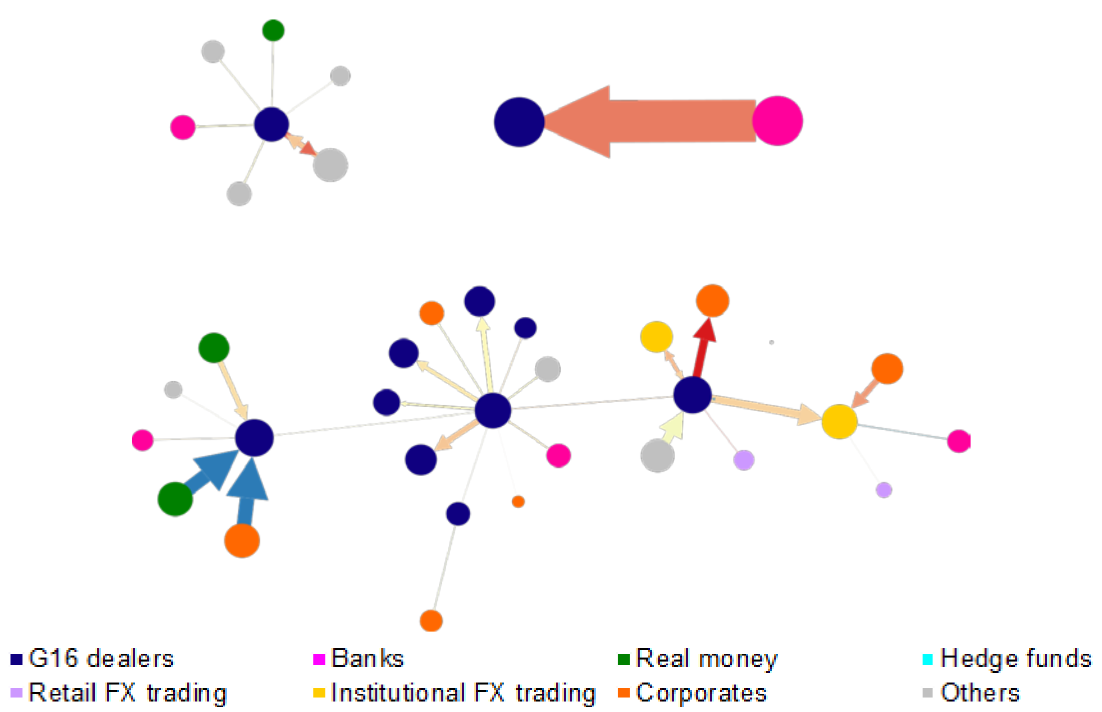
Source: DTCC and Bank calculations.

[22] A logarithmic scale has been used for the size of the nodes to allow all the market participants to be displayed clearly. Some of the larger nodes would have been much larger if a linear scale had been used.

9.50-10.10 am: Swiss franc depreciation

In the subsequent 20-minute period between 9.50 am and 10.10 am (see Chart 19) there was more dealer-to-client activity with dealers building-up larger and potentially loss making positions. This can be seen in the increasingly net long Swiss franc positions of dealers and the inner-core in Chart 17. The network diagram shows it was mainly the outer-core that was consuming liquidity, while the periphery remained relatively inactive. When looking at the trading behaviour of individual counterparties we observe there were five dealers providing liquidity to non-dealers, up from three in the previous 20-minute period. These dealers were at the core of clouds of different clients and were actively buying and selling Swiss franc. Clients consisted of mainly banks, real money investors and corporates. The seemingly stronger engagement of dealers in the provision of liquidity coincided with the price reversal to the new equilibrium level at about 1.05 Swiss franc per euro.

Trading activity by counterparty type in EURCHF forwards market between 9.50 am and 10.10 am(Swiss franc depreciation) — Chart 19



Source: DTCC and Bank calculations.

10.10 am onwards: Swiss franc stabilises

Most of the other counterparties, such as hedge funds, real money investors and corporates re-entered the market only after the price of the Swiss franc stabilised at around 10.10 am. For example, trading volumes between the inner- and outer-core increased dramatically after 10.10 am, with the former taking long Swiss franc positions and the latter short. Around midday the periphery also became more active and started building up short positions. Around the same time we observe that the traded notional in the dealer-to-client market peaked too. Dealers' net long position continued to increase throughout the day as dealers bought the Swiss franc from their clients.

Overall, the evidence suggests that in the first 20 minutes after the event there was limited provision of liquidity as (i) it was difficult to execute any large trade as demonstrated by the small average trade size, (ii) there was limited dealer-to-client trading, and (iii) dealers seemed to be unwilling to build up potentially loss-making inventories. This impairment of liquidity might explain to some extent the sharp appreciation of the Swiss franc (i.e. overshooting). When dealers started engaging more in the dealer-to-client market, the buying pressures to the Swiss franc eased, prices reversed and gradually stabilised.

The V-shaped price movement between 9.30 am and 10.10 am, together with the evidence on the prevailing market liquidity conditions, fits well with the literature that examines the limits to arbitrage (see for example Shleifer and Vishny, 1997). The basic idea of limits to arbitrage is that arbitrage becomes ineffective in extreme circumstances, for example because of the lack of market liquidity, which causes prices to diverge far from fundamental values. In the case of the Swiss franc de-pegging, if more liquidity had been available, arbitrageurs might not have allowed the Swiss franc to appreciate above the new equilibrium price. In other words, we should have seen the exchange rate quickly move to the seemingly new equilibrium price of around 1.05.

Long-term impact on liquidity, volatility and collateralisation

Analysis of both the network structure and trading activity in Section 4.2 implies limited liquidity provision on the day of the event. Here we look into the impact of the SNB action on market liquidity by comparing liquidity levels before and after the event. The main limitations we face for measuring liquidity is that we cannot use one common method of doing this by using bid and ask quotes as we are relying on trade data. As a result, we rely on metrics that require only executed prices to proxy effective spreads and hence liquidity. For all of these measures, a higher value indicates lower liquidity.

The first is the Roll (1984) effective spread measure, which is based on the serial covariance of changes in prices. The measure is defined as:

$$\mathrm{Roll}_{i,t} = 10{,}000 * 2 * \sqrt{-\operatorname{cov}\left(R_{i,s}, R_{i,s-1}\right)},$$

where $R_{i,s}$ is the intraday return between transaction s-1 and s, for contract i on day t. This is shown in Chart 20.

The second is based on the price dispersion measure of Jankowitsch, Nashikkar, and Subrahmanyam (2011), which we define as the average of the relative differences between individual execution prices and the average execution price on day t. More formally,

$$\mathrm{Dispersion}_{i,t} = 10{,}000 * \sqrt{\frac{1}{N_{i,t}} \sum_{i=1}^{N_{i,t}} \left(\frac{P_{s,i,t} - \overline{P_{\imath,t}}}{P_{i,t}}\right)^2},$$

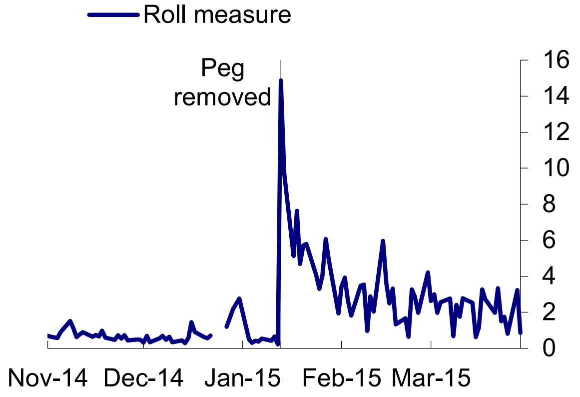
where N_t is the total number of trades executed for contract i on day t, $P_{s,i,t}$ is the execution price of transaction s, and $\overline{P_t}$ is the average execution price on contract i and day t. This is based on the premise that traded prices may deviate from the expected value of an asset because of inventory risk for dealers and search cost for investors.

Both metrics have been derived from market microstructure models and are commonly used in the context of OTC derivatives markets as proxies of transaction costs (see for example, Goyenko et al. (2009), Friewald, Jankowitsch and Subrahmanyam (2014), and Benos, Payne and Vasios (2016) among others).

Other than the liquidity measure we have also estimated daily variance from intraday data. To do this we use the sum of the squares of the high-frequency returns within a given day, which is the standard definition of the realised variance measure of Barndorff-Nielsen and Shephard (2002). Finally, we present the average trade size before and after the SNB announcement, which can also been seen as a proxy for liquidity (market depth).

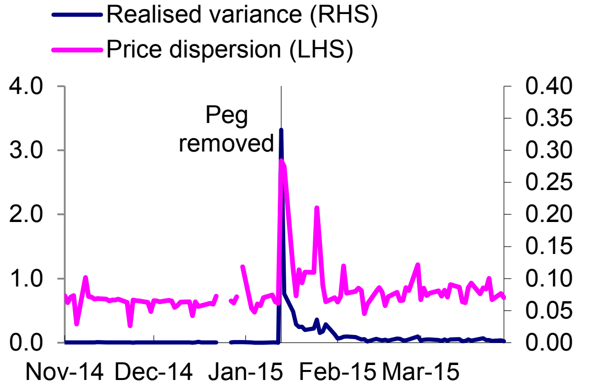
For collateralisation, on the day of the event we observe an increase in the proportion of trades that are fully collateralised between market participants This might reflect an increase in counterparty risk following the change in the SNB policy, another potential driver of the increase in transaction costs.

EURCHF effective spreads based on Roll measure — Chart 20



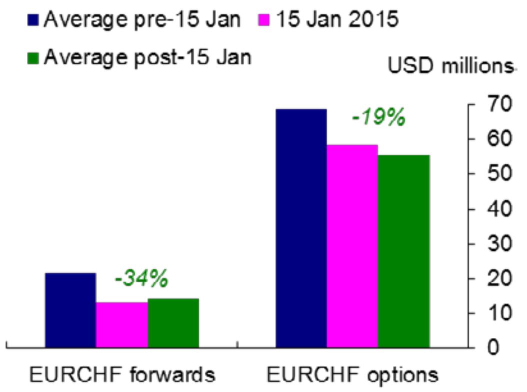
Source: DTCC and Bank calculations.

EURCHF price dispersion and realised variance — Chart 21



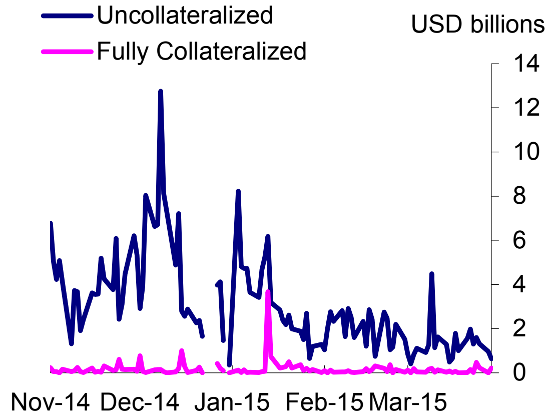
Source: DTCC and Bank calculations.

Average trade size before, on and after 15 January — Chart 22



Source: DTCC and Bank calculations.

Notional traded of uncollateralised and fully collateralised trades — Chart 23



Source: DTCC and Bank calculations.

Charts 20 and 21, present the liquidity metrics for the EURCHF forward market, which includes all forwards contracts with maturities up to five days[23]. The Chart shows that the two liquidity measures provide essentially the same qualitative picture. Market illiquidity rose sharply on 15 January and remained at a high level for the remainder of our sample period. This long-term impairment of market liquidity in the new exchange rate regime is more evident in the case of the Roll effective spread measure. Overall, trading in the Swiss franc OTC derivatives market appears to have become more costly after the change in policy. This may be because the trading costs were artificially depressed while the floor was in place.

Realised variance also rose sharply on the event day and remained at an elevated level. The pattern of volatility might explain to some extent the impairment of liquidity in the months following the SNB announcement. The reason is that the increased volatility is expected to have increased (i) inventory costs for dealers, since market risk increased too, and (ii) information asymmetry, both of which are considered to be the two main determinants of dealer illiquidity.[24] Therefore, if the removal of the floor made it more costly for dealers to provide liquidity, they might have passed these costs to other market participants by charging a wider bid ask spread, thus hurting liquidity.

A similar picture arises when we look at the average trade size variable. Chart 22 shows that the drop in average trade size, observed on 15 January persisted for the remainder of our sample period. Post announcement we observe the average trade sizes for EURCHF forwards and options were 34% lower and 19% lower, respectively (although the drop in EURCHF options trade size is not statistically significant). The smaller trade size might reflect dealers' inability (or unwillingness) to accommodate trading of large positons.

Impact on the trading network and market fragmentation

We next look at whether the change in SNB policy had an impact on the structure of the Swiss franc trading network, as this could provide a micro-founded explanation for the market phenomena observed in the previous sections. We observe that a large number of new counterparties entered the Swiss franc market on 15 January. Many new entrants were small counterparties which were not classified.[25]

We assess the impact on the trading network by looking at the trading backbone network of the market, which we define as the network formed by reciprocal-only daily trading links of comparable contracts in the five-day forward market. The basic idea of this approach is to gauge the event's impact on the most active parts of the market. For this, we measure the number of connected components in the trading backbone on each day. A connected component is a part of a network within which

[23] When calculating the liquidity metrics and the realised variance, we remove all trades executed before 10.10 am on 15 January. We do so to control for the rapid Swiss franc appreciation immediately after the event.

[24] For instance, seminal papers by Glosten and Milgrom (1985) and Kyle (1985) have shown that asymmetric information is positively related to illiquidity. This is because market makers or dealers tend to ask an additional compensation to offset their potential losses on trades with better informed investors. This is known as adverse selection. Stoll (1978) was the first to show that inventory risk plays an important role for market liquidity too. The basic idea is that as dealers accumulate positions they are exposed to losses from adverse price movements, because not all of these positions can be unwound immediately. Dealers tend to pass these losses to other market participants by charging a wider bid ask spread.

[25] This is both because of lack of LEIs and the fact these counterparties' exposure fell below the threshold we used for classifying firms actively (there being no definitive source of counterparty sector information currently).

every node can be reached from every other node across at least one path going along the network's links. For example, a market where all counterparties are connected to each other consists of one component. If we split this market into two parts that are not connected to each other, then we will increase the number of components to two. Intuitively, a large number of components will indicate a high degree of market fragmentation.

We apply this approach to the EURCHF forward market in Chart 11/12.[26] The results are shown in Chart 24. The blue line reports the number of connected components (of at least three counterparties). A value of one indicates that everyone was linked in a single network, while higher values mean the trading network was made up of two or more separate parts. We observe that the market appears to have become more fragmented after the removal of the EURCHF floor, with the number of unconnected sub-components increasing to about 4.5 from 3.5.[27] This might have been driven by dealers' unwillingness to facilitate trading among different parts of the network, as a result of the increased transaction costs in the same period (see Section 4.3).

We test this assertion by looking at the number of interdealer links before and after the SNB event. This is defined as the number of inter-dealer links as a proportion of all links and is presented in Chart 25. We observe a decline in the average number of interdealer links, which is however, less pronounced than the average increase of the number of connected sub-components. Note, however, that the variation of the number of long-range connections in a network, which are given by inter-dealer links in our case, can have far-reaching implications for its aggregated properties (see Albert and Barabási (2001)). For instance, liquidity and price dispersion are expected to be affected by the amount of inter-dealer activity.

We look at the impact of the SNB event on market fragmentation and interdealer links more formally in Table 1, where both variables are regressed on a number of date dummies. The post SNB event dummy equals 1 after the event and 0 otherwise, and it captures the longer-term effects of the event. The Wednesday dummy equals 1 on 14 Jan 2015 and 0 otherwise, while the Thursday and Friday dummies are defined in the same fashion. The results in Table 1 show that the 5d EURCHF forward market became more fragmented in the weeks following the SNB event. In the same period the number of interdealer links decreased. All these effects are strongly statistically significant.

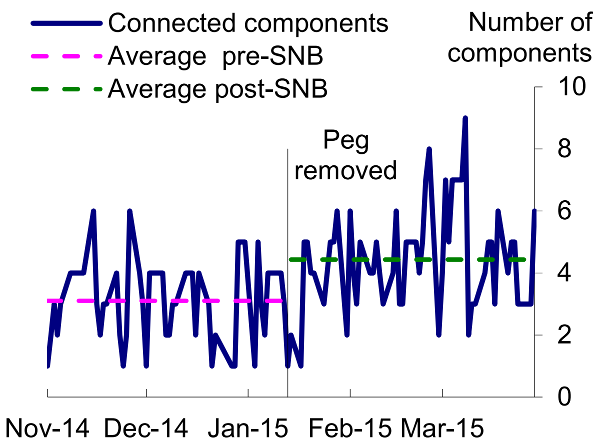
As an illustration of the higher market fragmentation we compare the backbone activity on two days: the event day and 21 January (one week after the event), which are depicted on the left- (LHS) and right-hand-side (RHS) of Chart 26, respectively. Chart 26 shows that the trading network on 15 January was very dense. Most clients were connected to their corresponding dealers in star-shaped sub-structures (rather than connecting parts of the network), and all dealers were connected to each other through the interdealer market. As a result there was just one connected component. In contrast, the number of connected components increased to two on 21 January. This is true for most days after the removal of the floor.

[26] The EURCHF option market is too illiquid to construct similar measures.

[27] It can be shown that the increase in the number of sub-components after the event is statistically significant.

Number of connected components of at least three counterparties in the Swiss franc market

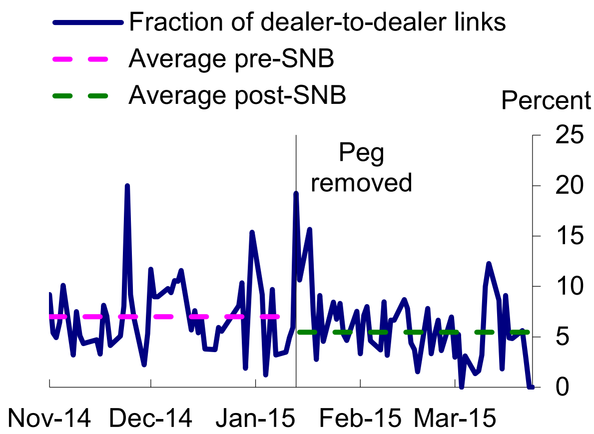
Chart 24



Source: DTCC and Bank calculations.

Dealer-to-dealer links as fraction of all links

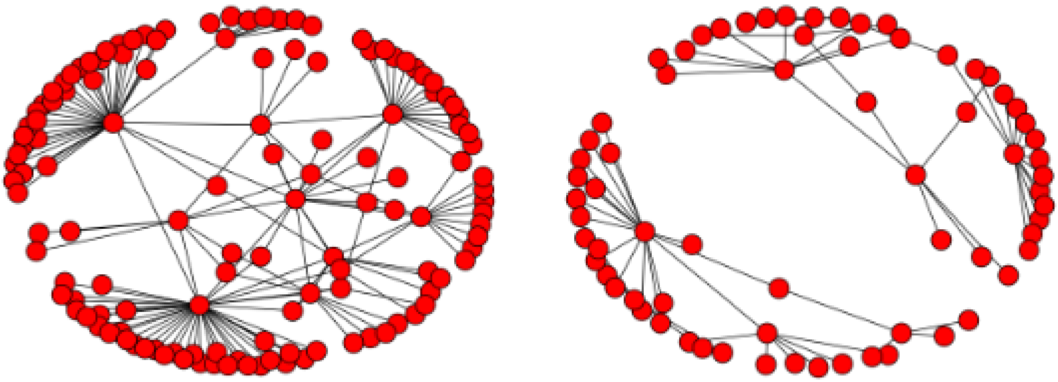
Chart 25



Source: DTCC and Bank calculations.

Schematic description of the fragmentation of the EURCHF forwards market cores (LHS: 15 January, RHS: 21 January)

Chart 26



Source: DTCC and Bank calculations.

Regression analysis of the impact of the SNB event on the trading network of the 5d EURCHF forward market. Robust t-statistics are shown in the square brackets. *, ** and *** denote significance at 10%, 5% and 1% levels respectively

Table 1

	Fragmentation	
Wednesday (14/01)	-0.102	-0.0107**
	[-0.531]	[-2.111]
Thursday (15/01)	-2.102***	0.122***
	[-10.93]	[24.00]
Friday (16/01)	-1.102***	0.0362***
	[-5.732]	[7.118]
Post SNB event (17/01-31/3)	1.379***	-0.0164**
	[4.652]	[-2.421]
Constant	3.102***	0.0702***
	[16.13]	[13.78]
R^2	0.216	0.188
Adjusted-R2	0.185	0.155
N	104	104

5. Conclusions

In this study, we present the first in-depth and large-scale study of the FX derivatives market using trade repository (TR) data resulting from the EMIR reporting framework. TR data cover bilateral trading activity on a trade-by-trade basis and information on outstanding contracts, which can be used to gauge exposures in a detailed manner. Thus, they provided us with a great wealth of information about activity in the FX derivatives market. Using data from a single large TR, we investigated the properties of the EURCHF forward and option market and analysed the impact of SNB's decision to discontinue the floor of 1.20 Swiss francs per euro on the morning of 15 January 2015. Importantly, TR data allow us to understand the complex structure of OTC markets and analyse the provision of liquidity during adverse market conditions.

We observe a decline in market liquidity and increase in market volatility after the SNB's announcement, which also had lasting consequences for the market. The TR data gives us the ability to carry out an intraday analysis of the prevailing trading conditions on the event day. We find that there was very little activity immediately after the SNB announcement, particularly in the dealer-to-client segment of the market. This might reflect dealers' unwillingness (or inability) to provide liquidity, which potentially exacerbated the sharp rise and then decline in the franc in the first 40 minutes of the event.

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7. Appendix

Methodology for three tier network construction

Segmentation of the market into three tiers is done by classifying nodes in the network using the degree distributions of the forwards and options networks. [28] In Chart 27, the x-axis represents the number of connections a given counterparty has with other counterparties (i.e. the number of outstanding positions with different counterparties). The y-axis shows the fraction of counterparties which have a larger or equal number of connections, i.e. the inverse cumulative degree distribution. Both the forwards and options markets are characterised by a heterogeneous topology with a densely connected group of dealers at its centre (to the right of the vertical lines). At the other extreme around a fifth of counterparties have only one link. This distribution is stable over time and largely unaffected by the event.

This heterogeneous topology means the market is highly concentrated around high-degree nodes and liquidity provision relies on a small number of highly interconnected counterparties, that is, mainly dealer banks. This may make the network more vulnerable to shocks that affect any of these central counterparties, see Albert and Barabási (2002). Based on the observations that not all dealer banks are high-degree hubs in this network picture [29] and that there is a high degree of heterogeneity between the remaining clients, we propose a topological three-tier classification of the market: Note that the three-tier structure is determined endogenously, i.e. by the properties of the market structure. Only the cut-off to distinguish between the inner and outer core has been set in a data-driven way.

- Inner core (red in Chart 12): All counterparties to the right of the vertical lines in Chart 27 (Chart 28 shows the corresponding picture for options). The cut-offs have been set before the 'scale-free-like' part of the distributional tails of the out-degree (number of CHF-short positions) distribution, which is stable at about 50-60 over the whole period for forwards and 10-20 for options.[30] These nodes are the hubs, i.e. mostly connected counterparties, of the network and consist of a stable group of 11 dealer banks[31].
- Outer core (blue in Chart 12): The largest strongly connected component of the network, excluding counterparties in the inner core. Every node in the outer core can be reached from every other node via a path of directed long/short positions. These are counterparties which have at least one short and one long position in EURCHF, which, for some counterparties, could mean they were engaging in market-making activity to some degree. These counterparties also can be classified by their degree, which lies between two and 55/15 for forwards/options.
- Periphery (green in Chart 12): The largest weakly connected component of the network, consisting of counterparties which are connected to the core, but have no

[28] The degree (number of connections) distribution of a network is an indicator for its internal structure. The main distinction is made between homogeneous topologies, where most nodes have a comparable number of connections, and heterogeneous topologies, where the degree can vary over several orders of magnitudes and where, in most cases, there is a small fraction of interconnected hubs with a particularly high number of connections. The topology of a network has implications for a network's resilience under different attack/shock scenarios.

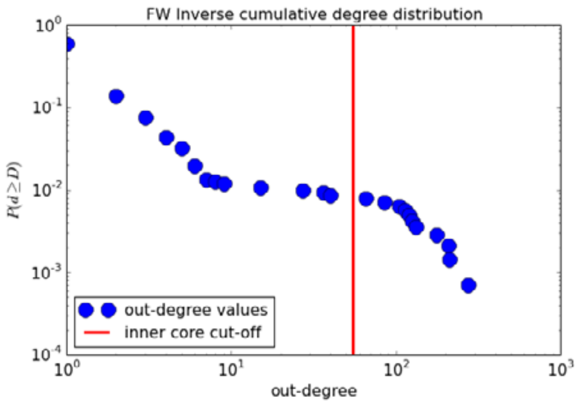
[29] This may be related to the lack of data on the EURCHF market.

[30] Taking the in-degree or total (i.e. in -plus out-) degree leads to the same overall picture.

[31] Here we used the out-degree distribution, that is the number of aggregated CHF short-positions a counterparty has. The classification is broadly the same in composition and stability when using CHF long-positions. There is one smaller dealer in our dataset which may switch between the inner and outer core depending on the chosen cut-off (see Chart 12 and the second pie-chart in Chart 13).

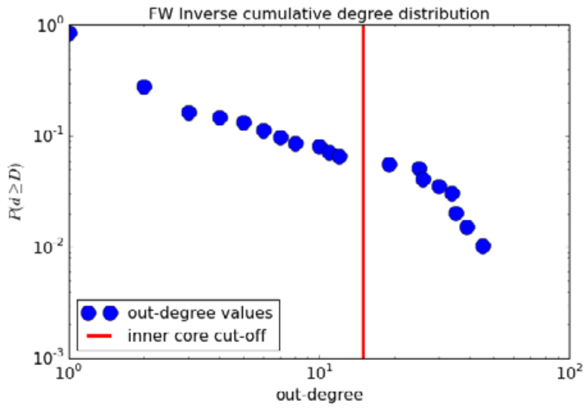
directed paths to or from all other counterparties. The periphery mostly consists of typical clients in the traditional two-tier picture, which only buy or sell a given currency, hence mostly having a single connection going in either direction.

Out-degree distribution for Swiss franc forwards on 14 January 2015 Chart 27



Source: DTCC and Bank calculations.

Out-degree distribution for Swiss franc options on 14 January 2015 Chart 28



Source: DTCC and Bank calculations.

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Measuring the foreign exchange position for the corporate sector: CBRT's experience[1]

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Central Bank of the Republic of Turkey

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Measuring the Foreign Exchange Position for the Corporate Sector: CBRT's Experience[1]

Aylin Aslan[2] and Burcu Tunç[3]

Abstract

The foreign exchange (FX) assets and liabilities of the corporate sector could give important insights regarding the funding conditions of the sector and also signal financial strengths/vulnerabilities of the economy. Specifically, the indirect exchange-rate-induced credit risk for the banking sector stemming from the FX denominated loans to commercial sector is considered as one of the systemic risk measures. Two different methodological approaches could be applied to measure FX assets and liabilities of the non-financial sector: (1) a micro approach which basically depends on the direct aggregation of the granular data and (2) a macro approach which refers to indirect compilation of the data from the counterpart information e.g. from financial sector's balance sheets and balance of payments statistics. The granularity of the data in micro approach would provide the user the opportunity to pursue a comprehensive currency mismatch analysis which could also be extended for the sub-sectors and firm size. However, it comes with a difficult task of collecting the FX balance sheets of each single firm and applying plausibility checks on the data and hence has a potential timeliness problem. Even though it has a drawback due to the non- granularity of the data, the macro approach produces a timely and reliable data set which covers the whole corporate sector for the transactions with the financial sector and the non-resident sector. This paper aims to represent the Foreign Exchange Assets and Liabilities of the Non-Financial Companies data set compiled by the Central Bank of Turkey (CBRT) on a monthly basis within a macro perspective and propose a new methodology to fill in the gaps by using firm-level granular data without losing the advantages of the macro approach.

Keywords: Currency mismatches, corporate balance sheets, FX assets and liabilities, macro approach, micro approach

JEL classification: E40, F20, F30, F34, F41, G15, G21, G23

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[1] We would like to thank Ahmet Adnan Eken for his valuable contributions. The views expressed are those of the authors and not necessarily reflect the views of Central Bank of the Republic of Turkey.

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Contents

1- Introduction

The FX assets and liabilities of the corporate sector could give important insights regarding the funding conditions of the sector and also signal financial strengths/vulnerabilities of the economy;

- funding conditions of the corporate sector directly affects the growth performance of an economy. FX funding is a crucial source for the corporate sector especially in the economies with relatively low saving rates.
- the ability of the commercial sector to raise FX funding especially from abroad is a good indicator for the overall creditability of the economy.
- the indirect exchange-rate-induced credit risk for the banking sector stemming from the FX denominated loans to commercial sector is accepted as one of the systemic risk measures. Although the degree of currency mismatch in bank balance sheets is small, banking sector might face a spillover effect stemming from the FX loans granted to the unhedged corporate sector. To assess this indirect risk accurately, the structure of the FX assets of the corporate sector is as crucial as the structure of the FX liabilities.

Two different methodological approaches could be applied to measure FX assets and liabilities of the non-banking sector: (1) a micro approach which basically depends on the direct aggregation of the granular data and (2) a macro approach which compiles the data indirectly from the counterpart information e.g. from financial sector's balance sheets and balance of payments statistics.

Micro approach, ideally, refers to a direct summation of FX financial balance sheets data collected from each of the individual firms that are classified as corporate sector. Since the output will be a fully aggregated balance sheet of the corporate sector, it is expected to cover the whole set of economic and financial activities and hence would give the exact stock values of the FX assets and liabilities of the sector. With such a comprehensive data set, it would be possible to analyze accurately the level of currency mismatches (if there is any) for the sector. The analysis could also be extended for the sub-sectors, firm size (large and small and medium size enterprises) and even for firm level (e.g. systemically important firms). In addition to the information regarding the currency mismatch, the maturity breakdown of the FX debt could easily be assessed. The level of hedging is also derivable from the data since the granularity of the data gives the user the opportunity to pursue an instrument- and firm-level analysis.

On the other hand, collecting the FX balance sheets of each single firm can be costly and frequency of these micro data bases (mostly annual) is not in accord with the need of the users.

The macro approach, on the other hand, refers to an indirect compilation of the data from the counterpart information instead of the firm-level balance sheets. This approach utilizes monetary and financial statistics (MFS) that capture the relations between the corporate sector and financial sector, and the international investment position (IIP) that captures the relations between the corporate sector and non-resident sector. Both MFS and the IIP statistics are compiled on a monthly basis and have sectoral and currency breakdowns. The data produced with macro approach would be timely and accurate since all the plausibility checks regarding the relevant information for this study is already applied. Thus, the macro approach produces a timely and reliable data set which covers whole corporate sector for the transactions with the both domestic and non-resident financial sector as well as non-financial non-resident sector.

However, the data set does not cover the intra-sector relations or FX cash hold by the sector. Besides the disadvantage regarding the coverage, the main disadvantage arises from the fact that the data set is compiled from an aggregated data set instead of the granular data and thus the level of currency mismatch can only be tracked for the whole sector. In other words, the data for a deeper analysis on a sub-sector or firm size level is not available with this approach.

There is an extensive literature analyzing currency mismatch and its risks. As defined in the paper of Chui et al. (2016), a currency mismatch between domestic and foreign currencies arises whenever a company's balance sheet or income flows (or both) is sensitive to changes in the exchange rate. The "stock" aspect of a currency mismatch is revealed by the sensitivity of the balance sheet to changes in the exchange rate, and the "flow" aspect is revealed by the sensitivity of the income statement (net income) to changes in the exchange rate. The greater the degree of sensitivity to exchange rate fluctuations, the greater the extent of the currency mismatch.

Most of the papers tend to explore currency risk within a micro perspective by using a firm level dataset. For example, Hülagü and Yalçın (2014) find that firms in Turkey with small size and high currency risk have reduced their liability dollarization ratios and extended the maturity of FX debt in recent years. Moreover, their findings suggest that firms in Turkey with limited export revenues and having high FX denominated debt obtain higher FX profits which compensate a significant amount of their FX financial expenditures.

Özmen and Yalçın (2007) have similar approach on this aspect. They also discuss financial fragilities of Turkish corporate sector to exogenous financial risks stemming mainly from global imbalances by using the CBRT Risk Center and CBRT Company Accounts firm level data over the 1996-2005 period. The findings of their study suggest that, in spite of improvements in the leverage ratios and interest risks after the 2001 crisis, liability dollarization and short maturity structure of debt still appear to be the main sources of fragility in Turkish corporate sector against exogenous financial shocks.

In the same vein, Özlü et. al. (2012) investigate the trade credit channel of monetary policy transmission in Turkey by using a large data set of corporate firms, which includes detailed information on balance sheets and income statements of firms regularly reported to the CBRT in the period of 1996-2008. Their study suggests that the composition of external finance differs considerably across firm types based on size and export performance under tight and loose financial conditions.

Chui et al. (2016) emphasize that data on the aggregate position of the corporate sector are meagre. They report on a balance sheet analysis of about 280 companies, distinguishing in particular those which produce tradable goods or services and those which produce non-tradables. According to their analysis, microeconomic or firm-level data may be more illuminating and show that the companies producing tradable goods or services are better placed to service foreign currency debt suggesting they have a natural hedge.

Another strand emphasizes the implications of using aggregate data. For example, Cowan et al (2006)'s study of Chilean nonfinancial corporations makes a comparison between the inferences of using macro data and micro data. They suggest that both dollarization of external liabilities and dollarization of the domestic financial system are correlated with increased volatility of output and capital flows and with greater financial vulnerability. Moreover, external dollarization reduces the expansionary effects of depreciation and makes a sudden stop in capital flows more likely. In contrast to the macroeconomic literature, they argue that studies based on firm-level data obtain ambiguous results on the impact of depreciation on investment and output of firms with dollar debt.

This paper aims to represent the FX Assets and Liabilities of the Non-Financial Companies data set compiled by the Central Bank of Turkey (CBRT) on a monthly basis using macro approach and propose an improvement to fill in the gaps by using firm-level granular data without losing the aforementioned advantages of the macro approach.

The paper is organized as follows: Section 2 introduces the data and methodology regarding the current compilation practices of Turkey, Section 3 gives an overview for the FX position of the non-financial sector based on the data produced, Section 4 discusses the deficiencies of the data with future plans for improvement and Section 5 concludes the paper.

2. Data and Methodology

2.1. Assets

2.1.1. Deposits consist of the sum of deposits held in domestic banks and banks abroad. Deposits held in domestic banks, in turn, are the sum of deposits held in deposit banks and participation banks.

2.1.1.a. Deposits held in domestic banks: Data source is Monthly Money and Banking Statistics of CBRT. Data is compiled from Participation Banks' Funds Raised (Sectoral Breakdown) and Deposit Money Banks-Deposits-Sectoral Breakdown. The relevant data is the total of the entire "Resident Legal Persons' Foreign Exchange Funds" item and "Precious Stones Deposit Accounts (FX) of non-financial corporations and individual corporations''. Legal persons include Commercial Firms, Individual Corporations and Non-Profit Institutions Serving Households. The data is published on a monthly basis with a lag of 2 months.

2.1.1.b. Deposits abroad: Data is accessible, in its broadest form, through the Locational Banking Statistics published by the Bank for International Settlements (BIS). As the relevant data provides a breakdown of the sector as banks and non-banks, deposits of the non-bank sector abroad may also include non-bank financial sector. Data on deposits, covers all institutions except the banking sector, includes real persons and excludes official monetary authorities. Also included in the non-bank sector are general government and public administrations.

As the Turkish lira is not one of the reported currencies, in the BIS statistics pertaining to 'deposits abroad', data includes both TL deposits held with the branches of domestic banks abroad, as well as TL deposits held with the banks abroad. Data for the countries such as Bahrain, Cayman Islands and the Bahamas have been consolidated as "the data for off-shore centers" upon the requests from these countries. The relevant data is accessible through the BIS web site: Statistics/Banking/Locational Statistics/A6 Residence of counterparty. BIS publishes the data on a quarterly basis with a six-month lag.

2.1.2. Securities consist of government securities issued in Turkey, Eurobonds and portfolio investments abroad.

2.1.2.a. Government Securities: Data compiled from the Securities Weekly Information Form reported by banks and intermediaries as a part of "Supervisory Reporting Package of Banks and Participation Banks" while the current values of the stock by the final week of the each month are used as a proxy for end-month stocks values. The data covers FX denominated government securities issued domestically or abroad and which are held by domestic non-bank commercial sector which is classified as other commercial corporations in the weekly report.

2.1.2.b. Portfolio Investments Abroad consists of the market value of residents' investments in equities, bills and bonds issued abroad. Data source is the Portfolio Investments Surveys that have been conducted initially on an annual basis between 2001 and March 2006, and on a quarterly basis then onwards. Data is derived by deducting the non-financial firms from the sum of Equity Securities, Debt Securities and Money Market Instruments of Firms listed under Other Sectors in the table of "Residents' Portfolio Investment Assets in Foreign Securities-By Instrument" published on CBRT's website under Statistics/Balance of Payments and Related Statistics/ International Investment Position/Data. The data is published quarterly with a lag of 2 months.

2.1.3. Export Receivables equals to the sum of short-term trade credits extended by domestic exporters to the clients abroad and classified as a short term asset in the Foreign Exchange Assets and Liabilities of Non-Financial Companies Table. Trade credits include the payment methods of cash against goods, deferred payment letter of credit, acceptance credit and advance payments. The data covers the export receivables of "non- bank financial institutions" including insurance companies, pension funds and other financial intermediaries; "non-financial institutions (including SOEs)", including non-profit institutions such as trade unions, charities, etc. and "households".

The data is accessible at the CBRT's website, through "International Investment Position: External Assets and Liabilities at End of Period" link under Statistics/Balance of Payments and Related Statistics/ International Investment Position/Data. The data is published on a monthly basis and the lag period is 2 months.

2.1.4. Direct Investments Abroad: Main source of the data is the annual survey of "Turkey's Direct Investment by Country and Sector" applied by the Undersecretariat of Treasury. The data is taken from the table "Residents' Foreign Direct Investments Abroad-By Sectors" published at CBRT's web site under Statistics/Balance of Payments and Related Statistics/International Investment Position/Data (Tables) by deducting Financial and Insurance Activities. Because the table is drawn up as annual stock values, the flow variable in Balance of Payments Statistics is used for the monthly data set. The data includes the loans granted by the resident parent enterprise to the nonresident enterprise in which the resident enterprise owns 10 percent or more of the shares and the loans granted by the resident enterprise to its nonresident affiliates. Stock data are released annually and flow data are released monthly. The lag period of stock data is 6 months, and that of flow data is 2 months.

2.2. Liabilities

2.2.1. Loans composed of Domestic Loans and External Loans.

2.2.1.1. Domestic Loans composed of Loans extended by Banks, Non-Bank Financial Institutions and Past-Due Loans Taken Over by SDIF.

2.2.1.1.1. Loans Extended by Banks composed of FX loans and FX-indexed loans extended by deposit, development, investment and participation banks. The data is based on the forms filled in by the banks within the framework of the "Uniform Reporting Package of Banks and Participation Banks". Loans Extended to Private Sector is composed of non- financial companies, private companies, non-profit corporations serving households, agricultural sales cooperatives and other items. The data is published on a monthly basis and the lag period is 2 months.

- *FX-Indexed Loans:* The data is compiled from the forms filled in by the deposit, development, investment and participation banks within the framework of the "Uniform Reporting Package of Banks and Participation Banks". Accruals arising from exchange rate appreciation and exchange rate appreciation discounts are added to the private sector FX-indexed loans while the reductions resulting from exchange rate depreciation are reduced from the private sector FX-indexed loans. Beginning from the data of December 2008, FX Indexed Loans are decomposed into "short term" and "long term" based on the original maturity of the loans. The data is published on a monthly basis and the lag period is 2 months.

2.2.1.1.2. Non-Bank Financial Institutions: For receivables of non-bank financial institutions from corporate sector (private companies, non-financial companies (including SMEs)), the data is based on the FX and FX-indexed loans of a total of 188 non-bank institutions that have reported to the Banking Regulation and Supervision Agency (BRSA). Data for December 2005 was directly obtained from the Turkish Leasing Association (FĐDER), the Factoring Association and finance companies. As of March 2006, data started to be obtained directly from the BRSA based on quarterly terms. Receivables from Leasing Transactions refer to the sum of the credit at the amount of the invoice of the goods provided by the leasing company to institutions and the interest accrued on the credit. This sum is subject to a discounting operation by subtracting the unearned finance income from this sum. Receivables from Factoring Transactions (Net) are followed under two headings as discount and other transactions on balance sheets, where in a discount transaction the net amount paid to the bill holder is directly recorded as loans receivable. The credits extended by finance companies are composed of credits extended to non-financial companies as commercial loans. The data is published on a quarterly basis and the lag period is 3 months.

2.2.1.1.3. Past-due Loans Taken Over by SDIF: The past-due loans taken over by Saving Deposits Insurance Fund are the receivables from controlling shareholders of bankrupt banks. Receivables in foreign currencies are affected by the exchange rate movements. Data is accessible at CBRT's website through "Monthly Money and Banking Statistics" under Banking Sector Credit Volume Data. The data is published weekly and the lag period is 2 weeks.

2.2.1.2. External Loans: The cash loans received from abroad are reported with respect to their maturities based on declarations of non-bank financial companies and real sector excluding real persons. Data source is the "Outstanding Loans Received From Abroad by Private Sector" tables published at the CBRT's website under Statistics/Balance of Payments and Related Statistics/Outstanding Loans Received From Abroad by Private Sector/Data, which are based on real sector's declarations about loans. While loans received by the resident enterprise from the nonresident parent enterprise which owns 10 percent or more of the shares in the resident enterprise or from its nonresident affiliates, and debt securities issued abroad by residents with original maturity of more than one year and with fixed interest rates or variable interest rates specified on a contractual basis are included; TL loans, loans borrowed by banks, and non-bank financial companies and real persons are excluded. The data is first decomposed into "short term" and "long term" based on the original maturity, then the loans classified as long term is decomposed into "One Year or Less to Maturity" and "Over One Year to Maturity" based on a remaining maturity basis. The data is published monthly and the lag period is 1 month.

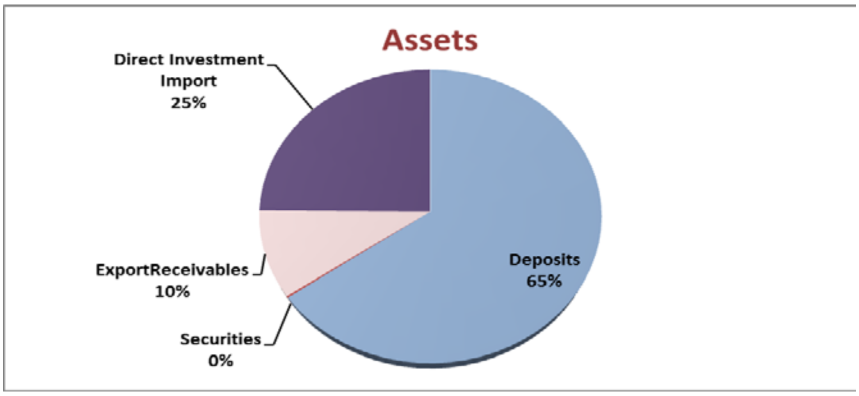
2.2.2. Import Payables are short-term liabilities arising from imports and its payment is due after the delivery of goods. They are followed under "Short-term Debt Stock" under International Investment Position. Import payables are compiled from Turkish Statistical Institution's data on commercial loans. Data is available at CBRT's website under Statistics/Balance of Payments and Related Statistics/International Investment Position/Data/Short-term Debt Stock/Due to Imports. The data for long-term liabilities arising from imports is accessible through the CBRT's website at Statistics/Outstanding Loans Received From Abroad by Private Sector/Data/Outstanding Long-Term Loans Received From Abroad By Private Sector. The relevant data is "Trade Credits" item under "Nonfinancial" part of the table. The data is published monthly and the lag period is 1 month.

3. An FX Position Overview for Turkish Non-Financial Corporation Sector

This part of the paper aims to provide an overview regarding the FX assets and liabilities of the non-financial corporations sector based on the produced data. It is seen in Table 14 that the analysis covers the period between 2002 and 2016. As of April 2016, the net FX position is USD 195 billion with assets USD 109 billion and liabilities USD 302 billion.

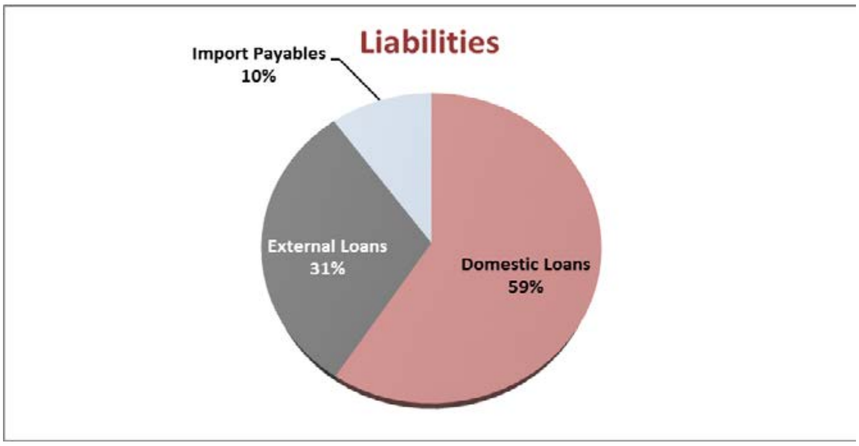
Structure of assets and liabilities is displayed in Chart 1. The asset structure shows that deposits and the direct foreign investments are the main asset items with 65 and 25 percent shares as of April 2016, respectively. On the liabilities side, cash loans item has a share of 90 percent while non-cash loans (import payables) item's share is 10 percent. 66 percent of the cash loans are raised in domestic sector, banking sector being the main fund supplier with a 95 percent share in the domestic loans.

Chart 1. Structure of Assets and Liabilities (Percentage Share of the Items)



Source: CBRT

[4] The table of "Foreign Exchange Assets And Liabilities of Non-Financial Companies" is available in Appendix.



Source: CBRT

Net FX position defined as the difference between the FX assets and FX liabilities shows the indebtness of sector. Table 1 also shows that the non-financial corporations are net FX debtor and carry a deficit throughout the analyzed period. As a second fact, the liabilities grow faster than the assets and thus deficit is growing continuously. For example, Chart 25 shows that the net FX deficit increased from USD 66 billion to USD 192 billion from December 2009 to April 2016.

While the high deficit holding of the sector signals vulnerability against the exchange rate fluctuations both for the non-financial and also for the banking sector as an indirect risk, maturity structure of the assets and liabilities reveals a positive picture. More specifically, data shows that the corporate sector is holding short-term liquid assets against its long-term liabilities. Chart 36 demonstrates short term net FX position of the sector. Accordingly, as of April 2016, short-term assets recorded USD 82 billion, while short-term liabilities recorded USD 78 billion. As a result, the sector has a short term surplus of USD 3,7 billion over its liabilities.

4. A proposed Improvement to Macro Approach

As noted earlier, the FX assets and liabilities data of the corporate sector for Turkey could give important insights regarding the exchange rate risk the non-financial companies carry. For the purpose of providing necessary data for such analysis, the "Foreign Exchange Assets and Liabilities of Non-Financial Companies" data is compiled from transaction records of non-financial private companies in Turkey with the counterpart being the resident financial institutions and non-residents. The data provides end-of-period stock values of sector's FX denominated and FX indexed assets and liabilities of domestic non-financial corporate sector with their net short positions regarding maturity breakdown. However, the dataset is not complete since it does not cover the data on the items whose counterpart is not a domestic financial institution or non-residents. To be more specific, the dataset misses the information on the FX cash holdings of the sector which is beyond the coverage of counterparty-based macro datasets we use.

To fill the gaps, an approach constructed by means of Monthly Money and Banking Statistics (MBS) and Financial Accounts (FA) would be beneficial. The aim of the approach is to estimate the FX cash holdings of the sector by using the figures of deposits and funds holding of the non-financial companies from

[5] Chart 2 in Appendix presents net FX position of the sector.

[6] Chart 3 in Appendix presents short term net FX position of the sector.

MBS and the total cash holdings of the sector from FA. In this approach, we assume that that the share of FX denominated deposits in total deposits is a proxy for the share of the FX cash holdings relative to the total cash holdings. The FX/total deposits ratio is calculated from the MBS and then this ratio is going to be used to calculate FX cash holdings by applying it to the total cash holdings figure in the FA. The resulting data will be quarterly.

Table 2 shows the cash holdings of the sector calculated with this approach. Our calculations showed that between 2010 and 2015, the FX cash holding of the sector is around USD 7 billion on average.

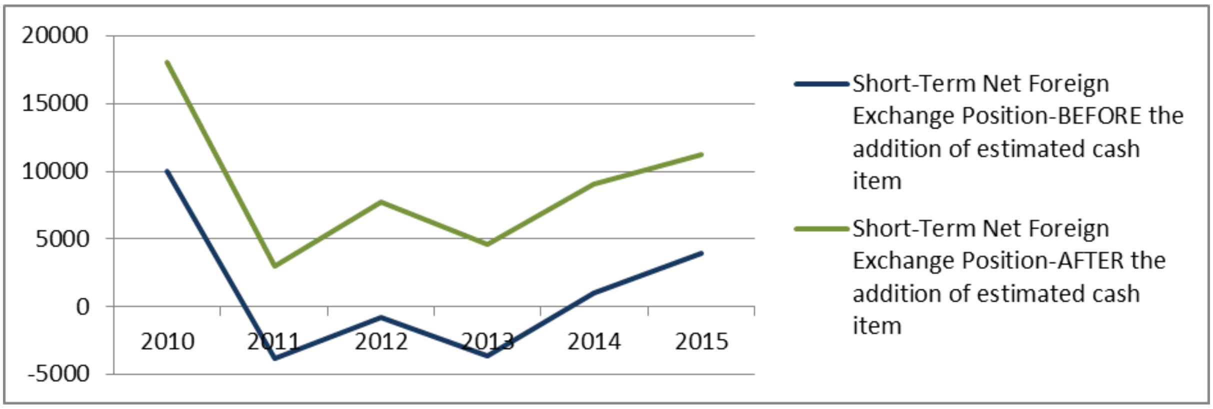
Table 2: Cash Holdings of the Non-Financial Companies

thousand TRY						
Non-financial Corporations	2010	2011	2012	2013	2014	2015
Currency	32.499.999	28.324.296	34.885.554	39.009.621	40.499.980	40.499.980
ratio found before	0,380	0,458	0,434	0,450	0,460	0,521
FX-currency, in TRY	12.350.931	12.970.865	15.124.357	17.559.339	18.629.997	21.106.213
exchange rate	1,546	1,9065	1,7826	2,1343	2,3189	2,9076
thousand dollar	7.988.959	6.803.496	8.484.437	8.227.212	8.033.980	7.258.981
million dollar	7.989	6.803	8.484	8.227	8.034	7.259

Source: CBRT, Authors' calculations

On the other hand, Chart 4 shows how the addition of the cash item into our macro table changes the figures. After incorporating cash item into short-term assets, as of 2015, the short-term surplus increased by USD 7.259 million and reached from USD 3.964 million to USD 11.223 million.

Chart 4: Short-Term Net Foreign Exchange Position (Million USD)



Source: CBRT

In addition to the cash item, other accounts receivables/payables items are also not possible to be included to the table via counterparty-based information. To complete the picture precisely, we need additional and preferably micro-level information.

For tax-related purposes, the Revenue Administration Unit of Ministry of Finance (RA) is collecting balance sheets and income statements of every company which operates in Turkey on a yearly basis. The financial statements are reported in TRY and there is no distinction between TRY and FX items. What we propose is to fill in the gaps of the macro data with this comprehensive micro dataset by carrying out a joint project with the RA which will basically depend on collecting a separate financial statement from each firm on their FX denominated assets and liabilities within the regular reporting routine. The result will be a big and flexible micro dataset which covers all the firms in the sector with all the items in their balance sheet.

Macro data, although compiled indirectly and lacks some information, is produced by reliable MFS and IIP data. Thus, instead of compiling the FX position directly from the micro dataset we will have, merging the micro and macro datasets might be the optimal way to produce a monthly report for the FX position of the sector. Since the resulting micro dataset will come with a different frequency (annually) and a longer time lag, we are going to estimate the monthly stock of the missing items, such as FX cash holding, depending on their last available annual stocks to enhance the existing report.

5. Conclusion

Transaction records of non-financial companies operating in Turkey, arising from their transactions with resident financial institutions and non-residents, provide indicators for the amount of their FX assets and liabilities, and hence the FX risk they bear.

To conclude; though its drawbacks, the FX assets and liabilities data set of Turkey based on macro approach is an important data source in evaluating the financial structure and developments of non-financial corporations. There is an area of improvement through either collecting micro data in cooperation with the RA or through utilizing additional data sources like MBS and FA or both.

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APPENDIX

Table 1:

FOREIGN EXCHANGE ASSETS AND LIABILITIES OF NON-FINANCIAL COMPANIES (Million USD)

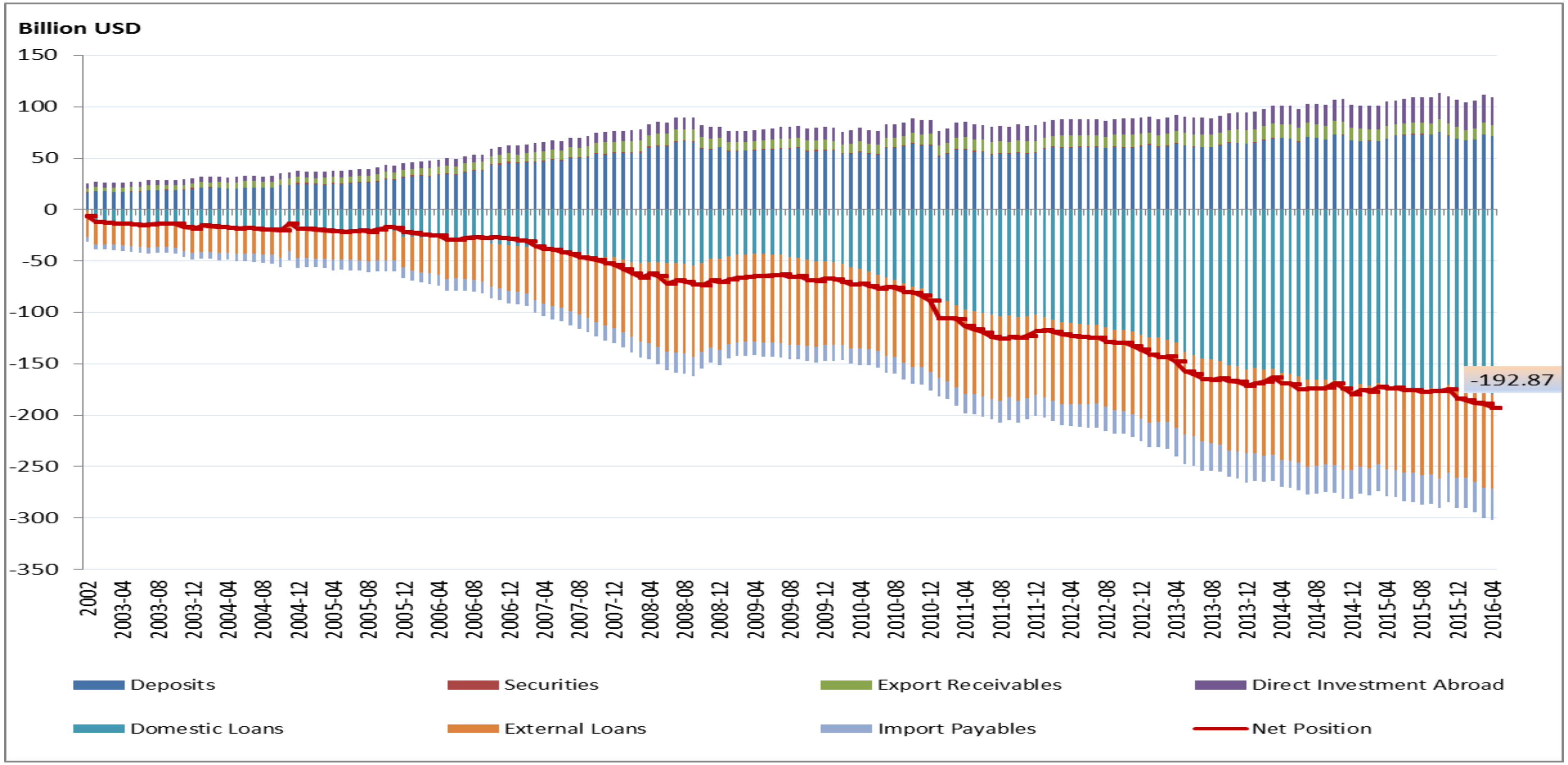
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015-03	2015-06	2015-09	2015-12	2016-03	2016-04
ASSETS	**25.100**	**30.202**	**37.671**	**45.393**	**62.659**	**76.132**	**80.465**	**80.385**	**87.379**	**82.183**	**89.402**	**94.038**	**102.004**	**101.192**	**107.500**	**109.371**	**106.948**	**111.610**	**109.253**
Deposits	**16.678**	**19.957**	**24.565**	**30.898**	**45.446**	**54.821**	**60.370**	**57.301**	**62.150**	**54.755**	**61.298**	**63.872**	**67.340**	**66.396**	**72.442**	**72.624**	**69.068**	**73.196**	**71.077**
Domestic Banks	6.891	8.573	10.598	12.636	18.756	24.401	27.261	29.833	30.638	35.864	40.825	47.032	49.037	48.786	54.605	53.898	50.668	55.364	53.245
Banks Abroad	9.787	11.384	13.967	18.262	26.690	30.420	33.109	27.468	31.512	18.891	20.473	16.840	18.303	17.610	17.837	18.726	18.400	17.832	17.832
Securities	**146**	**919**	**1.307**	**1.035**	**933**	**831**	**695**	**1.116**	**1.288**	**929**	**843**	**327**	**278**	**202**	**196**	**181**	**182**	**200**	**204**
Goverment Securities	0	807	1.176	789	632	573	495	589	565	412	421	322	271	189	182	170	171	189	193
Issued Domestically [1]	0	271	379	96	83	61	40	15	0	3	0	0	0	0	0	0	0	0	0
Issued Abroad	0	536	797	693	549	512	455	574	565	409	421	322	271	189	182	170	171	189	193
Portfolio Investment Abroad	146	112	131	246	301	258	200	527	723	517	422	5	7	13	14	11	11	11	11
Export Receivables	**3.471**	**4.381**	**6.016**	**6.404**	**8.823**	**10.289**	**8.566**	**9.310**	**10.526**	**10.945**	**11.693**	**13.175**	**12.167**	**11.436**	**11.091**	**11.272**	**11.186**	**11.155**	**10.656**
Direct Investment Abroad	**4.805**	**4.945**	**5.783**	**7.056**	**7.457**	**10.191**	**10.834**	**12.658**	**13.415**	**15.554**	**15.568**	**16.664**	**22.219**	**23.158**	**23.771**	**25.294**	**26.512**	**27.059**	**27.316**
LIABILITIES	**31.638**	**48.623**	**56.616**	**67.086**	**91.152**	**129.718**	**151.067**	**147.135**	**176.246**	**200.423**	**225.784**	**265.438**	**281.693**	**273.577**	**283.470**	**286.016**	**290.667**	**300.518**	**302.123**
Loans	**26.293**	**42.078**	**47.226**	**56.082**	**79.446**	**115.227**	**136.442**	**131.894**	**158.147**	**179.987**	**203.289**	**237.279**	**253.631**	**247.723**	**255.882**	**257.700**	**260.790**	**270.796**	**271.805**
Domestic Loans	**600**	**18.158**	**20.458**	**26.429**	**34.804**	**46.323**	**48.066**	**50.333**	**81.887**	**102.292**	**121.842**	**155.164**	**171.705**	**168.968**	**174.008**	**173.551**	**173.912**	**178.656**	**179.014**
Banks	0	12.664	14.245	20.796	24.744	32.805	37.435	41.155	73.015	92.608	111.158	144.041	160.099	157.900	162.635	162.298	162.555	167.141	167.518
FX Loans	0	12.664	14.245	15.397	17.370	20.800	22.547	28.897	57.268	74.522	90.209	116.762	133.748	132.418	137.574	137.815	139.127	143.558	143.991
Short-Term	0	0	0	0	0	14.416	15.895	14.340	17.927	18.277	19.300	21.021	23.932	22.714	22.483	21.508	20.021	20.989	20.931
Long-Term [2]	0	0	0	0	0	6.384	6.652	14.557	39.341	56.245	70.909	95.741	109.816	109.704	115.091	116.307	119.106	122.569	123.060
FX Indexed Loans [3]	0	0	0	5.399	7.374	12.005	14.888	12.258	15.747	18.086	20.949	27.279	26.351	25.482	25.061	24.483	23.428	23.583	23.527
Short-Term	0	0	0	0	0	0	6.847	4.502	6.684	7.628	9.354	14.111	13.501	12.817	11.143	10.875	9.554	9.533	9.182
Long-Term	0	0	0	0	0	0	8.041	7.756	9.063	10.458	11.595	13.168	12.850	12.665	13.918	13.608	13.874	14.050	14.345
Non-Bank Financial Institutions	**0**	**0**	**0**	**0**	**4.869**	**8.220**	**8.576**	**7.320**	**6.739**	**7.312**	**8.293**	**9.709**	**10.223**	**9.688**	**10.033**	**9.949**	**10.042**	**10.181**	**10.181**
Factoring Companies	0	0	0	0	143	270	405	462	765	765	771	954	999	952	1.091	866	911	864	864
Consumer Finance Companies	0	0	0	0	400	383	447	428	343	405	439	439	466	421	438	471	518	562	562
Financial Leasing Companies	0	0	0	0	4.326	7.567	7.724	6.430	5.631	6.142	7.083	8.316	8.758	8.315	8.504	8.612	8.613	8.755	8.755
Past-Due Loans Taken Over by SDIF	**600**	**5.494**	**6.213**	**5.633**	**5.191**	**5.298**	**2.055**	**1.858**	**2.133**	**2.372**	**2.391**	**1.414**	**1.383**	**1.380**	**1.340**	**1.304**	**1.315**	**1.334**	**1.315**
External Loans	**25.693**	**23.920**	**26.768**	**29.653**	**44.642**	**68.904**	**88.376**	**81.561**	**76.260**	**77.695**	**81.447**	**82.115**	**81.926**	**78.755**	**81.874**	**84.149**	**86.878**	**92.140**	**92.791**
Short-Term	1.281	1.595	1.113	837	839	661	1.086	556	830	854	1.049	1.383	1.582	1.437	1.200	960	813	1.271	1.376
Long-Term	24.412	22.325	25.655	28.816	43.803	68.243	87.290	81.005	75.430	76.841	80.398	80.732	80.344	77.318	80.674	83.189	86.065	90.869	91.415
One Year or Less to Maturity	0	0	0	0	0	0	26.279	22.240	19.627	22.204	21.401	15.069	10.368	10.835	11.819	13.924	14.986	14.993	15.197
Over One Year to Maturity	0	0	0	0	0	0	61.011	58.765	55.803	54.636	58.996	65.663	69.976	66.483	68.854	69.265	71.078	75.877	76.218
Import Payables	**5.345**	**6.545**	**9.390**	**11.004**	**11.706**	**14.491**	**14.625**	**15.241**	**18.099**	**20.436**	**22.495**	**28.159**	**28.062**	**25.854**	**27.588**	**28.316**	**29.877**	**29.722**	**30.318**
Short-Term	5.136	6.297	9.088	10.674	11.354	14.085	14.049	14.710	17.483	20.132	22.084	27.828	27.744	25.566	27.263	27.947	29.464	29.315	29.891
Long-Term	209	248	302	330	352	406	576	531	616	304	411	331	318	288	325	369	413	407	427
One Year or Less to Maturity	0	0	0	0	0	0	249	222	280	154	204	189	128	124	149	195	205	220	235
Over One Year to Maturity	0	0	0	0	0	0	328	309	336	150	207	143	190	164	176	174	208	188	193
Net Foreign Exchange Position	**-6.538**	**-18.421**	**-18.945**	**-21.693**	**-28.493**	**-53.586**	**-70.602**	**-66.750**	**-88.867**	**-118.240**	**-136.382**	**-171.400**	**-179.689**	**-172.385**	**-175.970**	**-176.645**	**-183.719**	**-188.908**	**-192.870**
Short -Term Assets							69.631	67.727	73.964	66.629	73.834	77.374	79.785	78.034	83.729	84.077	80.436	84.551	81.937
Short -Term Liabilities							65.257	57.460	63.939	70.419	74.602	80.994	78.720	74.866	75.586	76.746	76.472	77.747	78.238
Short-Term Net Foreign Exchange Position							**4.374**	**10.267**	**10.025**	**-3.790**	**-768**	**-3.620**	**1.065**	**3.168**	**8.143**	**7.331**	**3.964**	**6.804**	**3.699**

Short-Term Assets = Deposits + Securities + Export Receivables

Short-Term Liabilities = Short-term Domestic FX Loans + Short-term FX Indexed Loans + FX Liabilities to Factoring Companies + FX Credits Extended by Consumer Finance Companies + Short-term External Loans + Long-term External Loans With One Year or Less to Maturity + Short-term Import Payables + Long-term Import Payables With One Year or Less to Maturity

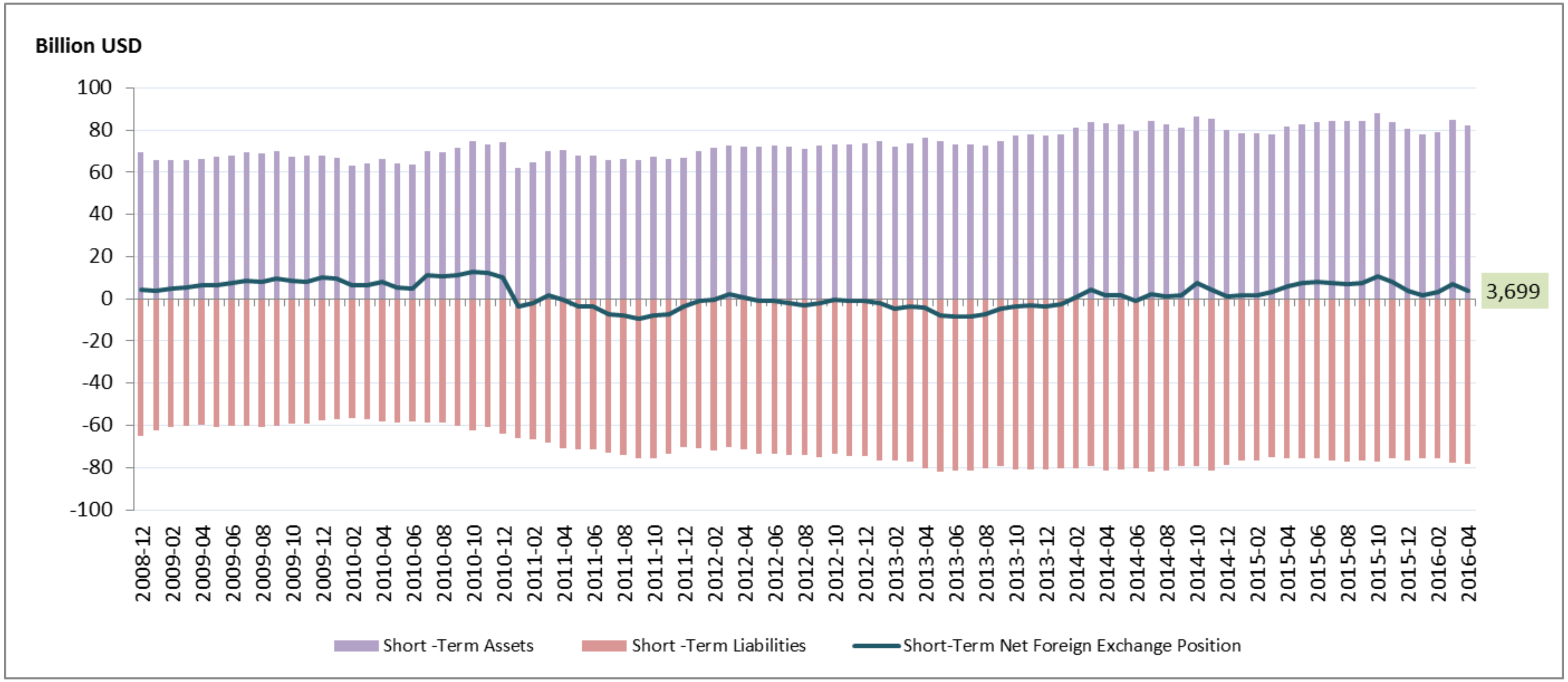
Source: CBRT

Chart 2 Net FX Position of the Sector (Billion USD)



Source: CBRT

Chart 3 Short Term Net FX Position of the Sector (Billion USD)



Source: CBRT

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Macroeconomic surveillance of portfolio flows and its real effects: Malaysia's experience[1]

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Central Bank of Malaysia

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Macroeconomic Surveillance of Portfolio Flows and its Real Effects: Malaysia's Experience

Tng Boon Hwa[1], Mala Raghavan[2] and Teh Tian Huey[3]

Abstract

This study highlights Bank Negara Malaysia's (BNM) statistical efforts for capital flow surveillance. We describe the development of various data systems that capture capital flows with differing levels of timeliness and coverage, and discuss how these datasets complement each other. We then estimate Structural Vector Autoregression (SVAR) models to assess the causes and effects of portfolio flows in Malaysia. Three findings emerge: first, global and domestic factors play transitory roles in driving portfolio flows, with domestic influences having a more gradual and persistent effect. Second, higher portfolio inflows lead to exchange rate appreciation, higher equity prices and higher credit. The effects are first visible in the exchange rate, followed by equity prices and credit. Portfolio inflows lead to transient short-term improvements in domestic growth, with volatile dynamics. In the transmission of higher portfolio flows to growth, the positive effects from improved equity prices and credit conditions are partially offset by the dampening effect that the appreciating exchange rate has on output.

Keywords: Capital flows, SVAR, Malaysia

JEL classification: F41, F43

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Introduction

Emerging economies (EMs) with open capital accounts constantly face risks associated with large capital inflows and their corresponding reversals. In developed financial markets, capital flows are easily dispersed across assets and sectors. Financial markets in many EMs, however, have not reached this level of development, resulting in capital flow movements being more visible in the exchange rate, asset prices and bank credit. When large enough, capital flow movements can cause the build-up of financial imbalances (e.g. over-valued asset prices, high credit growth and over-investment), exchange rate misalignments and a higher probability of financial crises. A policy priority for EMs with open capital accounts should therefore focus on pre-emptive measures to diffuse these risks.

This study uses Malaysia as an example to describe two pre-conditions that are necessary to implement such pre-emptive policies. The first pre-condition is having a robust framework to monitor capital flows with timeliness, depth and breadth. The second pre-condition is knowledge of the causes and effects of capital flows. We start by describing Bank Negara Malaysia's (BNM) efforts to develop several complementary data sources for capital flow surveillance. Several data sources are necessary as there is a trade-off between timeliness and coverage in the data collection. We then estimate a Structural Vector Autoregression (SVAR) model to give insight to three issues: What drives Malaysia's portfolio flows; what is the impact of portfolio flows on domestic financial markets and the real economy; and how important are domestic financial markets in the transmission of portfolio flows to the real economy. The model depicts Malaysia as a small-open economy and accounts for key features of the global environment, such as global liquidity and financial market volatility.

This study focuses on the portfolio (debt and equity) component of the financial account.[4] Our interest arises from the uncertainty surrounding the effects of portfolio flows on economic growth. Portfolio inflows are associated with higher asset prices and credit growth, which affect growth positively. However, inflows also cause the exchange rate to appreciate, which exerts downward pressure on growth.

Existing studies tend to analyse the effects of capital flows on financial markets and credit[5] and, separately, the effects of financial markets and credit on the real economy.[6] There are fewer studies, especially on EMs, that encompass capital flows, financial markets and the real economy within a common empirical framework. Our model uses monthly data which departs from most relevant studies using cross-country and lower frequency datasets (quarterly or annually). A country-specific model is likely more informative as the causes and transmission of portfolio flows may differ across countries due to differences in institutions, regulation and financial market structure. Meanwhile, higher frequency data is arguably better suited to study the transmission of portfolio flows, which can be volatile and short-term in nature.

4 We exclude other types of flows such as foreign direct investment as their causes and effects could differ from portfolio flows.

5 See, for instance, Kim and Yang (2011), Tillmann (2013), Lane and McQuade (2014) and Rhee and Yang (2014).

6 See, for instance, Schularick and Taylor (2012), Drehmann and Juselius (2014) and Jordà, Schularick, and Taylor (2015).

The SVAR estimations reveal that global and domestic factors play important transitory roles in driving Malaysia's portfolio flows, with domestic influences having a more gradual and persistent effect compared to global factors. Higher portfolio flows lead to first an appreciating exchange rate, followed by higher equity prices and increased credit. Though there are gains to growth from looser credit conditions and higher equity prices, there is also a downward pressure on growth from an appreciating exchange rate. The overall effect of portfolio flows on growth is positive with a time dynamic that is volatile and transitory.

The remaining sections proceed as follows. We first set the stage by giving a brief overview of Malaysia's portfolio flows, highlighting relevant regulatory changes and discussing how BNM monitors developments in portfolio flows. We then empirically assess the causes and effects of portfolio flows using an SVAR framework. The final section concludes the paper.

Malaysia's Portfolio Flows: Trends and Monitoring

This section presents a stylised exposition of how Malaysia's portfolio flows have evolved over time and how they are facilitated by institutional changes. Subsequently, we describe how BNM monitors these cross-border flows.

Figure 1 illustrates cumulative net portfolio inflows from 2004 to present for EMs and Malaysia. Malaysia has experienced portfolio flow cycles that are strikingly similar to other EMs and the region. From 2005 to mid-2008, EMs, including Malaysia, were recipients of substantial inflows. These economies subsequently experienced outflows until mid-2009, during the most intense phase of the Global Financial Crisis (GFC). Inflows resumed until 2013 as liquidity from monetary easing by central banks in the advanced economies flowed largely to EMs with more favourable macroeconomic prospects. [7]

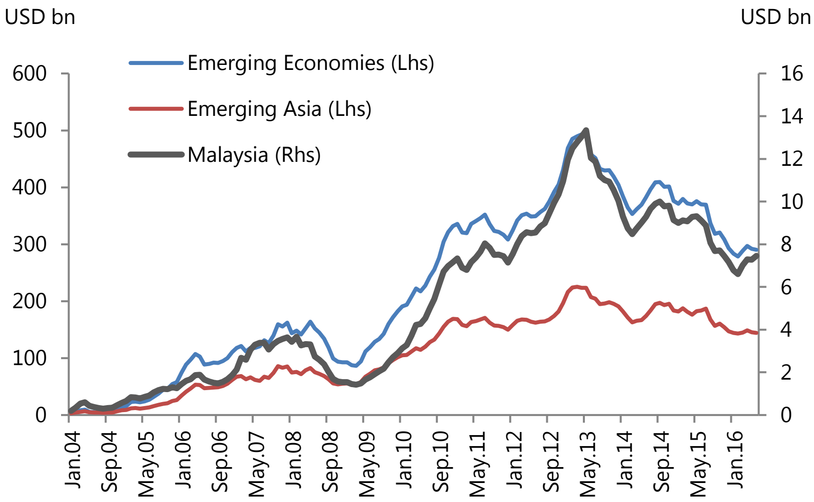
Figure 2 illustrates net portfolio flows from Malaysia's Balance of Payments (BOP), showing a steady increase in the magnitude and volatility since 2000. This occurred as Malaysia deepened its integration with global financial markets and increasingly exposed itself to global events. While major financial events since 2008 (the GFC and euro debt crisis) and loose global monetary conditions contributed to the higher volume and volatility in portfolio flows globally, in Malaysia's case, regulatory and policy efforts since the Asian Financial Crisis (AFC) in 1997 also played an important role in facilitating greater two-way movements in its portfolio flows. First, there was a significant effort to develop Malaysia's domestic bond market as an alternative source of financing from bank credit and equities.[8] Second, there was a continuous liberalisation of foreign exchange administration rules that were implemented in 1998. Third, the central bank adopted a managed float regime for the Malaysian ringgit on 21st July 2005. Reflecting these developments, there was a notable shift in composition of portfolio flows from predominantly equities in the early-2000s to debt

7 See Ooi (2008), Anwar and Tan (2009), BNM (2010), Razi, Ripin, and Nozlan (2012) and Sim and Tengku Muhammad Azlan (2016) for comprehensive discussions on the trends of capital flows in Malaysia and policy efforts to liberalise the foreign exchange market.

8 See BNM and SC (2009) for a detailed account of the initiatives taken to develop Malaysia's bond market.

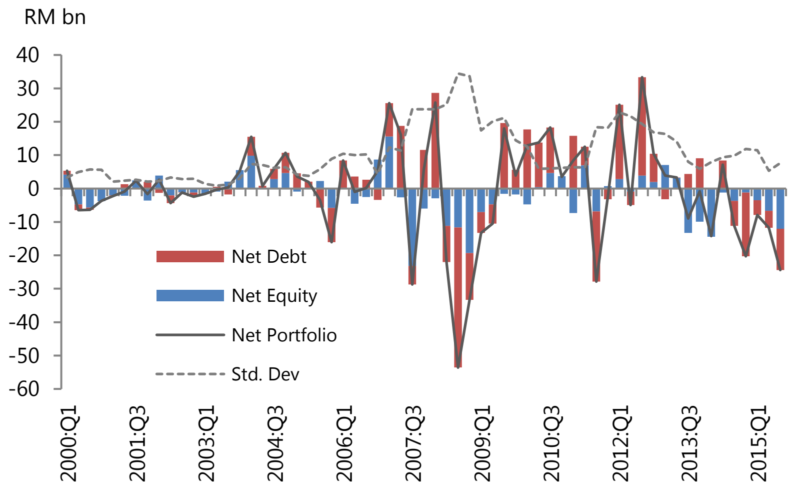
currently. The share of debt and equity securities shifted from 22% and 78% of gross portfolio flows in 2001 to 60% and 40% in 2015, respectively.

Figure 1. Cumulative Net Portfolio Inflows in EMs and Malaysia[9]



Source: EPFR Global

Figure 2. Net Portfolio Debt and Equity Flows in Malaysia (2000-2015)



Source: Bank Negara Malaysia

9 The economies covered are listed in the Data Appendix.

In recognizing the risks associated with capital flows, BNM developed several data systems for monitoring and statistical inference. The following are three main systems/databases used to monitor capital flows[10]:

- **Ringgit Operations Monitoring System (ROMS)**: A system where authorized dealers report foreign exchange transactions to the central bank. Cross-border flows captured by ROMS are those converted from foreign to domestic currency. ROMS captures these transactions on a near real-time basis.
- **Cash Balance of Payments (CBOP)**: CBOP records cross-border cash transactions between residents and non-resident. This system captures transactions that are intermediated through the banking system, intercompany and overseas accounts. CBOP is distinct from the official BOP statement as information is recorded on a cash basis while the BOP is recorded on an accrual basis.
- **BNM-DOSM Joint Survey on International Investment Position (IIP)**[11]: This quarterly survey records the size and structure of external assets and liabilities in the Malaysian economy. The IIP informs the size and composition of financial assets held by residents abroad and non-residents in the Malaysian economy. The information is captured on a stock and flow basis and contains detailed breakdowns. The assets and liabilities are marked to market, accounting for changes in the exchange rate and asset prices, as at end-period.

These databases encapsulate BNM's view that no system perfectly captures portfolio flows (and, more generally, capital flows) with maximum timeliness, depth and breadth. Table 1 summarizes the timeliness and coverage across ROMS, CBOP and IIP, reflecting a trade-off between lags and coverage.

Table 1. Timeliness and Coverage across Databases

	Lag	Coverage	Example of Application
ROMS	Near real-time	Flows with foreign exchange transactions	Time sensitive open market operations and reserves management
CBOP	1 month	Flows intermediated through bank, inter-company & overseas accounts	Business/financial cycle and macro-financial analyses
IIP	1-2 quarters	All flows	Structural analyses

The near real-time basis in which ROMs captures capital flows makes it useful for decision-making on time sensitive market operations, such as open market operations to smooth exchange rate volatility as well as management of domestic liquidity and international reserves. In contrast, IIP is lowest in frequency but most comprehensive in detail and is able to give a complete snapshot of how Malaysian residents have been re-allocating their wealth across borders by the type of assets. The IIP also captures the participation of non-residents in Malaysia's assets and the

10 These systems/databases are also described in Ooi (2008).

11 BNM and DOSM refer, respectively, to Bank Negara Malaysia and the Department of Statistics Malaysia. This quarterly survey commenced in 1Q-2008, replacing the Survey on International Investments and Services by DOSM and the Report on External Assets and Liabilities by BNM.

composition of these asset types. Hence, the IIP is useful for gauging Malaysia's aggregate risk profile in terms of its external wealth position.

The timeliness and coverage of CBOP lies between ROMS and IIP, and is suitable for analyses related to business/financial cycles and the characterization of macro-financial linkages for three reasons: First, the monthly frequency is compatible with macro-financial dynamics and information, which are typically captured at monthly or quarterly frequencies. Second, CBOP captures flows that are intermediated through the domestic financial system which have direct implications for the balance sheet positions of institutions responsible for extending financing to the private sector. Finally, cross-border flows captured by CBOP includes transactions that involve conversions to the Malaysian ringgit and those left in foreign currency, making CBOP's data better suited than ROMS to study macroeconomic issues beyond just the exchange rate implications.

Assessing the Macroeconomic Causes and Effects of Portfolio Flows

We now use the CBOP database to assess the causes of portfolio flows and its transmission to domestic financial markets and the real economy. This section starts by summarising findings from the macro-finance literature. We then use the findings and the narrative of global and Malaysia's portfolio flows to guide our empirical strategy.

What Drives Portfolio Flows: "Push" and "Pull" Factors

Since the wave of financial liberalisation in the early 1980s, EMs experienced various episodes of large portfolio flows that brought benefits and risks to these economies. Following Calvo, Leiderman, and Reinhart (1996) and Fernandez-Arias (1996), the distinction between country-specific "pull" factors and foreign "push" factors provide a useful underlying theoretical framework to understand the drivers of capital flows.[12]

Several papers have investigated how global and domestic, economic and financial conditions, classified as push- and pull-factors respectively have influenced the flow of capital to EMs.[13] Among the common push-factors that matter for portfolio flows are global growth, global liquidity and global risk aversion. Stronger global growth increases portfolio flows. Higher global liquidity amplifies global leverage and together with global risk aversion, which measures risk appetite and is mainly influenced by uncertainties, can cause sudden shifts in capital flows.

12 The push-pull dichotomy provides an intuitive classification of capital flows drivers, mainly to assess whether portfolio flows are mostly 'pulled' by attractive domestic conditions or 'pushed' by unfavourable external conditions. The push-pull framework is also useful for explaining the behaviour of portfolio flows during and after the financial crisis. See, for example, Koepke (2015).

13 See, for example, Milesi-Ferretti and Tille (2011), Fratzscher (2011), Forbes and Warnock (2012), Ahmed and Zlate (2014), Cerutti, Claessens, and Puy (2015), Rey (2015), Koepke (2015), among many others.

Though classified as common shocks to EMs, the size and effects of these push factors on portfolio flows tend to vary across countries.[14] According to Fratzscher (2011), a large part of this heterogeneity is due to country specific pull-factors. Some commonly identified pull-factors are domestic macroeconomic conditions, monetary policy responses, financial sector development and the exchange rate exposures.

The Transmission of Portfolio Flows

The capital flows literature has also concentrated on the macroeconomic implications and associated policy responses to surges in capital flows. This includes the benefits and costs in terms of economic growth, financial stability and other risks associated with portfolio flows. Unlike the broad consensus in existing literature on the positive impact of trade openness on growth, there is little agreement on the impact of financial openness and the associated portfolio flows on EMs. Obstfeld and Rogoff (1996), Obstfeld (1998), Mishkin (2009), Kose, Prasad, Rogoff, and Wei (2009) and Obstfeld (2009) argue that increased openness to capital flows is important and beneficial for growth in EMs. The premise is that access to international funds allows developing countries to supplement domestic savings and achieve higher rates of capital accumulation, thus accelerating growth through investment and/or greater consumption. Rodrik (1998) and Rodrik and Subramanian (2009), among others, argue that increasing capital flows is a serious impediment to global financial stability, consequently leading to adverse effects on the growth stability in EMs. After the financial crises in the 1990s in Latin American and Asian economies, it became apparent that capital flows to EMs came with risks. This was mainly attributable to the liquidity risks underpinned by maturity mismatches between foreign assets and liabilities, and the associated exchange rate exposures (Bosworth & Collins, 1999; Rey, 2015).

More recently, developing countries have been receiving large amounts of financial flows arising from expansionary unconventional monetary policy in major advanced economies. The increase in global liquidity and associated inflows have led to concerns over excessive asset prices and the unsustainable build-up of leverage in EMs. In the short-term, large capital inflows fuel credit booms and elevate asset prices, thus increasing household consumption and investment through laxer credit and positive wealth effects. Over the longer-term, however, higher debt and overheating asset markets may lead to vulnerabilities, such as increased domestic and external indebtedness and the erosion of current account positions. As described in Calvo (1998), an exogenous sudden slowdown in capital flows can cause large unexpected changes in relative prices such as depreciation of the domestic currency and collapse of asset prices. These developments can trigger a further reversal of capital flows, leading to sharp corrections in collateral values and a credit crunch (Borio & Zhu, 2012; Meissner, 2013).

Capital flows related crises have often been attributed to misguided macroeconomic policies and weak country fundamentals, with proponents often citing the reluctance of developing economies to allow free-floating exchange rates. Central to this view is the concept of the "impossible trinity" or the "open-economy

14 Cerutti et al. (2015) finds that Malaysia's portfolio flows is largely sensitive to push factors in comparison with other EMs.

trilemma". Countries with an open capital account that wish to maintain monetary autonomy have to allow their exchange rates to float freely. Attempts to control currency movements are unsustainable and ultimately result in speculative attacks and financial instability (Bosworth & Collins, 1999; Koepke, 2015; Obstfeld, 2009; Obstfeld & Taylor, 1997; Reinhart & Reinhart, 2008).[15]

Several studies on EMs have empirically explored the macroeconomic effects of capital flows. One strand uses cross-country panel models with relatively low data frequency (mostly annual), in part due to limited data availability. Soto (2000), Kose, Prasad, and Terrones (2005), Bussière and Fratzscher (2008) and Ferreira and Laux (2009) find that portfolio equity flows promote growth. On the other hand, Durham (2004), Baharumshah and Thanoon (2006) and Choong, Baharumshah, Yusop, and Habibullah (2010) find that short-term capital inflows do not positively affect growth. More recently, Aizenman, Jinjarak, and Park (2013) find that the association of portfolio flows with growth is smaller and less stable compared to FDI flows.

Another strand of papers focus on the impact of global liquidity and capital flows on asset prices and credit conditions in EMs using panel VAR models. Kim and Yang (2011) and Tillmann (2013) find that a surge in portfolio inflows boosts asset prices and the exchange rate in emerging East Asian countries. Brana, Djigbenou, and Prat (2012) find that excess global liquidity contributes significantly to higher GDP and inflation, while the effects on equity and property prices are less clear. Rhee and Yang (2014) show that a positive shock to global liquidity leads to larger portfolio inflows, exchange rate appreciation and positive effects on GDP, inflation and equity prices.

It appears that the effects of capital flows on growth depend on how the flows are intermediated and channelled to productive economic activities. The evidence suggests that capital inflows can benefit growth, depending on factors such as the type of flows, state of financial market development and exchange rate regimes of the recipient country. The effects on GDP, stock prices and exchange rate are often larger and more persistent in emerging recipient economies compared to advanced economies.

The Data

Ten variables are considered for econometric analysis, falling into two broad categories with some overlap: those used to identify push- and pull-factors of portfolio flows and those that capture fundamentals and market characteristics of the Malaysian economy. Appendix 1 provides the sources and detailed data descriptions. The series are in monthly frequency spanning January 2000 to September 2015.

Three variables characterise the global push-factors. The world production index ($WIPI$) captures the global business cycle. GLI is a measure of global liquidity and proxies for unconventional monetary policy in the advanced economies.[16] GLI is

15 A recent study by Rey (2015) argues that the global financial cycle has transformed the well-known "trilemma" into a "dilemma". Since exchange rate adjustment cannot insulate against large movements in capital flows, independent monetary policies are only possible if the capital account is managed accordingly and is supported with the right policies to curb excessive leverage and credit growth.

16 In recent years, unconventional monetary policy and the associated lower interest rates in mature economies have driven much of portfolio flows to EMs (Cerutti et al., 2015).

constructed as the sum of $M2$ from the United States, Euro Area, Japan and United Kingdom.[17] The implied volatility index (VIX) captures global investors' reaction to economic and financial markets uncertainties.

Seven variables characterise the domestic economy. The industrial production index (IPI) captures business cycle movements and is an important pull-factor for portfolio flows (Koepke, 2015). The consumer price index (CPI) reflects the price level. The short-term interbank interest rate (IR) reflects liquidity conditions in domestic financial markets and the nominal effective exchange rate (EX) represents the exchange rate. Credit (CR) refers to loans outstanding from domestic banks. Lane and McQuade (2014) find a significant relationship between international capital flows and domestic credit growth. Berkelmans (2005) and Jacobs and Rayner (2012) find that the inclusion of credit is necessary to capture the balance sheet effects of portfolio flows on banks. The equity price ($KLCI$) proxies asset prices. The final variable is portfolio flows (CF), comprising debt and equity securities flows from the CBOP database. This variable is expressed in net terms (inflows minus outflows).

Except for interest rate and portfolio flows, all variables are transformed to natural logarithm and where necessary are seasonally adjusted. Portfolio flows are in level terms as the series contains negative values.

The SVAR Model

The relationship among the ten variables is modelled using a Structural VAR (SVAR) framework. With the intercept suppressed for ease of exposition, an SVAR model representation is:

$$A_0 X_t = A_1 X_{t-1} + \cdots + A_p X_{t-p} + \varepsilon_t \qquad (1)$$

where X is a (10×1) vector of variables, the $A_i (i = 0,1,2,\cdots,p)$ are (10×10) matrices of coefficients with A_0 normalised across the main diagonal and ε_t is a (10×1) multivariate white noise error process with zero mean and a diagonal covariance matrix, Σ_ε containing the variances of the structural disturbances. The SVAR in (1) is represented as:

$$A(L) X_t = \varepsilon_t \qquad (2)$$

where $A(L)$ is a matrix polynomial in lag operator L and $A(L) = A_0 - A_1 L - \cdots - A_p L^p$. Since shocks to small open economies have little impact on major foreign economies, we treat the foreign variables as exogenous to domestic economic variables. The SVAR system, divided into foreign and domestic blocks and the X_t in (2), is represented as:

$$X_t = [X_{1,t} \quad X_{2,t}]'$$

where $X_{1,t} = [WIPI_t, GLI_t, VIX_t]$ and $X_{2,t} = [IPI_t, CPI_t, IR_t, CF_t, CR_t, KLCI_t, EX_t]$ represent the foreign and domestic blocks, respectively. To capture the foreign block

17 For a detailed explanation on the construction and the interpretation of this index, please refer to Rhee and Yang (2014).

exogeneity phenomenon, the contemporaneous and lagged values of the Malaysian variables are restricted from entering the foreign equations. Hence, the $A(L)$ in (2) is:

$$A(L) = \begin{bmatrix} A_{11}(L) & 0 \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \tag{3}$$

Apart from foreign block exogeneity restrictions, no further restrictions are imposed on the lag structure. To provide some economic structure to the model, restrictions on the contemporaneous matrix A_0, shown in (4), are drawn from theory, stylized facts and existing literature.

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & \vdots & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{2,1}^0 & 1 & 0 & \vdots & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{3,1}^0 & a_{3,2}^0 & 1 & \vdots & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \cdots & \cdots & \cdots & \vdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{4,1}^0 & 0 & a_{4,3}^0 & \vdots & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \vdots & a_{5,4}^0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{6,2}^0 & 0 & \vdots & a_{6,4}^0 & a_{6,5}^0 & 1 & 0 & 0 & 0 & 0 \\ a_{7,1}^0 & a_{7,2}^0 & a_{7,3}^0 & \vdots & a_{7,4}^0 & a_{7,5}^0 & a_{7,6}^0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & \vdots & a_{8,4}^0 & a_{8,5}^0 & a_{8,6}^0 & a_{8,7}^0 & 1 & 0 & 0 \\ a_{9,1}^0 & a_{9,2}^0 & a_{9,3}^0 & \vdots & a_{9,4}^0 & a_{9,5}^0 & a_{9,6}^0 & a_{9,7}^0 & a_{9,8}^0 & 1 & 0 \\ a_{10,1}^0 & a_{10,2}^0 & a_{10,3}^0 & \vdots & a_{10,4}^0 & a_{10,5}^0 & a_{10,6}^0 & a_{10,7}^0 & a_{10,8}^0 & a_{10,9}^0 & 1 \end{bmatrix} \tag{4}$$

World production index ($WIPI_t$) is ordered first with the expectation that it has flow-on effects on global liquidity (GLI_t) and financial market volatility (VIX_t). GLI is ordered before the VIX index, which captures the fact that the uncertainty variable responds instantaneously to global economic and liquidity shocks (Bekaert, Hoerova & Lo Duca, 2013). All three variables can influence one another in the lags.

Among the domestic variables, portfolio flows (CF_t), equity prices ($KLCI_t$) and the exchange rate (EX_t) respond immediately to the foreign shocks. As in Forbes and Warnock (2012), Tillmann (2013) and Koepke (2015), the portfolio flow shock is partially driven by push-factors, where global financial and macroeconomic conditions lead investors to channel funds to EMs. On the other hand, the price level (CPI_t) and bank credit (CR_t) do not contemporaneously react to foreign shocks. As in Raghavan, Silvapulle, and Athanasopoulos (2012) and Tng and Kwek (2015), these variables are perceived as sluggish and respond slowly through the lag structure. As a small open economy, interest rates (IR_t), reflecting liquidity and financing conditions in Malaysia's financial markets, is assumed to be contemporaneously affected by foreign monetary conditions, represented by global liquidity. Malaysia's output (IPI_t) responds immediately to world production, which is a common assumption in small open economy SVAR studies (Cushman & Zha, 1997; Dungey & Pagan, 2009; Dungey, Osborn & Raghavan, 2014). We also allow Malaysia's output (IPI_t) to respond contemporaneously to the VIX index, as export-oriented companies may interpret increases in global financial turmoil as higher uncertainty and foreshadow slower future external demand.

The contemporaneous ordering assumptions in the domestic block are largely in line with existing literature. The production index, the most exogenous variable has immediate effects on the domestic variables. The domestic price level equation reflects a basic Phillips curve, where prices respond contemporaneously to output shocks. We also assume firms do not change their output and prices to unexpected changes in output, inflation, financial signals or monetary policy within a month due to inertia, adjustment costs and planning delays. No such restrictions are imposed in the lag structure. The short-term interest rate is modelled as contemporaneously dependent on output and prices, reflecting money market behaviour. IPI_t, CPI_t and IR_t affect portfolio flows contemporaneously, while portfolio flows have immediate flow-on effects on equity prices and the exchange rate.

Credit is influenced by expectations of future activity. As such, credit contemporaneously reacts to output as current activity gives some indication of future conditions. Credit also reacts contemporaneously to prices and the interest rate, which reflects the perception that borrowers respond quickly to the real cost of credit (the difference between the interest rate and the inflation rate). Credit is restricted from having an immediate effect on output because it is likely that firms and households use internal funds and savings to finance spending in the short term rather than rely on new credit. The equity price is a forward-looking variable. We therefore assume that all variables have contemporaneous effects on equity prices except the exchange rate. The exchange rate is an information market variable and is contemporaneously affected by all variables.

We also include two exogenous dummy variables. The first dummy identifies the post-GFC period from January 2009 to September 2015 and is included in the foreign block equations and the portfolio flow equation. This dummy reflects the structural break from major central banks shifting their monetary policy from controlling a short-term interest rate to quantity-based policies. This shift likely changed the monetary policy transmission in these economies and also created substantial liquidity which potentially increased gross portfolio flows globally, especially to EMs. The second dummy identifies the shift in Malaysia's exchange rate from a fixed to floating regime and corresponds with the dates January 2000 to July 2005. This dummy is included in all domestic equations.

We estimate our SVAR model with 6 lags. The Schwarz (SC) and Hannan-Quinn (HQC) tests chose an optimal lag length of one, while Akaike (AIC) and log likelihood (LR) ratio tests picked a lag length of at least twelve. One lag is likely inadequate to capture the underlying dynamics of the system, while too many lags risks over-parameterising the model. Subsequently, we rely on the LM-test for residual autocorrelation which indicates that at least six lags are required to capture the model's dynamics.

The disturbances, ε_t, have economic meaning and therefore the effects of various shocks on domestic variables are captured effectively by the impulse response functions given in (5):

$$X_t = A(L)^{-1}\varepsilon_t \tag{5}$$

where $\varepsilon_t = [\varepsilon_{WIPI,t}, \varepsilon_{GLI,t}, \varepsilon_{VIX,t}, \varepsilon_{IPI,t}, \varepsilon_{CPI,t}, \varepsilon_{IR,t}, \varepsilon_{CF,t}, \varepsilon_{CR,t}, \varepsilon_{KLCI,t}, \varepsilon_{EX,t}]'$

Estimation Results

This section presents the results. First, we analyse how foreign (push-factors) and domestic (pull-factors) variables affect portfolio flows. Second, we assess the effects of portfolio flows on domestic output and financial markets. Finally, we characterise the role of domestic financial markets in transmitting portfolio flow shocks to the real economy.

The impulse responses are plotted over three years and measured relative to one-standard deviation shocks. The shocks, ε_t, are one standard deviation of the orthogonal errors obtained from (1) and are presented in Table 2. The confidence bands are computed using the bootstrap-after-bootstrap method of Kilian (1998). Although (1) does not guarantee that the residuals are orthogonal, Table 3 indicates that the values are zero or very small. This implies that the portfolio flow residual is effectively uncorrelated with other residuals.

Table 2. Magnitude of One Standard Deviation Shocks

	Size of shocks from foreign variables			Size of shocks from domestic variables						
	WIPI	GLI	VIX	IP	CPI	IR	CF	CR	KLCI	NEER
Shocks	0.0279	0.0497	0.2925	0.0942	0.0255	0.1077	0.6677	0.0095	0.1080	0.1933

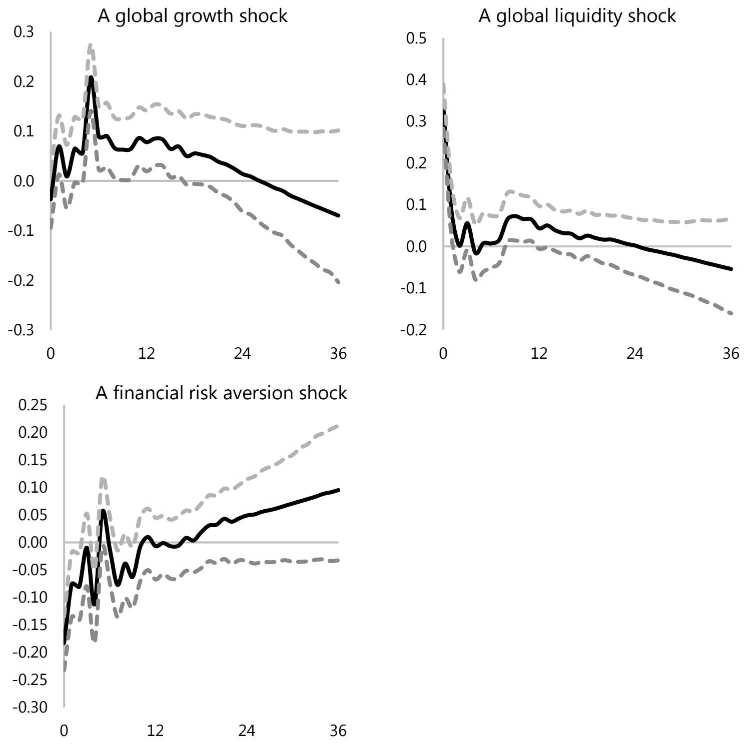
Table 3. Residual Correlations

	with shocks from foreign variables			with shocks from domestic variables						
	WIPI	GLI	VIX	IP	CPI	IR	CF	CR	KLCI	NEER
Portfolio Flow Shock	0.000	0.000	0.000	0.000	0.000	0.000	1.000	-0.017	-0.038	-0.027

The Role of Push and Pull Factors in Driving Portfolio Flows

Figure 3 illustrates how net portfolio flows respond to changes in global conditions. An increase in global growth (*WIPI*) leads to higher portfolio flows to Malaysia. Portfolio flows increase after the shock, peaks after 6 months and normalise after approximately two years. Two possible transmission channels are at play here. Initially, higher global growth improves market expectations of Malaysia's growth prospects, which manifests as portfolio inflows with a low lag. As higher global growth leads to enhanced realised growth over time via higher exports, there is added impetus for more portfolio inflows due to the improved macroeconomic outlook.

Figure 3. Responses of Portfolio Flows to Global Shocks



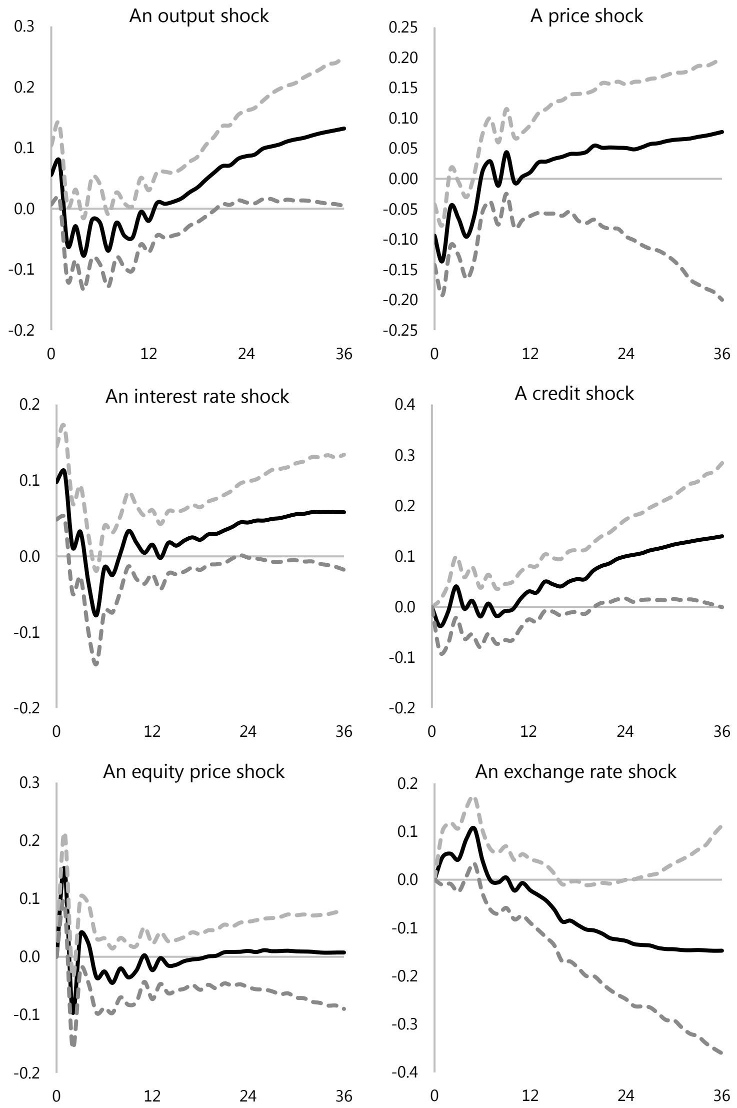
Source: Authors' calculations

Higher global liquidity (GLI) leads to an immediate and transitory increase in portfolio inflows. While most of the effects normalise to initial levels within 6 months, portfolio flows remain higher with the effects fully dissipating only after 2 years. This indicates that the expansion of global liquidity created by the quantitative easing policies of major central banks have indeed led to higher portfolio inflows into Malaysia. Meanwhile, an increase in global financial risk aversion (VIX), causes an immediate and volatile net outflow of portfolio securities which returns to normal levels after approximately 1 year.

Figure 4 gives insight into how domestic factors attract inflows into Malaysia. Portfolio inflows increases immediately and normalises quickly in response to higher domestic interest rates, equity prices and exchange rate. The increase in portfolio inflows from higher domestic output and credit is more persistent, as the increase occurs with a lag of approximately 12 months and remains higher throughout the 36-month horizon. Meanwhile, higher prices trigger an outflow over a 12-month period.

Figures 3 and 4 show that both foreign push and domestic pull factors influence Malaysia's portfolio flows. The effects on portfolio flows from financial shocks (*GLI, VIX, KLCI* and *IR*) manifest quicker compared to the growth (WIPI and IPI) and credit shocks. The slower response of portfolio flows to these shocks likely reflects information delays vis-à-vis the lag in data releases of these variables.

Figure 4. Response of Portfolio Flows to Domestic Shocks



Source: Authors' calculations

Table 4 presents the forecast error variance decompositions (FEVD) of portfolio flows. The results suggest that push- and pull- factors play significant roles in portfolio flow trends. At the 12-month horizon, all global variables emerge as the main drivers of Malaysia's portfolio flows, with the largest shares attributable to global liquidity (14.37%), global output (9.57%) and global financial risk aversion (7.22%). At the 24- and 36-month horizons, global growth and global liquidity remain among the top three most significant drivers of the variation in portfolio flows, although the exchange rate becomes increasingly important role as the horizon increases. Domestic growth also gains significance in its role over time, as its share rises gradually from 2.89% at 12-months to 7.82% at 36-months, almost equivalent to the share of global growth (8.66%). Hence, for Malaysia's portfolio flows, push- and pull-factors are important, as the push factors are initially attributable, while the overall influence of pull factors rise over time.

Table 4. Forecast Error Variance Decomposition of Portfolio Flows (%)

	Global			Domestic (Exc. Portfolio Flows)					
	WIPI	GLI	VIX	IPI	CPI	IR	CR	KLCI	NEER
12 Months	9.57	14.37	7.22	2.89	5.12	2.80	0.65	3.57	2.86
		31.16				*17.89*			
24 Months	10.23	12.60	6.24	4.59	5.77	2.85	2.47	2.88	10.15
		29.06				28.71			
36 Months	8.66	9.00	6.23	7.82	6.72	3.07	5.90	2.04	20.53
		23.90				*46.09*			

Source: Authors' calculations

The Macroeconomic Effect of Portfolio Shocks

We now analyse how portfolio flows affect domestic financial markets and growth. Figure 5 illustrates the responses of financial market variables from a portfolio flow shock. Portfolio flow shocks are not persistent as they return to initial levels within 3 months of the shock.

The financial market responses to portfolio flow shocks are also largely transitory. The exchange rate appreciates immediately, peaks within 1 month and dissipates close to initial levels by the fourth month. Although the response indicates some persistence, the confidence bands become large especially after the first year, making inference over that horizon difficult. Equity prices rise immediately in response to a portfolio flow shock, with the highest impact after 7 months that normalises beyond 1 year. The response of credit is the most persistent, increasing only gradually after the shock and dissipates back to initial levels after 2-3 years.

Figure 6 shows that higher portfolio inflows have a positive effect on domestic output. Output becomes volatile during the first 6 months after the shock, but displays a positive effect that peaks after 10 months before converging to initial levels just over a year after the shock.

Figure 5. Response of Domestic Financial Markets to Portfolio Flow Shocks

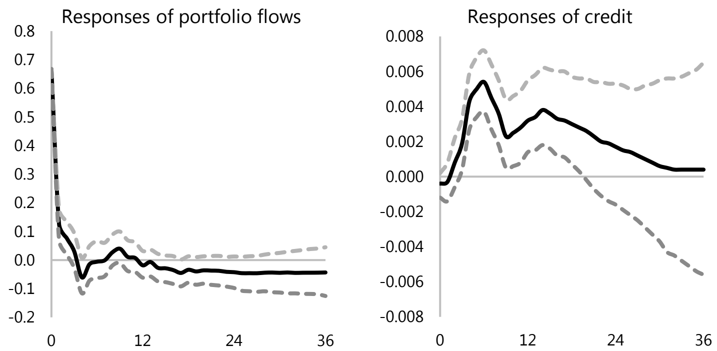
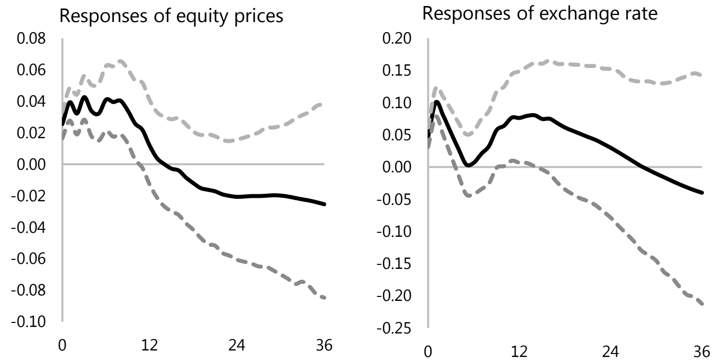
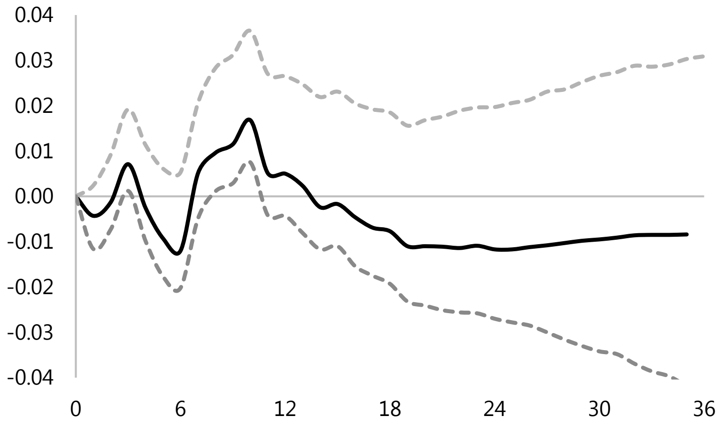


Figure 5. Continued



Source: Authors' calculations

Figure 6. Response of Output to a Portfolio Flow Shock



Source: Authors' calculations

The impulse response results are qualitatively in line with those by Jansen (2000), Berument and Dincer (2004), Kim and Yang (2011), Brana et al. (2012), Tillmann (2013) and Rhee and Yang (2014), for which comparable impulse response functions are reported. Nonetheless, the speed of reaction and persistence differ considerably. Jansen (2000) finds that capital flow shocks have more persistent implications on the financial and real variables, with the positive impact on output lasting for more than 3 years. In contrast, Berument and Dincer (2004) find that a positive capital flow shock very quickly led to higher output that lasted for 2-5 months. Our results also differ from the literature in the persistence of the exchange rate appreciation, with these four studies reporting persistent effects. Nevertheless, the impulse responses are intuitive and match our expectations on the time dynamics. When portfolio flows increase, the initial effects are most visible first in the exchange rate and asset prices. Bank credit then starts increasing as the effects of portfolio flows on the balance sheets of banks and economic agents gradually translate to a higher credit quantity. Finally, the positive effect on the real economy is the slowest, temporary and marked by volatility.

Table 5 illustrates the importance of portfolio flows in driving Malaysia's output. Portfolio flows play a relatively small role in the overall variation of output, with shares of 1.62% and 1.59% at the 12- and 24-month horizons. This result and Figure 6 suggests that portfolio flows are “tail risks” to growth. While its share to output dynamics is low, the impulse responses show that output does change when there are portfolio flow shocks.

Table 5. Forecast Error Variance Decomposition of Output (%)

	Global			Domestic (Exc. IPI)					
	WIPI	GLI	VIX	CPI	IR	CF	CR	KLCI	NEER
12 Months	22.48	16.54	1.35	7.72	2.07	1.62	7.81	1.54	13.23
	40.38			*34.00*					
24 Months	18.06	18.19	1.31	5.58	3.59	1.59	9.52	2.82	18.25
	37.57			*41.39*					
36 Months	10.64	10.58	3.24	4.62	3.08	1.16	14.53	2.05	30.08
	24.47			55.53					

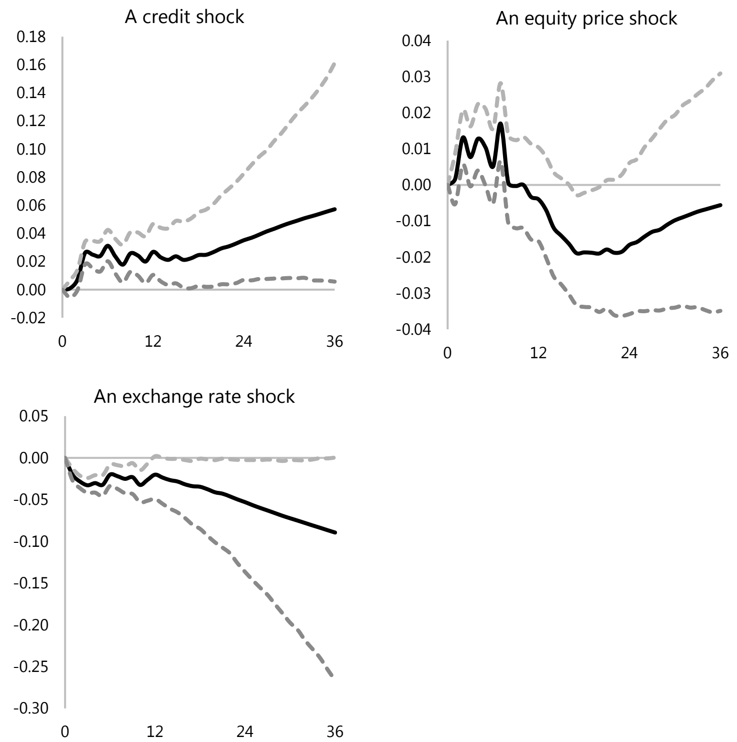
Source: Authors’ calculations

Channels of Transmission of Portfolio Flow Shocks to Output

We now give insight to the contribution of the various transmission channels of portfolio flow shocks to output. Figure 5 shows the impulse responses of variables that serve as key transmission channels - the exchange rate, equity prices and credit - to portfolio flow shocks. To quantify the contribution from each channel, we first analyse the impulse responses of output to exchange rate, equity prices and credit shocks. We then compare the impulse response of output to portfolio flow shocks from the baseline model with those from alternative models with the respective channels individually shut down. This is done by incorporating the variables exogenously, which restricts the “exogenised” variables’ direct and indirect roles in the transmission process. This approach to quantifying transmission channels follows from Morsink and Bayoumi (2001), Chow (2004), Raghavan et al. (2012) and Tng and Kwek (2015).

Figure 7 shows the impulse responses of output to exchange rate, equity prices and credit shocks. An exchange rate appreciation leads to a gradual decline in output that reaches its trough 6 months after the shock. The effects thereafter are uncertain as the error bands start to widen substantially, especially after 12 months. Meanwhile, higher equity prices and credit lead to higher output, although the output response to credit is more persistent. In a scenario, as shown in Figure 5, in which all three variables increase given positive portfolio flow shocks, an appreciating exchange rate has an offsetting effect that reduces the improvements in output from higher credit and equity prices.

Figure 7. Responses of Output to Domestic Financial Shocks

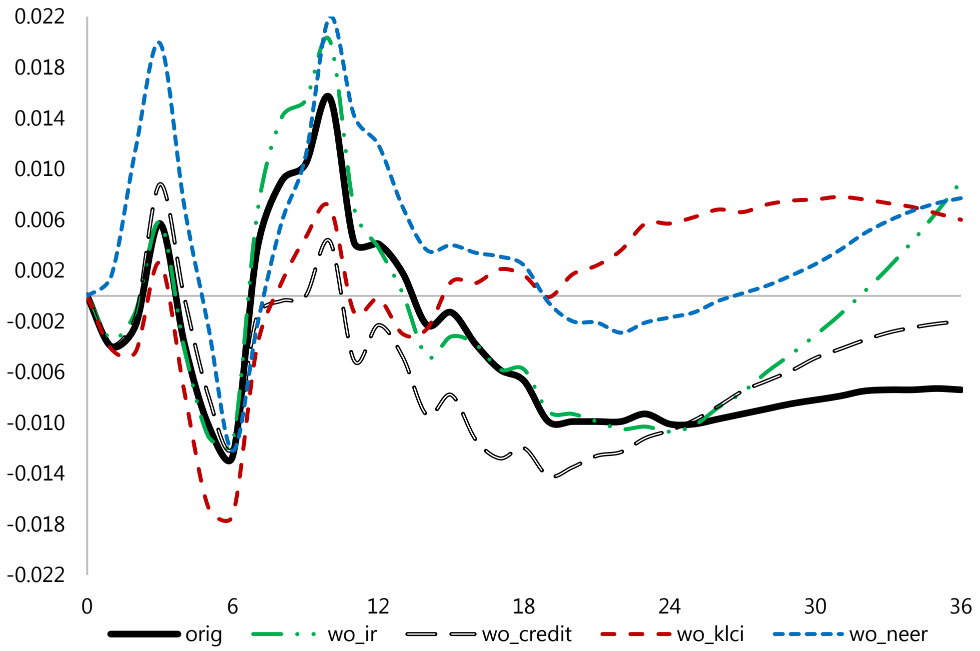


Source: Authors' calculation

Figure 8 illustrates the output responses from a portfolio shock from the baseline and alternative SVAR models with the exchange rate, equity prices and credit individually exogenised. Credit and equity prices are important conduits in channelling the increase in portfolio flows to output. Compared with the baseline output response (solid black line), the response of output with the equity price channel shut down (dotted red line) is materially smaller after approximately 4-12 months. The difference with the credit channel shut down (dotted grey line) is most visible between the 7- to 24-month period. This reflects that relative to credit, portfolio flows affect asset prices quicker, which in turn affects output quicker (as shown in Figure 6). Credit's role in the transmission occurs with more lag and is more persistent. The exchange rate channel plays the opposite role compared to equity prices and credit, as the exchange rate reduces the positive effect of portfolio flows on output. The effects are visible relatively quickly[18]. These results reiterate the output dynamics highlighted in Figure 7, where the exchange rate appreciation from higher portfolio flows partially offsets the increase in output through the equity and credit channels.

18 Inference on the role of the exchange rate over longer horizons is complicated by the large error bands. Hence, we focus only on the shorter-term dynamics.

Figure 8. Responses of Output to a Portfolio Flow Shock from Baseline and Restricted Models



Source: Authors' calculation

Note: wo_neer, wo_klci and wo_credit refer to the impulse response of output to a portfolio shock in SVAR models with the neer, klci and credit included as exogenous variables.

Concluding Remarks

In this study, we start by describing BNM's efforts to develop complementary data systems that ensure sufficient timeliness, depth and breadth in the monitoring of capital flows. Monitoring capital flows is a multi-faceted task with distinct policy goals, ranging from ensuring a stable exchange rate and managing international reserves, to assessing cyclical growth prospects and risks of financial imbalances, to longer-term structural issues. We show that different measures of capital flows are better suited for each surveillance/policy goal, where the analytical demands on timeliness and coverage differ.

We then estimate an SVAR model to examine the causes and effects of portfolio flows for Malaysia. Three key findings emerge: First, global and domestic factors play important transitory roles in driving Malaysia's portfolio flows. Portfolio flows increase immediately with higher global liquidity, falls when global financial risk aversion increases and increases gradually when global growth improves. Higher domestic equity prices and output lead to higher portfolio inflows, with the response to the former occurring sooner than the latter. Second, higher portfolio inflows lead to exchange rate appreciation, higher equity prices and higher credit. The impact of portfolio flows is felt most immediately by the exchange rate, followed by equity prices and finally credit. Portfolio inflows lead to short-term improvements in growth, but with volatile dynamics. Finally, the transmission from higher portfolio flows to higher growth occurs through improved equity prices and credit conditions, which is partially offset by the dampening effect of the appreciating exchange rate on output.

While our results suggest that growth benefits from portfolio inflows, its contribution to variations in output is nonetheless small. This indicates that portfolio flows are "tail risks" to growth and that these risks magnify when portfolio flows are large and volatile. The positive effect of portfolio inflows on growth may even be partially due to foreign exchange intervention operations by the central bank. While the central bank does not target a level of the exchange rate, foreign exchange operations are conducted to reduce exchange rate volatility when capital flows are volatile, both during episodes of inflow and outflow. Hence, the exchange rate does not react as strongly as it otherwise would to portfolio flow movements and thus does not exert the full pressure on growth through the trade and valuation channels.

As a whole, while the size and volatility of portfolio flows have increased significantly over the years, the impact of these flows on the Malaysian economy appear to have remained relatively contained. This likely reflects both the steady development of domestic financial markets as well as policies that have been implemented by regulatory authorities. Thus, while our findings suggest that portfolio flows do increase the volatility of the Malaysian business cycle, its effects remain manageable.

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Data Appendix

Coverage of Economies in Figure 1

Emerging Asia refers to Bangladesh, Cambodia, China, India, Indonesia, North Korea, South Korea, Malaysia, Mongolia, Myanmar, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Taiwan, Thailand and Vietnam. Emerging Economies refer to Emerging Asia economies plus Angola, Botswana, Egypt, Ghana, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Swaziland, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe, Baltic Republics, Bulgaria, Croatia, Syprus, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Tajikistan, Turkey, Turkmenistan, Ukraine, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela, Algeria, Bahrain, Iran, Iraq, Israel, Jordon, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, United Arab Emirates and Yemen.

Summary of Variables used in the SVAR Model

Variable	Abbreviation	Definition	Source
World Production	WIPI	World Industrial Production Index	CPB Netherlands Bureau for Economic Policy Analysis
Global liquidity	GLI	M2 for the United States, Japan, United Kingdom and Euro area	Datastream
VIX index	VIX	Implied volatility of the S&P index from the Chicago Board of Options Exchanges	Bank for International Settlements
Output	IPI	Industrial production index	Bank Negara Malaysia
Prices	CPI	Consumer price index	Bank Negara Malaysia
Interest rate	IR	3-month interbank offered rate (KLIBOR)	Bloomberg
Portfolio flows	CF	Portfolio flows from the cash balance of payments database	Bank Negara Malaysia
Bank credit	CR	Bank credit, deflated by CPI	Bank Negara Malaysia
Equity Price	KLCI	Kuala Lumpur Composite Index, deflated by CPI	Bank Negara Malaysia
Exchange rate	EX	Nominal effective exchange rate	Bank Negara Malaysia

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The use of foreign exchange derivatives by exporters and importers: the Chilean experience[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

The use of foreign exchange derivatives by exporters and importers: The Chilean experience[1]

Faruk Miguel Liriano[2]

Abstract

This paper presents micro-level stylised facts on the use of foreign exchange derivatives by Chilean exporters and importers. By exploiting contract-by-contract data from more than 5,600 firms over the 2000-2015 sample period, this paper provides a greater understanding of the structural characteristics of derivatives markets in developing countries. The results echo those observed in more advanced economies, showing that a growing number of firms create currency hedging strategies which are largely in proportion to their net trade exposures. Additionally, there is evidence of significant market concentration with a small number of entities accounting for a large share of the total amount of derivatives outstanding.

Keywords: importers, exporters, foreign exchange derivatives, hedge

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Contents

1. Introduction

This paper analyses the use of foreign exchange (FX) derivatives by Chilean exporters and importers (EXIM) that conduct international transactions in foreign currencies. These firms generate currency mismatches between their assets and liabilities and potentially increase their exposure to financial instability due to exchange rate fluctuations.

In practice, firms can hedge their currency mismatches by using different types of financial instruments, including foreign-denominated debt and FX derivatives. As an example, exporters can take advantage of natural hedges by aligning their revenues in foreign currency with foreign-denominated debt obligations. On the other hand, both exporters and importers may reduce the uncertainty of their expected cash flow by fixing a future exchange rate with FX derivatives. Indeed, Allayannis & Ofek (2001) show that "exposure through foreign sales and trade" is the only significant determinant of the usage level of FX derivatives.

One of the most important lessons learned from the Global Financial Crisis (GFC) was the need for policy makers to have access to a wide range of reliable, timely and detailed financial statistics (BIS, 2010). Consistent with this idea, this paper exploits a database of FX derivatives catalogued by the Central Bank of Chile (CBCh) at the contractual level and studies the FX coverage strategies employed by EXIM firms from 2000 until 2015. This database is unique in the revised literature in terms of the scope of businesses covered and the length of time analysed.

By taking advantage of the richness and granularity of this database it is possible to gain a better understanding of the structural characteristics of the FX derivatives markets in developing countries. Moreover, a solid set of stylised facts regarding the use of FX derivatives at the micro level has been established in order to study the FX risk management strategies followed by EXIM firms in Chile.

Evidence of a high concentration in the use of FX derivatives among EXIM firms has been found, as well as a clear differentiation between their strategies. The paper shows a positive relation between firm size and the number of firms that use FX derivative hedging strategies. Furthermore, a direct relationship is observed between the level of foreign trade flows and turnover in the FX derivative market. The most common instruments used are Chilean peso against US dollar forward agreements maturing in less than 180 days.

The remainder of the paper is organised as follows. The next section reviews the literature on existing studies of the FX derivatives markets. Section 3 describes relevant details regarding the Chilean FX derivatives market. Section 4 discusses the data used. Sections 5 and 6 outline aggregate FX derivatives usage and analyse the data at the micro-level. Finally, the conclusions and main findings are summarised.

2. Literature review

The literature presenting stylized facts on FX derivative use by EXIM firms is limited, especially for emerging or developing economies. Some exceptions include cross-country studies as well as some specific case-studies for countries like England, New Zealand, the Czech Republic, Uruguay, Brazil and Chile.

Bartram et al. (2010) compares the use of derivatives for a wide range of countries. This study relies on accounting information from 7,000 non-financial corporations to show that 60% of the firms in their sample use some type of derivative. In particular, 45% use FX derivatives, 33% use interest rate derivatives and only 10% use commodity price derivatives. The latter two show a marked difference across industry types, while those that use FX derivatives show more widespread usage across industries. Across all countries, large firms tend to use more coverage than their smaller counterparts.

The Bank of England (1998) looks at survey information in order to characterise the use of derivatives by exporters in England. They show that 78% of exporters, especially larger ones, hedge themselves against exchange rate risk exposures, while smaller exporters are less inclined to do so. The coverage type taken is also shown to differ depending on firm size, with smaller firms typically hedging through standardised products such as bank overdrafts and loans. This is related to the fact that smaller firms possess more limited resources in order to identify, understand and manage exchange rate risk.

On the other hand, Briggs (2004) uses interviews with large banks and 42 EXIM firms in New Zealand as a principal input to show that exchange rate hedging is more important for smoothing revenue as opposed to generating net gains. Fabling & Grimes (2008) also consider New Zealand but only focus on exporting firms in a wide ranging database. They show that exporters hedge approximately 65% of their exposure and that hedging is positively correlated with firm size. They also find a positive relationship between export intensity and hedging which is related to the larger balance sheet risk arising from currency fluctuations.

More recently, Čadek et al. (2011) analyses the hedging behaviour of 184 Czech exporting firms, relying on information from surveys and bank interviews. The vast majority of exporters (approximately 60%, covering over 88% of exports) hedge their FX exposures with natural hedging or derivative contracts. Forwards and zero-cost options are the most widely-used instruments in maturities ranging from 3 months to 1 year. They find that hedging increases with firm size as well as with the foreign sales (exports) to sales ratio.

Buscio et al. (2011) use survey data to show that the use of FX derivatives by Uruguayan firms ranges between 6-7%. This use is positively related with the size of the firm, the firm´s orientation towards exports and whether or not the firm is publicly listed. They attribute this moderate use of FX derivatives to a poor awareness of exchange rate exposures and the implicit insurance produced by official interventions in the FX market. Specifically, EXIM firms tend to have income and cost structures in foreign currency that provide natural coverage.

Júnior (2006) uses accounting information from publicly traded firms in Brazil (more than half of whom are exporters) to present evidence of increasing hedging using FX derivatives[3]. Currency swaps are found to be the most commonly utilised instrument, pointing to the importance of coverage versus speculation. The authors also find a negative relationship between hedging and the foreign sales (exports) to sales ratio. Factoring in natural coverage, the author associates low FX derivative usage to the belief by exporters that there is a low probability of appreciation of the Brazilian real.

Finally, there are several studies that analyse the use of derivatives in EXIM firms in Chile. Acharán et al. (2009) finds evidence that lower global activity after the fall of Lehman Brothers did not produce a reduction in the usage of FX derivatives by exporters, irrespective of size. Rodríguez & Villena (2009) show that for different EXIM firm sizes there was an acceleration in the growth of FX derivative usage between 1998 and 2008.

This article expands on these previous works to analyse the use of FX derivatives in Chile. In particular, a micro-level analysis was built in order to characterise FX derivatives strategies followed by EXIM firms in Chile. At the same time, stylised facts have been outlined for the Chilean FX derivatives market in the context of experiences from other countries. This yields micro-based evidence that confirms the aggregate conclusions found in the literature, which is that the usage of FX derivatives is growing, particularly with larger-size firms or firms with more foreign trade.

3. The Chilean FX derivatives market

In a description of the Chilean FX market, Villena & Salinas (2014) observe significant growth in the derivatives market between 1998 and 2013. In particular, the volume of derivative market activity grew from US$ 76 billion to US$ 903 billion during the period studied. From an international perspective, Chile shows greater levels of depth[4] than both emerging economy and Latin American averages. This development is explained by a variety of general and specific factors: the elimination of capital controls in 2001, a higher level of international trade and greater stocks of assets and liabilities outside the country throughout the sample and, perhaps most importantly, the need to hedge growing Pension Fund investments[5].

This article shows that for the year 2013, derivatives operations were undertaken almost completely in over-the-counter (OTC) markets and that the most used FX derivatives are forward contracts and FX swaps, which account for 96% of the total amount traded. The remaining 4% of corresponds to currency swaps and options. Almost all (98%) transactions are Chilean pesos against US dollars. In terms

[3] The increase in exchange rate hedging is associated with the adoption of a floating exchange rate regime in Brazil.

[4] Measured as notional amounts normalised by GDP.

[5] Avalos & Moreno (2013) present evidence that the greater depth and liquidity in the Chilean FX market is due largely to the necessity to cover Pension Funds.

of settlement of non-interbank transactions, the vast majority of contracts are cash-settled (98%) with the remaining (2%) being physically delivered. The decomposition of the outstanding positions by sector shows that Pension Funds are the most relevant sector, followed closely by Real Sector and Financial Companies (excluding banks and institutional investors), and then Insurance Companies.

4. Data Description

Since 1992, the CBCh has collected daily information on FX derivatives transactions made through the Formal Foreign Exchange Market (FEM)[6]. Using this database, the CBCh produces separate series on turnover and amounts outstanding and is used as a main input in understanding the FX derivatives market in Chile. For this article, a monthly series was created from 2000 to 2015 for turnover, amounts outstanding, contractual term length, currency type and instrument. Additionally, the database of the National Custom Service was utilised to identify FX derivative contracts between FEM institutions and EXIM firms[7].

The aggregate analysis performed at the CBCh shows that FX derivatives contracts with maturities less than 7 days can be associated with a speculative nature. Given that the focus of this article is to study the use of FX derivatives for hedging purposes, the analysis excludes contracts with maturities of less than 7 days. This is also justified by the fact that the majority of international trade by EXIM firms have payment timeframes longer than 30 days.

In order to identify EXIM firms, the "net" definition of exporters (importers) is used. Thus, those firms that have a level of exports (imports) higher than imports (exports)[8] during a calendar year are considered as exporters (importers)[9] in that year. This permits a correct interpretation of the expected FX derivatives position of a particular type of business. Furthermore, because data are difficult to obtain and in line with Briggs (2004) this investigation does not consider international trade in services.

As a result of the definition of an EXIM firm used, the database yielded a sample of more than 5,600 FX derivatives-using companies. The revised literature on FX derivatives usage stresses the convenience of access to more detailed information

6 According to CBCh surveys, 96% of Chilean market transactions take place through FEM channels. The institutions that make up the FEM include banks and banking institutions (other financial firms) who are legally obligated to make daily reports on all signed foreign exchange derivatives contracts. See Orellana & Rodriquez (2009) for a description of the statistical collection methodology utilized by the CBCh.

7 Counterparty information is matched with National Custom Service data via the unique tax identification number (*RUT*) held by all legal persons and entities residing in Chile. Furthermore, firms were matched to sectors using the CBCh directory using the same legal ID. It is important to note that both databases contain individuals. For simplification, these are treated as businesses in this paper.

8 Čadek et al. (2011) use an alternative definition of exporters for the Czech Republic: firms that have a share of exports in total sales greater than 50%, or those whose nominal exports sum to more than CZK 1 billion.

9 This paper is focused on "direct" exporters. A firm that sells a product to another national firm, who exports said product is an "indirect" exporter, not considered here.

such as larger databases or administrative contract registries (Čadek et al. (2011), Fabling & Grimes (2008), Briggs (2004) and Bank of England (1998)). This database, which utilises contract-by-contract information from bank administrative records combined with a sample of all Chilean EXIM firms from 2000-2015, makes this work unique in this research area due to the sheer number of companies included and the breadth of time covered.

4.1. General aspects of EXIM firms

International goods trade growth in Chile has averaged 7.7% annually over the past 16 years; even as it was interrupted briefly by the GFC where exports and imports contracted by 19% and 31% respectively from peak to trough. The number of importers reached a peak of more than 160,000 firms in 2015 with an average annual growth rate of 19% between 2008 and 2015. This compares with an annual growth rate of 2% before the GFC[10] (2000 to 2008). For their part, the number of exporters is substantially lower, with a peak sample of 8,400 in 2014.

In order to gain insight into the structure of EXIM firms, the gross amounts of exports and imports were calculated for each firm during the entire sample period. This provided a number of exporters and importers on a "gross" basis. After applying the "net" definition of an EXIM firm, the number of exporters was reduced by 40% and the number of importers was reduced by 6%. This net effect confirms that exporters generally import goods as well, as they often require inputs from abroad[11].

Throughout the sample period, a total of 25,058 exporters and 558,818 importers were observed including both hedgers and non-hedgers. The differences that exist in the composition of EXIM firms by size are shown in Appendix 1. On average, more than 93% of importers are small (importing less than US$ 500,000 of goods annually) while only 66% of exporters are small (exporting less than US$ 500,000 of goods annually). Furthermore, the rotation of businesses and individuals that enter and exit the sample annually was greater for exporters. For exporters, 47% remained in the sample for at least 4 years with only 3% in all 16 sample years. On the other hand, 65% of importers remained in the sample for at least 4 years with only 5% in all 16 years (see Appendix 2).

5. Do EXIM firms hedge?

5.1. FX derivatives usage

Figure 1 shows the number of EXIM firms that use FX derivative contracts (hedgers) as well as the proportion of hedgers within exporters and importers over time. Increasing usage of FX derivatives by both exporters and importers is

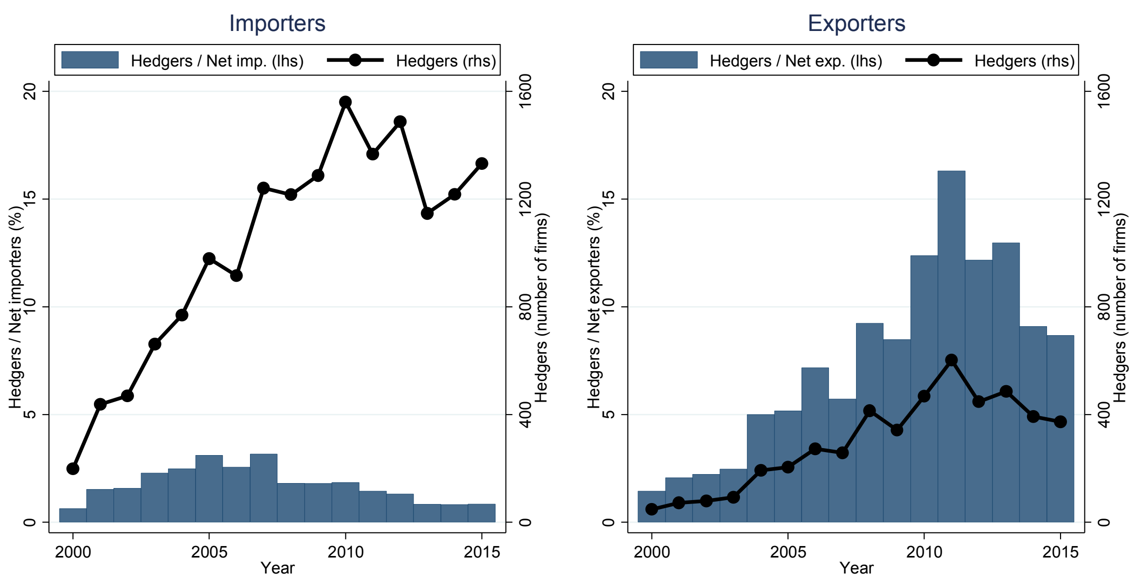
10 This difference is explained, in part, by the incorporation of small importers once several bilateral free trade agreements became active.

11 Rébora & Vivanco (2016) confirm this finding by showing that Chilean exporters have made significant use of imported goods in recent years.

observed over this sample period. In 2000 only 48 exporting companies utilised derivative contracts (hedgers). Eleven years later this figure reached a peak of 602. For its part, the number of hedging importers went from 199 in 2000 to a sample peak of 1,560 in 2010. As importers outnumber exporters 22:1 in the sample, and even more so if we consider only smaller firms, the utilisation rate is less for importers than for exporters. This rate is measured as the number of firms that use derivatives (hedgers) divided by the total number of firms (hedgers and non-hedgers).

At the macro level, the increase in the use of derivatives in EXIM firms is related to the growing depth of the Chilean derivatives market (see section 3). This is in line with Bertram et al. (2009) who show that one factor consistently relevant is the size of the local-currency derivatives market, notwithstanding that this is generally less important than firm-specific factors.

Derivatives usage | Figure 1



Source: Author's calculations using CBCh data.

As shown in Figure 2, the utilisation rate is not homogeneous among different sized firms. Firm size is calculated as the total value exported for exporting firms and the total value imported for importing firms[12]. Larger sized firms exhibit higher utilisation rates than their smaller counterparts.

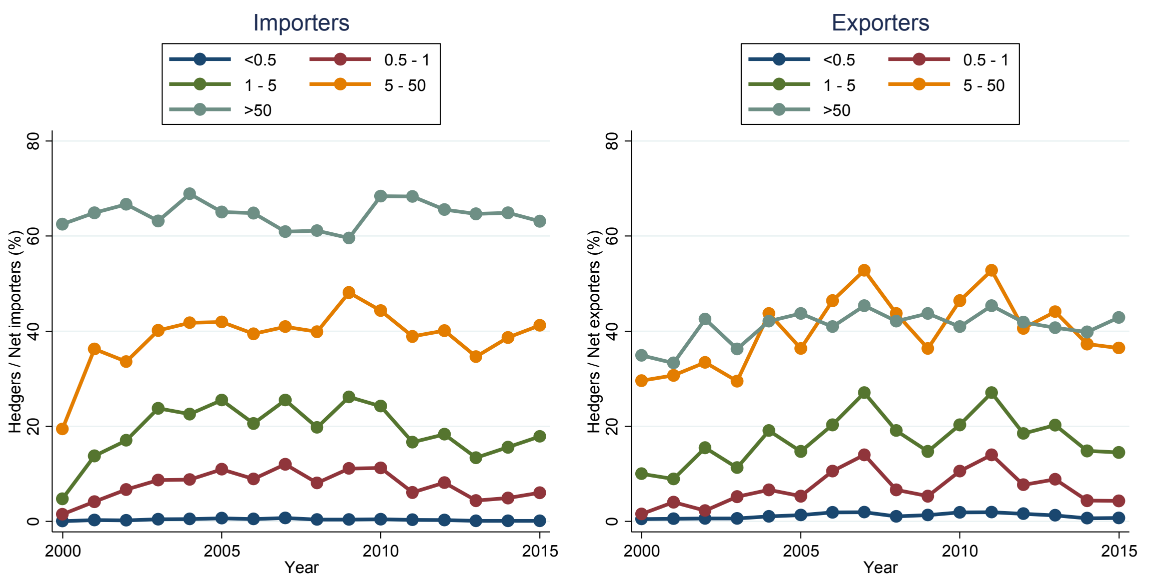
Over the entire sample period, the utilisation rate of importers increases with firm size. Firms that import less than US$ 500,000 per year exhibit very low utilisation rates. This compares with firms importing more than US$ 50 million that

[12] As consistent with Rodriguez & Villena (2009) and Acharán et. al (2009), this paper uses the same method of determining firm size. Other methods can include calculating by number of employees or total asset.

exhibit utilisation rates of between 60% and 70%. Similarly, larger exporters display higher utilisation over the entire sample. However, exporting firms in the two largest groups by firm size only present utilisation rates between 40% and 50%. While Rodriguez & Villena (2009) use a different methodology to define EXIM firms, their results regarding the use of FX derivatives are consistent with the results of this paper.

Derivative utilisation rates by firm size

Figure 2



Note: Legend numbers refer to millions of USD.

Source: Author's calculations using CBCh data.

The fact that smaller firms exhibit lower utilisation rates is expected as implementation of exchange rate hedging requires a more sophisticated level of financial management. Furthermore, due to the credit lines associated with FX derivatives usage, the greater inherent credit risk of smaller firms restricts their participation in the market. The fixed cost of this type of product is another factor that limits their use by smaller firms as the relative cost of hedging is higher when the amounts to cover are lower.

For the specific case of small exporters, the Bank of England (1998) provides an analysis of vulnerabilities to an appreciation in the domestic currency. This includes the fact that they have less negotiating power in external markets, their sales are generally concentrated in only a few markets, it is more difficult for them to cut prices in order to maintain market participation and they use fewer imported inputs, which diminishes the benefits received when import prices fall. That smaller firms may be more vulnerable, and therefore more likely to hedge, runs counter to the observed results in this paper which shoes a low utilisation by small exporting firms.

5.2. Long or short?

The previous subsection showed that both exporters and importers use financial derivative instruments, however, the strategies employed by each vary over business types. This section outlines expected strategies that would be employed by an exporter. It then tries to empirical verify whether or not the evidence supports this expected behaviour for both exporters and importing firms at the aggregate level and by sector.

Assuming an exporter sells US$ 5 million of goods on 31 March and both parties agree that payment should be made in 90 days. At the current exchange rate of 650 pesos per dollar the equivalent value in pesos is CLP$ 3,250 million. In 90 days, if the Chilean peso falls to 600 pesos per dollar, the equivalent value in pesos would be CLP$ 3,000 million. Without hedging, this would create an unfavourable difference for the exporter of CLP$ 250 million. In order to avoid uncertainty about future cash flows, the exporter could sign an FX derivatives contract in which the exporter agrees to sell the US$ 5 million at a fixed exchange rate of 640 pesos per dollar. This "short position" would guarantee a cash flow of CLP$ 3,200 million in 90 days.

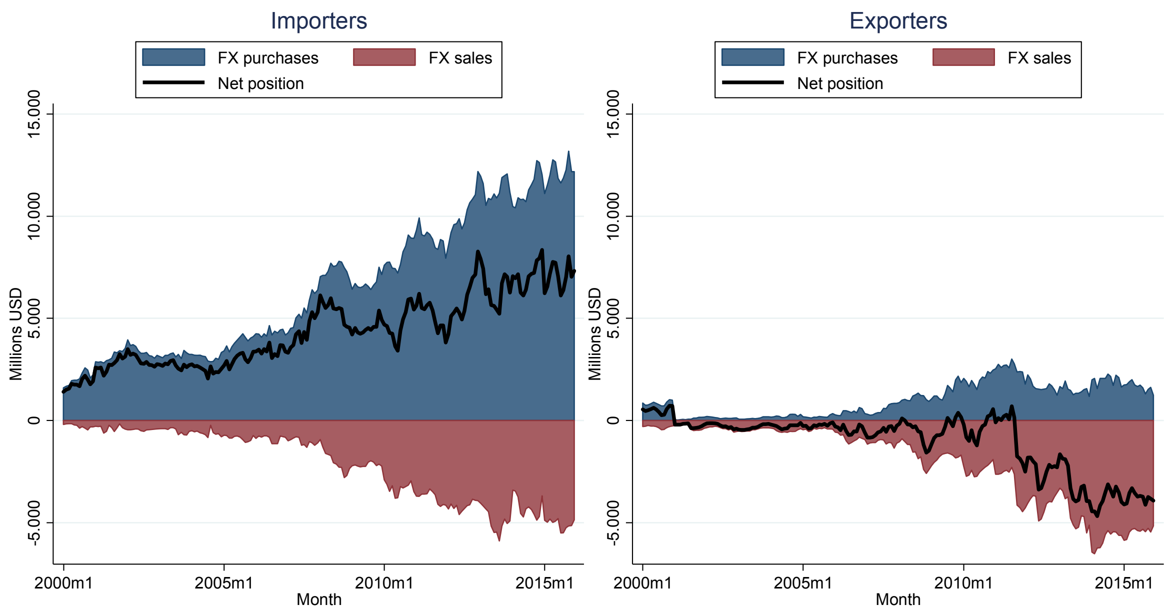
This hypothetical situation is reversed for the case of importers because they are interested in fixing the exchange rate for the future purchase of foreign currency. This "long position" can guarantee a fixed cost for the importer in the future.

International trade operations generate FX risks because the exchange rate can vary between the moment an obligation occurs and when the payment is made[13]. Derivatives contracts allow firms to reduce this uncertainty and stabilize their cash flows by providing protection against unexpected exchange rate movements. It should be noted that derivatives do not guarantee a better result than simply waiting and making the transaction via the spot market. Nonetheless, the elimination of uncertainty allows firms to focus on and optimise core business elements.

Figure 3 presents the gross positions for purchases and sales, as well as net positions (purchases minus sales), of foreign currency by EXIM firms. On average, the observed net derivative position (NDP) is negative (short) for exporters and positive (long) for importers throughout the period, as expected. Importers display a markedly positive NDP throughout the period. However, exporters show occasional periods where the NDP is positive. Reasons for the latter include: (i) exporters also hedge their imports; (ii) it is normal to close or terminate contracts by taking the opposite position; (iii) large companies that use derivatives usually have natural hedges via obligations (liabilities) in foreign currency. Also noted are the large gross positions held by importers as compared to exporters.

[13] Buscio et al. (2011) show that the reasons for derivatives use in Uruguay are 1) to cover operating expenses in foreign currency and 2) to cover costs.

Gross positions for purchases and sales and net derivative position Figure 3



Source: Author's calculations using CBCh data.

The amount of coverage chosen by these companies, measured as the NDP divided by the net flow of foreign trade, averages around 9% for exporters and 19% for importers[14]. Note that this only considers hedging through FX derivatives, so effective coverage is underestimated. With broader coverage measures, Fabling & Grimes (2008) and Čadek et al. (2011) found higher coverage ratios in more developed countries.

The expected NDP for importers is displayed across the majority of economic activities and/or sectors[15] (Figure 4). Indeed, 92% of the NDP is explained by four sectors: Commerce, Restaurants and Hotels (32%); Transportation and Communication (26%); Manufacturing Industry (18%); and Electricity, Water and Gas (16%). For their part, exporters show a higher grade of concentration with 90% NDP held across just 3 sectors: Manufacturing Industry (67%); Commerce, Restaurants and Hotels (14%); and Mining (9%). It should be noted that even though mining is the highest exporting sector in Chile[16], it has a relatively low participation in derivative markets. This is likely due to strong natural hedging due to currency matching of foreign-denominated assets and liabilities in the industry. Specifically, a

[14] Using Chilean firms from 2008 and 2009, Acharán et al. (2009) find that smaller firms display higher coverage than their larger counterparts due to the fact that the latter tend to utilise more natural hedges.

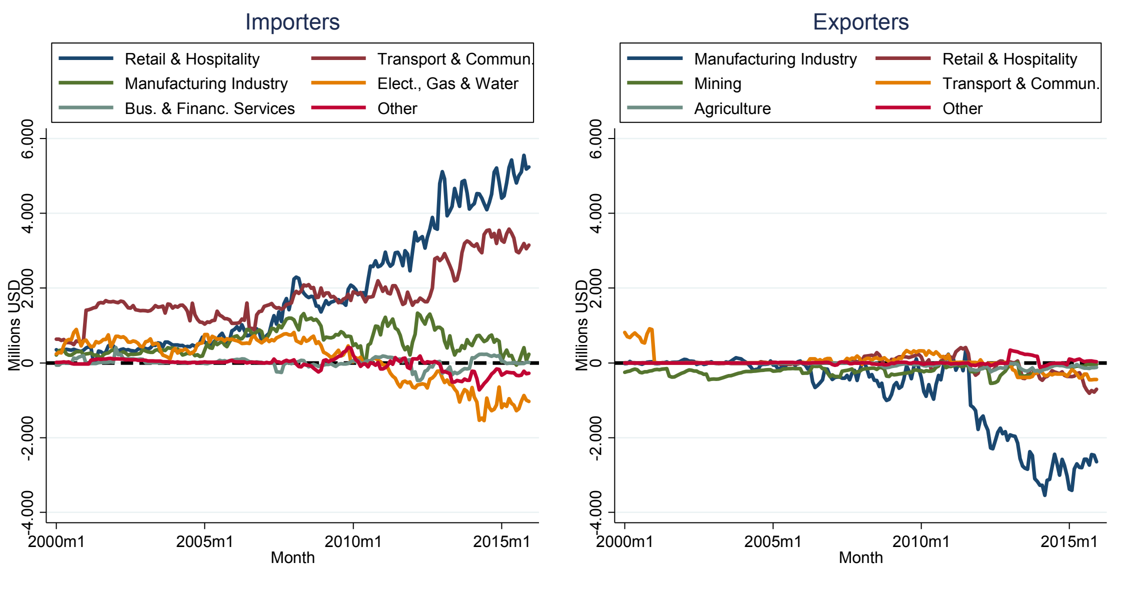
[15] Firms are grouped using a CBCh characterisation method with in the following categories: Manufacturing industry; Retail and Hospitality; Mining; Transport and Communications; Agriculture; Business and Financial Services; Fishing; Electricity, Gas and Water; Construction; Personal Services; and Others.

[16] In 2015 the mining industry represented more than 50% of total exports.

large part of the mining industry´s liabilities are held in foreign currency while many make utility payments in that same foreign currency, as in many cases they are owned by foreign firms[17].

Net derivative position by sector

Figure 4



Source: Author's calculations using CBCh data.

5.3. Contract characteristics

FX derivative contracts are characterised by annual turnover by instrument, currency and maturity. The shares of characteristic are presented in Figures 5 and 6.

The FX derivative instruments contracted by both types of firm have similar characteristics. The vast majority of contracts are forwards with an average share of over 80% for the entire period[18]. A greater diversification into more sophisticated instruments has been observed however over the sample period. Among them, cross-currency swaps (CCS) have played an important role, along with options, FX swaps and combinations thereof (classified as "Other").

The most traded currency pair by far is the CLP/USD. However, the figures show a high proportion of non CLP/USD contracts at the beginning of the sample period, which includes both currency pairs labelled as CLP/OT (other currencies) and UF

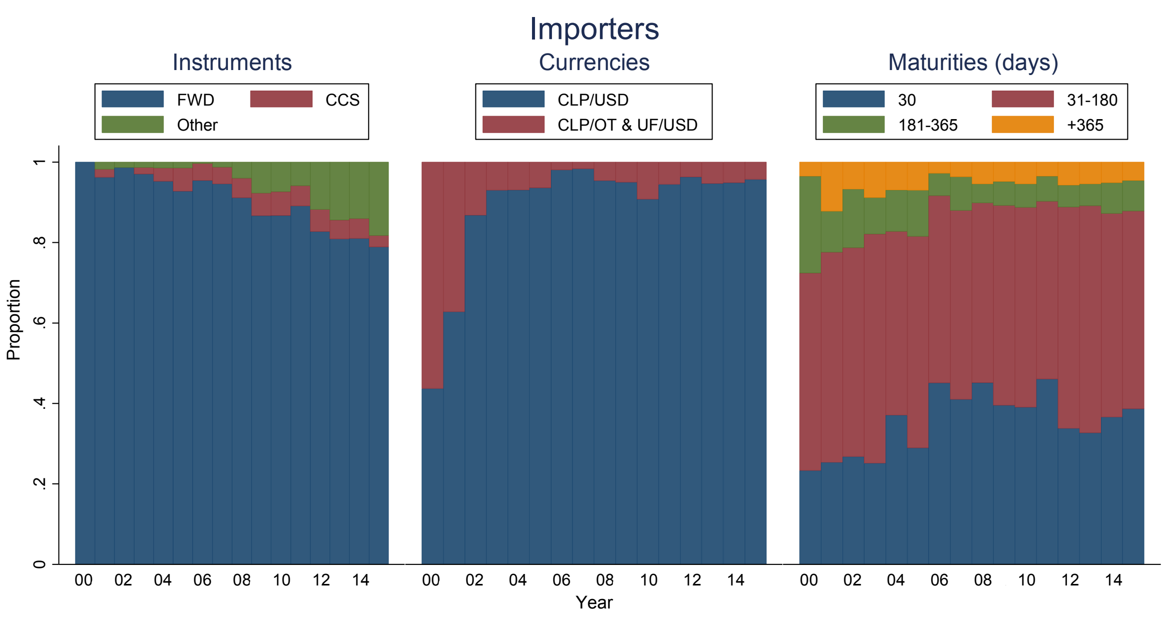
[17] According to Bank of England (1998), hedging in each industry depends on contract length in each industry, each firm´s capacity to project cash flow, and the cost of hedging.

[18] The high popularity of forward contracts is due to their simplicity and low entry costs, as no payment is required at the beginning of the operation.

(*Unidad de Fomento*[19])/USD. For the purposes of this analysis, the latter currency pair can be considered a transaction between the national currency and the US dollar. As such, almost all of the coverage includes the US dollar on one side of the transaction. Within "Other Foreign Currencies", the euro and Japanese yen make up the most significant proportion.

Contract characteristics for importers

Figure 5



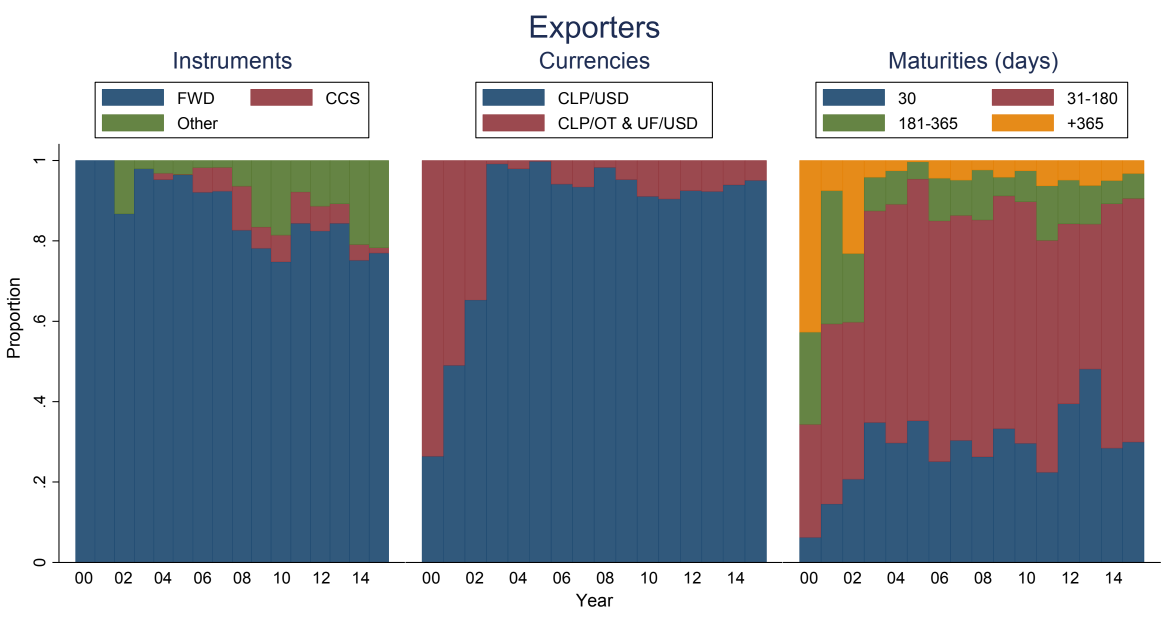
Source: Author's calculations using CBCh data.

On average, more than 80% of contracts have maturities of less than 180 days. Of these, two-thirds are between 31 and 180 days. Those with longer maturities (more than 1 year) are mostly CCS´s. This is related to the use of CCS´s as a debt hedging instrument which regularly have longer-term obligations.

[19] The UF (*Unidad de Fomento*) is a readjustable measure widely used in Chilean financial markets that varies daily with past inflation. This tool was particularly important before the nominalization of Chilean monetary policy in August 2001 (Jara et. al, 2003).

Contract characteristics for exporters

Figure 6



Source: Author's calculations using CBCh data.

6. Micro-level analysis

This section studies the behaviour of FX derivative use at the micro-level. Firstly, the degree of concentration of the total amount outstanding is analysed. The expected NDP is then studied to see if it is satisfied at the individual level. Subsequently, the relationship between the magnitude of foreign trade flows and derivatives market activity exhibited by EXIM firms is examined.

To measure the degree of concentration, a graphical representation of the distribution of wealth, known as the Lorenz curve (Lorenz, 1905), is used. As an application of this study, the wealth variable is replaced by the gross derivative position (purchases + sales)[20]. The concentration analysis reveals that 80% of exporters and importers accumulate less than 1% of the total gross positions throughout the period. The related Gini coefficient, which measures the degree of inequality based on the Lorenz curve, shows a value of 0.886 for importers and 0.872 for exporters, implying a high degree of concentration in both cases[21].

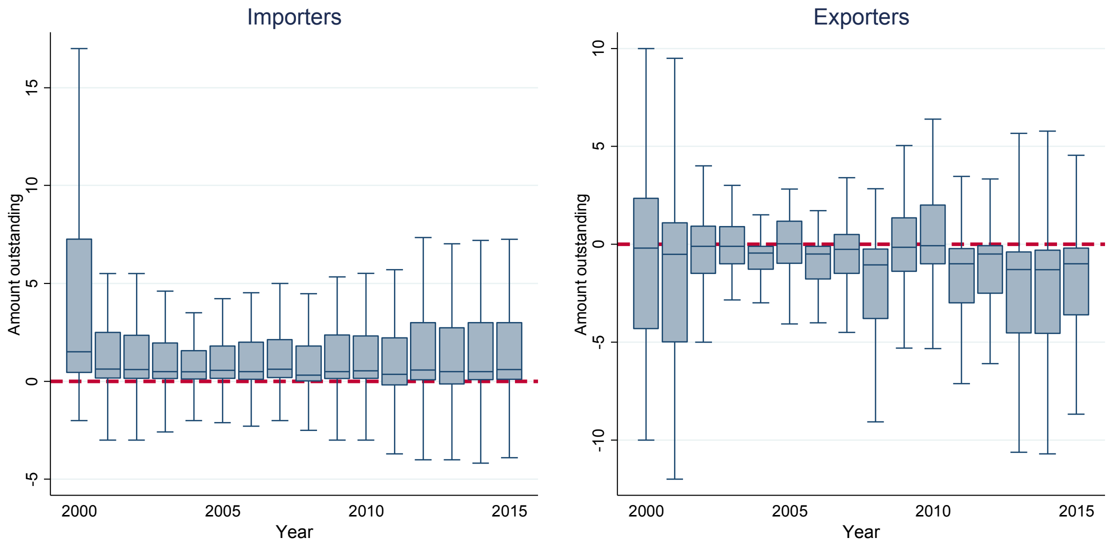
The high level of concentration could lead to think that the positions observed at an aggregate level (Figure 3) do not correspond to the hedging strategies taken by most companies. However, this is ruled out by analysing the empirical distributions of NDP´s for the last month of each year (Figure 7). These distributions

[20] Appendix 3 shows the Lorenz curves for exporters and importers.

[21] This index is from 0 to 1, in which 0 represents perfect equality and 1 represents perfect inequality.

confirm that the expected behaviour also holds at the individual level. It is noted that 75% of importers display the expected NDP, with exporters displaying no less than 50%.

Distribution of net derivative positions | Figure 7



Note: Excludes outside values

Source: Author's calculations using CBCh data.

Figure 8 presents some key points in the relationship between the flow of foreign trade of each company and the frequency of FX derivative transactions. The horizontal axis shows gross exports and imports while the vertical axis shows turnover of FX derivatives, with both classified into 20 quantiles. The colours simulate the density of companies through an index ranging from 0 to 100. Cooler colours represent a lower density of firms with warmer colours representing a higher density[22].

Warmer colours dominate the lower quantiles of trade flows and turnover. This implies a greater density of EXIM firms with low levels of foreign trade flows and turnover in the derivatives market compared to the total of companies analysed. In other words, a high number of small EXIM firms display lower activity in the FX derivatives markets.

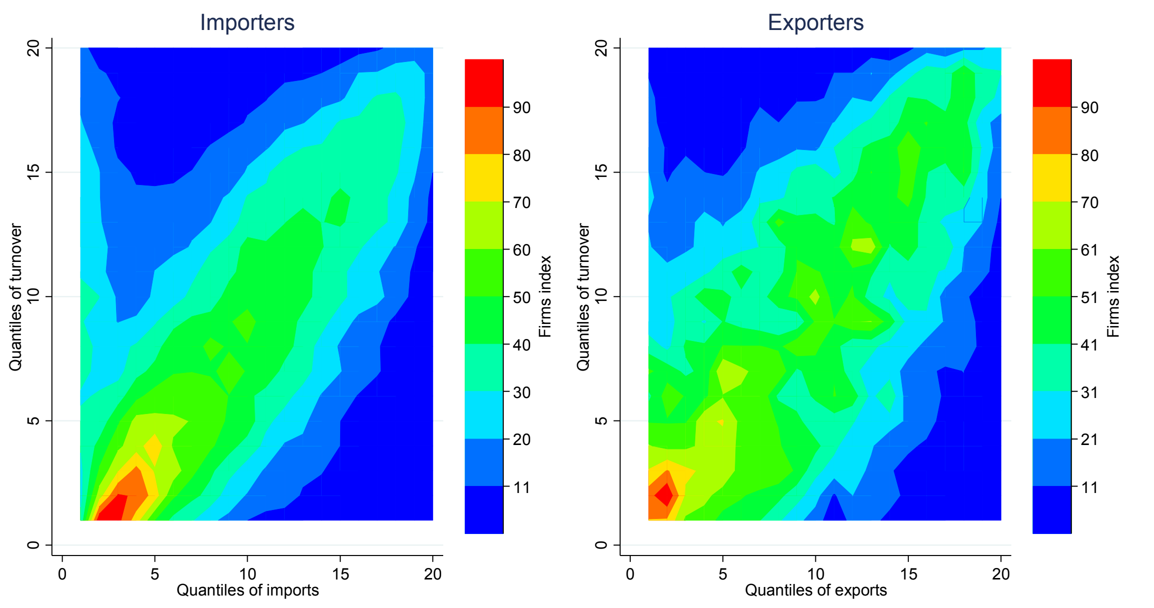
Furthermore, the cold colours are concentrated in two distinct areas: (1) high turnover and low levels of foreign trade flows, (2) low turnover and high levels of foreign trade flows. Therefore, a positive relationship is observed between the level of foreign trade and activity in the FX derivatives market. This is in line with previous empirical evidence and literature. This result also corroborates Villena & Salinas (2014) who suggest that the increased activity noticed in the Chilean FX market

[22] Appendix 4 shows this graph divided into 3 sub periods.

between 1998 and 2013 was influenced by greater international trade flows during this period.

Quantiles of foreign trade flows and turnover, 2000-2015

Figure 8



Source: Author's calculations using CBCh data.

7. Conclusions

A unique micro-level database has been exploited in order to characterise the structure of FX derivative usage by EXIM firms in Chile. Evidence is presented of a growing number of EXIM firms utilising FX derivatives as a hedging strategy against exchange rate risk. Furthermore, the paper shows a positive relation between firm size and the number of firms that use FX derivative hedging strategies. A direct relationship is also observed between the level of foreign trade flows and turnover in the FX derivative market.

The development of hedging strategies is in line with the currency mismatches experienced by different firms. Thus, importers exhibit net purchase (long) positions on FX derivatives while exporters exhibit net sale (short) positions. In both cases, the expected net derivatives position is found to hold for most sectors and for the majority of individual firms. The latter is true despite the high concentration in the FX derivatives market, where 80% of EXIM firms hold less than 1% of the total amount outstanding.

Even though there is a general trend towards the use of more diversified and sophisticated financial instruments, forward contracts are by far the principal instruments used by EXIM firms in Chile (with maturities of less than 180 days). This is consistent with the maturities of outstanding accounts payable or receivable in foreign trade operations. Breaking down these contracts by maturity shows that about two-thirds of them are between 31 and 180 days. Companies also cover foreign-denominated debt using cross-currency swaps with maturities longer than 1 year. Most exchange rate protection measures are taken against the US dollar.

The database constructed for this project as well as the initial evidence presented in this article can be used as a starting point for future research questions. These elements, used in conjunction with the financial statements of companies, could be used to examine in more detail the determinants of FX derivatives usage in Chile. This database could also shed light on the financial results of currency hedging made by EXIM firms. Finally, given the amount of available information in the dataset, analysis could be undertaken on how hedging strategies evolve over time due to changes in exchange rate volatility.

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Appendix

Average concentration of EXIM firms by firm size, 2000 - 2015 1

	Firm size by amount imported or exported (US$ million)				
	<0,5	0,5 - 1	1 - 5	5 - 50	>50
Importers	93.2%	2.3%	3.0%	1.3%	0.2%
Exporters	66.6%	7.6%	14.4%	9.2%	2.2%

Source: Author's calculations using CBCh data.

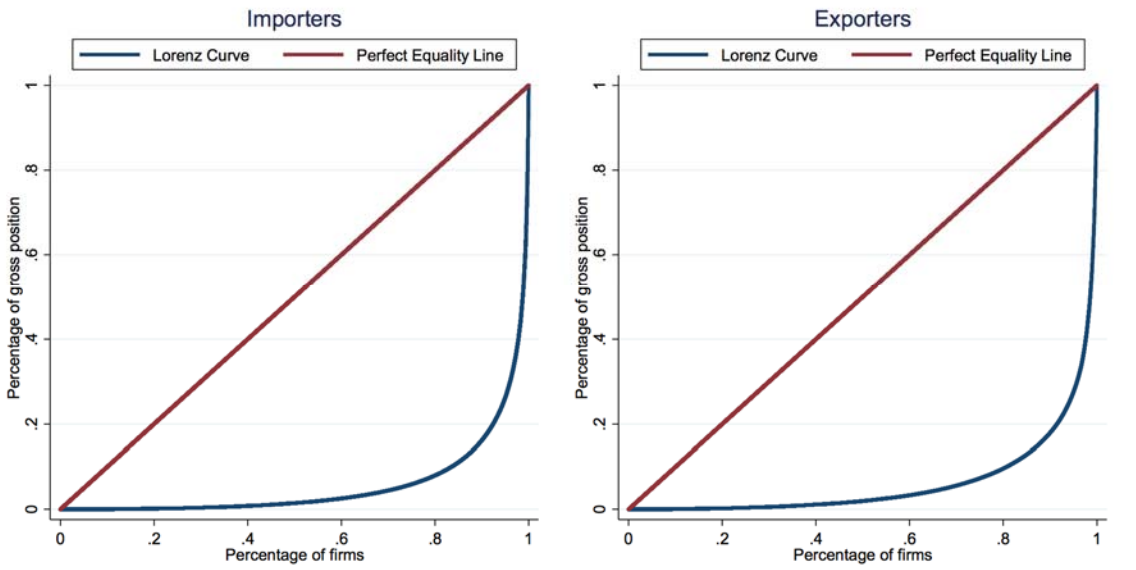
Turnover of EXIM firms (hedgers and non-hedgers) within the sample period 2

Years in the sample	Exporters		Importers	
	Number	Percent	Number	Percent
1-4	31,457	46.9%	749,814	65.5%
5-8	14,472	21.6%	206,491	18.0%
9-12	8,854	13.2%	83,932	7.3%
13-16	12,359	18.4%	105,195	9.2%

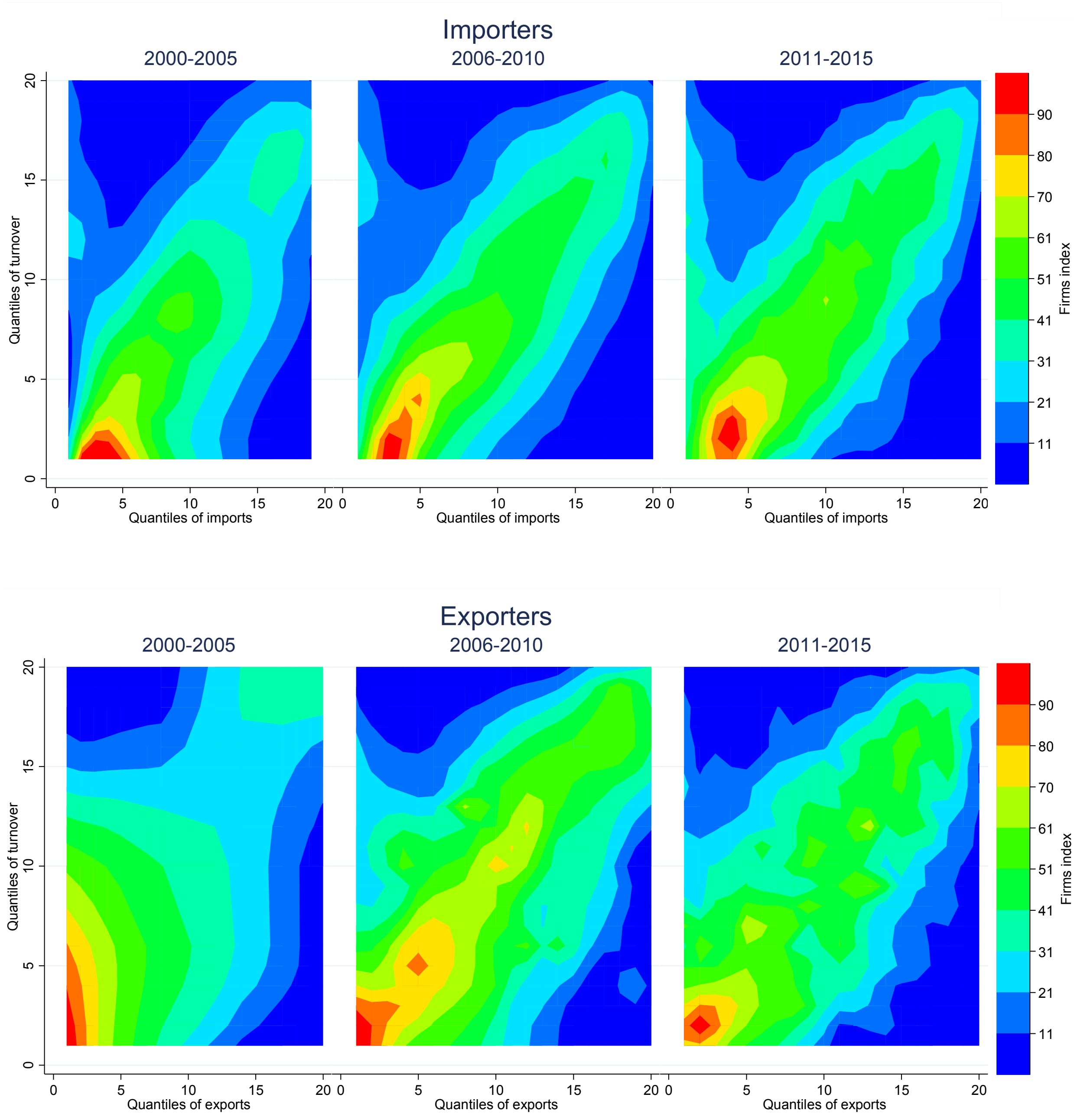
Source: Author's calculations using CBCh data.

Lorenz Curve for EXIM firms

3



Source: Author's calculations using CBCh data.



Source: Author's calculations using CBCh data.

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Basel, 8–9 September 2016

Monitoring business cycles in Lebanon: Is economic growth cyclical?[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Monitoring business cycles in Lebanon: Is economic growth cyclical?

Sana Souaid Jad

Abstract

Small countries with an open market economy, such as Lebanon, differ considerably from industrialized ones in the nature and characteristics of short-run macroeconomic fluctuations. This paper focuses on the Banque du Liban coincident indicator and the possibility to explore this composite indicator to explain short run economic fluctuations and business cycles in Lebanon. Based on Bry & Boschan procedure, this study examines the cyclicality of the coincident indicator growth. It lays out the different cycles and phases of Lebanese expansions and recessions with their respective downturn and upturns durations for the period 1993-2015.

Keywords: Business cycles, coincident indicator, expansions, recessions

Contents

I- Business cycle literature

Business cycles are the recurring and fluctuating levels of economic activity that an economy experiences over a long period of time. The National Bureau of Economic Research NBER defines business cycles as recurrent sequences of alternating phases of expansion and contraction. These cyclical fluctuations are persistent and the duration of a business cycle as a rule lasts several years. The four stages or phases of the business cycle are: Expansion, peak, contraction and trough.

In the literature, we have four types of cycles with different durations:

Kitchin inventory cycle (3-5 years)

Juglar fixed investment cycle (7-10 years)

Kuznet infrastructural investment cycle (15-25 years)

Kondratieff wave or long technological cycle (50-60 years)

Theories of business cycles are divided into two categories:

The first category states that cycles are exogenous and they are due to different external shocks (war, political shocks, change in raw material prices like oil prices…). The second argues that cycles are endogenous and self-generated by the market economy such as the interaction between demand and supply and Keynes multiplier-accelerator effect. The latter states that economic output depends on the level of the investment, the investment determines the level of aggregate output (multiplier), and is determined by aggregate demand (accelerator).

History has proven that both exogenous and endogenous factors could be the reason behind business cycles fluctuations. Moreover, Keynes theory states that monetary policy and fiscal policy can have positive role to play in smoothing the fluctuations of the business cycles, this is why usually expansion duration is longer than recession duration.

II- Methodology

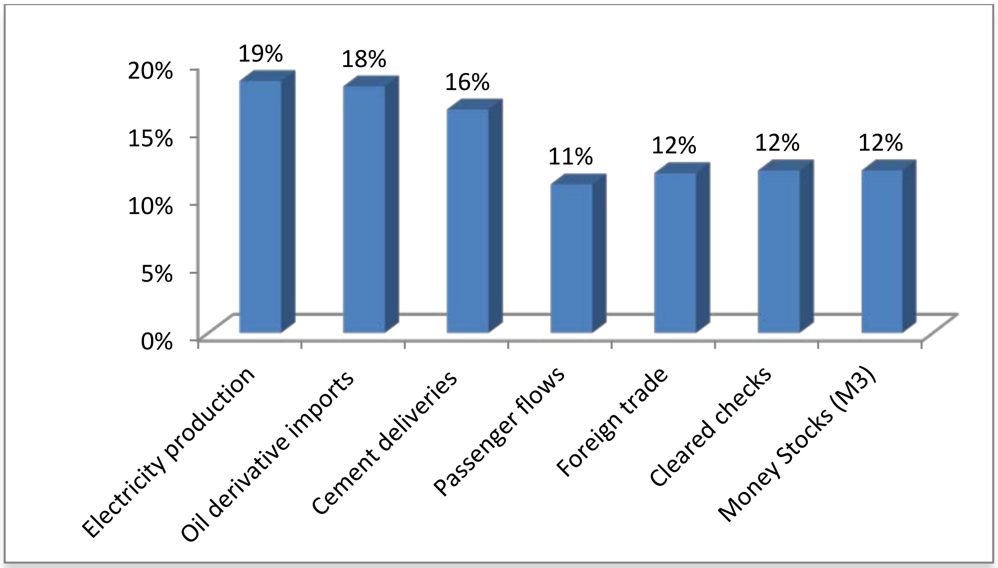
The classical method for measuring business cycles consists in monitoring the national production or GDP fluctuations. In Lebanon as in most developing countries, the statistical sources to analyze business cycles are insufficient, especially the ones related to national accounts.

Thus, given the importance of monitoring economic activity and the delay in publishing national accounts, researchers can use the BDL coincident indicator to sense economic developments on a monthly basis.

In this context, the Banque du Liban adopted in 1994 a composite indicator named "BDL coincident indicator" which gives an idea about GDP trends, without being a substitute. It is composed of seven economic variables that reflect the Lebanese economic activity.

1- Electricity production
2- Oil derivative imports
3- Cement deliveries
4- Passengers flows
5- Foreign trade(Imports and Exports)
6- Cleared Checks
7- Money Stocks (M3)

Figure 1.BDL coincident indicator components



The coincident indicator is computed from the sum of these variables, as weighted according to their importance. Weighting coefficients are derived from the results of standard regression of the components over GDP.

The BDL Coincident Indicator is strongly correlated with real GDP growth as shown by the national account. The econometric relationship between these two variables is the following:

$$\frac{\Delta GDP}{GDP} = 0.8\frac{\Delta IND}{IND}$$

Over the past years, it has been proved that this equation gives an accurate estimate of GDP. Moreover, the BDL Coincident Indicator is coherent with the BDL Business Survey results, where three qualitative variables "Industrial Production, Sales and Construction" have a coincident relationship with the BDL Coincident Indicator.

All the components of the BDL Coincident Indicator are in real term (M3, cleared checks and foreign trade are in fact deflated and converted to real values using the CPI inflation rate) and adjusted from sharp fluctuations resulting from seasonal and non-seasonal factors.

Based on the cycle's literature and inspired by Bry & Boschan quarterly procedure and the NBER methodology, we will test the cyclicality of the BDL coincident indicator by detecting the different phases and turning points of the Lebanese business cycles from 1993 till 2015.

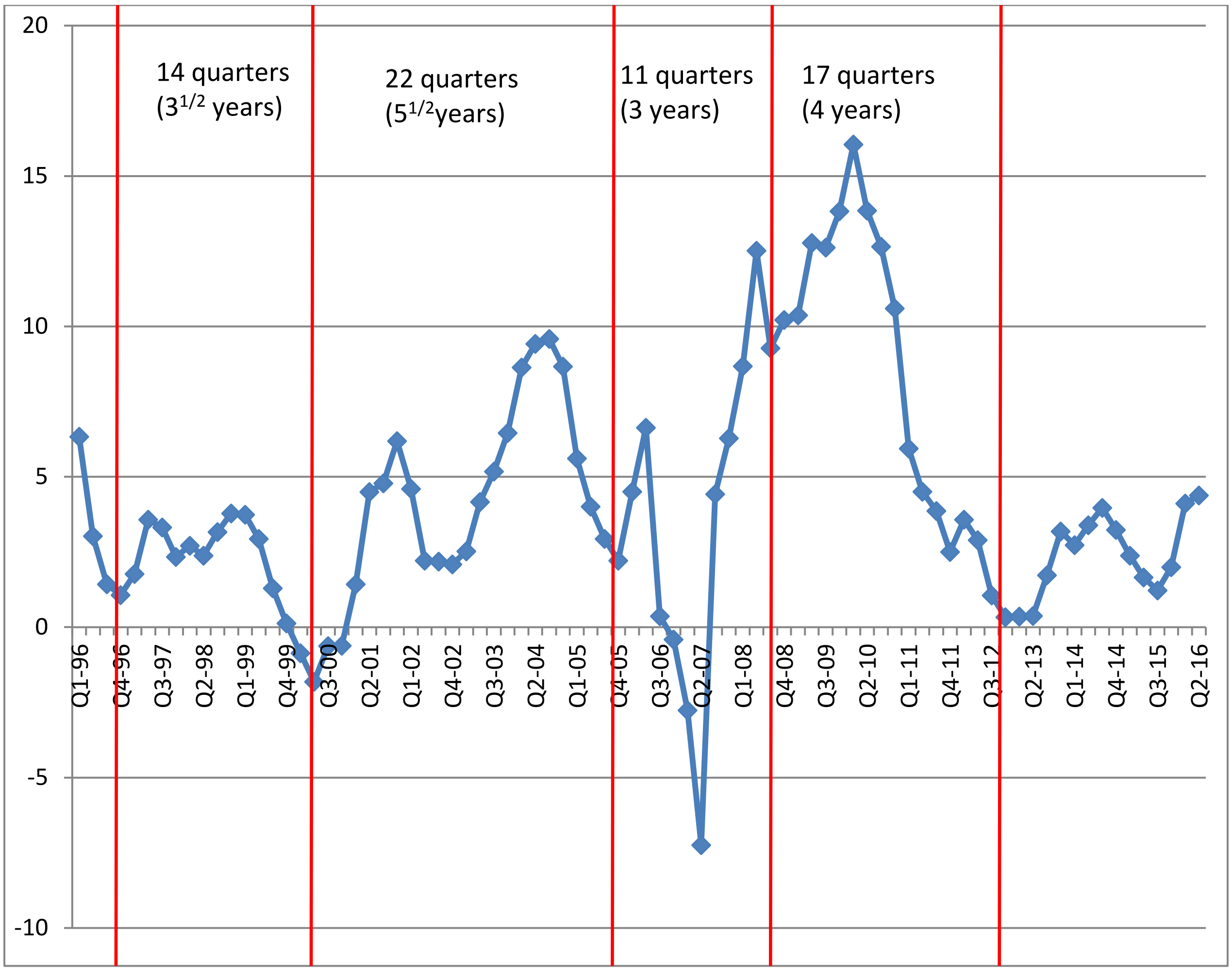
- The first step is to transform the monthly data to quarterly data.
- The second step is to calculate the quarter to quarter growth of the BDL coincident indicator.
- Finally, the cycles in a four–quarter moving average are identified.

Table 1. Assumptions for the quarterly Bry & Boschan procedure
A peak (trough) must be followed by a trough (peak)
A cycle (from peak to peak or from trough to trough) must have a duration of at least 5 quarters
A phase (from peak to trough or from trough to peak) must have a duration of at least 2 quarters
Turning points are not to be situated within the first or last 2 quarters of a time series
The first (last) peak and trough must be higher respectively lower than values closer to the beginning (end) of the data series

Source: Everts Martin P., 2006, "Duration of Business Cycles"

III- Lebanese cycles: 1994-2016

Figure 2.BDL Coincident indicator evolution: 1994-2016



Source: Banque du Liban, own calculations

Table 2. Business cycle duration

Business cycles- Reference dates (quarterly dates)		Duration in Months		
Turning points Peaks	Turning points Troughs	Cycle (from trough to trough)	Expansion (Trough to peak)	Contraction (Trough from previous peak)
Q4-98	Q4-96	42	24	
Q3-04	Q2-00	66	51	18
Q2-08	Q4-05	33	30	15
Q1-10	Q3-08	51	18	3
	Q4-12			33
Average duration in years		4 years	2 years and a half	1 year and a half

Q4 1998- Q2 2000: Recession, duration 18 months

The public finance crisis along with the restrictive policy that followed starting 1998 had together led to a drop in investment and a recession turning into stagnation in the year 2000. The causes of the said crisis are mainly endogenous and structural. In fact, the open-door policy adopted by the Lebanese government years ago had been accentuated in 2000 through the sudden and spectacular customs duties taxes cut. Nevertheless, this policy had multiple adverse effects on several economic sectors exposed to the foreign competition such as the industrial sector that witnessed a massive closing of enterprises as well as a severe production drop.

Moreover during this period a general decline in prices and Demand were depicted causing deflation in conjunction with a notably decrease in the purchasing power and an increase in indirect taxes.

Q2 2000- Q3 2004: Recovery& expansion, duration 51 months

Upon Rafic Hariri's return as Prime Minister after 2000, the resumption of investments following 11 September 2001 as well as the effects of Paris II Agreement alleging the fears from a financial crisis, had contributed to the revival of the economy reaching its peak in Q3-2004.

Q3 2004-Q4 2005: Slowdown, duration 15 months

The assassination of Prime Minister Rafic Hariri and all the political and security troubles in 2005 had put a term to this growth. During that period, an obvious degradation in the confidence was shown in the real sectors of the economy. However, the banking sector had solely known how to grant confidence to the savers via the practice of a policy of support for the Lebanese Pound.

Q4 2005- Q2 2007: political turmoil and instability

In this period, political turmoil and July 2006 war had harmful effects on the Lebanese infrastructure and consequently on the economic growth. This recession had reached its lowest point with a negative growth rate. These exogenous and unexpected factors had biased the Lebanese economic cycle.

Q3 2008- Q1 2010: Revival& Strong growth, duration 18 months

After the political crisis paralyzing the public institutions over a period of one year and a half, Paris III Agreement as well as the presidential election in June 2008 had contributed to a confidence regain translated into an economic revival on all the sectors' level and in particular on the construction one.

In contrast with some Gulf, European and Asiatic countries, Lebanon had solid regulatory framework which isolated its markets from negative effects of the international financial crisis.

In addition, the remittances into Lebanon have increased since the start of the financial crisis as the expatriates preferred to liquidate a part of their fixed assets due to the bad world economic context and effectuate transfers into a trustworthy banking system.

Since then, the Lebanese banks benefited from very high liquidity ratios that pushed the BDL to provide loan incentives intended to bring down the cost of borrowing (Both lending rates in USD and LBP were brought down from 8%- 12%% to 1%- 5%). These loans have contributed to a remarkable growth and activity revival in the industry and construction field.

The BDL coincident indicator clearly captured this revival: its annual growth had reached historical values during this period.

Q1 2010- Q3 2012: Recession, duration 33 months

Since mid-2010, the conflict in Syria and the region had severe and negative impact on the Lebanese economy. Spillovers from Syria and regional turmoil had been particularly pronounced in the trade and tourism sectors. Moreover, the rising demand for public services stemming from the large refugee influx had damaged Lebanon's public finance.

Since Q3 2012:

Following a sharp drop in 2011, Lebanese growth has registered low levels averaging 2% since 2012 due to the instable political and economic environment as well as the vacancy in the presidency since May 2014. Lebanon's traditional growth drivers—tourism, real estate, and construction—have received a significant blow, Inflation also declined sharply in 2014 on the back of lower oil prices. The overall picture and growth estimates are still gloomy and under the potential.

By monitoring the evolution of the BDL coincident indicator during the last twenty years, the different phases and turning points of the Lebanese business cycles are detected and summarized as follows:

- There were nine turning points consisting of five troughs and four peaks.
- The minimum duration of the Lebanese cycle is three years and the maximum is five years. The average duration of the cycle is four years.
- The average length of expansion periods is two years and a half and the average length of recession periods is one year and a half.

- Since 2005, exogenous factors (war and political turmoil) are affecting the regularity of the Lebanese cycles.

Lebanese cycles could be attributed to Kitchin inventory cycle of forty months with an M shape. As shown by its name, it is a short cycle due an excess supply or accumulated inventories. When the Supply becomes greater than the Demand, prices dropped and stocks appear, this will reduce the production (recession period). After this decrease takes place, we can observe a new phase of growth of Demand, prices and output (expansion), etc.

IV- Conclusion

This paper presents an attempt to monitor and analyse Lebanese business cycles in the lack of regular national accounts data. The BDL coincident indicator has been proved a sound tool for this purpose and the results showed that between 1994 and 2016 the average duration of lebanese cylcles is four years and could be attributed to Kitchin inventory cycle of forty months with an M shape.

The results are close to the cycles attributed to small developing countries with an open market economy; the average duration of business cycles in developing countries is three years while in industrialized ones between six and eight years. The overall picture of Lebanese business cycles will be clearer with longer series and less exogenous and unpredictable factors.

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Portuguese economy: Statistical analysis on the current account reversal´s sustainability[1]

João Falcão Silva and Vitor Lopes Silveira,
Bank of Portugal

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Portuguese economy: Statistical analysis on the current account reversal´s sustainability

João Falcão Silva, Vítor Lopes Silveira[1]

Abstract

In the past, Portugal exhibited persistent deficits on the current and capital account. In 2012, this situation reverted and a surplus in the current and capital account has been registered since 2012. The aim of this paper is to explore external statistics as a key source to evaluate country´s economic performance. External macroeconomic imbalances have to be analysed beyond traditional current and capital account. In particular, real economy cannot be disregarded from financial flows and positions. The richness of statistical data availability constitute a relevant tool to monitor economies performance and support economic decision makers.

Keywords: macroeconomic imbalances, current and capital account, financial account, international investment position, VAR model.

JEL classification: E66, O52.

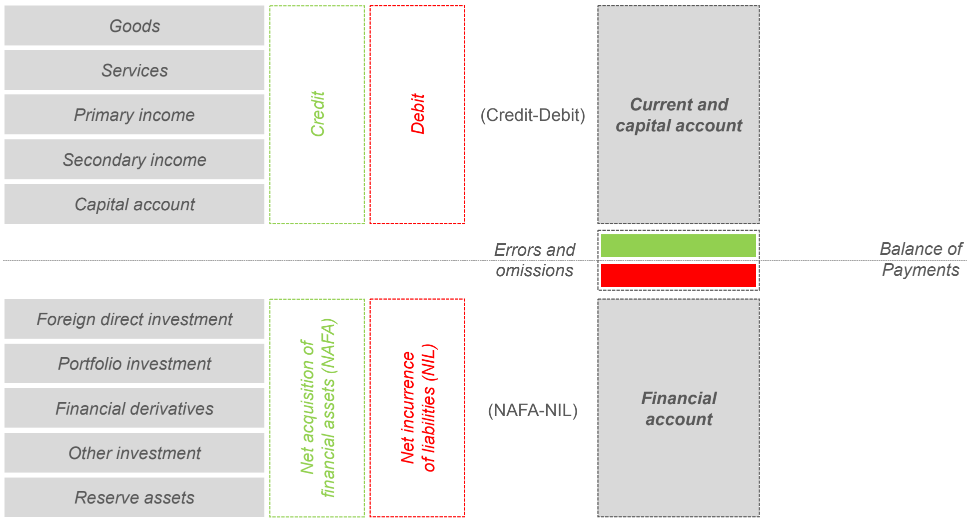
1 The authors would like to thank Filipa Lima, of Banco de Portugal, for the valuable contributions to the paper. The opinions expressed in this paper are those of the authors and do not necessarily reflect those of the Banco de Portugal.

Contents

1. Introduction

Balance of payments measures external transactions occurred between residents and non-residents in one economy, in a specific period of time. It is composed by two main categories that should be balanced on a regular basis - current and capital account and financial account[2] (Figure 1). Current account deals with real and short – term external transactions (international trade - goods and services - and income - primary and secondary), while capital account records physical assets, in/ out flows of capital that brings a change in a country´s foreign assets and liabilities. Financial account includes financial assets and liabilities external transactions.

Figure 1 | *Balance of payments composition*



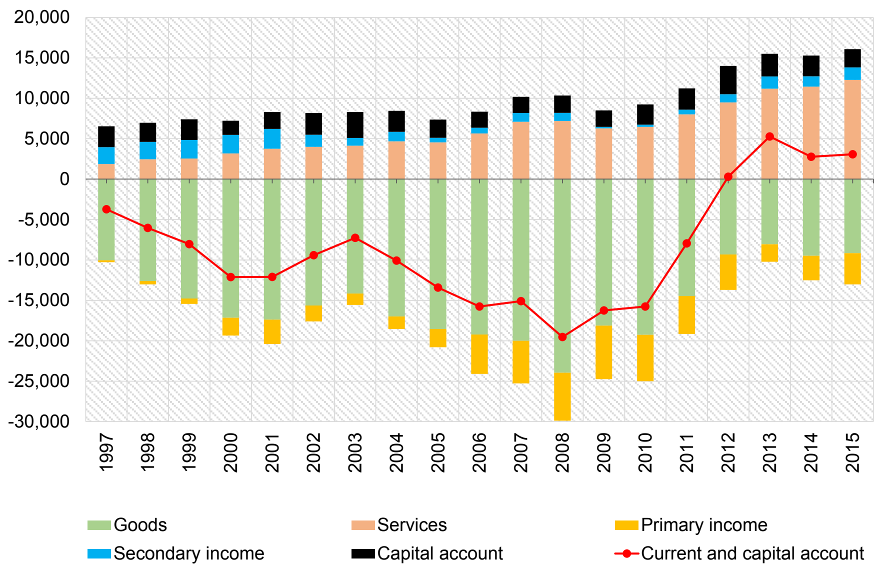
An economy that exhibits a deficit/ surplus in the current and capital account is considered as a net debtor/ creditor to the rest of the world with positive/ negative external inflows, meaning that its external net incurrence of liabilities is higher/ lower than its external net acquisition of net financial assets.

Until 2012 Portugal was a net external debtor. Graph 1 shows the Portuguese current and capital account and its main components. Services, secondary income (where migrants' remittances are included) and capital account contribute positively to the balance of current and capital account, while goods and primary income (income earned from production, capital and labour factors) contribute negatively.

Current and capital account cannot be however disregarded from its financial flows. In the Portuguese case, primary income for example, is mainly determined by investment income which is linked with the international investment position performance.

2 Current and capital account is not always equal to the financial account due to some statistical imperfections, lack of information, leads and lags measured by *errors and omissions*.

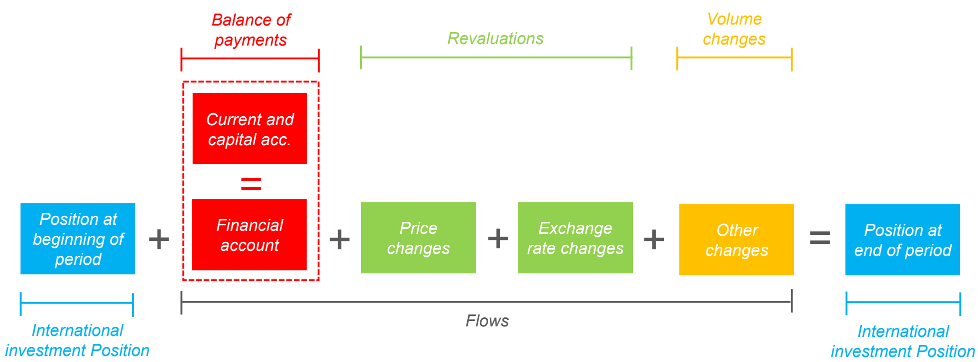
Graph 1 | *Portuguese current and capital account by component, in MEUR*



[Source: Banco de Portugal]

The analysis of the current and capital account has to be complemented with financial transactions and the corresponding outstanding amounts. Financial transactions are one important component of the external stock amounts since the increase/ decrease of net financial assets will increase/ decrease the net international investment position. However, the change of the net international investment position is affected also by the existence of other flows; namely, price and exchange rate changes - earnings/ losses due to price (de)valuations/ exchange rates fluctuations - and other changes, which is a residual component expressing, for example, extinguished assets/ liabilities and statistical reclassifications (Figure2).

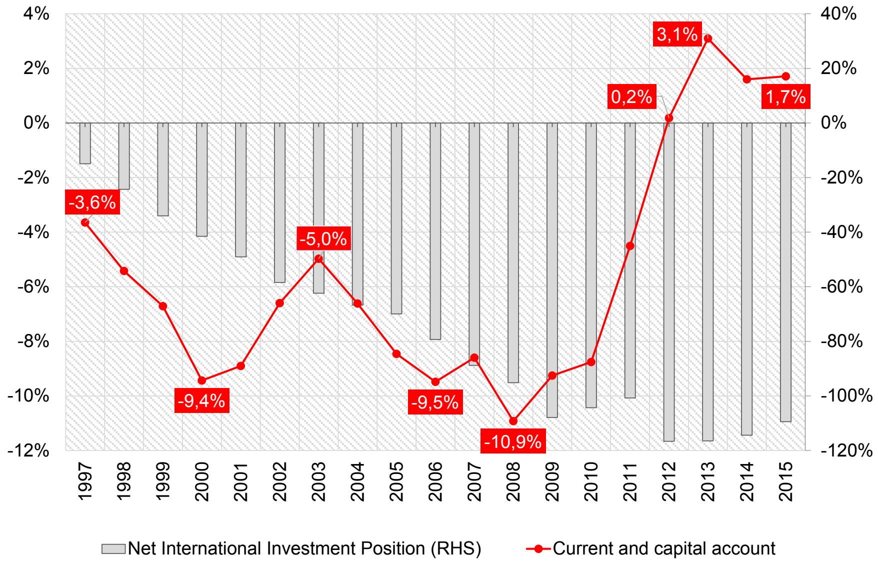
Figure 2 | *International investment position decomposition*



The ratio of the net international investment position to Gross Domestic Product (GDP) is commonly used to gauge the creditworthiness of a country. As stated by the European Comission: '*The more negative the net international investement position to Gross Domestic Product, the more country becomes vulnerable to volatility in international financial markets. Many countries that accumulated a large negative net outstanding amounts in the run-up to the crisis lost access to financial markets when the crisis struck and needed to accept international financial assistance to cover the deficit in their budgets*'. Therefore, it is a good statistical indicator to evaluate the risks to financial stability.

Portuguese current and capital account and the net international investment position are shown in Graph 2. For the time span considered, there is, in general, a positive relation between the two variables. However, for some years, there is a negative relation meaning that other flows than transactions explain the change in the stock amount and therefore cannot be disregarded. In 2012, for example, the current and capital account which stood at 0,2% of Gross Domestic Product (+4,7 p.p. when compared to 2011), the international investment position record -117% of GDP (-15,9 p.p.).

Graph 2 | *Portuguese current and capital account and international investment position, in % of GDP*



[Source: Banco de Portugal]

This paper does not aim to address any conclusion on the Portuguese recent current and capital account reversal sustainability. Instead, it takes Portugal as a case-study to demonstrate that the full understanding of one economy competitiveness cannot be dissociated from financial flows and positions and other macroeconomic statistics.

Currently, there exists a wide range of statistical data available which can provide a very important information to support decision makers and that can be used to monitor economies aiming to predict economic crises, for example.

Based on a statistical perspective and descriptive analysis, this paper focuses both on the level and composition of Portuguese debits/ liabilities *vis-à-vis* the rest of the world. Strengths and weaknesses are explored.

This paper comprises six sections. After the introduction in section 1, section 2 conducts a brief literature survey. Section 3 detail some external linkages between Portugal and other economies. Section 4 searches possible external risks and vulnerabilities of the Portuguese economy. Section 5 states some final considerations.

2. Literature survey

In 1817 David Ricardo supported that there are many economic benefits from international trade. External openness improves economic welfare if comparative advantages are explored. However, benefits can be offset if external economies connections are not wisely managed and understood.

International trade is the most relevant component of the Portuguese current and capital account. Its determinants are highly discussed in the literature. It is argued that current account is determined by both structural medium-term (more permanent) components and cyclical (transitory) determinants. Ca'Zorzi, Chudik and Dieppe (2012) use inter-temporal optimization to conduct a stock taking exercise on these relations. These authors argue that structural determinants are linked with gap between domestic savings and investment, demographic factors (for example, dependency ratio), trade imbalances, external competitiveness and dependency on production factors like energy. Although there are cyclical elements as business cycles that influence also the current account.

However, due to the complexity of the current and capital account, other macroeconomic indicators need also to be used to explain its evolution. Brimissis (2010) assumes that *'a higher fiscal deficit (...) decreases private saving (...) under the Keynesian model (...) supports the twin-deficit hypothesis (...) fiscal deficits usually be accompanied by wider current account deficits*'.

On the linkages between current and capital account and financial account, Obstfeld (2012) supports that external exposure cannot be dissociated to the financial account, because international crisis are the product of severe liquidity constraints: '*while policymakers must continue to monitor global current accounts (...) large gross financial flows entail potential stability risks that may be only distantly related*'. Accordingly, available literature suggests joint assessment of current and capital and financial accounts imbalances.

The sign and magnitude of the current account is also commonly discussed. Ghosh and Ramakrishnan (2012) state that '*whether a deficit is good or bad depends on the factors giving rise to that deficit*'. For instance, current account deficit can be used to mitigate external shocks, particularly when initial level of deficit is not excessive. External exposure soundness depends (*inter alia*) on risk minimization (portfolio diversification and solvency binomial).

On the current account reversals Ghosh and Ramakrishnan (2012) said that '*several economies during the recent global crisis (...) Such reversals can be highly disruptive because private consumption, investment, and government expenditure must be curtailed abruptly when foreign financing is no longer available (...)*'.

In this concern, current account reversals have to be monitored. Financial statistics and other economic indicators can provide an insight on the strengths and weaknesses of the reversals.

3. New financial landscape: The Portuguese case and international comparison

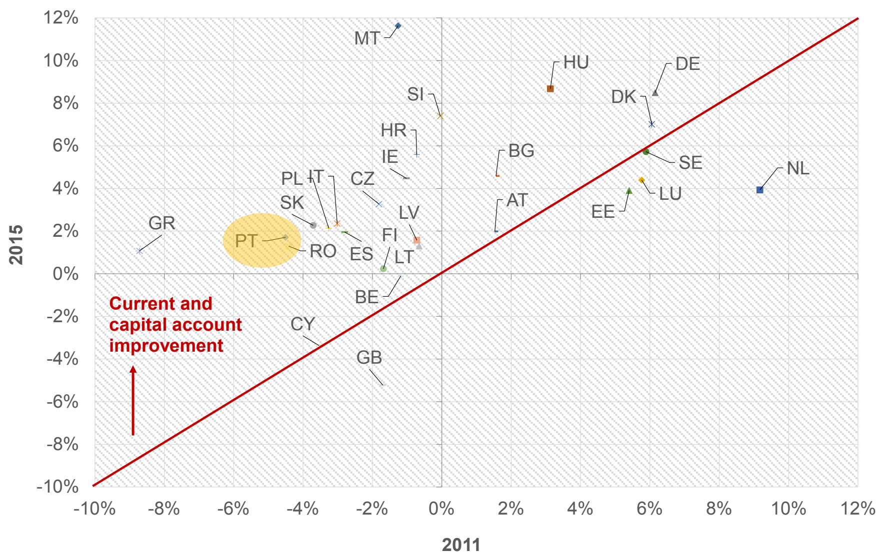
External linkages between Portugal and other economies

In 2015, the degree of openness - measured as the sum of exports and imports over nominal GDP - of the Portuguese economy was levelled at approximately 80%. When compared with the other European Union countries, Portugal stood in the 28th position. According to Eurostat data, other vulnerable economies were aligned with Portugal - Italy (29th), Greece (26th) and Spain (24th), with the exception to Ireland which ranked third more opened economy of the European Union.

The Portuguese external deficit between 1997 and 2011 reflected low external economic competitiveness. After 2012 Portugal becomes an external net lender. It is worth mentioning that this situation is followed by the recent world economic and financial crisis.

The Portuguese (PT) current and capital account reversal was not an exception when compared with other European countries (Graph 3). The majority of these countries evidenced current and capital deficits in 2011 and were external net lenders in 2015.

Graph 3 | *European countries current and capital account balances, in % of GDP (2011 and 2015)*



[Source: Eurostat]

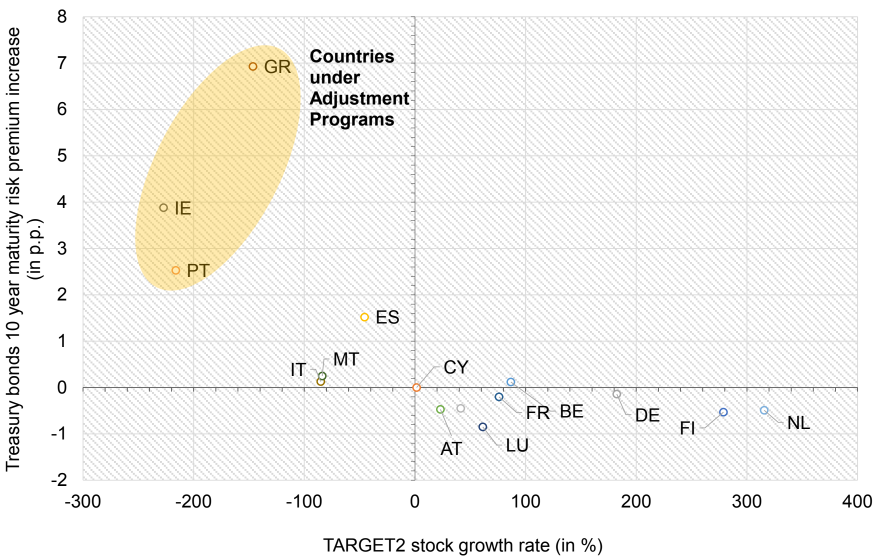
Euro-Area vulnerable economies liquidity constraints were attenuated by the accommodative policy led by ECB which reflected in the Trans-European Automated Real-time Gross settlement European Transfer system (TARGET2). Tressel (2014) argued that '*overall support provided by the Eurosystem to banks or sovereigns of various Euro-Area countries is reflected in the TARGET2 balances*'.

According to Sinn and Wollmershäuser (2011) '*Greece and Portugal financed their current account deficits in 2008 to 2010 through TARGET2*' suggesting that TARGET2 can predict external financing problems.

Graph 4 compares for a sample of selected Euro-Area countries, TARGET2 growth rate and 10 year Treasury bonds interest rate (risk premium) developments. According to this graphic, between 2008 and 2010, the accommodative policy led by ECB which reflected in TARGET 2 financed vulnerable Euro-Area economies as Portugal and Greece. For the particular case of Germany, Cecchetti et. al. (2012) argued that '*since the beginning of the financial crisis in August 2007, claims of the Deutsche Bundesbank on the Eurosystem through the TARGET2 system have gone from basically zero to more than €700 billion*'. At the same time, international markets were already penalizing public debt issues - Treasury bonds risk premium increased, due to macroeconomic imbalances, in vulnerable economies.

Graph 4 | *TARGET2 stocks variation and Treasury bonds risk premium*

(2008 – 2010)



[Source: European Central Bank]

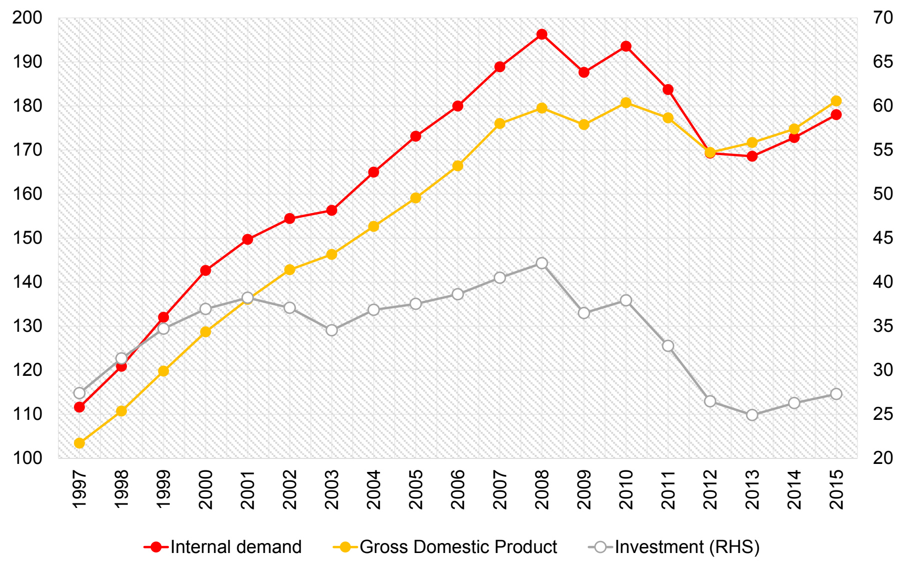
Portuguese current account and financial account

In Portugal, at the same time that current account increased, internal demand via investment (Graph 5) decreased.

According to the European Commission article '*The cyclical component of current-account balances*', '*The rebalancing of trade (and thus current-account) balances in the vulnerable countries is reflected in domestic demand declining faster than output*'. This situation can be observed in Portugal. After 2010 there was a decline of private investment; private consumption has generally declined more than GDP and contributed to raising saving rates.

The European Commission article states that: '*The countercyclical increases in fiscal deficits initially slowed the narrowing of current-account deficits in a number of vulnerable countries, but fiscal consolidation has contributed to improving their current-account balances since 2009-10*'.

Graph 5 | *Portuguese Gross domestic product and internal demand, in 1,000 MEUR*



[Source: Eurostat]

Current and capital account recent reversal is attributable to a combined increase in the services account surplus and an improvement in the goods account deficit.

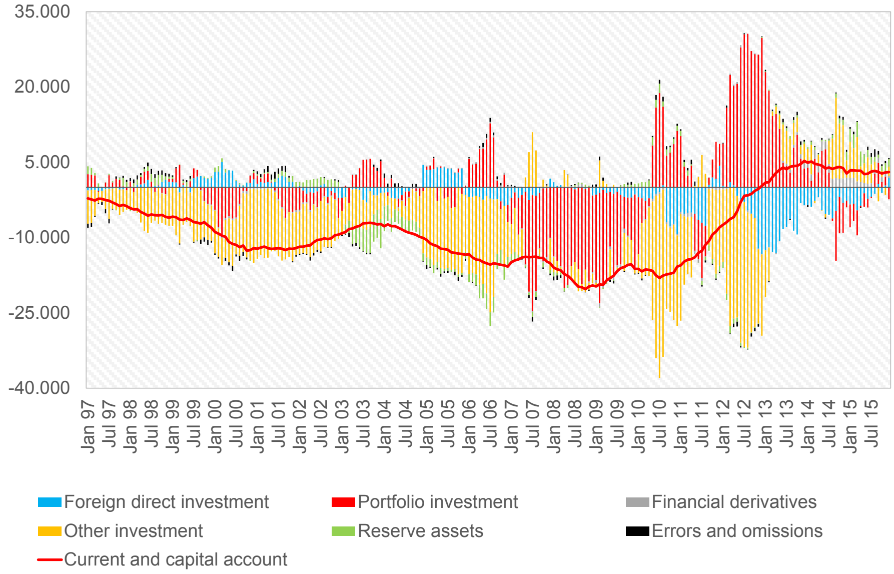
Financial account, the mirror of the current and capital account - captures financial transactions which correspond in many circumstances to exports/ imports and/ or primary/ secondary income of the economy. However, there are transactions that may have impact in the same account.

On the financial side, different patterns can be referred before and after the world economic and financial crisis. Graph 6 displays the relation between current and capital account and financial account (broken down by functional category). According to this evolution four different phases can be inferred:

1. Between [1997-2007] Portuguese current and capital account accumulated deficits. On the financial account, Portugal was mainly financed by external loans (other investment functional category);
2. Between [2007-2010] there is also an accumulation of the current and capital deficits. In this period, Portuguese external financing was mainly obtained under portfolio investment - issuance of debt securities and equity by corporations (financial and non-financial) and general government. Portfolio investment is considered a more volatile investment than foreign direct investment;
3. Between [2010-2014], under the recent Bailout Programme (Economic and Financial Assistance Programme), a reversal of the current and capital account is observed. Financial transactions were compensated within financial account and not in the current account. Portugal obtained external loans from the European Commission, European Central Bank and International Monetary Fund (IMF) (with a negative impact on other investment balance) and in the meantime there are long term debt securities amortizations with a positive impact on the net portfolio investment. Reserve assets[3] also increased after the Bailout programme. Net foreign direct investment shows also during this period a negative performance associated with intra-group inflows in the form of loans to suppress internal liquidity constraints; and,
4. After 2014 there is an increase of the issuance of general government debt securities in the international markets - with a negative impact on the net portfolio investment. At the same time, there were European Union-IMF loan redemptions (other investment exhibited a positive sign). Direct investment decreased induced by some non-resident companies that controlled/ had significant degree of influence on the management on domestic firms.

[3] External assets controlled by monetary authorities and readily available to be used (high degree of liquidity).

Graph 6 | *Portuguese balance of payments (12 month accumulated flows), in MEUR*



[Source: Banco de Portugal]

International investment position performance

The new financial landscape brought also some changes in the net international investment position performance and composition.

Between 1997 and 2015, the Portuguese net international investment position was negative (-109% of the GDP in 2015), which reflects a potential risk to financial stability. According to the European Commission countries with largest negative net international investment positions manage to reduce their large current account deficits or even shifted to external surpluses, which are sufficient to stabilise and slowly reduce their net external indebtedness over the medium term.

However, a mere stabilisation of external indebtedness may not be enough to restore full confidence, in particular for countries where the large negative net international investment positions essentially reflect level of debt (as opposed to countries where large negative amounts is driven by significant inflows of foreign direct investment).

In Portugal, recent positive current and capital account developments have contributed positively to the increase of the Portuguese external wealth. Nonetheless, there are other flows which influence international investment position and external sustainability that cannot be disregarded.

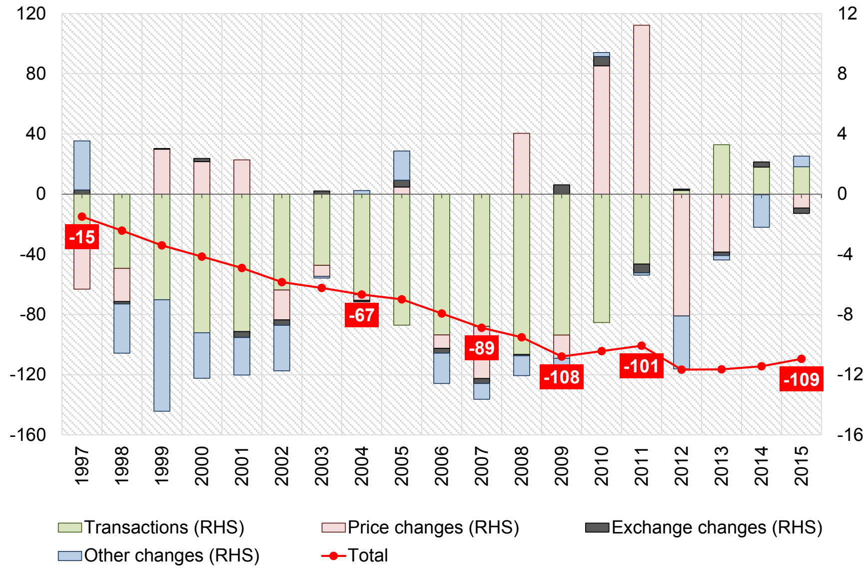
Graph 7 depicts Portuguese net international investment position between 1997 and 2015, broken down by transactions, revaluations (exchange rate and price changes), and other flows. Until 2009, financial transactions were the most important contributor to the international investment position. After the financial crises, in 2009 (with a 'new financial landscape') the net international investment position was determined by revaluations and other changes in volume. Before 2009, financial transactions were the main driver.

Price changes (a small component of the international investment position until 2008) increased after 2008 and was the main contributor between 2012 and 2013. Price changes show the valuation of Treasury bonds issued by general government held by non-residents, associated to the risk increase of the Portuguese economy. Non-financial corporation sector was also responsible to the price changes under the Portuguese stock exchange index (PSI 20). On the monetary financial institutions rather than central bank Banco de Portugal reported that '*both the return on equity and the return on assets improved considerably in 2015 (...) positive development in profitability was mainly driven by a significant reduction in the flow of impairments*'.

Other changes which measure, for instance, write-offs played also an important role in the net international investment position between 2012 and 2014.

Finally, recent evolution of the net international investment position as a percentage of GDP, benefits from a denominator effect (especially in 2014 and 2015); GDP increase (around 2% and 3%, respectively), after a sharp decrease in 2012 (nearly 4%).

Graph 7 | *Portuguese international investment position by type of flow, in % of GDP*



[Source: Banco de Portugal]

When compared to other vulnerable economies, Portugal has a similar net international investment position performance to Greece and Spain (in 2015, -126% of GDP and -90% of GDP, respectively). Italian net international investment position accounted for -27% of GDP (the better performance among the European vulnerable economies). Ireland registered its worst amount in 2012 (-130% of GDP), recovering to -70% of GDP in just 3 years (2015).

In the context of the three European economies with recent Bailout Programs – Greece, Ireland and Portugal – Portugal is the only country that exhibits a negative change in the net foreign direct investment position.

Excluding equity and financial derivatives from the international investment position, Portuguese net external debt chiefs 102% of GDP in 2015; which is the highest value (virtually equal to 2012) since 1997.

Current account and financial components linkages: an empirical analysis

The causality between current and capital account and financial account is highly discussed in the literature. Ersoy (2011) conducted causality tests for Turkey in order to understand the relationship between these 2 variables: '*Granger causality that runs from financial inflows to current account deficits (..) investigation suggest that the current account sustainability may be provided via better management of financial account*'.

In order to conduct an empirical analysis on the causalities and impacts of financial components into the current and capital account, a vector autoregressive model (VAR) was conducted. These models, became popular by Sims (1980) who provided a flexible framework to analyse the linkages and impacts among different financial/ non-financial variables.

In general – Pfaff et. al. - a VAR is a process constituted by K endogenous variables $y_t = (y_{1t},\ldots,y_{kt},\ldots,y_{Kt})$:

$$y_t = A_1 y_{t-a} + \ldots + A_p y_{t-p} + u_t$$

Where A_i are coefficient matrices KxK for $i = 1,\ldots,p$ and u_t is a K dimension white noise process.

In this respect, VAR models capture linear interdependencies between different time series. By exploring causality between different variables, these models allow to explore impact of shocks in explanatory variables in the dependent variables (impulse response functions).

Quarterly data was considered from 2001Q4 to 2015Q4 covering the following variables: the change rate of current and capital account seasonal adjusted in percentage of GDP; change rate of trade openness, sum of exports and imports as a percentage of GDP; change rate of net portfolio investment as a percentage of GDP; Portuguese stock exchange index variation (PSI 20); exchange rate measured in euro *vis-à-vis* US dollars, change rate of net other investment as a percentage of GDP. GDP used is seasonal adjusted.

In methodological terms, stationarity tests were run. Augmented Dickey-Fuller tests were considered for trend and intercept, intercept and none, and the conclusion is that variables have different degrees of integration (no cointegration). Non-stationary time series were transformed.

VAR lag length was chosen taking into account standard information criteria information. Quality tests and stability –inverse roots of AR characteristic polynomial, residual autocorrelation, for example – was analysed.

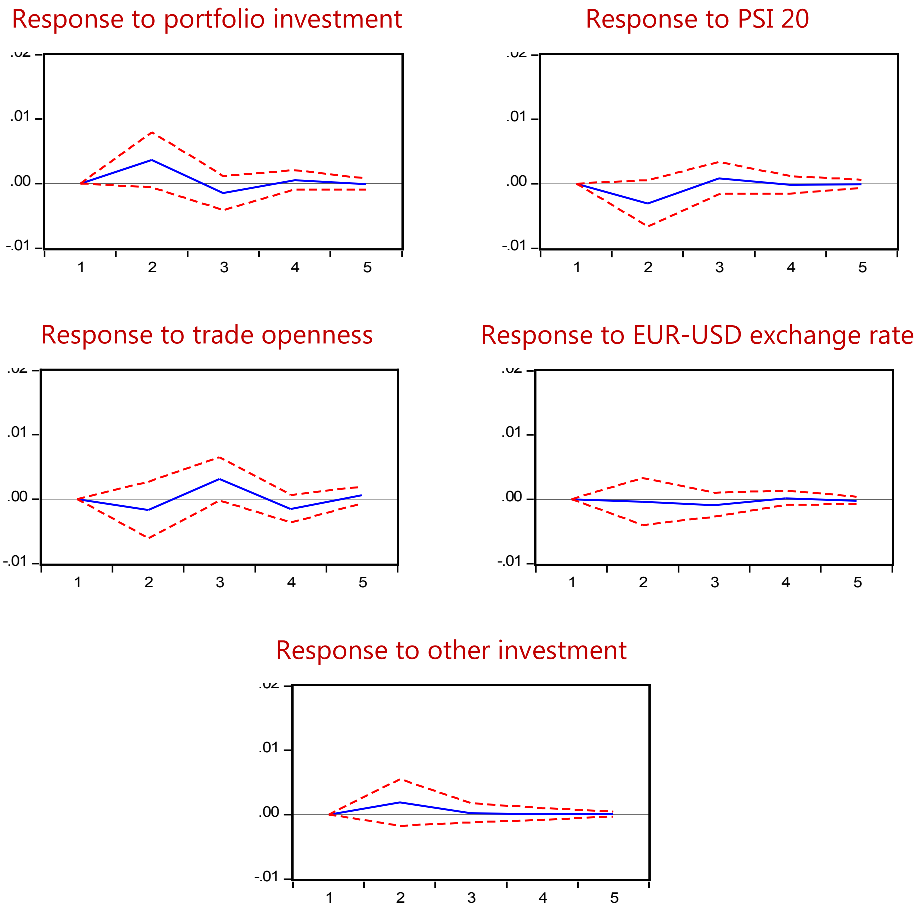
VAR Block Exogeneity tests suggest that the chosen independent variables jointly explain current and capital account variation. More particularly, trade openness, portfolio investment and the Portuguese stock exchange individually Granger cause the current and capital account variation. It is also worth mentioning that bidirectional causality was also found.

Non-accumulated 5 period impulse response functions are shown in Figure 4; mixed results among the variables considered. The two main lessons: i) there is statistical evidence of a link between the financial and current and capital account time series; and, ii) financial account components have a direct impact on the current and capital account.

Figure 3 shows a positive impact of the net other investment in the current and capital account and an accumulated positive impact of the net portfolio investment. Trade openness, have mixed effects but also positive accumulated effects on the current and capital account. Exchange rate has a negative impact since imports becomes less expensive and exports get more expensive, so there is a negative impact on international trade. Portuguese companies index have negative almost null effects.

The results obtained are consistent with the joint analysis of the balance of payments/ international investment position, since financial transactions are linked with investment income and also can reflect the capacity of the economy to be a net creditor of the rest of the world. When there is an investment abroad (or positive net acquisition of financial assets) it means that the economy has the ability to be a net creditor of the rest of the world. It will have also a positive impact on the investment income meaning that the economy will receive more credits from those investments.

Figure 3 | *Portugal: non-cumulative impulse response functions of the current and capital account variation*



4. Looking beyond traditional components

There are several indicators that have to be taken into account when analysing a country's risk exposures and vulnerabilities both on current account transactions and on financial flows.

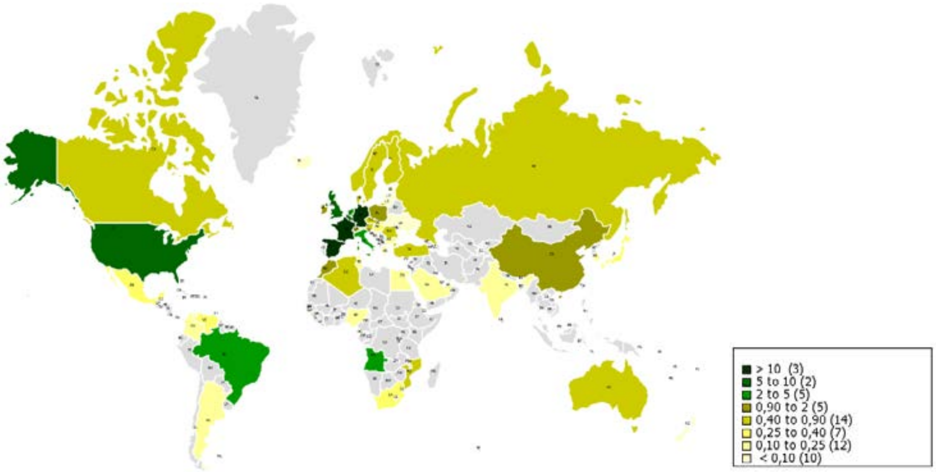
The degree of a country diversification of exports/ imports is important to address risk exposures to international trade. In Portugal, international trade of goods and services plays the most relevant role in the current and capital account.

By counterpart country of destination, both Portuguese exports and imports are highly concentrated (Figure 4) on a restricted number of countries. In 2015, approximately 75% of the Portuguese exports and imports were mainly attributable to ten markets of destination. Spanish economy alone contributes with 20% and 31% for exports/ imports, respectively. It is also visible that international trade is mainly attributable to the European economy.

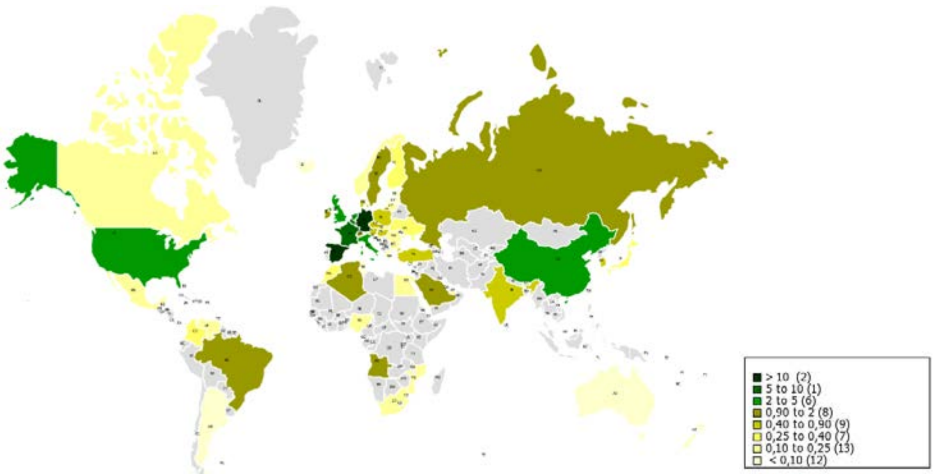
Between 1997 and 2015, Herfindahl-Hirschman Index reveals an increase of the exports geographical diversification, while imports suffered from the opposite phenomenon. It is important to state that the increase in exports diversification occurred after the world economic and financial crisis. Since 2008, Portuguese exports weight to non-European Union countries increased by 4,1 p.p. (United States increased by 1,2 p.p. and China by 0,9 p.p.). With the exception to Greece, this result can be also extended to other European economies. On the contrary, imports driven by non-European Union countries decreased by 1,7 p.p. (however, United States and China increased by 0,3 p.p. and 0,6 p.p., respectively).

Figure 4 | *Portuguese international trade by geographical breakdown (2015)*

Exports weight



Imports weight

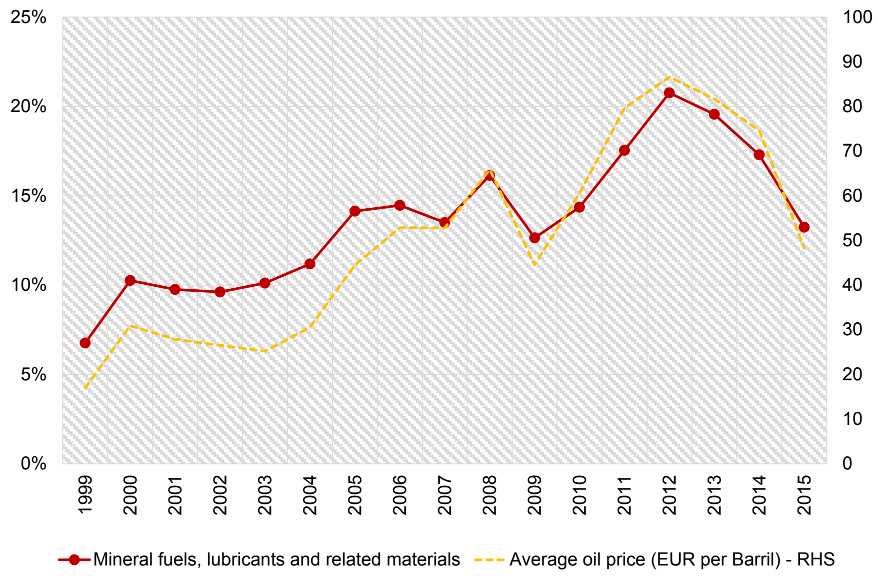


[Source: Banco de Portugal]

Standard International Trade Classification (SITC) is used to get an insight by type of product. In 2015, 13% of the Portuguese imports were related to mineral fuels, lubricants and related materials. At least in the short-run, energy is not substitutable therefore, there is a higher energetic dependency. Graph 8 shows that the weight of mineral fuels, lubricants and related materials is highly determined by oil price developments in international markets (correlation of 98%).

An inter-linked risk is associated to the fact that energy price changes are, most of the times, included in the price of exports (decrease of Portuguese manufacturers' margins). Imported energy price increases is associated to a Portuguese decrease in external competitiveness.

Graph 8 | *Weight of mineral fuels, lubricants and related materials on Portuguese total imports and oil prices*



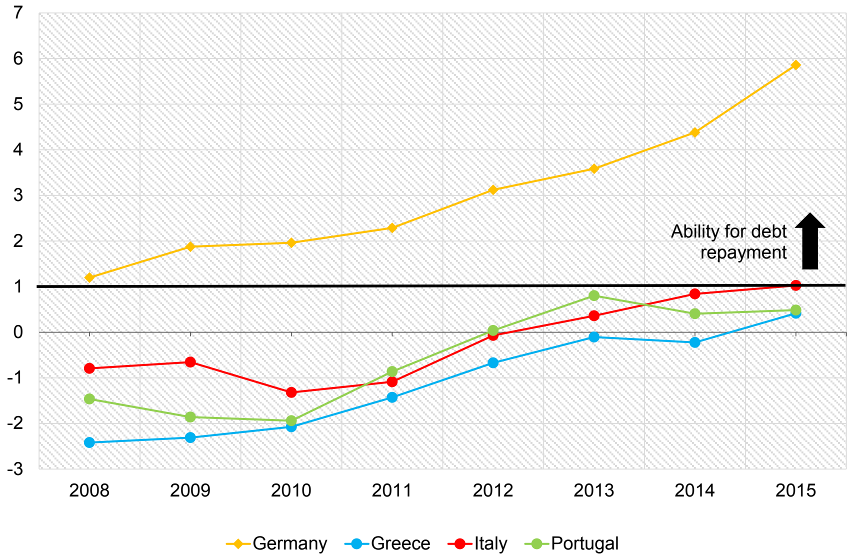
[Source: Banco de Portugal, Eurostat]

On the financial side, the Solvency Ratio of External Debt (SRED)[4] indicator, developed by Ucal and Oksay (2012), is applied for Portugal, Greece, Italy and Germany (Graph 9).

German economy exhibits a greater capability of repayment of debt when compared to Portugal, Greece and Italy (SRED greater than 1 for the entire period - 2008 to 2015). Although Portugal exhibits a favorable evolution on its external solvency situation in this period; after 2012, SRED slightly decreased, in contrast to the other vulnerable economies.

[4] Measured by the current and capital account as a percentage of interest and principal payments.

Graph 9 | *Solvency Ratio of External Debt (SRED)**



[Source: Eurostat]

[Legend: According to Ucal and Oksay (2012), '*SRED value close to 1 means that repayment ability increases while a value of 1 or greater denotes increasing debt servicing ability whereas a value of less than 1 indicates that hard currency shortage is approaching*']

*for some minor components there is no available information.

Other alternative measure for liquidity is the liabilities coverage – measured as the total liabilities over total assets. In 2012, this ratio stood at 162%; however, in 2015 total responsibilities *vis-à-vis* non-resident entities was virtually unchanged at 1.6 times greater than total assets. If data were publicly available, the level of risk associated to this level of indebtedness could be analyzed taking into account maturity mismatch – which aims to analyze if different obligations can be met with the available assets (treasury and liquidity management).

5. Final remarks

External statistics are an important source of information to evaluate competitiveness of one economy. The underlying macroeconomic aggregates enable to understand the external financing exposure, while permitting to address, together with other relevant statistics, its sustainability and potential vulnerabilities.

To address external sustainability issue, it is important to analyze current and capital account performance/ international trade markets (diversification of international markets, dependence on the imports …). However, current and capital account *per se* do not fully explain the ability of a country to be an external creditor of the rest of the world and its capability to repay liabilities.

Balance of payments (financial account), international investment position and external data are the corollary of operations with different natures that reflect real economy and financial positions and flows. In this respect, economic opportunities and weaknesses cannot be dissociated of all this implications, especially in a globalized world that increasingly relies on complex international financial transactions.

Statistical data is provided with a very detailed information. If correctly understood (impacts, methodology and linkages) it could perform economic predictions and anticipate economic crises. As mentioned above, in the case of Portugal the new financial landscape after the financial crises had some important statistical implications on the international investment position (and external debt) main components. In this concern, the external sustainability of the current account cannot disregarded financial components.

Although economic and financial crises are difficult to predict, statistical information can assess to monitor economies and support economic decision makers.

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The indebtedness of Portuguese SMEs and the impact of leverage on their performance[1]

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Bank of Portugal

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

The indebtedness of Portuguese SMEs and the impact of leverage on their performance

Ana Filipa Carvalho, Manuel Perestrello, Mário Lourenço[1]

Abstract

Small and medium-sized enterprises (SMEs) account for a relevant part of Portuguese companies' turnover and number of employees, standing for half the loans granted to non-financial corporations by resident financial institutions. Tracking their performance is one of the pillars of monitoring the country's financial stability. Focusing on these companies' performance, and using Banco de Portugal's Central Balance-Sheet Database and Central Credit Register data, stylised facts suggest that financial debt is not usually used to increase profitability. Instead, indebtedness seems to be increasingly linked to companies that eventually cease their activity. Implications regarding monetary policy, financial stability and risk assessment are also addressed.

Keywords: Enterprises, Indebtedness, Leverage, Profitability, SMEs, Financial stability

JEL classification: D22

Contents

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1. Introduction

Small and medium-sized enterprises (SMEs) are a relevant part of the non-financial corporations (NFC) sector in Portugal. Although debt has historically played a significant role in these companies' sustainability, it is not clear whether it has been used as a tool to expand their activity and achieve a better performance, or just as a way to carry on with their day-to-day operation, often leading to a situation where debt stands for a burden on company's operating profitability. Understanding this issue seems to be of particular relevance in the context of the recent economic and financial crisis and considering the deleveraging effort recently undergone by the Portuguese economy.

From the perspective of the financial system, it is also important to determine the extent to which debt is used to foster higher profitability levels. Unsustainable debt from the non-financial corporations' perspective is naturally linked to an increase in non-performing loans from credit institutions, with obvious impacts on its capital requirements. Such assets (from the financial sector's perspective) may even be written-off from its balance sheets. It is therefore of the utmost relevance to determine the extent to which financial debt is being properly used by such an important part of Portuguese companies.

2. Data

The current analysis is mainly based on data obtained from the Central Balance-Sheet Database (CBSD) of Banco de Portugal's Statistics Department. The CBSD is a micro database that gathers the economic and financial information of all Non-Financial Corporations[2] (NFCs) in Portugal. This information is reported directly by the companies through the submission of *Informação Empresarial Simplificada* (Simplified Corporate Information), an integrated report of economic, financial and statistical information (based on non-consolidated accounting data) which companies have to report, on an annual basis, to the Ministry of Finance, the Ministry of Justice, Statistics Portugal and Banco de Portugal.

Only the subset of SMEs was considered for the purpose of this analysis. Companies are categorised as SMEs if they employ fewer than 250 and more than 10 employees and have an annual turnover between 2 million euros and 50 million euros and/or an annual balance sheet total between 2 million euros and 43 million euros, a classification that follows European Commission's Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises.

[2] According to the 2010 European System of National and Regional Accounts (ESA 2010), the NFC sector includes private and public companies and excludes sole proprietors (included in the households' institutional sector). For the purpose of this analysis, holding companies (categorised under Section K of NACE Rev. 2) were also excluded. Companies developing activities classified under Sections O, T and U of NACE Rev. 2 were also excluded, as well as companies with no know NACE Rev.2 classification.

Microenterprises and large enterprises were not, hence, under the scope of this analysis.[3] In 2014, although accounting for only 10% of the total number of enterprises, SMEs represented 42% of the total turnover generated by Portuguese NFCs and 45% of the number of employees (Chart 1), a prominence in the Portuguese economic structure that has been relatively stable throughout the last years. SMEs are even more relevant within certain economic activity sectors. Indeed, in 2014 they stood for 28% of the enterprises of the "Manufacturing" and "Water supply; sewerage, waste management and remediation activities" sectors (Sections C and E of NACE Rev. 2), 60% of the turnover generated by companies within the "Education" and "Water supply; sewerage, waste management and remediation activities" sectors (Sections P and E of NACE Rev. 2) and for 64% of the number of employees of the "Manufacturing" sector (Section C of NACE Rev. 2) (Chart 2).

Chart 1: NFC's structure by size class (2014)

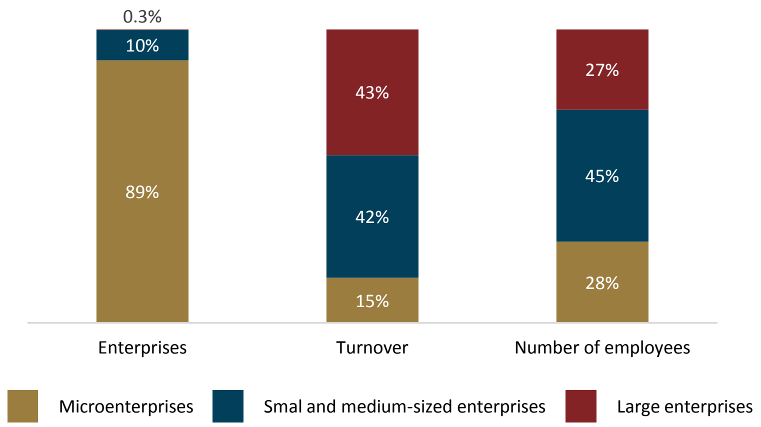
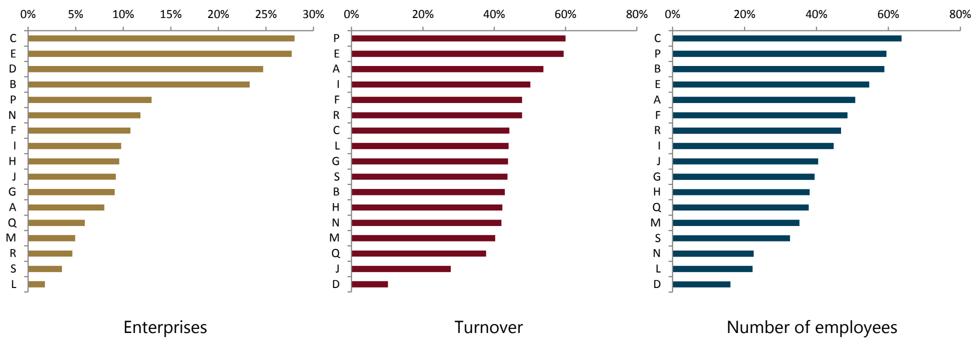


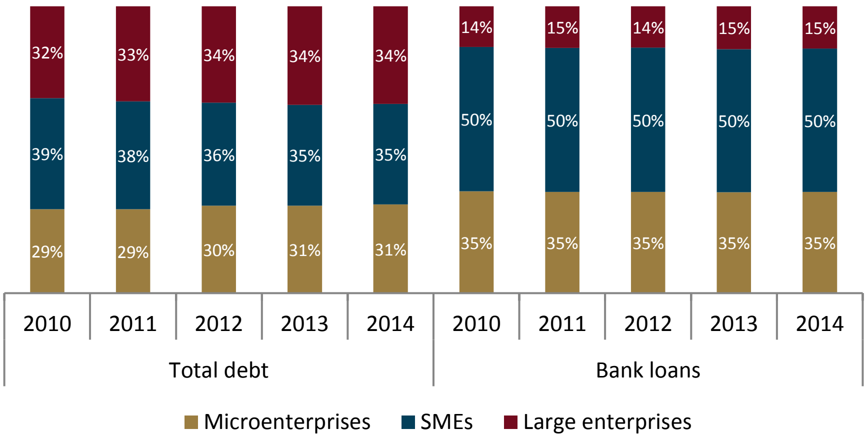
Chart 2: SMEs weight by NACE Rev. 2 Section (2014)



3 According to the European Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises, microenterprises are defined as enterprises which employ fewer than 10 employees and whose annual turnover and/or balance sheet total does not exceed 2 million euros. Large enterprises are those that are neither categorised as microenterprises, nor as SMEs.

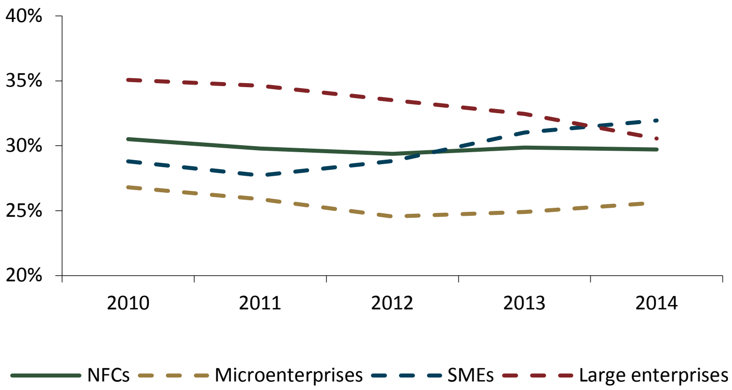
Breaking down NFCs total debt (understood as the total amount of balance sheet liabilities) by size class, it is relevant to notice that SMEs represented more than one third of such aggregate in the whole period under analysis. They accounted for 35% of the NFCs total debt in 2014 (Chart 3). Although NFCs total debt is almost equally distributed across the different size classes, data compiled by Banco de Portugal's Central Credit Register[4] show that SMEs stood for half of the bank loans granted by Portuguese Credit Institutions to the NFC sector during the 2010-14 period.

Chart 3: NFC's liabilities by size class (2010-14)



Debt has played a significant role in these companies' sustainability. Looking at NFCs' capital ratio (which determines the proportion of a company's assets funded by equity), in spite of a slight increase in recent years, 68% of SMEs' assets were funded by debt in 2014 (average capital ratio of 32%) [Banco de Portugal (2015)] (Chart 4).

Chart 4: NFC's capital ratio by size class (2010-14)



4 The Central Credit Register is a database managed by Banco de Portugal, which gathers information provided by participating entities (resident institutions) regarding credit granted. For more information, please refer to Banco de Portugal Booklet No 5, *Central de Responsabilidades de Crédito* (Portuguese version only).

3. Methodology

Bearing in mind the aspects previously discussed regarding SMEs' weight in the Portuguese economy and their financial situation concerning indebtedness, the purpose of this analysis is to understand how SMEs' level of indebtedness or financial leverage is reflected on their profitability within a three year period.

In order to conduct such assessment, several indicators were considered to perform an evaluation of each company's indebtedness: the capital ratio (relating equity to total assets), a financial leverage ratio (calculated as the ratio between financial debt and the aggregate of equity and financial debt), the debt to equity ratio (relating total liabilities to equity), and other financial distress indicators such as the ratio between financial debt and earnings before interest, taxes, depreciation and amortization (EBITDA) or the inverted interest coverage ratio (i.e., the ratio between interests paid and EBITDA).

Regarding profitability, some of the most traditional indicators were considered: the return on assets ratio (which relates the net profit to the company's total assets), the return on equity (the ratio between net profit and total equity), as well as operating and net margins indicators (where EBITDA and net profit are related to each company's total income, respectively).

Regardless of their usefulness in most economic and financial analysis, several of these indicators have limitations on their calculation requirements for individual companies. For instance, ratios using equity as their denominator are often not computed when equity is negative. On the other hand, ratios using specific parts of each company's balance-sheet and income statement reports may often be impossible to calculate due to missing values (for example, when elements such as interest paid or even financial debt are considered). Although the analysis was conducted for all the above mentioned ratios (bearing in mind their specific limitations, in each case), only the capital ratio and the return on assets ratio were selected to assess each company's indebtedness and profitability levels, respectively. These ratios capture the main features that the analysis was meant to focus upon and, additionally, they maximize the number of analysed companies as there is only one obstruction to their calculation - the existence of companies with null values for total assets - which is common to both indicators.

As so, the capital ratio was considered as an indirect measure of each company's indebtedness, considering that it measures the solvency of the company by determining the proportion of assets financed by equity. The return on assets ratio was considered to be this analysis profitability proxy, given that it measures how efficiently a company can manage its assets to produce profits.

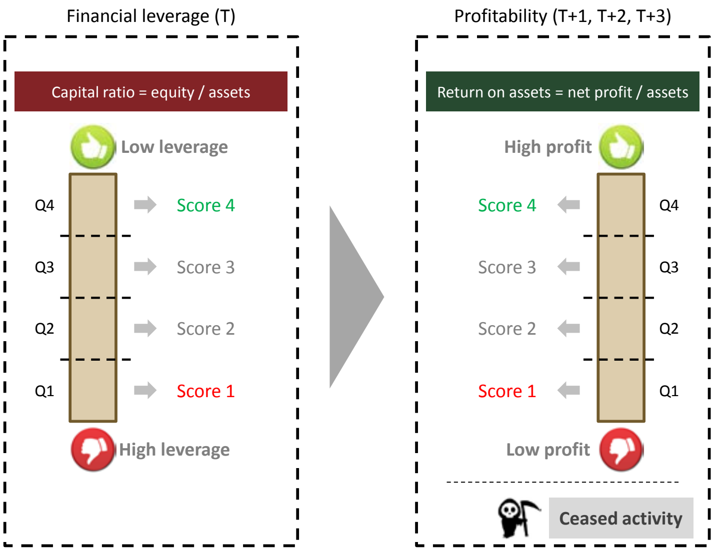
The CBSD data were used in order to determine each company's capital ratio and return on assets ratio for each year in the 2006-14 period. Subsequently, SMEs were scored from 1 to 4 according to their level of financial leverage and their positioning within the quartile distribution of individual capital ratios of SMEs. This score translates the company's performance as either being in the bottom 25% of the registered performances (score 1), above 25% but below 50% of its peers (score 2), above 50% but below 25% of its peers (score 3) or above 75% of its peers (score 4). The higher the company's capital ratio, and hence the score, the lower the company's financial leverage.

The same procedure was carried out regarding the profitability ratio. SMEs were then scored from 1 to 4 according to their level of profitability and their positioning within the quartile distribution of individual return on assets ratios of SMEs. In this case, the higher the return on assets ratio, and hence the score, the higher the company's profitability level.

Each company's leverage score in period T was then linked to its profitability score in the subsequent three years (periods T+1, T+2 and T+3). Results are first displayed as average values of the analysed indicators in the 2006-14 period, and, subsequently, as average values of two different time periods within that time span.

A special flag was considered when the company ceased its activity, a situation determined using Banco de Portugal's business register (which combines information from several databases managed by Banco de Portugal, as well as other administrative sources) [Gonçalves et al. (2013)] (Figure 1).

Figure 1: Summary of the proposed analysis framework

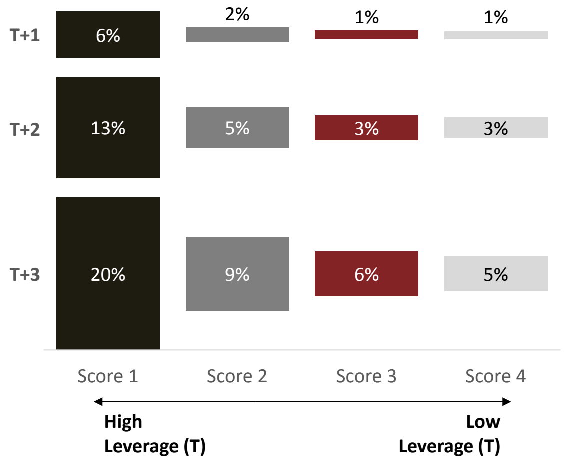


Considering the particular scope of this analysis and the above mentioned methodology, it is important to mention that once a company is categorised as SME in period T, it will be evaluated according to its profitability level for the three subsequent years, regardless of any changes in the company's size class during this period. This avoids discarding companies due to size classification changes, as this would probably introduce unnecessary "noise" in the current analysis. Nevertheless, it is important to notice that each year's quartile distribution of individual indicators is determined solely by the set of SMEs of that year.

4. Results

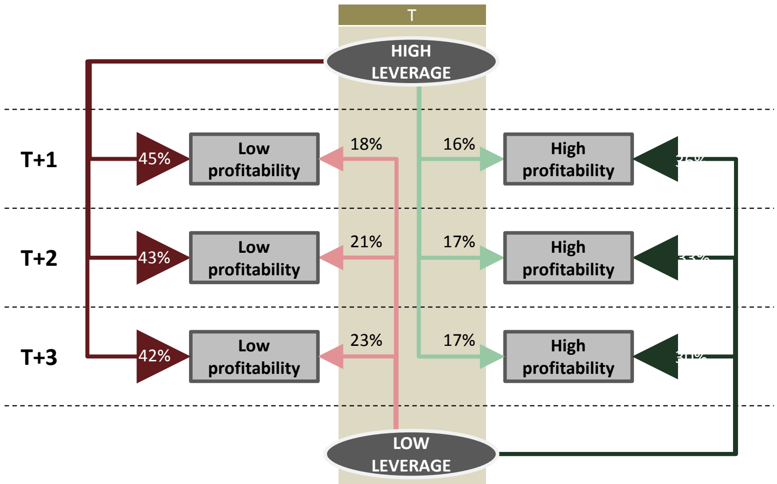
Focusing the analysis on the share of SMEs that ceased their activity on the three year time span following its indebtedness score classification, results seem to indicate that this situation is more relevant among Portuguese SMEs with the lowest capital ratio levels (hence, highest financial leverage levels). About 6% of SMEs with the lowest capital ratio levels in one year ceased their activity in the following year, a share higher than the share of enterprises that ceased their activity one year after having registered low leverage levels (1%). In a three year time span (bearing in mind that these results are cumulative across this time period), 20% of companies with the highest financial leverage levels ceased their activity. These results contrast with the 5% registered among enterprises with the lowest levels of financial leverage (Chart 5).

Chart 5: Share of SMEs that ceased their activity according to financial leverage scores in T



Among companies that did not cease activity, data reveal that SMEs with the highest financial leverage in period T are most commonly linked to low profitability levels in the following years. Indeed, 42% of SMEs with the highest leverage levels in one year registered the lowest profitability levels after three years, a share relatively similar when one year and two year time spans are considered (Figure 2). The stability of the results across different time spans enabled the analysis to be focused on the financial leverage of SMEs in period T and their profitability level three years after (T+3).

Figure 2: SMEs by financial leverage scores and profitability scores (high and low levels, at different time spans)



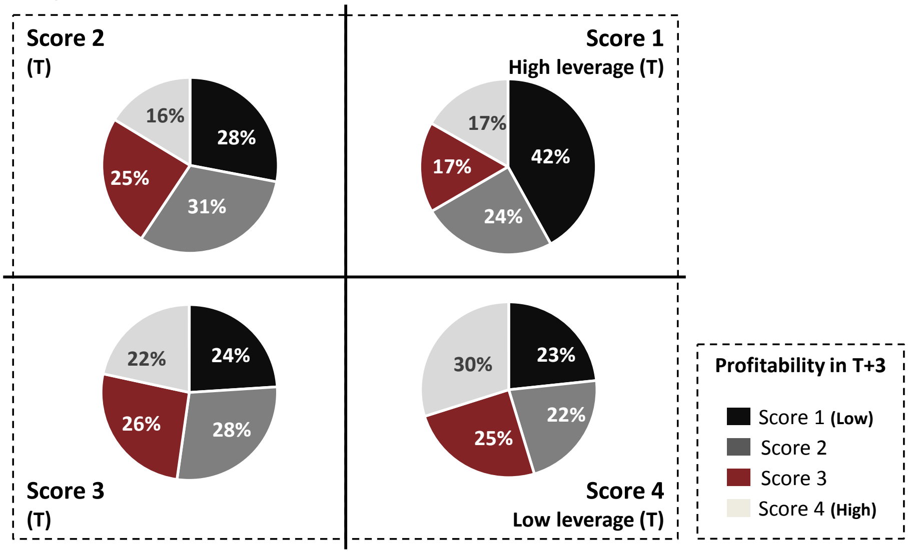
The link between companies with the highest leverage levels in one period and the lowest profitability levels three years after seem to be more noticeable when the set of least leveraged SMEs is considered. In this case, the percentage of SMEs posting the lowest profitability levels after three years drops to 23%, which compares with the previously mentioned share of 42%, when the highest leveraged SMEs are considered.

On the other hand, only 17% of the most highly leveraged SMEs reached high profitability levels in three years. For the least leveraged firms the percentage increases to 30%.

These stylised facts seem to indicate that high financial leverage is not usually associated with short/medium term profitability for Portuguese SMEs. Therefore, it could be argued that a significant share of Portuguese SMEs seem to be indebted (carrying non-profitable debt) rather than leveraged (debt leading to higher profitability levels).

Another aspect the data seem to point to is that (with the exception of SMEs with an indebtedness score of 3) profitability levels seem to be closely linked to the same indebtedness score (Chart 6). Within SMEs of the lowest leverage quadrant (score 4 at time T), the most relevant share of companies at time T+3 is the one related with the ones with the highest profitability levels (score 4 at time T+3). The same can be pointed out at leverage score 2 (where SMEs with profitability score 2 are the most relevant after three years) and leverage score 1 (where, as pointed out, the lowest profitability score stands for the largest share of SMEs).

Chart 6: SMEs by financial leverage scores (in T) and profitability scores (in T+3)



4.1. Breakdown by economic activity sectors

The results previously analysed were broken down according to the NACE Rev. 2 classification of economic activity, allowing the analysis to focus on specific economic activity sectors.

Considering different Sections of NACE Rev. 2, and focusing the analysis on the share of enterprises that ceased their activity, it is possible to identify economic activity sectors where this proportion is higher. This situation is particularly relevant in "Construction", "Manufacturing" and "Administrative and support service activities" (Sections F, C and N of NACE Rev. 2, respectively) (Chart 7).

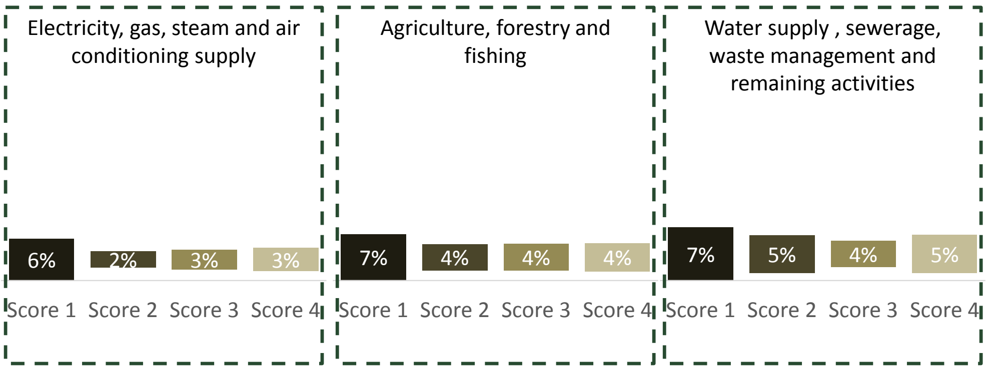
Chart 7: Share of SMEs that ceased activity in the three subsequent years according to financial leverage scores (sectors with highest shares) – by NACE Rev. 2 Section

"Construction" (Section F of NACE Rev. 2) stands out as the sector with the highest share of companies that ceased activity in the three year period after a high indebtedness level (leverage score 1) had been registered (27%), followed by

"Manufacturing" (26%) and "Administrative and support service activities" (21%) (respectively, Sections C and N of NACE Rev. 2). Still, it is important to mention that, among SMEs that ceased activity in the referred time span, "Manufacturing" displays the largest differential between the share of companies that ceased their activity having registered the highest and the lowest indebtedness levels (a differential of 22 percentage points between both cases).

By contrast, sectors such as "Electricity, gas, steam and air conditioning supply", "Agriculture, forestry and fishing" and "Water supply, sewage, waste management and remediation activities" (Sections D, A and E of NACE Rev. 2, respectively) exhibit the lowest share of SMEs with the highest leverage levels that ceased activity in the ensuing three-year period (Chart 8). Market regulation regarding utilities may determine to some extent the fact that Sections D and E of NACE Rev. 2 seem to have the lowest share of companies ceasing activity despite of them having the highest indebtedness ratios.

Chart 8: Share of SMEs that ceased activity in the three subsequent years according to financial leverage score (sectors where shares are lowest)



Regardless of the economic activity sector, the share of SMEs that ceased their activity after a three year period seems to be larger among SMEs with the highest indebtedness levels (score 1 in period T).

Considering only the companies that did not cease activity, the analysis then focused specifically on the subset of companies with the highest leverage levels (leverage score 1 in period T) and the lowest profitability levels after a three year period (profitability score 1). This high-low leverage-to-profitability situation and the structure of SMEs under these circumstances (according to their economic activity sector) was then compared to the breakdown of all the SMEs in order to understand if a particular sector is over- or under-represented in this leverage-to-profitability situation (Table 1).

Results show that the "Accommodation and food service activities" sector (Section I of NACE Rev. 2) is more relevant in the high-low leverage-to-profitability situation, when compared to its relevance among total SMEs. This sector accounts for a 15% share of the subset of companies with high leverage and low profitability levels, a share 7 percentage points higher than this sector's share among total SMEs. Likewise, "Real estate activities" (Section L of NACE Rev. 2) is also over-represented in the analysed subset of SMEs, with a share 2 percentage points higher than the one this sector accounts for when the total population of SMEs is considered.

Table 1: SMEs' structure by leverage-to-profitability situation and economic activity sector

NACE Rev. 2	Total SMEs (1)	High leverage and low profitability (2)	=(2)-(1)	Low leverage and high profitability (3)	=(3)-(1)
A – Agric., forestry and fish.	2.3%	2.5%	0.2%	2.7%	0.4%
B – Mining and quarrying	0.6%	0.5%	-0.1%	0.6%	0.0%
C – Manufacturing	28.3%	23.7%	-4.6%	26.9%	-1.3%
D – Elect., gas, steam	0.4%	0.2%	-0.2%	0.6%	0.2%
E – Water supply, sewerage	0.6%	0.4%	-0.3%	0.6%	-0.1%
F – Construction	15.6%	13.3%	-2.4%	9.1%	-6.5%
G – Wholes. and retail trade	23.0%	21.2%	-1.8%	24.0%	1.0%
H – Transportation	4.1%	3.1%	-1.0%	4.3%	0.3%
I – Accomod., food storage	8.0%	15.2%	7.2%	9.2%	1.2%
J – Information and commun.	2.0%	2.1%	0.1%	2.4%	0.4%
L – Real estate activities	1.3%	2.9%	1.6%	0.8%	-0.5%
M – Prof., scient., tech. activ.	4.4%	3.2%	-1.2%	7.2%	2.7%
N – Adm. and support serv.	3.6%	4.4%	0.8%	3.3%	-0.3%
P – Education	1.7%	2.4%	0.7%	2.1%	0.4%
Q – Human health, soc. work	2.7%	2.3%	-0.4%	4.9%	2.2%
R – Arts, entert., recreation	0.5%	1.0%	0.5%	0.3%	-0.2%
S – Other service activities	0.9%	1.7%	0.8%	0.8%	-0.1%

Sectors such as "Manufacturing", "Construction" and "Wholesale and retail trade; repair of motor vehicles and motorcycles" (respectively, Sections C, F and G of NACE Rev. 2) seem to be under-represented in the high-low leverage-to-profitability situation when compared with the share they account for among total SMEs (-5, -3 and -2 percentage points, respectively).

The same kind of analysis was conducted taking into consideration the subset of SMEs with low indebtedness levels in period T (leverage score 4) and the highest levels of profitability in period T+3 (profitability score 4). The low-high leverage-to-profitability situation determined yet another structure of enterprises. Within these SMEs, the "Construction" sector (Section F of NACE Rev. 2) stood out as being under-represented, when compared to its relevance among the total number of SMEs. This sector stood for only 9% of SMEs under the referred low-high leverage-to-profitability situation, a percentage 7 percentage points lower than its share among total SMEs. Conversely, "Professional and scientific activities" and "Health and social activities" (Sections M and Q of NACE Rev. 2, respectively) stood out, displaying a larger share of companies in the low-high leverage-to-profitability situation than the one registered when considering total SMEs.

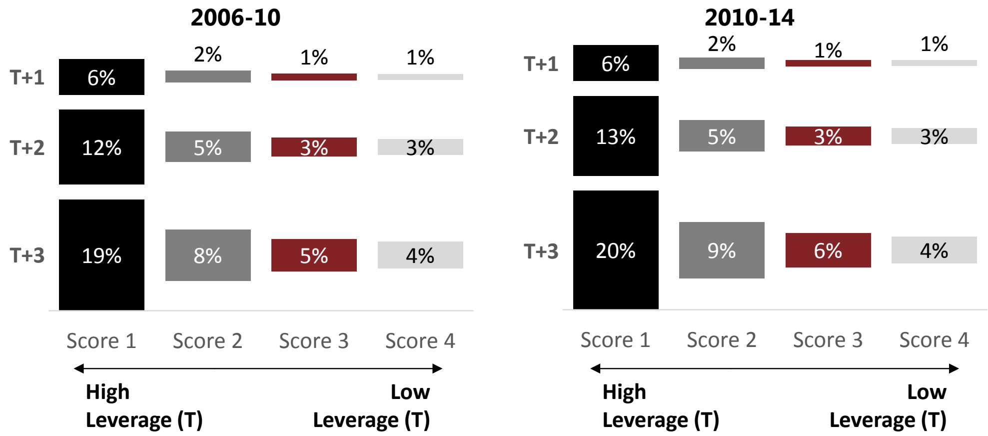
4.2 Breakdown by different time periods

The data used for this analysis encloses a relatively large time span, across which the world as seen significant changes affecting differently each country's economic and financial situation. In the case of Portugal, in the aftermath of the global financial crisis registered at the end of the first decade of the 21.st century, an economic and financial assistance program was implemented, targeted at solving some of the imbalances of Portuguese economy, regarding both the behaviour of public agents (namely, the structural deficit of the Portuguese Public Administration) and the increasing indebtedness of private economic agents (households and NFCs).

Hence, it would be important to see if the above mentioned results are somewhat different when distinct time spans are considered. In order to do so, the available data were broken down into two subsets of data, the first of which covering the period between 2006 and 2010, and the second set of data concerning the 2010-14 period.

Data seem to point to the fact that the share of SMEs ceasing activity in the three year period after having registered the highest indebtedness levels is not seemingly different between both time spans: this share stood at 19% and at 20% in the 2006-10 and 2010-14 periods, respectively (Chart 9).

Chart 9: Share of SMEs that ceased their activity according to financial leverage scores by different time periods

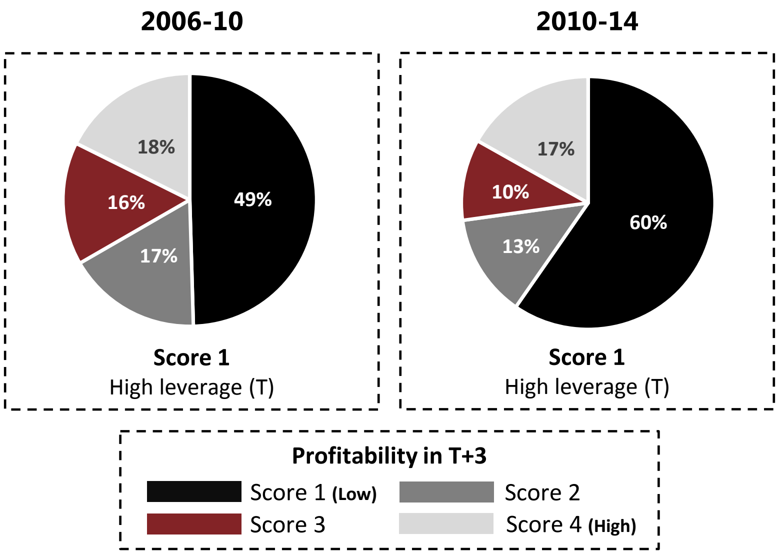


Notwithstanding, it is possible to identify economic activity sectors where the difference between both periods is more noticeable. For instance, the "Transportation and storage" sector (Section H of NACE Rev. 2) stands out with an increase of 6 p.p., from 16% in the 2006-10 period to 22% in the 2010-14 period. Likewise, in the "Agriculture, forestry and fishing" sector (Section A of NACE Rev. 2), the share of SMEs ceasing activity in the three year period after having registered the highest indebtedness levels doubled, from 4% to 8%. Inversely, in the "Electricity, gas, steam and air conditioning supply" sector (Section D of NACE Rev. 2) the share of companies in the same situation that ceased activity seems to have decreased: while the percentage of SMEs in this situation stood at 8% in the 2006-10 period, it dropped to 1% during 2010-14.

On the other hand, concerning the share of companies that did not cease their activity, results seem to indicate that in the most recent period under analysis, the share of SMEs with the lowest profitability levels (profitability score 1) among companies with the highest indebtedness levels (leverage score 1) is higher than in the previous period (44% in the 2010-14 period, compared with 41% in the 2006-10 period). Also, the share of enterprises with highest profitability levels (profitability score 4) among less leveraged enterprises (leverage score 4) seems to be lower in the second period under analysis (28% in the 2010-14 period, compared with 32% in the 2006-10 period).

The differences registered between the obtained results in the two periods seem to be particularly relevant in some economic activity sectors, especially among the enterprises with the highest indebtedness level and low profitability situation three years after. The "Accommodation and food service activities" sector (Section I of NACE Rev. 2) stands out with a 11 p.p. difference between the two periods (while 49% of the high indebted SMEs registered a profitability score of 1 during 2006-10, this percentage raised to 60% in 2010-14) (Chart 10).

Chart 10: Accommodation and food service activities' SMEs with high financial leverage scores in T and different profitability scores in T+3, at different time periods



5. Conclusions

Given the relevance of SMEs within the NFC sector in Portugal, the current analysis intended to explore the importance of financial debt on these companies' performance. The analysis aimed at revealing some stylised facts on the link between SMEs' indebtedness and profitability levels: are Portuguese SMEs indebted (carrying non-profitable debt) as opposed to being leveraged (using debt as a mean to increase activity and reach higher profitability levels)?

Stylised facts show that the latter is, in general, not the case. The most leveraged SMEs seem to be, in broad terms, more prone to ceasing their activity in the short/medium term. This fact is consistently registered across different economic activity sectors, regardless of the time period considered to conduct such an analysis.

SMEs with the highest indebtedness levels do not seem to be associated with higher profitability levels during the same time period. Instead, they seem to have the lowest profitability levels, as opposed to less leveraged SMEs which tend to reach higher profitability levels.

From the perspective of the financial system, these results are of the utmost importance. They seem to indicate that, for each company, there is an ideal level of indebtedness which can be perceived as a good indicator of the company's capability to repay its debt and to obtain new financing. Debt above such levels may often be binding the company's future profitability in some way.

Given that unsustainable debt from the non-financial corporations' perspective often leads to default, the ability of financial institutions to identify and deal with such risk is of paramount importance. This is particularly true in the context of recent developments regarding credit constraints and new capital requirements.

A trustworthy assessment of each financial institutions credit at risk, based on a correct evaluation of its borrower's financial soundness is, therefore, particularly relevant. This evaluation, however, should be carried out regarding both the new credit granted by financial institutions to new and current customers, but also previously granted credit perceived as performing, regardless of the real performance of its counterparts. Hence, credit institution's balance sheets should be evaluated considering the possibility to write-off or set up provisions on credit that, although still performing, might be at risk. Such situations should be assessed based, not only on the counterparty's ability to repay its debt, but also on its ability to do so while reaching higher performance levels, given the evidence provided that SMEs often seem to carry non-profitable debt and, hence, non-repayable financing.

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Inflation outlook and business conditions of firms: evidence from the Tankan Survey[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Inflation Outlook and Business Conditions of Firms: Evidence from the *Tankan* Survey

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Abstract

In March 2014, the Bank of Japan introduced a survey on the inflation outlook of firms -- general prices and output prices -- in its Short-term Economic Survey of Enterprises in Japan (*Tankan*). The *Tankan* survey covers over 10,000 sample enterprises, as well as the overall corporate activity in a number of various survey items, and therefore, it provides us with detailed and credible data on both the inflation outlook and business environment of firms for more than two years since the introduction.

In this paper, we investigate the relation between the inflation outlook of firms and their business conditions, and analyze the changes in expectations using micro data. We find that current changes in output prices and input prices have a larger impact on firms' inflation outlook than business conditions or supply-demand measures. And the decline in commodity prices is also likely to exert a certain influence on the recent decline in firms' general price expectations.

1. Introduction

The standard New Keynsian Phillips curve models (Clarida, Gali, and Gertler (1999) or Woodford (2003), for example) define inflation outlook as an important determinant of actual inflation. For central banks that employ target inflation rates like the Bank of Japan (BOJ), understanding and monitoring the inflation outlook is crucial for achieving the targets.

More specifically, the inflation outlook of enterprises are thought to influence actual inflation rates because prices of products and employees' wages are determined based on firms' views per se regarding the inflation outlook. Until recently, little was known about their formulation process, what affects their inflation outlook or which type of enterprise has higher (or lower) ones, due to limited availability of data on the inflation outlook of enterprises. In recent years, however,

[1] The views expressed here are those of the authors and do not necessarily represent those of the Bank of Japan. The authors are responsible for any errors or omissions.

some empirical researches have been conducted based on a large set of sample survey data on firms. Bryan, Meyer and Parker (2015) use data from the Federal Reserve Bank of Atlanta's *Business Inflation Expectations Survey* and point out that the inflation outlook of firms has greater heterogeneity compared to the outlook by professional forecasters, due to the idiosyncratic cost structure that firms face when setting prices. Coibion, Gorodnichenko and Kumar (2015) use survey data of firms' macroeconomic beliefs in New Zealand. They find that the average inflation outlook is much higher than those of professional forecasters and that the dispersion in the outlook can be explained largely by difference in firms' incentive to collect and process information on prices.

In March 2014, the BOJ introduced a survey on the mid- to long-term inflation outlook of firms as part of the *Tankan* ("Short-term Economic Survey of Enterprises in Japan"), which is one of the important information sources for the BOJ in assessing the Japanese economy and highly appreciated across a wide spectrum of entities. We consider that data obtained from the *Tankan* survey are valuable for examining the inflation outlook of firms. First, its sample size is enormous. There are 10,862 sample firms (as of the June 2016 survey). Secondly, its data are based on a panel structure. The response rate is extremely high, consistently over 99%, with sample firms responding on an ongoing basis. Thirdly, it contains various survey items covering overall corporate activity.

In this paper, we investigate the effects of firms' business environment on their inflation outlook. And we examine the factors behind the recent decline in the inflation outlook of firms in the *Tankan* survey.

The remainder of the paper is organized as follows. Section 2 provides a detailed description of the survey on inflation outlook in the *Tankan* since the March 2014 survey. Section 3 depicts the relation among survey items, including the inflation outlook, by using the Bayesian network, one type of machine learning techniques. In Section 4, we estimate the random-effects ordinal probit regression to assess the impact of each survey item on the business environment. Section 5 evaluates the contribution of changes in the business environment to the recent decline in the inflation outlook. Section 6 concludes.

2. A Description of the Survey on the Inflation Outlook of Firms

With the absence of surveys on inflation outlook of firms in Japan, the BOJ introduced a two-section survey on the inflation outlook of firms in March 2014 (Table 1). The survey on "Output Prices" asks firms about their expectations on the rate of price change relative to the current level with respect to their mainstay domestic products and services. The survey on "General prices" asks firms about their expectations for the annual percentage change in general prices as measured in the consumer price index. Firms are asked to provide their forecasts over the horizon of one year, three years, and five years. Sample firms can choose either the "Don't know" or "Don't have a clear view" option when they find it difficult to choose any one of the indicated inflation figures.

Figure 1 depicts the average inflation outlook since the March 2014 survey, which is the weighted average by response in percentage terms. The average inflation outlook of all firms rises gradually as the forecasting horizon increases. The difference in the average inflation outlook among firm size is comparatively large, with that of small firms higher than that of large firms, and the inflation outlook for output prices of nonmanufacturing firms higher than that of manufacturing firms. The difference among industries is subtle for general prices, while it is large for output prices. Turning to changes in the time-series data, we see that the inflation outlook started to decrease gradually from the March 2014 survey through the June 2015 survey, and eventually showing a steeper decline from the September 2015 survey to the most recent survey. This trend is more apparent for general prices.

Figure 2 shows the contribution of each option to the change of the average inflation outlook for general prices. A decrease in the number of respondents of "4% or higher" and that of "around 2%" cause the recent decline. We consider a continuous decrease of "4% or higher" to be a learning process for respondents, that is, firms -- which had only little interest in the inflation outlook for general prices -- started to take a close interest in the *Tankan* survey since the inflation for general prices in Japan was far lower than their outlook in news reports and other sources, and thereby, initiating them to make reasonable responses. On the other hand, the recent decrease of the "around 2%" cohort probably indicates some sort of decline in firms' inflation expectations. We also see from Figure 3 that the recent decline in output prices is mainly attributable to the decreases of the "around 5%" and "around 10%" cohorts.

As for the percentage of respondents choosing from options "Don't Know" or "Don't have a clear view," Figure 4 shows that the share for the "Don't Know" option changed only slightly, with a majority of respondents choosing the "uncertainty about the future" option since they do not have a clear view on general price inflation expectations.

3. Bayesian Network Analysis

To investigate the relationship between the inflation outlook and business conditions of firms, we first use the Bayesian network approach.[2] The Bayesian network is a probabilistic graphical model that represents a set of variables and their probabilistic independence. It can be used to examine causal relationships and can represent these relationships graphically, which allows us to understand complex situations easily (see Appendix).

Together with the aforementioned questionnaire about outlook for output and general prices in 1, 3 and 5 years' forecast horizons, our dataset for this Bayesian network approach contains information on respondents': (1) judgment on several

[2] Although the graphical models in this analysis are technically referred to as chain graphs since these graphs have both directed and undirected edges as a result of a search by the algorithm, we call them the Bayesian network here in this paper for convenience.

business environments at the time of the survey (referred to as "actual"); and (2) that in three months hence (referred to as "forecast"), for each of the business environments described in Table 2 in Appendix.

For samples of the Bayesian network analysis, we use data of the March 2014 survey to June 2016 survey. We choose from a group of respondents that answer all of the items in Table 2 for each survey and exclude samples whose option is "Don't know" in the outlook for output prices and whose options are "Don't have clear view for uncertainty over the future outlook is high", "Don't have clear view for not really conscious of inflation fluctuations because they should not influence the strategy of the institution", or "Don't have clear view for other reasons" in the outlook for general prices. To identify an optimal Bayesian network, we use the Fast-IAMB algorithm, a kind of constrained-based algorithm (see Yaramakala and Margaritis [2005]). We apply some constraints: domestic supply-demand and input price judgments are exogenous, and there is no directional link from the forecast to the actual result of the same judgment.

The results of the optimal Bayesian network obtained from the algorithm are presented in Figures 5a to 5f. Collectively, these figures show that there are strong linkages among real-based judgments (business conditions, domestic supply and demand, production capacity, and employment conditions) and among price judgments (output prices, input prices, and inflation outlook). However, the link between real-based judgments and price judgments is relatively weak mainly in longer forecast horizons. We also find that these judgment items can be divided into a "real-based category" and a "price category," with the inflation outlook belonging to the price category.

Regarding the outlook for general prices, the actual result of input prices, forecast for input prices, forecast for output prices, and forecast for employment conditions are all linked in the Bayesian network. In addition to these judgments, there is a directional link from the actual result of output prices to the outlook for output prices. We interpret this result as to provide evidence that although the inflation outlook is a survey that shows firms' judgments on their mid- to long-term inflation expectations, it is affected by current price movements that firms are facing, and firms also see labor market conditions or wage trends as important determinants for future inflation rates.

4. Results of Probit Estimation

Next, we use the following regression in order to examine the statistical significance and the size of effect of each judgment on the inflation outlook. Since firm-level data on the inflation outlook in the *Tankan* survey are not continuous variables, we estimate in the form below:

$$\pi_i^* = \beta_0 + \beta_1 manu_{it} + \beta_2 Large_{it} + \beta_3 Small_{it} + \beta_4 LN(Employ_{it})$$
$$+ \sum_k \theta_k D_{kit} + \sum_t \rho_t \delta_t + \varepsilon_{it}$$

where π_i^* is a latent variable measuring the inflation outlook of firm *i*; *manu*$_{it}$, *Large*$_{it}$, and *Small*$_{it}$ are dummy variables for nonmanufacturing, large and small firms, respectively; *Employ*$_{it}$ is the number of employees at firm *i* in survey *t*.; *D*$_{kit}$ is the dummy for each option in the judgment survey items; and δ_t is the dummy for each survey period. Given the panel structure of the data sets and the ordinal nature of the dependent variable, we proceed by estimating the random-effects ordinal probit regression.

The results of the regression appear in Table 3. Firstly, the dummy for small enterprises and the number of employees are statistically significant for both the output price and general price outlook, and the dummy for nonmanufacturing is also significant particularly for the output price outlook. Inflation expectations of firms become higher as the firm size becomes smaller.

The input price and output price judgments show a strong correlation with the inflation outlook. Particularly for the output price outlook, the coefficients of the output price judgment -- actual results and forecasts alike -- are large and statistically significant. For the general price outlook, forecasts of the input price judgment and output price judgment are essential. These results coincide with the Bayesian network analysis.

As for other judgments, forecasts of business conditions and domestic supply-demand conditions correlate with the output price outlook. In terms of the long-term outlook for general prices, the forecast of employment conditions and the actual result of production capacity are statistically significant. These results suggest that firms' projections for product or industry growth affect their long-term outlook for output prices, and their projections for labor market conditions affect their long-term outlook for general prices.

We see from dummies for each survey period that all dummies are statistically significant after the September 2015 survey and that the outlook decreases with the passage of time. The result that the coefficients of dummy variables for general prices are larger than those for output prices implies that firms take account of information other than their own business environment when asked about their general price outlook in the *Tankan* survey.

5. Recent Decline in the Inflation Outlook and Business Environment of Firms

As discussed above, the current change in input and output prices that firms are now facing and will do so in the near future significantly affects their inflation outlook. Figure 6 shows the distribution of the inflation outlook based on the input price, output price, and business condition judgments. For example, the distribution illustrated for respondents choosing the "1. Rise" option for the forecast of the output price judgment differs from that for respondents choosing the "3. Fall" option. In contrast, the distribution of respondents choosing the "1. Favorable" option for the business conditions judgment shows a picture similar to that of other judgments.

For this reason, it is highly probable that changes in firms' judgments on price change have a certain influence on the recent decline in their inflation outlook. We see from Figure 7 that the DIs of input price and output price judgments have decreased sharply since the September 2015 survey, indicative of a decline in commodity prices including oil prices.

Figure 8 shows the contributions of each judgment and time dummy to changes in the latent variables π_i^* from the June 2015 survey to the June 2016 survey. Changes in options of output price and input price judgments have a comparatively large contribution relative to those of other judgment options, to changes in the latent variable, especially in terms of the outlook for output prices. On the other hand, the time dummy accounts for a large share both in the outlook for output prices and that of general prices.

Similarly, we estimate the contributions of output and input price judgments to the decline in the inflation outlook using results obtained from the Bayesian network analysis. To simulate the inflation outlook, we calculate the distributions of the inflation outlook using options of output and input judgments in the June 2015 survey, and then change only the constituent ratios of each option and convert them into the June 2016 survey. In other words, we simulate the inflation outlook taking account of changes in the output and input price judgments in the June 2016 survey and on the condition that distributions of the inflation outlook for respondents who answers specific combination of output and input price judgments do not change. Table 4 shows the contribution of changes in the price judgment to the inflation outlook: it accounted for over 45% for the output price outlook, while it was in the range of 15-20% for the general price outlook. We conclude that the decline in the output price outlook is largely accompanied by the current fall in output prices and input prices. However, a larger part of the decline in the general price outlook cannot be explained by these movements and it is likely that their macroeconomic views have also played a part for the recent decline in the general price outlook.

6. Conclusion

In this paper, we examined the relation between firms' inflation outlook and their business environment using micro data of the *Tankan* survey. We also analyzed the recent decline in the inflation expectation. To sum up the major characteristics, we found that current changes in output prices and input prices have a larger effect on firms' inflation outlook than business conditions or other supply-demand measures. Small enterprises tend to have a higher inflation outlook than large enterprises. And the decline in commodity prices may have a certain influence on the recent decline in firms' inflation outlook, especially for output prices.

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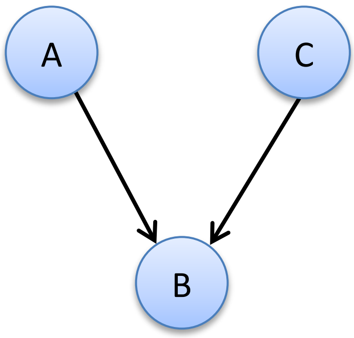
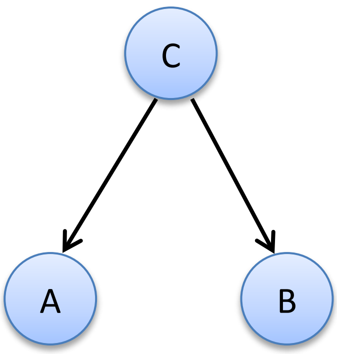
Appendix: Concept and Structure of Bayesian Network

A Bayesian network (BN) consists of nodes, a set of variables, and links that represent probabilistic or causal relationships among nodes. Here, for instance, we show a causal model. For a case where "A" and "C" are the causes of "B," we illustrate a graphical expression of the model as well as the joint distribution of the nodes below:



$$P\ (A,\ B,\ C) \\ = P\ (B|A,\ C)\ P\ (A)\ P\ (C)$$

The following example in figure below shows the graphical expression and joint distribution that "A" is related to "B," but is not the direct cause of "B," while "C" is the cause of "A" and "B."



$$P\ (A,\ B,\ C) \\ = P\ (A|C)\ P\ (B|C)\ P\ (C)$$

As illustrated above, we construct a joint distribution for the BN model given its probabilistic structure.

One of the goals of the Bayesian network analysis is to find the best model based on information criteria or other statistical measures. Since the structure of the BN is generally unknown, we need to learn about them from data. We faced various difficulties in this process due to the fact that there are many directional links among nodes and that the optimal network must be chosen from a vast number of competitive networks. For this reason, a rich set of research methods exists for the learning algorithms of BN.

Overview of the New Survey on Inflation Outlooks of Firms Table 1

<table>
<tr><td colspan="2">Survey Items</td><td>“Outlook for Output Prices” (rate of price change relative to the current level)
“Outlook for General Prices” (annual % change)</td></tr>
<tr><td colspan="2">Forecast horizon</td><td>1 year ahead, 3 years ahead, 5 years ahead</td></tr>
<tr><td colspan="2">Sample Firms</td><td>Equivalent to the sample firms of the current Tankan (“The Short-term Economic Survey of Enterprises in Japan”)
(10,862 firms as of June 2016)</td></tr>
<tr><td rowspan="4">Questionnaire</td><td rowspan="2">Outlook for Output Prices</td><td>[Question] Relative to the current level, what are your institution's expectations of the rate of price changes in your mainstay domestic products or services for one year ahead, three years ahead, and five years ahead, respectively?
Please select the range nearest to your own expectation from the options below.</td></tr>
<tr><td>[Options]
Rate of change relative to the current level
1. around +20% or higher (+17.5% or higher)
2. around +15% (+12.5 to +17.4%)
3. around +10% (+7.5 to +12.4%)
4. around + 5% (+2.5 to + 7.4%)
5. around 0% (−2.5 to +2.4%)
6. around − 5% (−7.5 to −2.6%)
7. around −10% (−12.5 to −7.6%)
8. around −15% (−17.5 to −12.6%)
9. around −20% or lower (−17.6% or lower)
10. Don't know.</td></tr>
<tr><td rowspan="2">Outlook for General Prices</td><td>[Question] What are your institution's expectations of the annual % change in general prices (as measured by the consumer price index) for one year ahead, three years ahead, and five years ahead, respectively?
Please select the range nearest to your own expectation from the options below.</td></tr>
<tr><td>[Options]
In annual % rate change
1. around +6% or higher (+5.5% or higher)
2. around +5% (+4.5 to +5.4%)
3. around +4% (+3.5 to +4.4%)
4. around +3% (+2.5 to +3.4%)
5. around +2% (+1.5 to +2.4%)
6. around +1% (+0.5 to +1.4%)
7. around 0% (−0.5 to +0.4%)
8. around −1% (−1.5 to −0.6%)
9. around −2% (−2.5 to −1.6%)
10. around −3% or lower (−2.6% or lower)
※If you have no clear views on general prices, please select one of the three following reasons.
11. Uncertainty over the future outlook is high
12. Not really conscious of inflation fluctuations because they should not influence the strategy of the institution.
13. Other</td></tr>
</table>

Variables used in the Bayesian Network Analysis　Table 2

Respondents are asked to choose one alternative among three as the best descriptor of prevailing conditions, excluding seasonal factors, at the time of the survey and three months hence.

Business Conditions	Judgment of general business conditions of the responding enterprise, primarily in light of individual profits. [1) Favorable. 2) Not so favorable. 3) Unfavorable.]
Domestic Supply & Demand Conditions for Products and Services	Judgment of domestic supply and demand conditions for major products and services in the industry of the responding enterprise. Judgment in light of movements of goods, customers, and order arrival is included. Judgment including overseas conditions is also acceptable when it is difficult to exclude them. [1) Excess demand. 2) Almost balanced. 3) Excess supply.]
Production Capacity	Judgment of excessiveness, adequacy, or shortage of production capacity or business equipments of the responding enterprise, excluding a shortage caused by temporary conditions such as a closure of a factory due to regular repairs. [1) Excessive capacity. 2) Adequate. 3) Insufficient capacity.]
Employment Conditions	Judgment of excessiveness, adequacy, or shortage of the number of employees at the responding enterprise. [1) Excessive employment. 2) Adequate. 3) Insufficient employment.]
Change in Output Prices	Judgment of changes in the yen-based selling prices of major products and services provided by the responding enterprise. [1) Rise. 2) Unchanged. 3) Fall.]
Change in Input Prices	Judgment of changes in the yen-based purchasing prices of main raw materials, processing fees for subcontractors, and/or prices of main purchasing merchandise paid by the responding enterprise. [1) Rise. 2) Unchanged. 3) Fall.]

Ordered Probit Regression Result

Table 3

Ordinal dependent variable:		Output Prices			General Prices		
		1 year ahead	3 years ahead	5 years ahead	1 year ahead	3 years ahead	5 years ahead
Enterprise Size	Large	0.046	0.012	-0.087	-0.383	0.023	-0.620
		(1.560)	(0.482)	(-3.035)	(-7.790)	(0.760)	(-14.273)
	Small	0.106	0.150	0.077	0.063	0.150	0.069
		(4.637)	(7.318)	(3.248)	(2.854)	(6.421)	(2.524)
Industries (Nonmanufacturing)		0.124	0.157	0.163	-0.068	0.011	0.023
		(6.197)	(8.794)	(8.168)	(-3.373)	(0.517)	(0.853)
Business Conditions (Actual)	Favorable	0.015	-0.006	-0.036	0.069	0.035	0.046
		(0.851)	(-0.302)	(-1.690)	(4.318)	(1.869)	(2.093)
	Unfavorable	0.041	0.018	0.016	0.000	-0.039	-0.029
		(1.919)	(0.819)	(0.659)	(-0.020)	(-1.722)	(-1.141)
Business Conditions (Forecast)	Favorable	0.110	0.057	0.078	0.051	0.062	0.036
		(5.476)	(2.786)	(3.320)	(2.846)	(2.971)	(1.525)
	Unfavorable	-0.109	-0.050	-0.045	-0.012	-0.017	-0.002
		(-4.937)	(-2.131)	(-1.681)	(-0.604)	(-0.708)	(-0.073)
Domestic Supply & Demand Conditions (Actual)	Excess Demand	0.156	0.043	0.093	0.035	0.011	0.051
		(5.067)	(1.344)	(2.538)	(1.238)	(0.336)	(1.343)
	Excess Supply	0.011	0.025	0.037	0.049	0.037	0.040
		(0.435)	(0.964)	(1.161)	(2.179)	(1.403)	(1.312)
Domestic Supply & Demand Conditions (Forecast)	Excess Demand	0.085	0.164	0.112	0.039	0.050	0.011
		(2.634)	(4.836)	(2.911)	(1.297)	(1.480)	(0.292)
	Excess Supply	-0.024	-0.057	-0.035	0.031	-0.005	0.009
		(-0.956)	(-2.205)	(-1.140)	(1.385)	(-0.197)	(0.282)
Production Capacity (Actual)	Excessive	0.001	0.028	0.034	-0.020	-0.010	0.081
		(0.029)	(0.732)	(0.730)	(-0.622)	(-0.269)	(1.873)
	Insufficient	0.038	0.005	0.074	0.029	0.085	0.113
		(1.289)	(0.158)	(2.158)	(1.122)	(2.853)	(3.263)
Production Capacity (Forecast)	Excessive	-0.046	-0.110	-0.130	0.031	-0.020	0.016
		(-1.253)	(-2.948)	(-2.926)	(0.947)	(-0.539)	(0.372)
	Insufficient	-0.016	-0.013	-0.051	0.017	0.033	0.003
		(-0.581)	(-0.493)	(-1.563)	(0.703)	(1.155)	(0.077)
Employment Conditions (Actual)	Excessive	-0.022	-0.048	-0.075	0.026	0.026	-0.006
		(-0.682)	(-1.478)	(-1.968)	(0.909)	(0.778)	(-0.154)
	Insufficient	-0.004	-0.016	-0.022	0.027	-0.040	-0.033
		(-0.216)	(-0.813)	(-0.939)	(1.574)	(-2.000)	(-1.434)
Employment Conditions (Forecast)	Excessive	-0.055	-0.046	0.011	-0.060	0.000	-0.031
		(-1.750)	(-1.422)	(0.282)	(-2.153)	(0.010)	(-0.806)
	Insufficient	0.004	0.036	0.019	0.025	0.061	0.095
		(0.210)	(1.885)	(0.863)	(1.477)	(3.137)	(4.214)
Change in Output Prices (Actual)	Rise	0.299	0.136	0.126	0.109	0.025	0.030
		(13.521)	(5.490)	(4.270)	(5.312)	(1.019)	(1.071)
	Fall	-0.312	-0.316	-0.189	-0.046	-0.034	-0.058
		(-12.823)	(-11.370)	(-5.765)	(-2.073)	(-1.305)	(-1.893)
Change in Output Prices (Forecast)	Rise	0.706	0.473	0.460	0.178	0.167	0.161
		(34.298)	(21.219)	(17.711)	(9.554)	(7.548)	(6.316)
	Fall	-0.798	-0.763	-0.735	-0.041	-0.071	-0.016
		(-33.495)	(-28.839)	(-22.920)	(-1.940)	(-2.841)	(-0.542)
Change in Input Prices (Actual)	Rise	0.178	0.068	0.099	0.189	0.064	0.006
		(10.061)	(3.714)	(4.624)	(12.013)	(3.422)	(0.282)
	Fall	0.005	0.021	0.115	-0.131	-0.055	0.022
		(0.173)	(0.627)	(3.028)	(-4.719)	(-1.649)	(0.564)
Change in Input Prices (Forecast)	Rise	0.108	0.138	0.121	0.165	0.151	0.172
		(6.272)	(7.853)	(5.896)	(10.822)	(8.471)	(8.157)
	Fall	-0.165	0.097	0.097	-0.084	-0.080	-0.097
		(-4.779)	(2.534)	(2.288)	(-2.676)	(-2.168)	(-2.234)
Log (Employment)		-0.040	-0.021	-0.019	-0.075	-0.041	-0.071
		(-6.594)	(-3.620)	(-2.837)	(-10.525)	(-5.727)	(-8.407)
Jun. 2014 Survey		-0.002	0.035	0.050	0.052	-0.025	-0.048
		(-0.093)	(1.580)	(1.999)	(2.743)	(-1.137)	(-1.891)
Sep. 2014 Survey		-0.007	-0.007	0.045	0.069	-0.030	-0.050
		(-0.340)	(-0.321)	(1.821)	(3.645)	(-1.346)	(-1.966)
Dec. 2014 Survey		-0.044	-0.013	0.008	-0.038	-0.044	-0.080
		(-2.022)	(-0.595)	(0.306)	(-1.994)	(-1.983)	(-3.151)
Mar. 2015 Survey		-0.041	-0.008	0.022	-0.069	-0.088	-0.097
		(-1.921)	(-0.348)	(0.896)	(-3.631)	(-3.935)	(-3.824)
Jun. 2015 Survey		-0.058	-0.013	0.002	-0.085	-0.121	-0.138
		(-2.698)	(-0.595)	(0.083)	(-4.485)	(-5.402)	(-5.442)
Sep. 2015 Survey		-0.148	-0.074	-0.060	-0.284	-0.242	-0.226
		(-6.787)	(-3.335)	(-2.372)	(-14.815)	(-10.757)	(-8.880)
Dec. 2015 Survey		-0.199	-0.132	-0.103	-0.431	-0.339	-0.307
		(-9.052)	(-5.919)	(-4.096)	(-22.298)	(-14.978)	(-12.008)
Mar. 2016 Survey		-0.236	-0.193	-0.163	-0.692	-0.544	-0.496
		(-10.670)	(-8.592)	(-6.450)	(-35.317)	(-23.858)	(-19.201)
Jun. 2016 Survey		-0.293	-0.250	-0.220	-0.851	-0.643	-0.558
		(-13.202)	(-11.159)	(-8.706)	(-43.211)	(-28.168)	(-21.648)
Number of Observations		75,670	55,240	40,510	65,410	46,100	35,320

Note:

The random-effects ordinal probit estimates are based on data of the *Tankan* survey. t-statistics are shown in parentheses. Shaded variables are statistically significant at the 5-percent level.

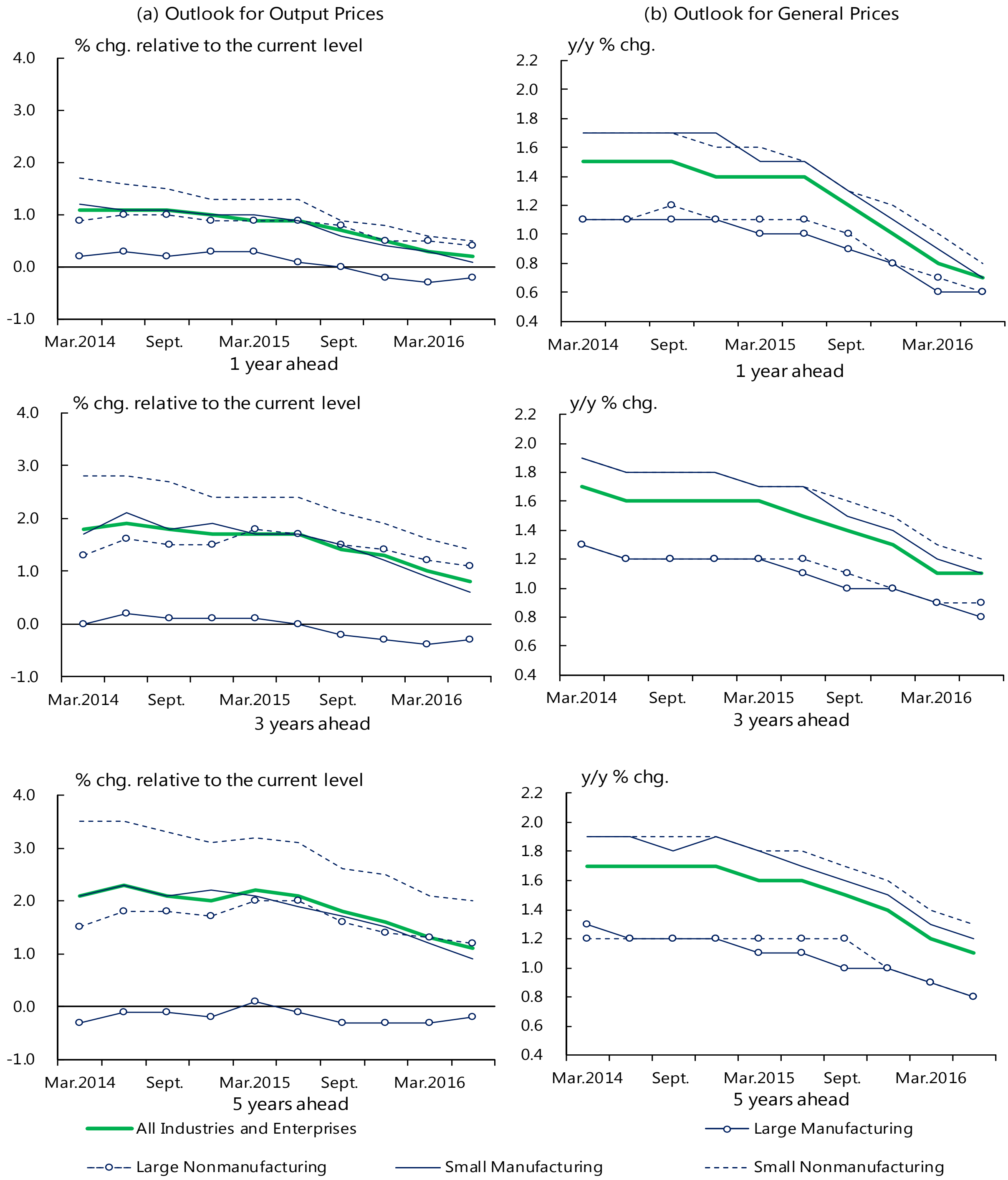
Simulation Result

Table 4

	Output Price			General Price		
	1 year ahead	3 years ahead	5 years ahead	1 year ahead	3 years ahead	5 years ahead
(A) June 2015 Survey Result	0.910	1.745	2.073	1.353	1.536	1.585
(B) Simulation Result	0.600	1.332	1.605	1.265	1.455	1.500
(C) June 2016 Survey Result	0.264	0.852	1.133	0.726	1.064	1.137
Contribution of "Change in Prices DI" ((A-B)/(A-C))	47.9%	46.2%	49.8%	14.2%	17.1%	18.9%

Weighted Average of Firms' Inflation Outlook

Figure 1

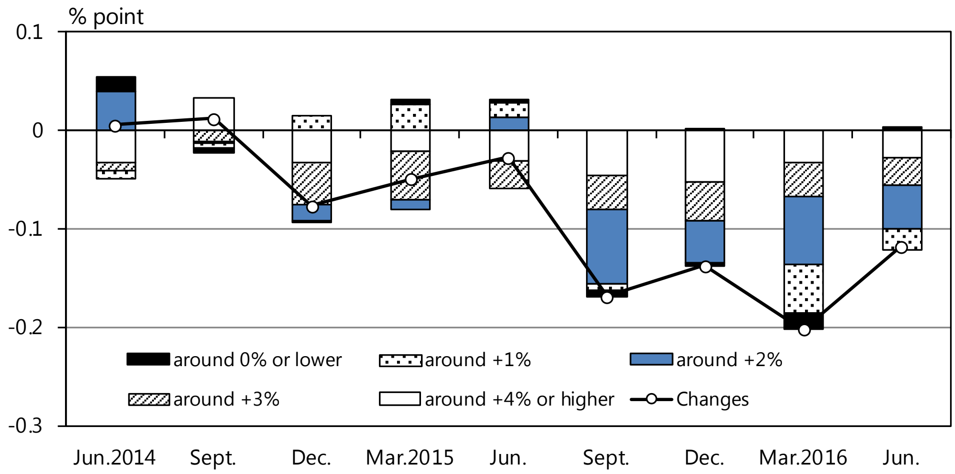


Source: Bank of Japan

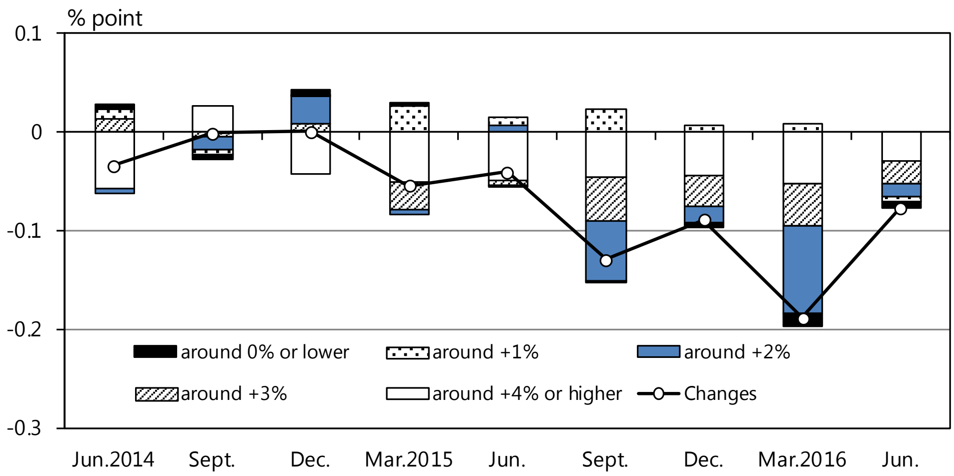
Notes:
Weighted average of firms' inflation outlook is calculated excluding "Don't know." Response numbers are rounded for calculation purposes: for example, "around +15%" and "around +20% or higher" are rounded to +15% and +20%, respectively.

Contribution of Each Option to the Average Outlook for General Prices

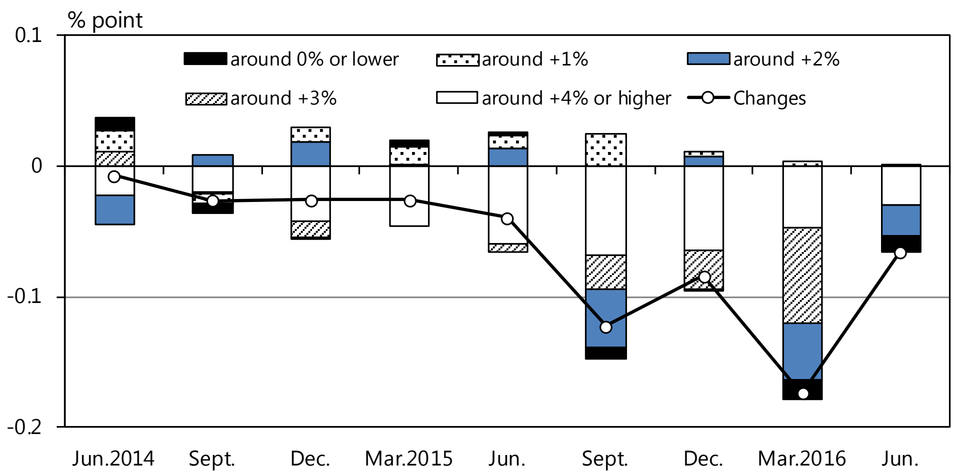
Figure 2



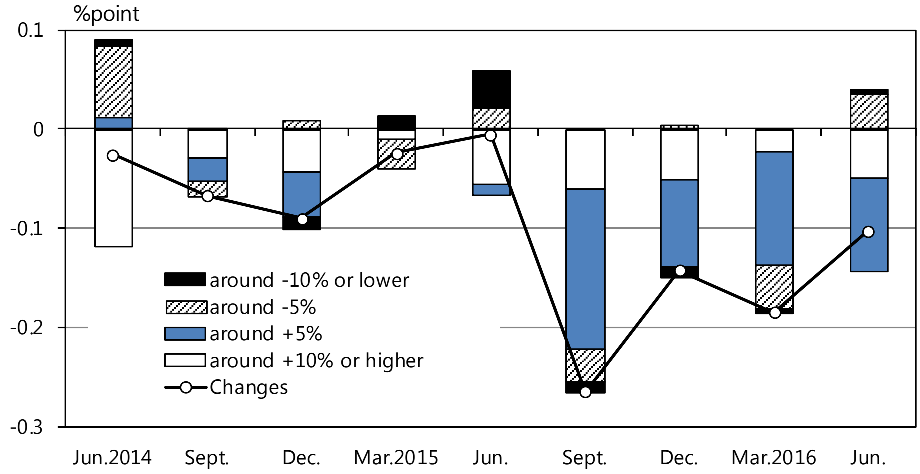
1 year ahead



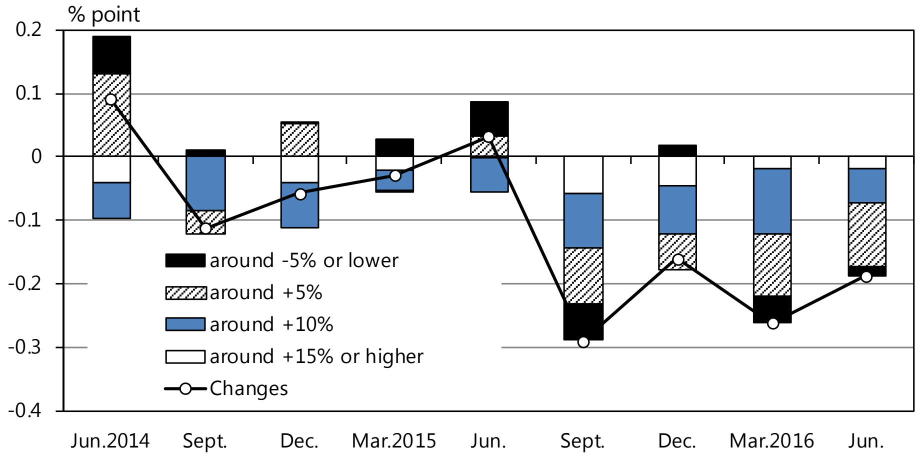
3 years ahead



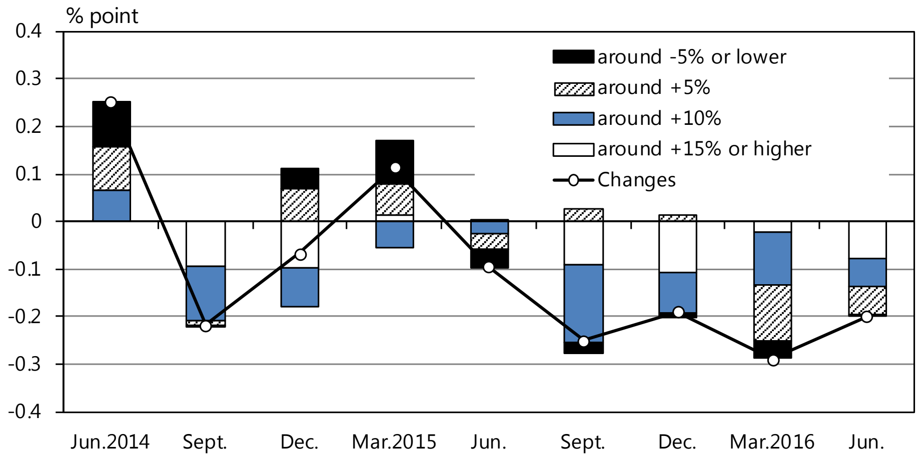
5 years ahead



1 year ahead



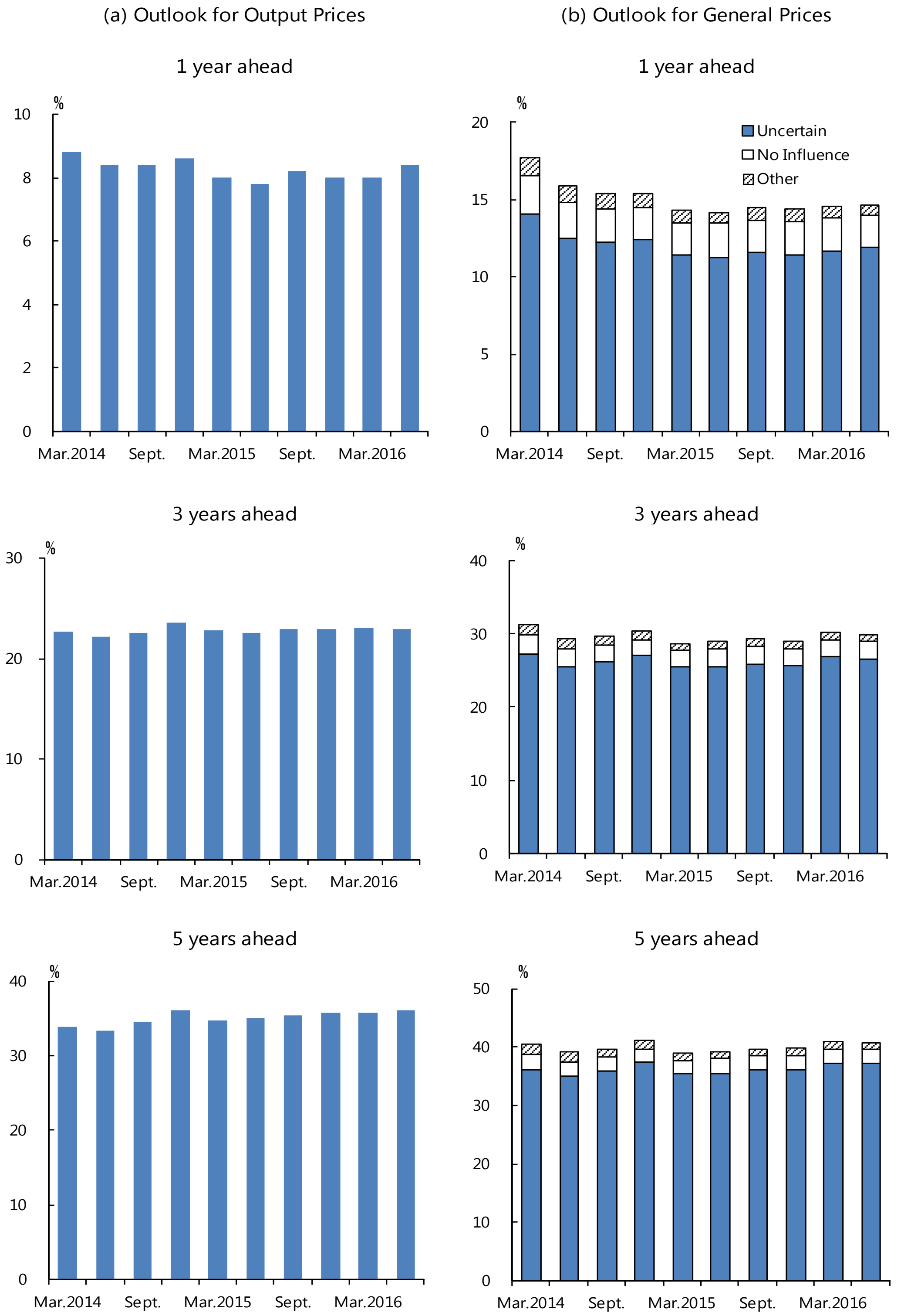
3 years ahead



5 years ahead

Percentage of Respondents Choosing "Don't Know"

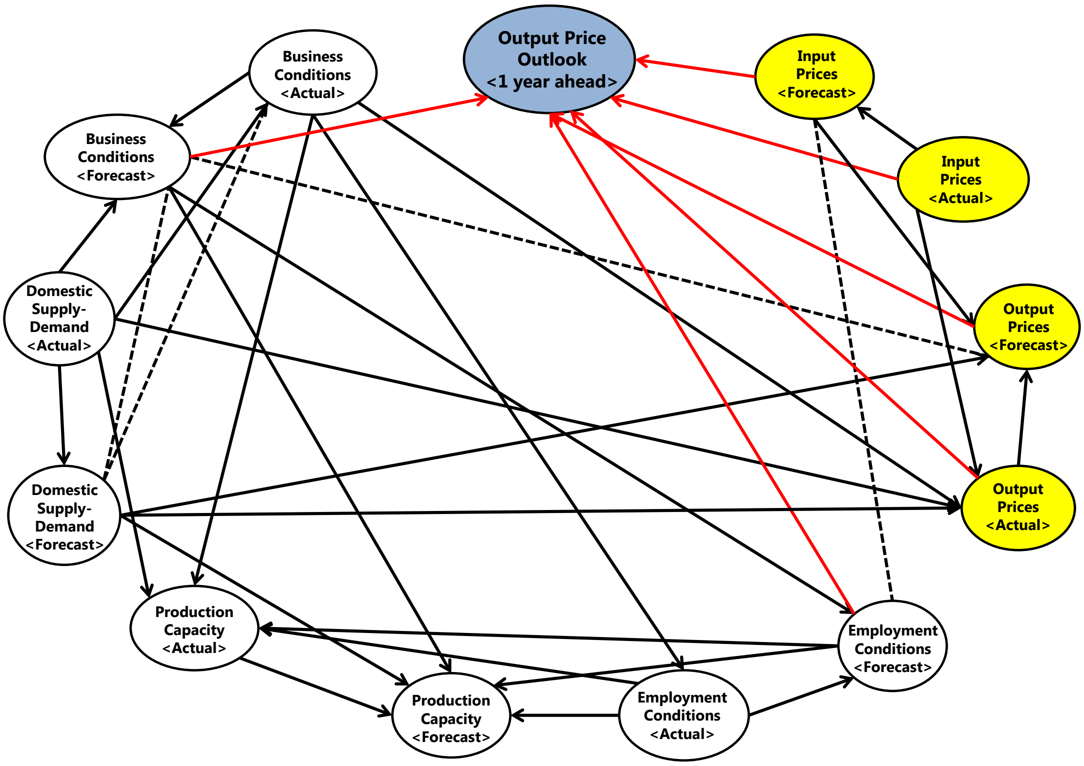
Figure 4



Note:
In outlook for general prices, “Uncertain,” “No influence” and “Other” correspond to “Don’t have clear view for uncertainty over the future outlook is high,” “Don’t have clear view for not really conscious of inflation fluctuations because they should not influence the strategy of the institution” and “Don’t have clear view for other reasons,” respectively.

Result of Bayesian Network Analysis

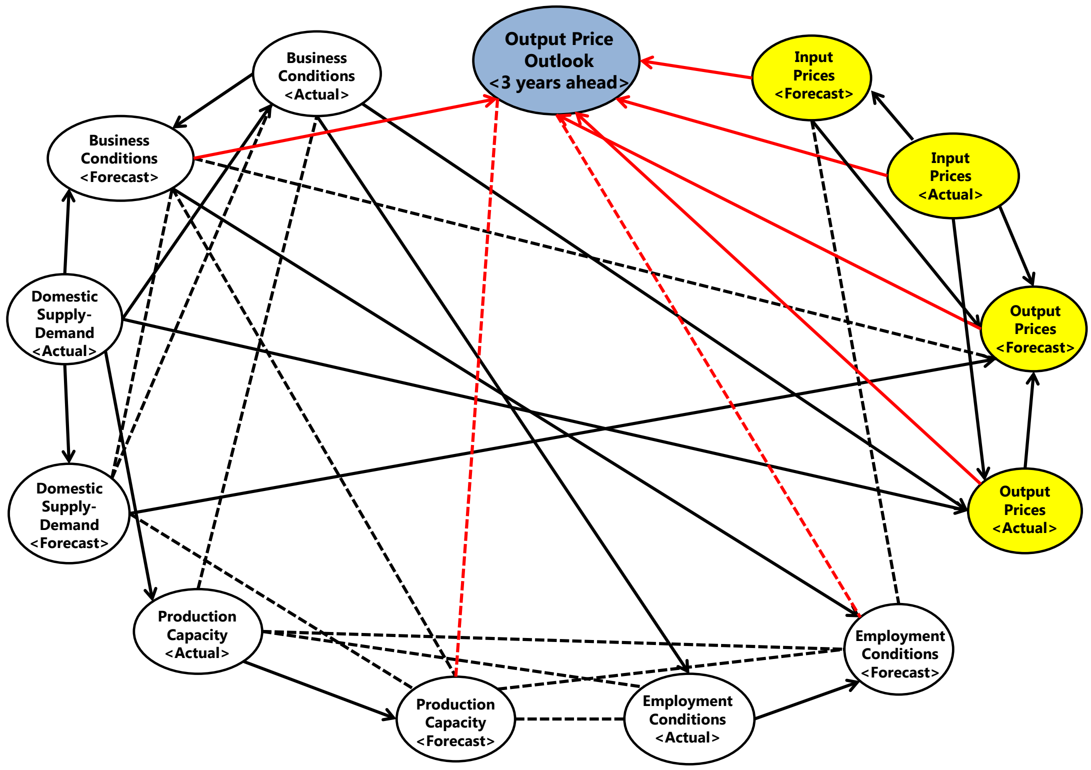
Figure 5a



Note: Arrows represent direct relationships and dotted lines indicate indirect relationships.

Result of Bayesian Network Analysis

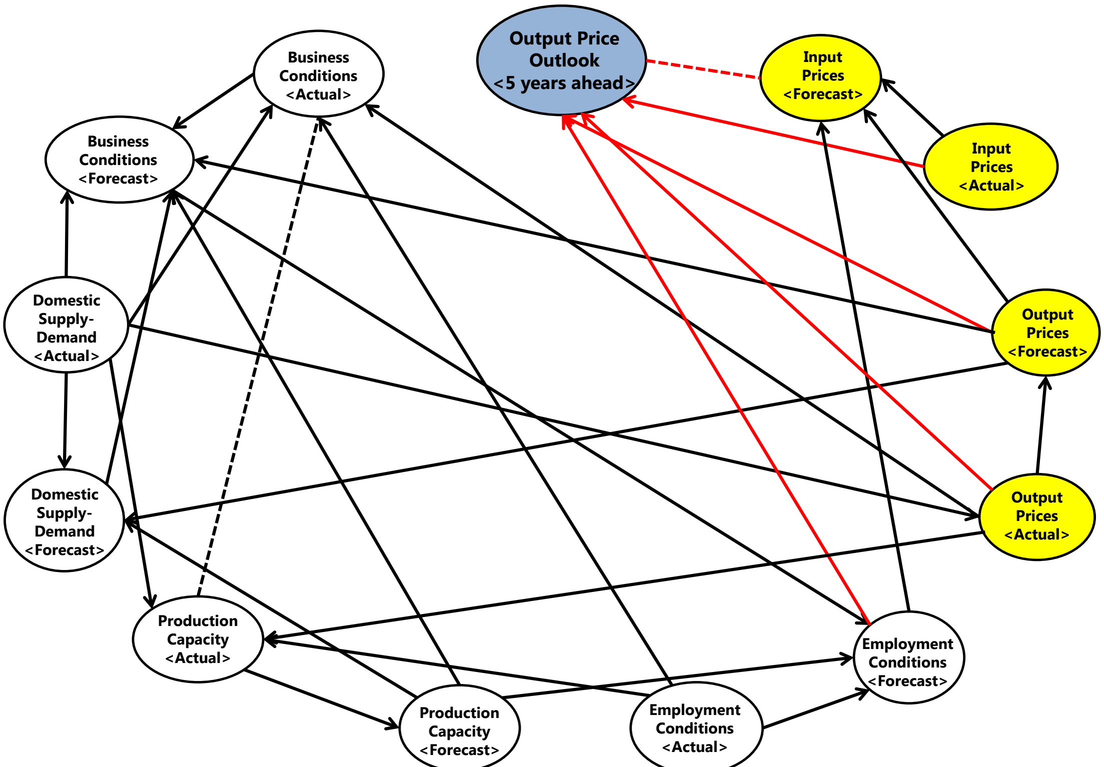
Figure 5b



Note: Arrows represent direct relationships and dotted lines indicate indirect relationships.

Result of Bayesian Network Analysis

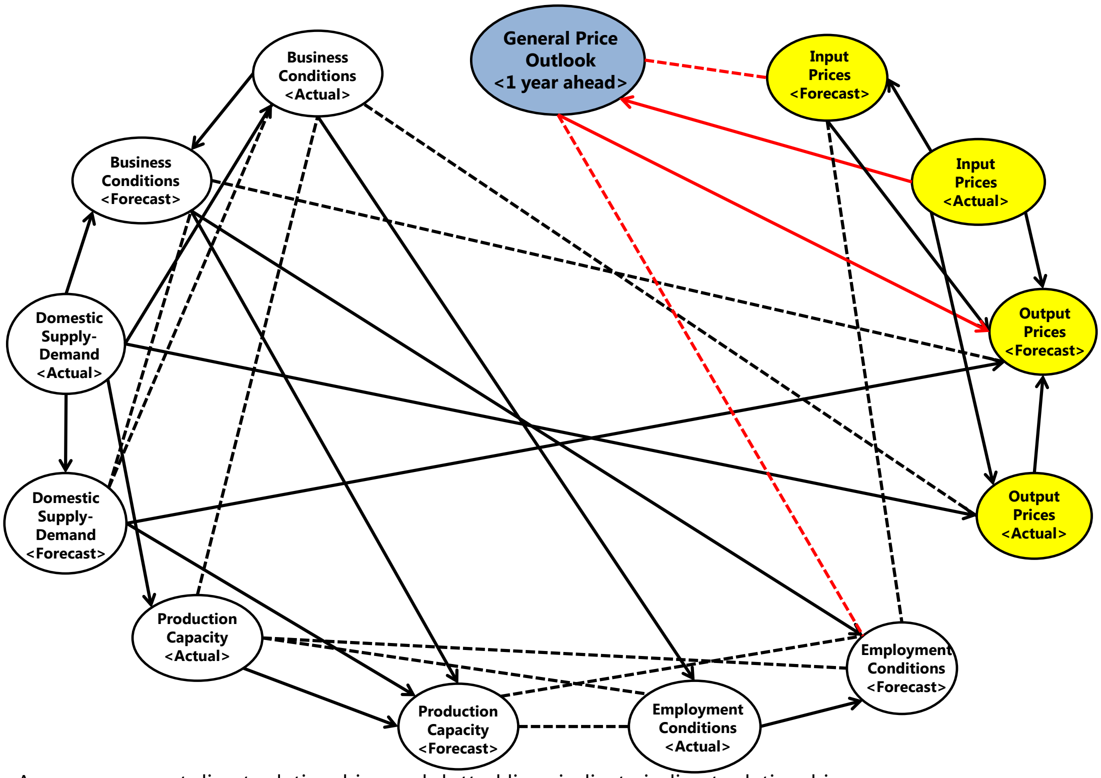
Figure 5c



Note: Arrows represent direct relationships and dotted lines indicate indirect relationships.

Result of Bayesian Network Analysis

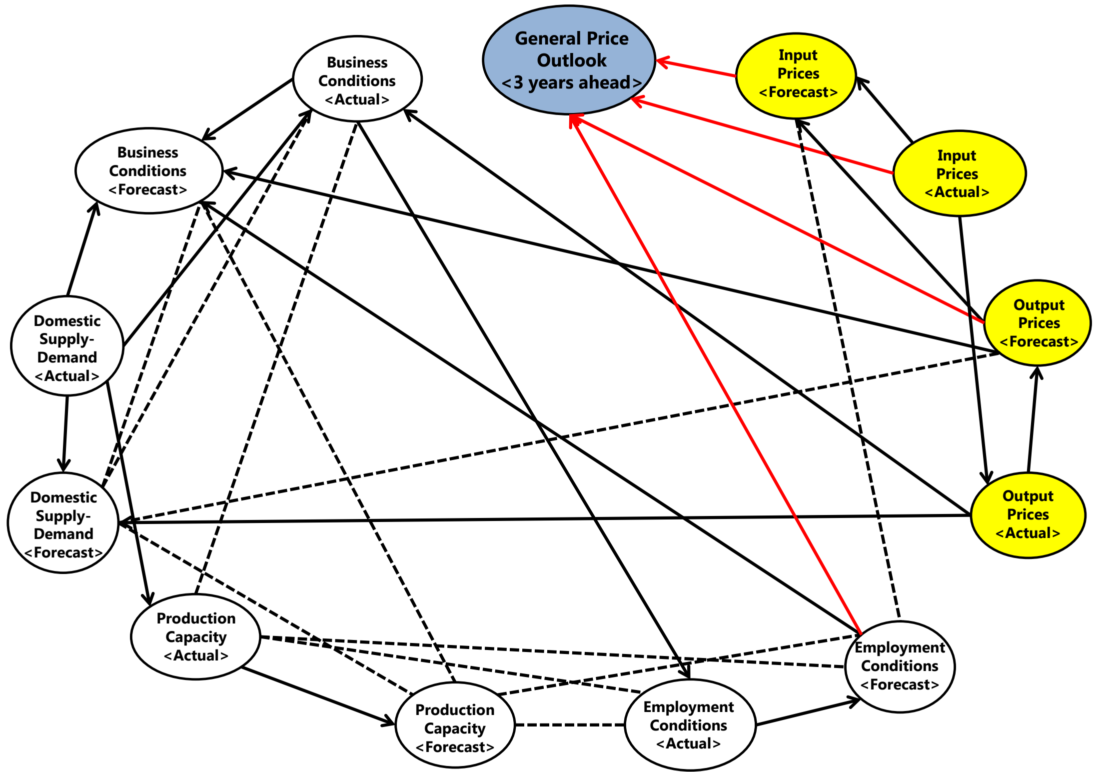
Figure 5d



Note: Arrows represent direct relationships and dotted lines indicate indirect relationships.

Result of Bayesian Network Analysis

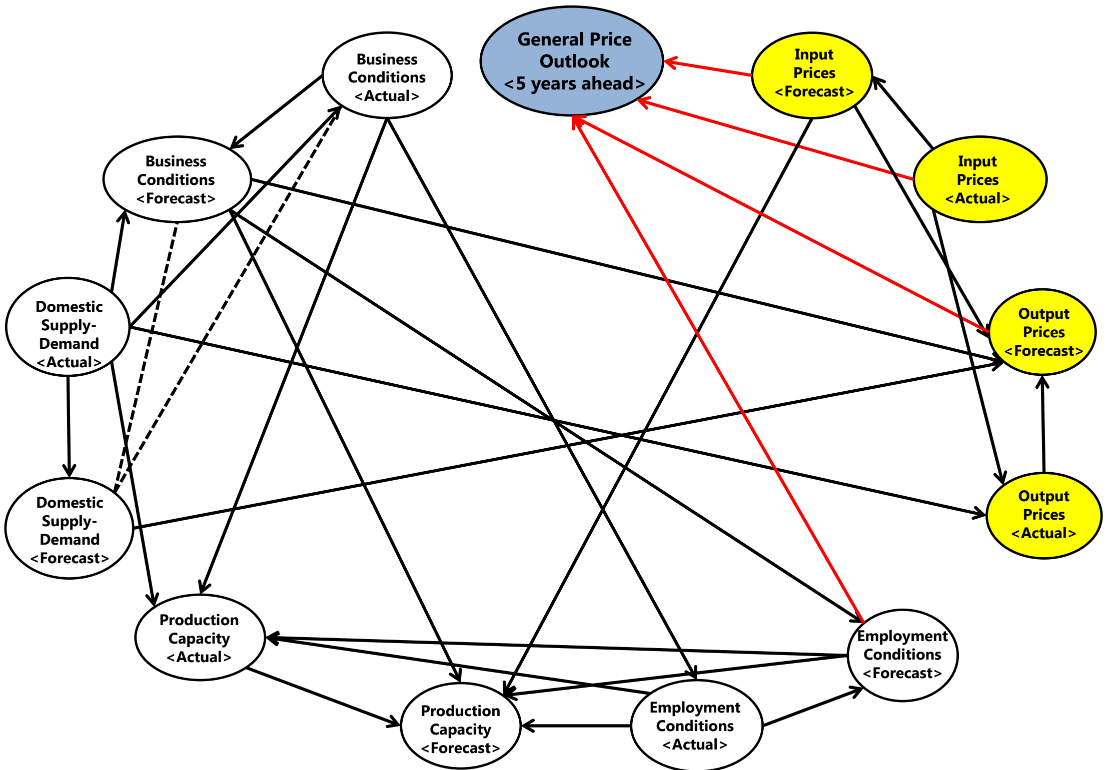
Figure 5e



Note: Arrows represent direct relationships and dotted lines indicate indirect relationships.

Result of Bayesian Network Analysis

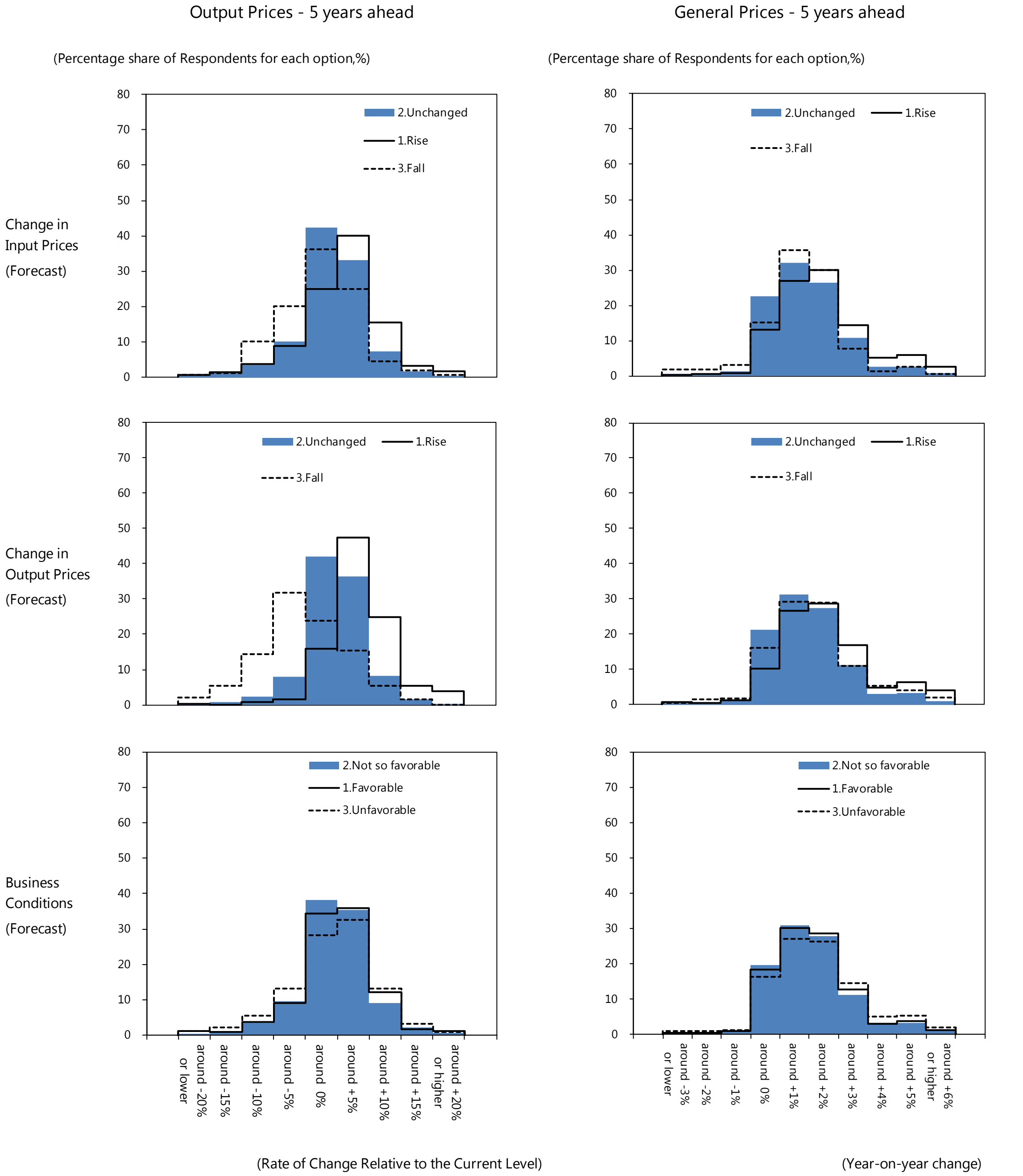
Figure 5f



Note: Arrows represent direct relationships and dotted lines indicate indirect relationships.

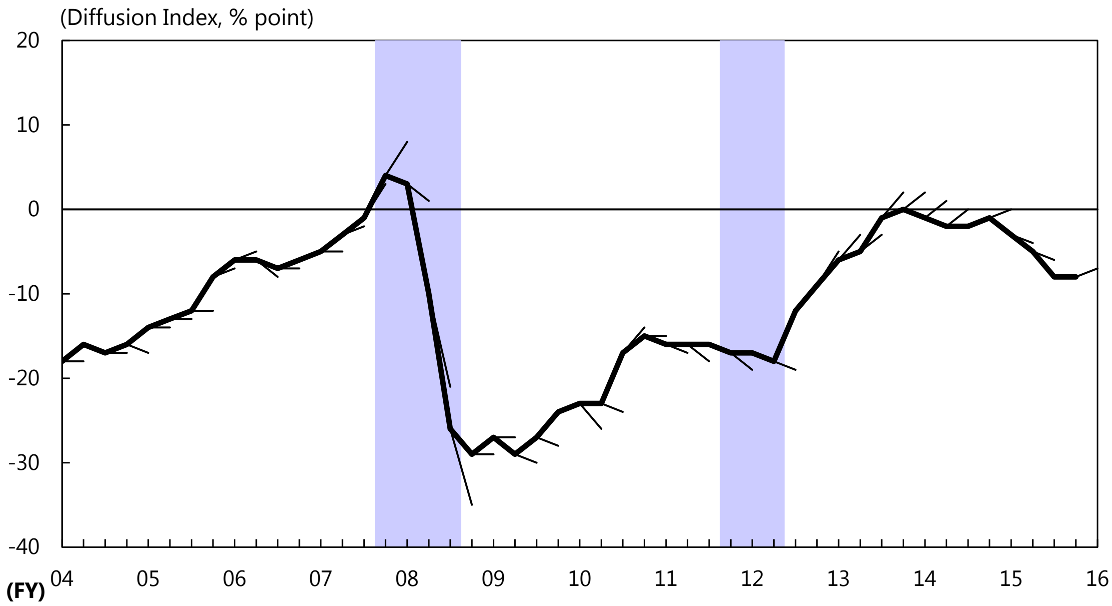
Distribution of "Inflation Outlook of Enterprises" Figure 6

[All Enterprises / All industries]
Previous projection: June 2015 survey

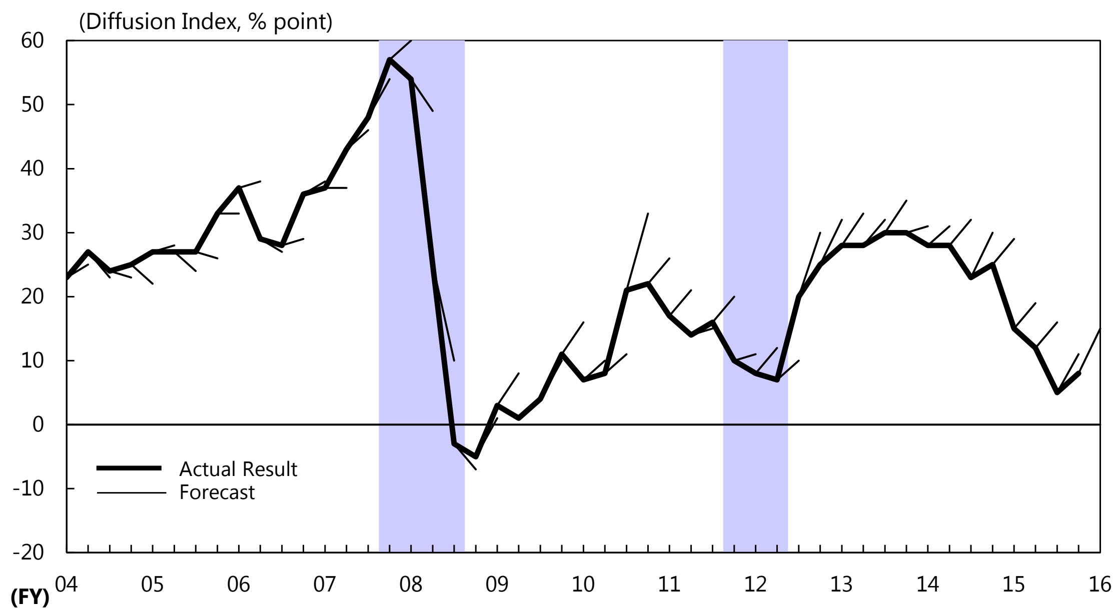


Note: "Don't know" option for output prices and "Don't have clear views" option for general prices are not shown here.

Output Prices (All Industries and Enterprises)



Input Prices (All Industries and Enterprises)

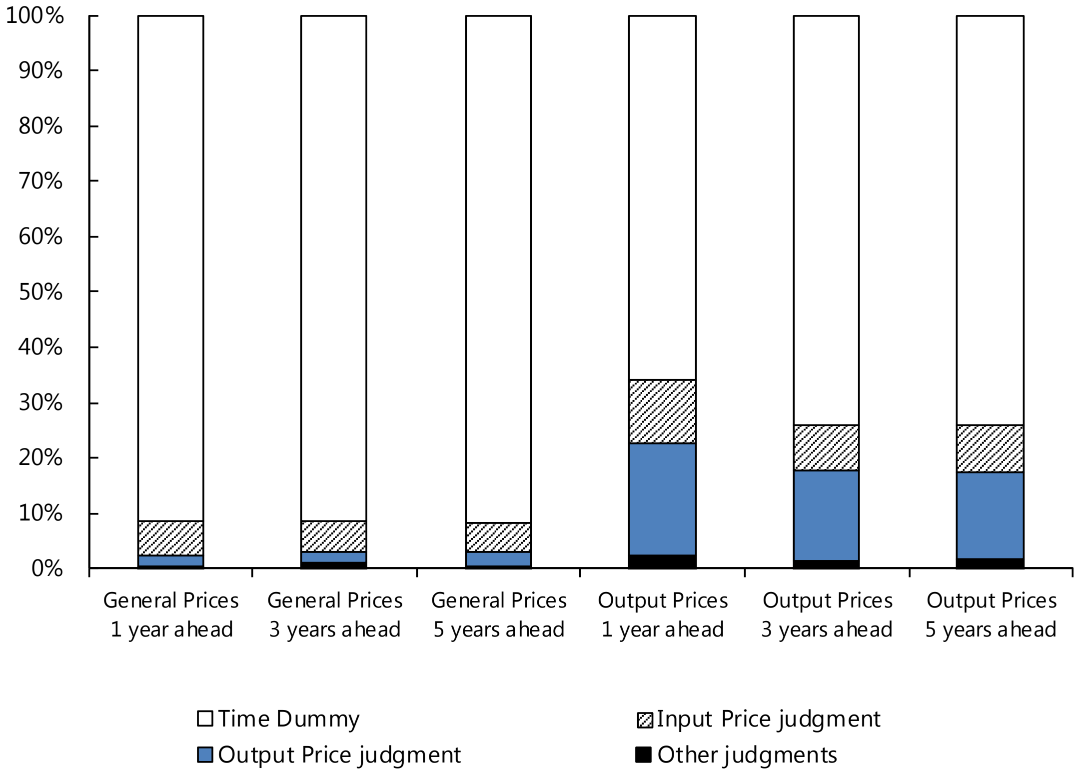


Notes: 1. Diffusion Index of "Rise" minus "Fall" is calculated from the judgment survey items "Change in Output Prices" and "Change in Input Prices."

2. Shaded areas indicate periods of recession.

Effect of Change in Judgments to the Latent Variable

Figure 8



Notes:
Here we estimate the contributions of each judgment and time dummy to the inflation outlook, using coefficients obtained from the ordinal probit regression and share of respondents for each judgment. Changes in the inflation outlook between the June 2015 and June 2016 surveys are roughly expressed in the following way. The above charts show the effect of each judgment and time dummy on changes in the inflation outlook in percentage terms.

$$\pi^*_{i_{201606}} - \pi^*_{i_{201506}} = \sum_k \theta_k (D_{ki201606} - D_{ki201506}) + \sum_t \rho_t (\delta_{201606} - \delta_{201506})$$

Other judgments consist of "Business Conditions," "Domestic Demand-Supply Conditions," "Production Capacity" and "Employment Conditions."

Irving Fisher Committee on
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BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

How should we measure residential property prices to inform policy makers?[1]

Jens Mehrhoff,
Deutsche Bundesbank

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

How should we measure residential property prices to inform policy makers?

Session 4 B – Assessing macroeconomic vulnerabilities

Jens Mehrhoff

Abstract

There is no simple answer to a complicated question; the high dimensionality of a complex and diffuse phenomenon such as "the residential property market" calls for a broad set of indicators which embodies the joint distribution of price, financial and real economic indicators.

As regards affordability and valuation indicators, another question remains: What drives the ratios? Is it the numerator (e.g. price) or the denominator (e.g. income)? Last but not least, lending standards differ considerably across countries. At the example of the price-to-income and annuity-to-income ratios it is shown that different drivers are at play in the euro-area member states.

Keywords: Financial stability; Indicators; Credit; Affordability; Valuation; Long series

JEL classification: C22; C43; E31; E58; G12; R31

Contents

Motivation and introduction

The various motivations for the analysis of house prices call for alternative measures to be applied. In macroeconomic analysis: identification of price signals, evaluation of monetary policy channels, and volume measurement in National Accounts; in macroprudential supervision: assessment of asset price bubbles, build-up of risks in banks' credit exposures, and financial soundness of private households. However, these indicators can give different results, which could undermine their credibility for many users. Yet, there should be no unique indicator. In order to determine whether threats to the economy or financial stability emanate from the housing market, the analyses should be based on a broad set of indicators.

The diverse uses and associated methods of residential property price indices, the statistical framework for the compilation of such indices, as well as a dashboard comprising the three dimensions price, financial and real sector variables will be discussed.[1] These include:

- Price and valuation indicators: E.g. price-to-rent, price-to-income and annuity-to-income ratios.
- Loans to and debt of households: E.g. banks' loans and interest payments.
- Construction and activity indicators: E.g. completed housing units and transactions.

Empirical results for the German residential property market will exemplify the usefulness of a multi-indicator approach in times of strong upward movements of price indicators.

About every third euro spent in Germany for private consumption purposes is spent on housing, including imputed rentals for homeowners. Owner-occupied properties constitute the most significant asset of German households; the rate of home ownership in Germany equates to just 44 %. Hence, more than half of the German households are renters. Among the homeowners, two out of five have a mortgage. The value of the property stock is an important part of the wealth of the German economy: gross fixed assets in housing stand at 265 % of GDP.

Composite indicators

Composite indicators, on the other hand, aim to combine numerous, diverse indicators in a single number. They claim to reduce complex relationships to a supposedly simple measure. For aggregating base variables to a composite indicators one has to select suitable data first and, then, to derive the respective weights. It is not straightforward at all how the selection and weighting of the base variables should be performed: Factor analysis maximises the explained variance of all base variables, the thus derived weights do not, however, represent relative importance. Regression analysis minimises squared error to a given target indicator, whose existence makes the whole exercise somewhat obsolete.

[1] http://www.bundesbank.de/Redaktion/EN/Standardartikel/Statistics/system_of_indicators.html

Hence, generally accepted and obvious selection procedures as well as weighting schemes cannot possibly exist. One composite indicator could use different base variables than another one; a third one could use the same base variables but apply a different weighting scheme. What is more, a composite indicator suggests substitutability between different base variables such that one would be indifferent between certain combinations. When the composite indicator is not constructed adequately or is not used so, the conclusions derived on that basis might be misleading and costly. Particularly with many base variables, their interpretation will be in conflict.

The high dimensionality of a complex and diffuse phenomenon such as "the residential property market" cannot adequately be reproduced by a composite indicator. Quite the contrary, the joint distribution of price, financial and real economic indicators seems to be at the centre of the current discussion. There is no simple answer to a complicated question; it might, thus, be better to look at a dashboard of indicators rather than to dissolve existing conflicts between base variables. Last but not least, statistics has a consulting function for policy makers – this makes it even more important to produce unbiased, easily interpretable and manageable measures.

Conceptual and methodological framework

Despite the quest for swiftly disseminated indicators, it is of utmost importance to set up a valid and reliable statistical framework first. The various data users make substantially different demands on the index concepts. These, in turn, need to be tailored for the distinctive purposes. The observation of values and prices generally yields different results. The change in market values between two consecutive periods does not necessarily reflect the pure, i.e. quality-adjusted, change in prices. It is rather a mixtum compositum of quality changes due to depreciation and renovation as well as the quality-adjusted change in prices; if quantities remain the same. Let, for example, the population be equal in the two periods under consideration. Due to depreciation the quality of all buildings will be lower on average. Ceteris paribus, it follows that in such a situation values decrease although quality-adjusted prices have remained constant.

In a market economy, prices give signals about relative scarcities through equilibria between supply and demand. In this way, both enterprises and consumers gain important insights into their production and consumption decisions, respectively, so that scarce resources are allocated to where they are most efficiently used. Real estate prices are a significant economic indicator and rising house prices are often associated with economic growth. They stimulate construction activity and promote house sales. Not least, price increases support private consumption via the wealth effect.

For monetary policy making, house price indices are an integral part of inflation measurement. In the near future, owner-occupied housing should become part of the European Harmonised Indices of Consumer Prices – as with other durable consumer goods, the net acquisitions approach will be applied. For the identification of pure price signals, a price index at constant quality is a condition sine qua non. Since for short-term business cycle analysis, the most recent developments are at the centre of attention, aggregation should be performed using transactions only (albeit not necessarily in terms of chain-linked indices).

In addition, figures on residential property are needed in National Accounts: Converting nominal to real figures (deflationing): The calculation of the volume requires a pure price index for this asset class (of course, nominal values have a right in their own as an indicator). Neglecting the issue of land-structure spilt, the measurement of the value of the entire housing stock calls for stock-weighted indices, which would also be appropriate for the assessment of households' wealth effects. Furthermore, deflators are needed to estimate the real output of the services of the real estate industry as well as gross (fixed) capital formation in new dwellings – in both cases, a transaction-based price index would be needed, which must cover new dwellings only in the latter case.

Apart from the potential build-up of asset price bubbles, the risks of banks' credit exposures associated to the financial soundness of private households are most relevant. Here, the change in values of financed objects needs to be tracked over time. This has two dimensions: Hazards emerging from newly granted loans, and value changes of properties in the credit stock.

The build-up of asset price bubbles frequently comes with misallocations, a strong surge in housing investment, say. In case of an adjustment, this bears the risk of higher probabilities of default in the non-financial corporations sector. Focussing on the homebuying of private households, the initial ratio of the loan to the value of the property is of special interest for macroprudential authorities. Price dynamics have to be seen here in conjunction with further indicators on the financing; particularly risky is the typical coincidence of housing booms and a credit expansion with lower lending standards.

Much like in short-term business cycle analyses, transactions can be used as a proxy for financings in order to provide valuable clues on the build-up of risks in banks' new business. On the other hand, through aggregation important information on the regional heterogeneity is lost. Empirical evidence in other countries with overheated housing markets has shown that regional developments can develop systemic relevance. This means that, at first, isolated undesired developments eventually gain breadth; a deeper investigation of spatial transmission channels necessitates a geographical breakdown.

Another important indicator is the change in values – price changes including quality changes – of financed objects over time. This is because, from the banks' perspective, the residual value of a home is of interest only should the debtor default, since then the bank would have to sell the home on the market (possibly in a forced sale). Since the quantity, i.e. floor space or number of bedrooms, is constant in general, the change in the property's value between the time of purchase and a potential foreclosure is: Value change = Price change + Quality change.

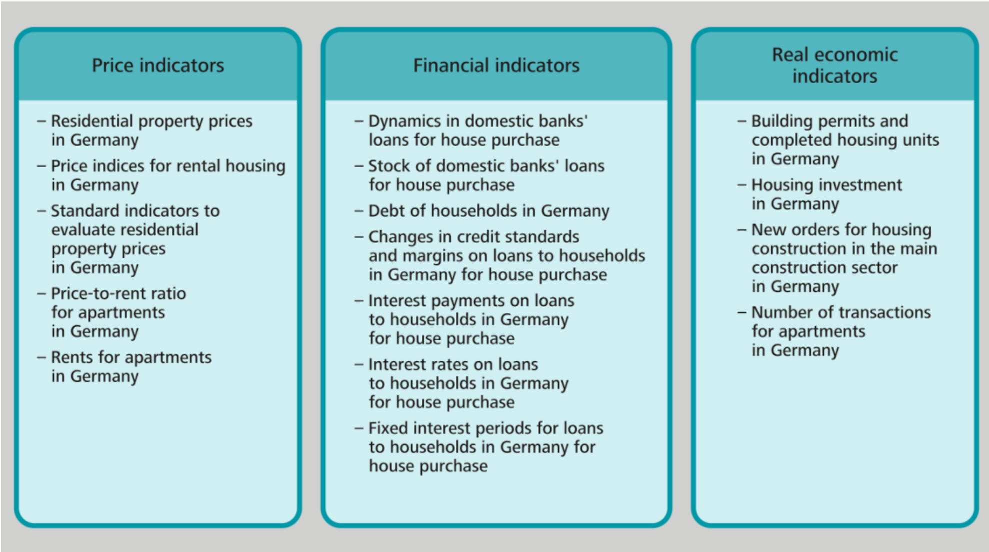
The quality of the house, however, is not fixed but it is assumed to be subject to a constant annual depreciation rate. The sole exogenous variable in the model then would be the quality-adjusted price. Still, it is not the absolute residual value of the house that matters but its ratio to the residual mortgage in the event of credit default. In the first years of the life of the loan, though, the amortisation rate of the annuity is rather low, so that the loan-to-value ratio worsens initially.

From a macroprudential view, only prices of financed objects would be relevant. A bank's credit portfolio would, furthermore, have a changing composition; newly financed objects enter, others exit due to repayments of the loans. For financial stability purposes, additionally, institution-specific figures are indispensable for the identification of risk potentials. The tails of the distribution need close examination as do credit vintages which reflect then-effective lending standards.

The Bundesbank's dashboard

The year 2010 saw a trend reversal in the German housing market, which was reflected in a sharp rise in prices. This situation needs to be addressed in light of the ongoing low-interest-rate environment. In order to determine whether threats to the economy or financial stability emanate from the housing market, the Bundesbank based its analyses on a broad set of indicators. This clearly shows that no statistical one-size-fits-all approach exists but that each subject matter has to be considered separately.

System of indicators for the German residential property market

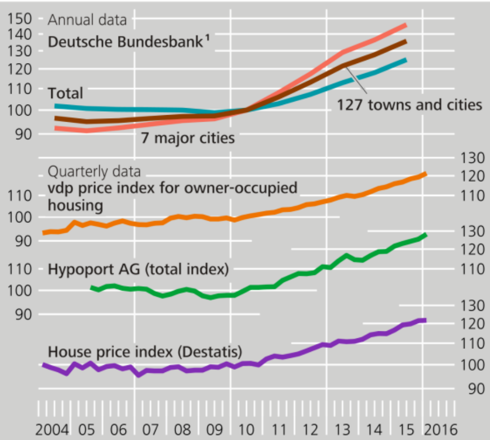


Deutsche Bundesbank S3IN0358.Chart

The observed price movements do not, on their own, make it possible to derive any potential overvaluation or undervaluation. A benchmark would be required, but it cannot be specified unambiguously from a conceptual point of view, nor can it be observed directly. Price data going far back into the past contain statistical breaks. Averages of the standard indicators do not take account of medium and long-term trends. If prices as well as rents rise substantially, the price-to-rent ratio may remain largely unchanged. Conversely, the price-to-income ratio would shoot upwards. If the interest rate conditions for new mortgage loans are taken into account, a substantial improvement of affordability can be observed since the outbreak of the financial crisis.

Residential property prices in Germany

2010 = 100, log scale



1 Transaction-weighted. Bundesbank calculations based on price data provided by bulwiengesa AG.

Deutsche Bundesbank 13 Jul 2016, 10:35:15, S3PR0110D.Chart

Standard indicators to evaluate residential property prices in Germany

2010 = 100, log scale

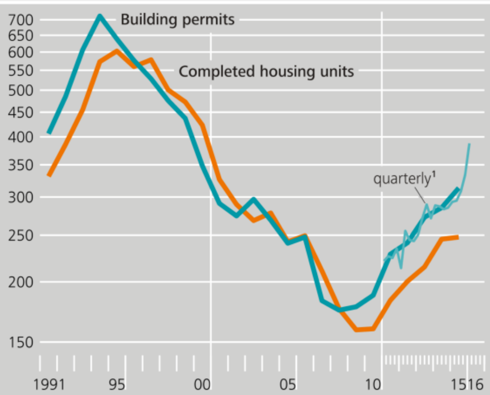
Source: Bundesbank calculations based on data provided by the Association of German Pfandbrief Banks (vdp). **1** Annuity of a mortage loan with a fixed interest rate (between five and ten years) and a hypothetical term of 30 years in relation to household income. **2** Disposable income per household in Germany, nominal. An increase represents a rise in the purchase price in relation to disposable income. **3** Prices and rents of apartments.

Deutsche Bundesbank 27 Mai 2016, 10:57:09, S3PR0182.Chart

Since 2010, only the price indicators for Germany demonstrated strong upward movements. The Bundesbank could not, on the basis of model-based analyses of the valuation situation in the housing market, detect any notable deviations from fundamentally justified housing prices throughout Germany. Hence, at present, no substantial macroeconomic risks are arising from the price structure on the housing market. In the 127 cities studied, current estimates put upward price deviations at between 10% and 20%, measured in terms of the longer-term demographic and economic variables; with freehold apartments in major cities showing the strongest overvaluations.

Building permits and completed housing units in Germany*

Thousand apartments, log scale

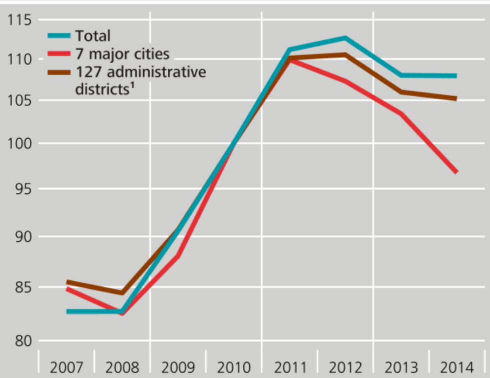


Source of unadjusted figures: Federal Statistical Office. * In residential and non-residential buildings. Including construction work on existing buildings. **1** Seasonally and calendar adjusted.

Deutsche Bundesbank 23 Jun 2016, 11:03:49, S3PR0112.Chart

Number of transactions for apartments in Germany

2010 = 100, log scale



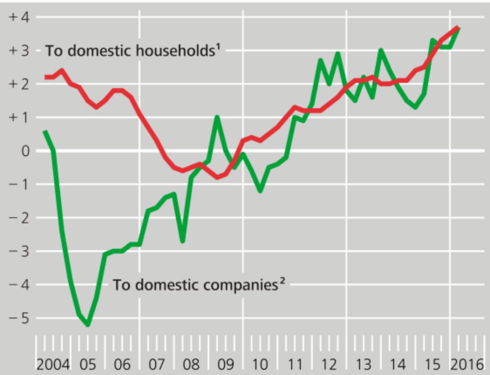
Source: Extrapolation provided by vdpResearch GmbH on the basis of data from surveyor committees. **1** Regional coverage not entirely comparable with residential property prices for 127 towns and cities from bulwiengesa AG.

Deutsche Bundesbank 27 Mai 2016, 10:25:29, S3PR0114.Chart

The other indicators mentioned above did not reach critical levels. However, studies of averages throughout Germany have limited value, as moderate rates of increase in housing loans for the whole of Germany could obscure a heterogeneous regional distribution of lending growth. The Bundesbank's analyses show very few signs of procyclical behaviour by banks or of a destabilising nexus between mortgage lending and property prices. However, it is striking that, in the towns and cities under consideration with sharply rising housing prices, a large share of mortgages have a German sustainable loan-to-value ratio (*Beleihungsauslauf*) of over 100%. This points to structural vulnerabilities in the German banking system to urban real estate market risks.

Dynamics in domestic banks' loans for house purchase*

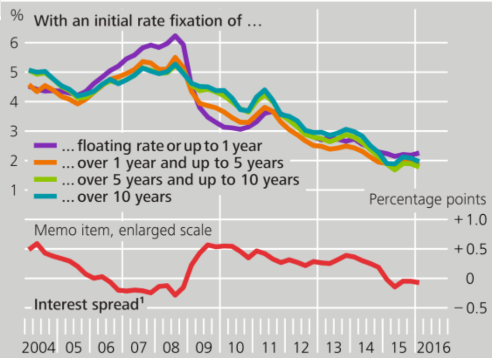
Year-on-year rate of change as a percentage, end-of-quarter data, seasonally adjusted



* Data for MFIs adjusted for statistical changes. **1** Including self-employed persons and sole traders. **2** Excluding self-employed persons and sole traders.

Deutsche Bundesbank 27 Mai 2016, 10:42:32, S3PR0120B.Chart

Interest rates on loans to households in Germany for house purchase*



* Data based on the monthly new business of the MFI interest rate statistics for secured and unsecured loans, excluding overdraft loans. **1** Calculated as the difference between the interest rate with an initial rate fixation of over 5 years and up to 10 years and the interest rate with an initial rate fixation of over 1 year and up to 5 years.

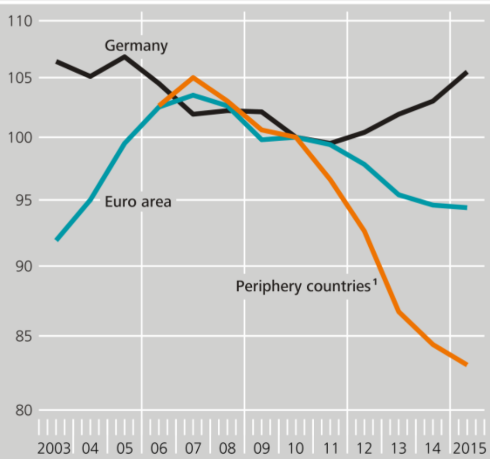
Deutsche Bundesbank 27 Mai 2016, 10:50:39, S3PR0123.Chart

Affordability indicators

The annuity-to-income ratio extends the price-to-income ratio in the sense that it takes into account the interest rate conditions. The question, however, remains what drives the ratio – is it the numerator (e.g. price) or the denominator (e.g. income)? Over and above, what price should be used? Certainly, it should be quality adjusted. But should it relate to apartments in urban markets only, say? The same line of reasoning applies to income. A per household approach appears to be reasonable. But how narrow or wide should it be defined? Last but not least, lending standards differ considerably across countries in terms of loan-to-value ratio, initial rate fixation, life of the loan and so forth.

Price-to-income ratio in the euro area

2010 = 100, log scale

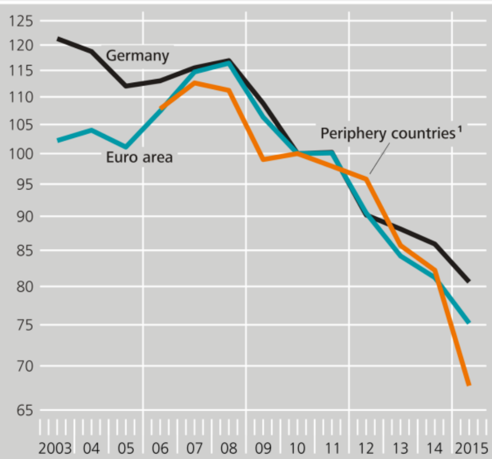


1 Greece, Ireland, Italy, Portugal and Spain.

Deutsche Bundesbank 14 Apr 2016, 15:17:13, S3PR0221.Chart

Annuity-to-income ratio in the euro area

2010 = 100, log scale



1 Greece, Ireland, Italy, Portugal and Spain.

Deutsche Bundesbank 14 Apr 2016, 15:18:24, S3PR0222.Chart

Summary

The system of indicators has to provide a quick and comprehensive overview of the situation on the housing market. Therefore, the set consists of a selection of particularly meaningful variables. Residential property prices in Germany have risen significantly since 2010. Yet, the price movements are also an expression of continued favourable demand conditions as well as the delayed expansion of supply. Despite the low interest rates, housing loans rose only moderately and lending standards did not ease either.

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Data revisions of pension obligations and alternative extrapolation methods: practical issues in bank of Japan's revised flow of funds accounts[1]

Mizuki Kurihara, Naoto Osawa and Yoshiko Sato,
Bank of Japan

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Data Revisions of Pension Obligations and Alternative Extrapolation Methods: Practical Issues in the Bank of Japan's Revised Flow of Funds Accounts

Mizuki Honda, Naoto Osawa and Yoshiko Sato[1]

Abstract

The Bank of Japan (BOJ) has published its revised Flow of Funds Accounts (FFA) conforming to the 2008 SNA in March 2016, distinguishing two types of employment-related pension schemes—defined-benefit (DB) and defined-contribution (DC)—as one of its major pillars of revisions. As a particular interest, the FFA records DB pension obligations as the present discounted value of future pension payments calculated by an actuarial model using a discount rate. On the one hand, this explicit presentation has revealed a linkage between long-term interest rates, a benchmark for a discount rate, and the pension fund balance sheet (and ultimately the corporate balance sheet). On the other hand, a limitation of low frequency source data on pension obligations obtained from corporate annual financial statements poses a practical challenge for statisticians; at most seven quarters of data must rely on estimates, but not actual data, which are subject to substantial revisions, with the current method of not accounting for a sharp declining trend in long-term interest rates induced by BOJ's recent accommodative monetary policy. This paper discusses sensitivities of pension obligations to interest rate changes and alternative extrapolation methods to minimize data revisions of pension obligations by examining forecast errors.

Keywords: defined-benefit pension schemes; actuarial model; discount rate; monetary policy

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Contents

1. Introduction

Since March 2016, the Bank of Japan (BOJ) has published its revised Flow of Funds Accounts (FFA) in accordance with the recommendations of the 2008 SNA (System of National Accounts), making significant improvements in data and methodologies of compiling corporate pensions. First, the BOJ separately records two different types of corporate pension schemes: a defined benefit (DB) scheme and a defined contribution (DC) scheme. In a DB scheme, employers promise employees to provide pensions on an actuarial basis, whereas in a DC scheme pensions paid are limited to the amount of contributions and investment performance of the funds. Second, in a DB scheme, retirement benefit obligations (RBO)[2] are recognized as total pension benefit obligations on an accrual basis and recorded in discounted present value. Third, the actuarial calculation of pension obligations makes it possible to explicitly record the claims of pension funds on pension managers as the assets of corporate pensions and liabilities of pension managers (corporations) in the FFA.

The revision to corporate pensions in the FFA makes it possible to present differences in the two types of pension schemes. Chart 1 shows that, as of the end of Fiscal Year (FY) 2015[3], the value of stocks of pension liabilities under the DB schemes is 128 trillion yen, whereas that for the DC schemes is 8 trillion yen.[4] The share of the DC schemes has remained at a significantly low level, despite its gradual upward trend in recent years. The pension liabilities under the DB schemes have shown a gradual declining trend during the second half of the 2000s, with the exception of a sudden increase in FY2014. This increase reflects a substantial decrease in long-term interest rates in recent years, which has resulted in a decrease in discount rates used to calculate the present discounted value of DB pension liabilities. Note that the two types of pension schemes also differ from each other in asset compositions, as depicted in Chart 2: the DB schemes invest in a wide range of financial assets from safe to risky; DC schemes concentrate on relatively safe assets such as currency and deposits, and investment fund shares.

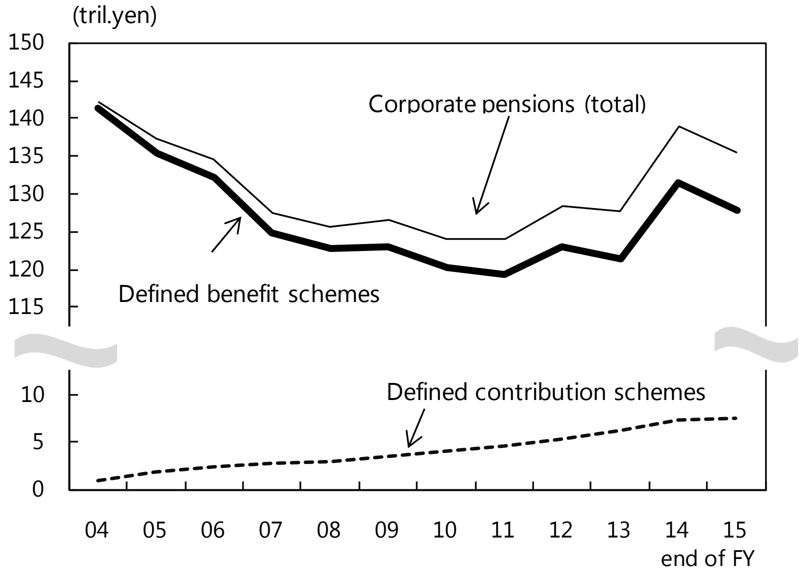
2 The FFA uses “pension entitlements” as the official statistical term for the RBO.

3 Fiscal year starts in Q2 and ends Q1 in the following year.

4 To be precise, pension liabilities under the DB schemes include liabilities of financial derivatives. In this paper, since financial derivatives hold a very small share in the total amount of DB pension liabilities, the term “RBO” is used synonymously with “DB pension liabilities.”

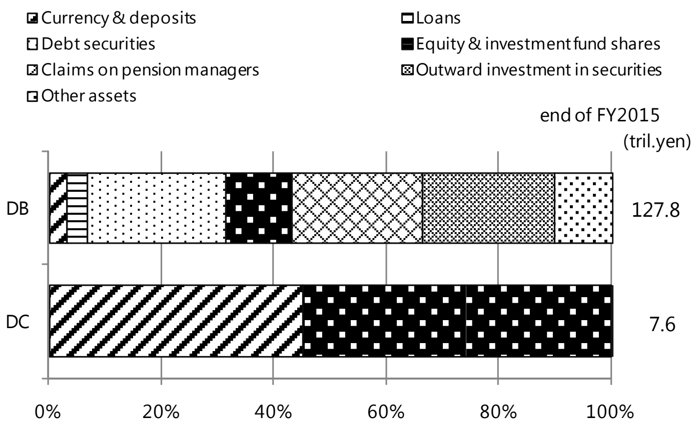
Pension liabilities

Chart 1



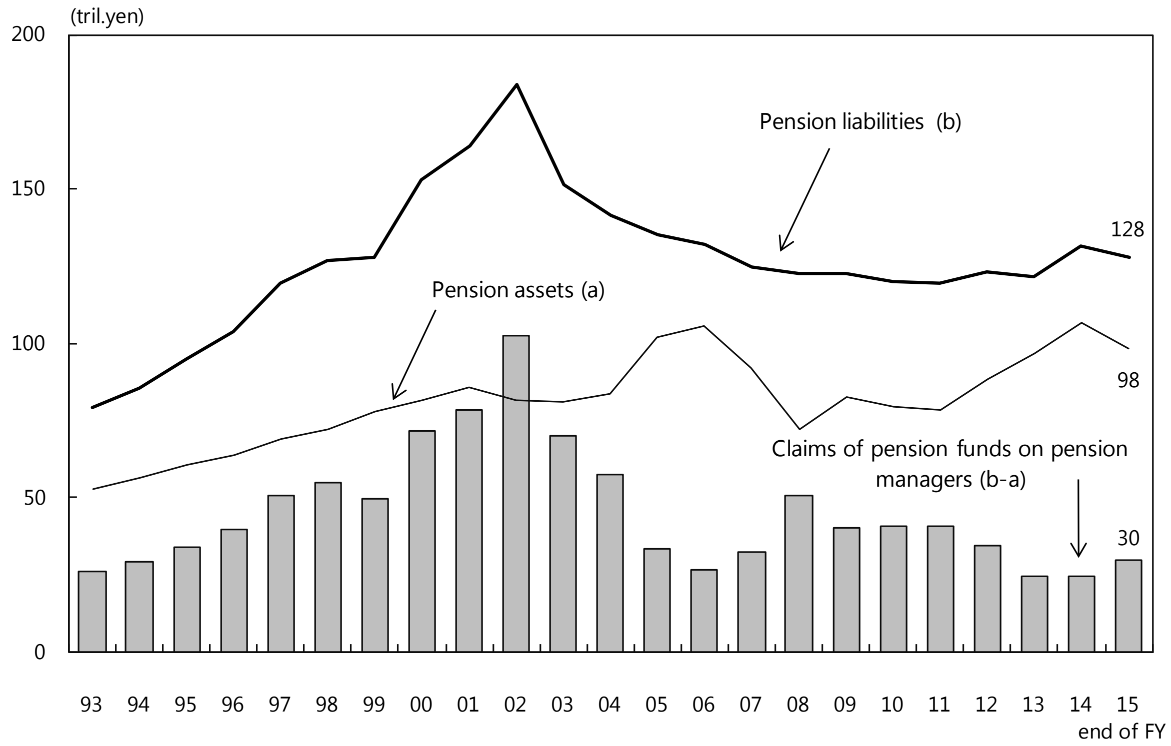
Pension assets

Chart 2



The FFA also reveals the underfunded portion of DB pension schemes. Claims of pension funds on pension managers—derived by deducting DB pension assets from liabilities—peaked at 102 trillion yen at the end of FY2002, as shown in Chart 3. Since then, however, with the retirement of baby boomers causing a decline in pension liabilities and with improved performance of financial markets causing an increase in pension assets in value, they turned to a decreasing trend and reached 30 trillion yen at the end of FY2015.

Claims of pension funds on pension managers (DB schemes) Chart 3



Moreover, this revision to corporate pensions enables users to analyze effects of interest rate changes on RBO. The revised FFA provides in its data a linkage between interest rates and a DB scheme: long-term interest rates would cause changes in discount rates used in the calculation of RBO by individual firms, revising the present discounted value of RBO. In particular, users would be interested in the effects of the interest rate changes on corporate balance sheets through the changes in the balance sheet of DB pension funds, and ultimately on corporate profits. While direct effects would center on the RBO on the liability side of the DB, total effects depend on other factors: interest rate changes may affect the asset side of the DB as well.[5] In the end, the claims of pension funds on pension managers, the difference between assets and

5 For example, a decline in interest rate raises DB pension liabilities via discount rate, but would also raise the value of DB pension assets if induced by lower interest rates, partially offsetting the effect of interest rates on the liabilities. It is even more complicated: taking into account differences in composition of assets and maturity mismatches between assets and liabilities, interest rate changes would affect corporate balance sheets through multiple channels.

liabilities in the DB balance sheet, would be a more appropriate indicator to examine effects on corporate profits.

While bringing about benefits for users to be able to analyze a DB scheme, the revisions of the FFA have posed a serious challenge to statisticians due to slow timeliness and low frequency of source data: raw data to calculate the RBO are disclosed only annually in financial statements of individual firms and thus statisticians must extrapolate data for periods in which actual data have not yet been available. Naturally, ensuring the accuracy of estimated figures is a serious issue for statisticians.

In fact, the magnitude of estimation errors turns out to be quite large, with the current extrapolation method. An estimation error of RBO comes out to be around 12 trillion yen, or 9% for FY2014 – an estimated level of 118 trillion yen of RBO has been revised up to be an actual level of 130 trillion yen. The current extrapolation method estimates the amount of claims of pension funds on pension managers as 13 trillion yen, while the actual figure turns out to be 25 trillion yen. The magnitude of this estimation error accounts for 46% of the claims of pension funds on pension managers and 1.5% of the net asset value of non-financial corporations.

This paper aims to present an alternative extrapolation method of RBO in the DB pension scheme, by taking into account interest rate changes and to examine the extent to which the alternative method would improve estimated figures. The rest of the paper is organized as follows. Section 2 explains data and the current extrapolation method of RBO, and shows the differences between actual and estimated figures of RBO in a time series from 2005 to 2015. Section 3 presents an alternative method that takes into account the effects of interest rate changes. Section 4 discusses the robustness of the alternative method and explores possibilities of further improvement compared with the current method. Section 5 concludes the paper.

2. Data and Current Estimation Method

2.1. Data and Current Compilation Method for Actual Value of RBO[6]

The FFA compiles actual value for stocks of RBO based on retirement benefit obligations disclosed in annual financial statements by individual firms. Despite quite large data coverage available from more than 3,000 firms—mainly but not limited to listed firms—aggregated figures for the pension liabilities do not represent total economy, mainly because many small and mid-size firms are exempt from disclosing pension liabilities. As a result, to calculate economy-wide DB pension liabilities, the FFA grosses up the aggregated figures from available microdata to the economy total by making use of available data on economy-wide pension assets disclosed by pension asset management companies.

The FFA compiles flows/transactions of RBO as the sum of service costs and interest costs net of pension benefits paid out. The data come from two sources: 1) annual financial statements of individual firms disclose actual value for service costs and interest costs, which are grossed up by the same proportion as the stock value of RBO, and 2) economy-wide pension funds provide actual value for pension benefits paid out annually.

Note that all data to compile stocks and flows of RBO are at annual frequency and available only with a long lag. As a result, the FFA, which compiles and publishes quarterly data, needs to extrapolate the value of RBO for quarters in which actual data have not yet been available, with the maximum of seven quarters. For example, for Q4 2016, preliminary figures are to be released in March 2017 (Q1 2017), and the latest actual value of RBO available as source data is only for FY2014 (ending in Q1 2015). It means that the FFA needs to reasonably extrapolate stocks and flows of RBO for the quarters from Q2 2015 to Q4 2016.

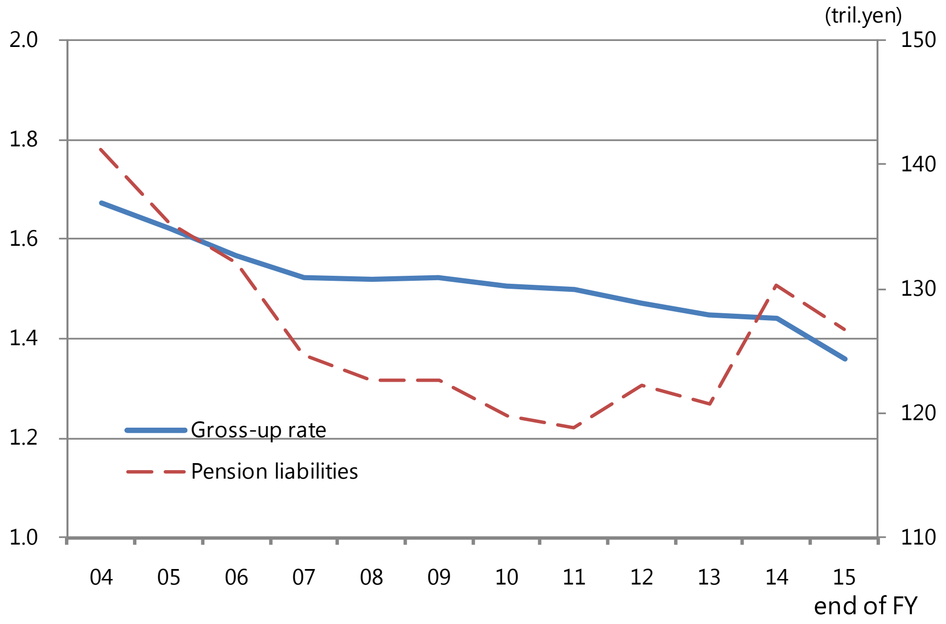
Also note that in the current estimation method, the estimated actual value of RBO conceptually consists of two elements: pension liabilities aggregated from more than 3,000 sample firms and the gross-up rate of sample to economy-wide pension liabilities. The accuracy of the extrapolated value of RBO, therefore, depends on the accuracy of the extrapolated value of those two elements. Historically, as Chart 4 shows the gross-up rate remains around 1.5 without wide fluctuations, whereas the

[6] The Annex drawing on Bank of Japan (2016) describes in detail the current estimation method for both stocks and flows of DB pension liabilities.

pension liabilities aggregated from the sample fluctuate relatively widely. Based on this observation, this paper focuses on an alternative extrapolation method only for the aggregated value of pension liabilities in the sample firms, which is discussed in Section 3. But, first, the next subsection takes up the current extrapolation method and its challenges.

Gross-up rate and pension liabilities

Chart 4



2.2. Current Extrapolation Method for Estimated Value of RBO

The FFA currently uses an extrapolation method to estimate flows and stocks of RBO, as explained below. The current method decides the value of flows for each quarter, which is assumed to be exactly the same as in the previous periods, and then derives the current quarter-end stock value by adding the quarter flow value to the previous quarter-end stock value.[7] For example, if the actual value of quarterly flows in FY2014 is 0.4 trillion yen, the extrapolated value in FY2015 is also 0.4 trillion yen. If the actual stock value of RBO in FY2014 ending in Q1 2015 is 100 trillion yen, that in Q2 2015 would be 100.4 trillion, and amounts to 102.8 trillion yen in Q4 2016.

7 Except for lump-sum payment upon retirement as part of pension benefits—since no information regarding obvious seasonality exists in source data—annual data are by and large equally divided into four to derive actual value of quarterly data.

Note that the current method takes into account only accumulation of flows when estimating value of stocks. Reconciliations between stocks and flows, which account mostly for changes in the value of stocks due to interest rate and discount rate fluctuations and thus might greatly affect the value of RBO stocks, are implicitly assumed to be zero in the extrapolation periods.

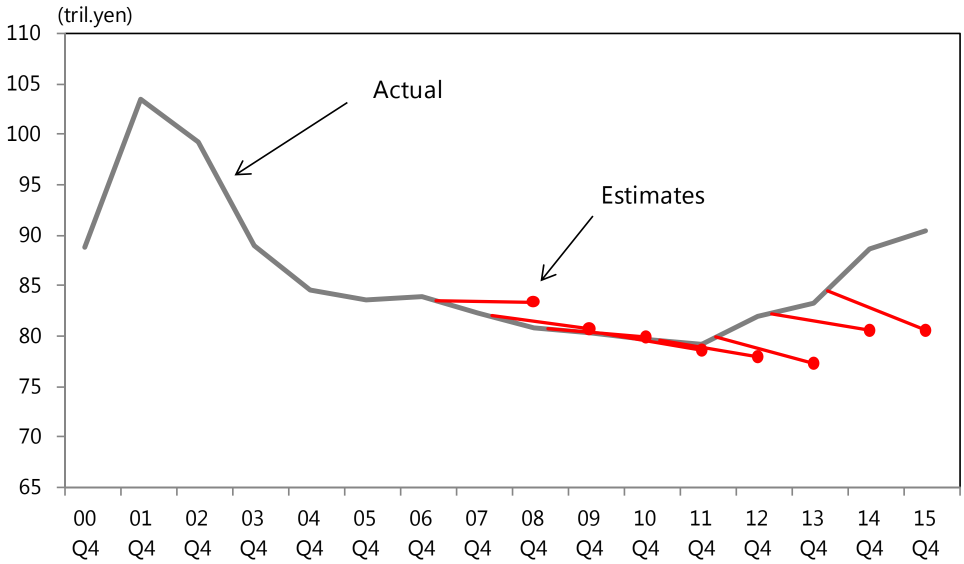
2.3. Estimation Errors

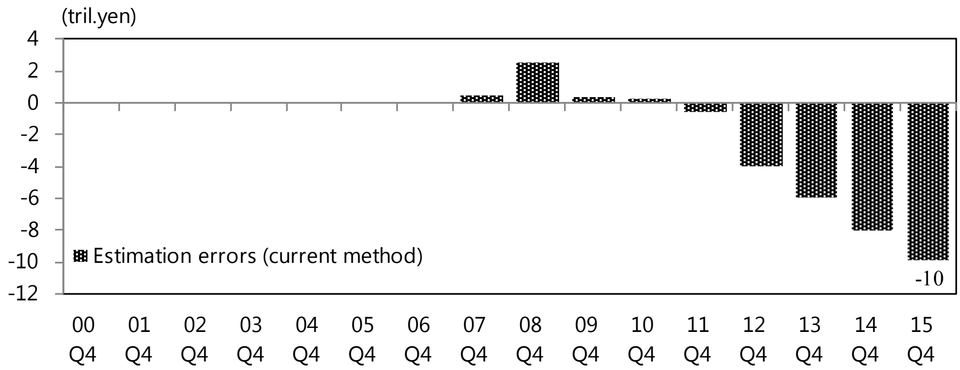
Current methods of estimating flows and stocks of RBO are considered reasonable under circumstances in which discount rates do not substantially change. In theory, the value of RBO, employees' pension entitlements, depends on factors such as the rate of increase in wages, working periods, turnover rates, and discount rates. In addition, institutional changes such as retirement benefit rules affect the value of RBO. Among the factors mentioned above, except for discount rates—which are determined based on long-term interest rates—other factors regarding employment are considered to be relatively stable in the short term. Institutional change—which usually require painstaking negotiation processes between employers and employees—would not take place in the short term. In fact, periods from the late 2000s through the early 2010s have not observed large fluctuations of long-term interest rates or major institutional changes.

Nonetheless, the current extrapolation method has generated substantial estimation errors—the differences between actual and estimated value of RBO—which widen sharply in times of large interest rate fluctuations. Chart 5 in the upper panel shows the actual stock value of RBO every fourth quarter until Q4 2015 in a solid black line, and the values of preliminary estimates are in red lines under the current extrapolation method. The current method extrapolates estimates, starting from the actual stock value of Q1 every year, by adding the value of the same quarter flows of the previous year—which are the latest values available at the time of estimation—to the previous quarter-end stock value. Since the actual value is only available seven quarters after the relevant Q1, the current method shows the extrapolated values from Q1 of any particular year to Q4 of the following year. For example, in deriving the stock value in Q4 2015, the current method takes the stock value in Q1 2014 and adds the quarter flow in the previous year to the previous quarter-end stock value until Q4 2015. Chart 5 in the lower panel shows estimation errors between the actual and estimated values, indicating a large overestimate of 2.9 trillion yen in Q4 2008 and widening large underestimates for the last few years , reaching 10 trillion yen in Q4 2015.

Current extrapolation method and estimation errors

Chart 5





The improvement of methodology for estimating RBO stocks is a vital issue in terms of magnitude as well as length of periods. Underestimates of RBO generate the same amount of underestimates of assets (pension entitlements) in the households' balance sheet and the same amount of underestimates of liabilities (claims of pension funds on pension managers) in the corporations' balance sheets. At the end of FY2015, claims of pension funds on pension managers were 30 trillion yen. The estimation error of 10 trillion yen means that the actual value of the claims of pension funds on pension managers in the corporations' balance sheet is underestimated by 33%. Note that if the same extrapolation estimate extends for seven consecutive quarters at maximum, the estimation errors would accumulate to nearly double at the end of the seventh quarter.

3. Alternative Extrapolation Method Considering Interest Rate Changes

This section presents an alternative extrapolation method that takes into account the effects of interest rate changes by examining two steps: the link between interest rate and discount rate, and the link between discount rate and RBO. Note that data used in the analysis are all aggregated levels from individual firms' micro data. In particular, discount rates are computed as a weighted average of the ratio of interest costs to RBO at the individual firm level.

3.1. Link between Interest Rates and Discount Rates

Accounting standards for retirement benefits in Japan stipulate that the discount rate applied to the calculation of the present value is the yield equivalent to risk-free bonds such as JGBs (Japan's Government Bonds), government agency bonds and high-quality corporate bonds; all reflect the expected payment periods of each pension.

Chart 6 depicts the time series of discount rate and long-term interest rate from FY2004 to FY2015. Long-term interest rate is a newly issued ten-year government bond yield at the end-date of each fiscal year. Looking at the levels, the discount rate has been higher than the long-term interest rate, running by and large in parallel throughout the time periods. A closer observation at the difference from a previous period reveals that discount rate has been influenced by long-term interest rates with a two year lag.

Long-term interest rate and discount rate

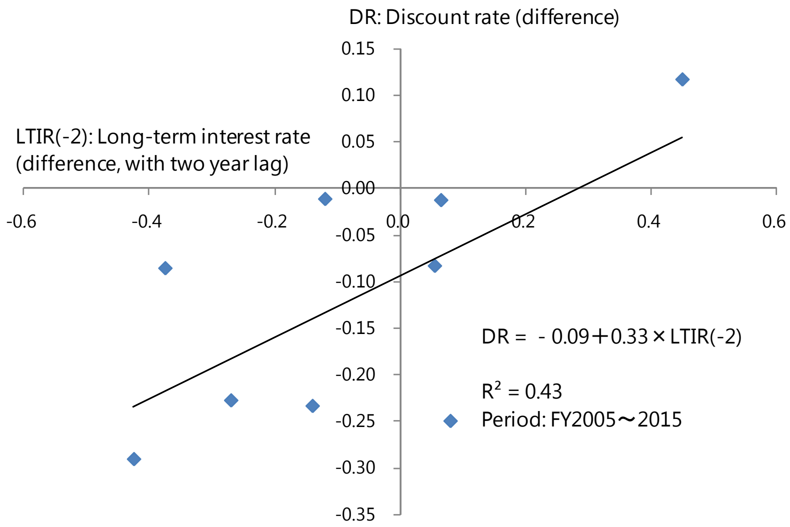
Chart 6

The two year lag may partly be attributable to the so called "10% rule" of the accounting practice in Japan. Accounting standards allow firms to maintain the existing discount rates if the RBO calculated by using the new discount rate at the year-end does not change by more than 10% of the value calculated at the previous year-end discount rate.

Regressing the year-on-year difference of the discount rate on that of the long-term interest rate with two year lag yields the coefficient of around 0.3 for the period from FY2005 to FY2015, as shown in Chart 7. This result implies that the elasticity of the discount rate to long-term interest rates is around 0.3: if long-term interest rates decline by 1% point from the previous year, the discount rate will fall by 0.3% points two years later.

Elasticity of discount rate to long-term interest rate

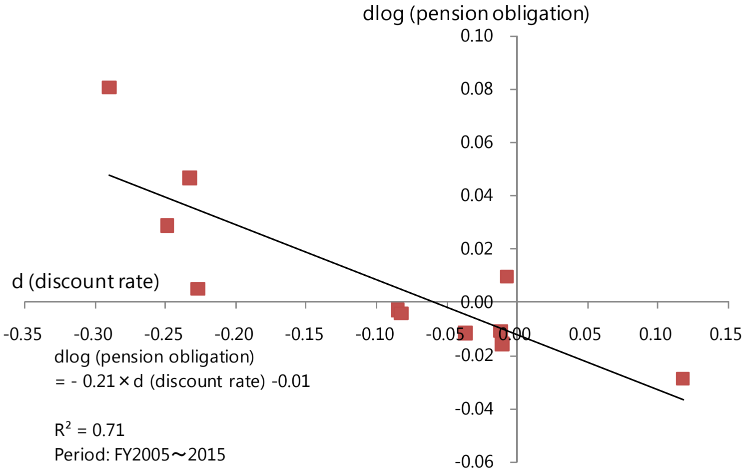
Chart 7



3.2. Link Between Discount Rates and RBO

Unlike the relationship between long-term interest rates and discount rates, no obvious lags and leads relationship are observed between discount rates and RBO. Regressing the difference of RBO in logarithm on the year-on-year difference of the discount rate yields a coefficient of around 0.21 for the same time period between FY2005 and FY2015, as shown in Chart 8. This result implies that the elasticity of RBO to the discount rate is around 0.21: a 1% point decline of discount rate leads to an increase of RBO by 21%. Combining the results of the two links together implies that a 1% point decline in long-term interest rates induces an increase of RBO by 6.3% (= 0.3 x 0.21).

Elasticity of pension obligation to discount rate	Chart 8



3.3. Alternative Extrapolation Method for Estimated Value of RBO

Building on the two links above among long-term interest rates, discount rates, and RBO, an alternative extrapolation method attempts to estimate the stock value of RBO by taking into account the effects of interest rate changes. Note that this alternative method aims to estimate the stock value directly while maintaining the same assumption of the constant value of flows unchanged during the estimation periods. It follows that, compared with the current method of assuming zero value of reconciliations, an alternative method generates a non-zero value of reconciliations.

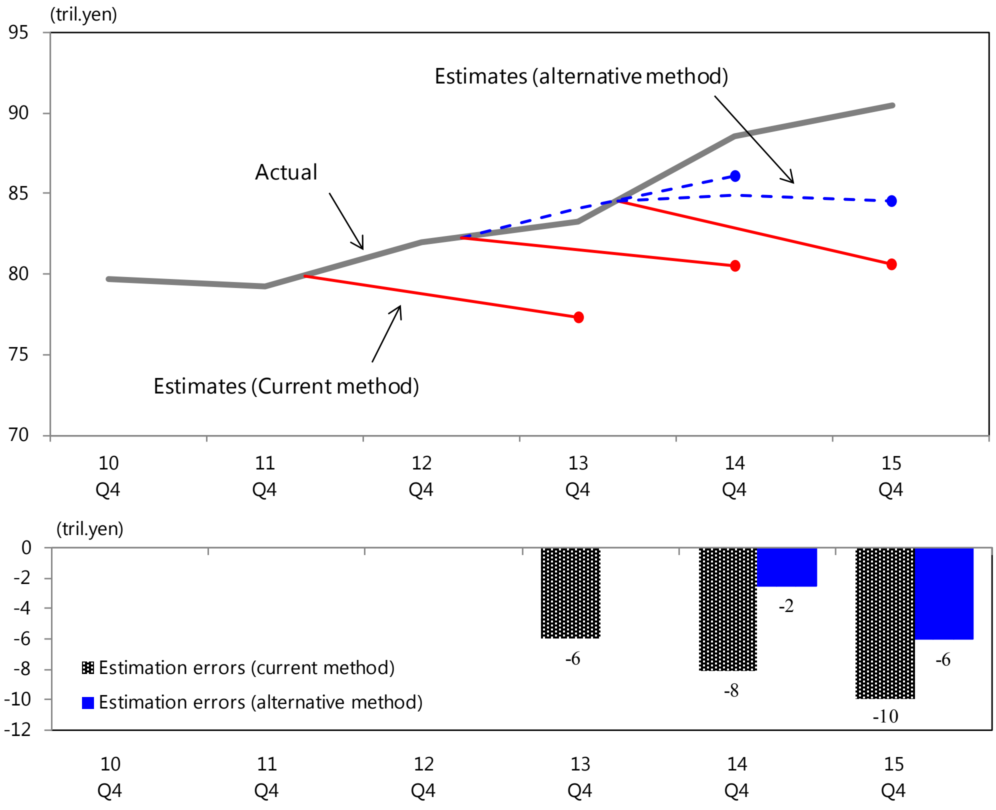
Chart 9 in the upper panel shows the actual stock value of RBO until Q4 2015 in a solid black line, with estimates by the alternative extrapolation method in a blue dotted line, and estimates by the current method in a red line, as calculated in Chart 5. The chart depicts estimates over seven quarters in blue dotted lines by the alternative extrapolation method for the two overlapping time periods: one starting from the actual stock value of Q1 2013 and ending in Q4 2014; and the other starting from the actual stock value of Q1 2014 and ending in Q4 2015. The alternative extrapolation method derives estimates in three steps: first, estimating the difference of the discount rate by multiplying the difference of long-term interest rates with the relevant estimated elasticity; second, estimating the difference of RBO by multiplying the difference of the estimated discount rate with the relevant estimated elasticity; and finally, estimating the value of RBO by adding the estimated difference value of RBO onto the previous period, starting the actual value of RBO of Q1.

The elasticities used to estimate for time periods ending in Q4 2014 and ending in Q4 2015 respectively differ due to different sample periods: the elasticities used to extrapolate for the time period ending in Q4 2014 are estimated by the sample from FY2005 to FY2012, the latest data available as of Q1 2013; and the elasticity of discount rate to long-term interest rate is 0.29 and that of RBO to discount rate is 0.20. Similarly, the elasticities used to extrapolate for the time period ending in Q4 2015 are estimated by the sample from FY2005 to FY2013, the latest data available as of Q1 2014; and the elasticity of discount rate to long-term interest rate is 0.34 and that of RBO to discount rate is 0.15. Note that since the alternative method uses the long-term interest rate with a two-year lag of the discount rate, the difference of the long-term interest rate can be used every year even during the extrapolation time period. As a result, the estimates in the blue dotted lines in Chart 9 in the upper panel are not linear, unlike those in the red lines.

Compared with estimates by the current method in red lines—which have a downward trend reflecting decreasing flows in recent years—the alternative method virtually reflects the increasing value of RBO due to recent declines of long-term interest rates. For Q4 2014 and Q4 2015, the accuracy of estimates clearly improves in terms of estimation errors measured as differences between the actual and the estimated values. The estimation error substantially lessens from 8 trillion yen to 2 trillion yen for Q4 2014 and from 10 to 6 for Q4 2015, suggesting that the alternative extrapolation method that considers interest rate changes performs better than the current method.

Alternative extrapolation method and estimation errors

Chart 9



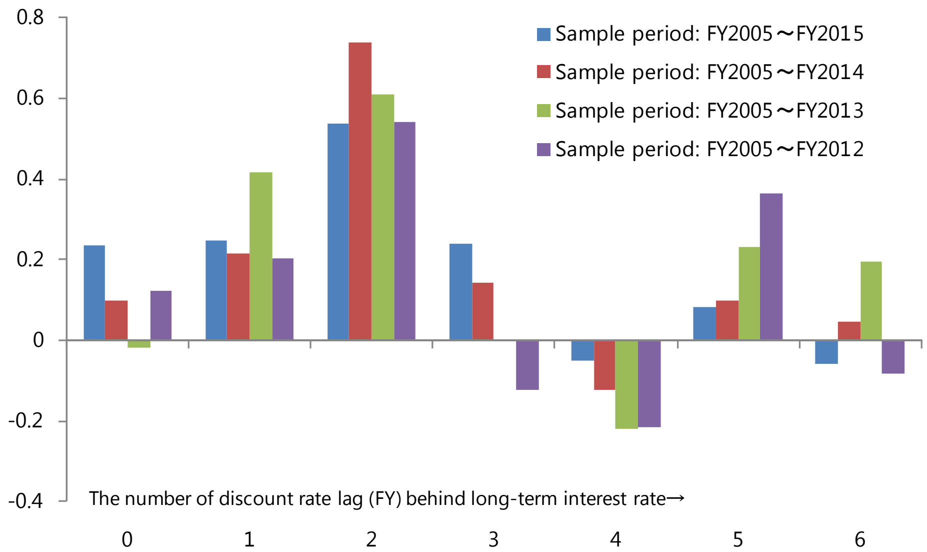
4. Discussion

The analyses in the previous section demonstrate that the accuracy of estimation improves if the alternative method takes into account the declining trend in long-term interest rates. Nonetheless, attention should be paid to the robustness of this alternative method in terms of the following issues. First, the sample size of 10 observations in a time series is small, and data accumulation is highly desirable. Second, the alternative method has been examined only with aggregated data. Using micro data on individual firms in a panel analysis would reinforce elasticity estimates. Third, the length of the lag of two years may not be robust enough. When there is a large increase or decrease of long-term interest rates—which will cause it to exceed the 10% rule of RBO—the lag length might well be shorter than two years. In fact, Chart 10 shows cross correlation coefficients between the year-on-year difference of the discount rate and that of long-term interest rate for four sets of observations in different time periods, indicating that in all cases the highest correlation is two years

– the discount rate lags two years behind long-term interest rates. Nonetheless, the distribution of correlation coefficients around two years varies among sample periods, with the highest concentration for sample periods of FY 2005-FY2014 and the lowest concentration for FY2005-FY2013, which may indicate that a one-year lag is nearly as dominant as a two-year lag. This sensitivity of correlation coefficients to the time periods would necessitate continuous examination regarding the lag length as time series data accumulate.

Cross correlation coefficients

Chart 10



Based on these observations above, one extrapolation method does not necessarily surpass the other regarding the accuracy of estimation and robustness when extrapolating estimated value of RBO in the FFA. On the one hand, the current method—accumulating flow values on the previous quarter-end stock—may run risks of reducing confidence in the FFA figures, if continuing to show the similar size of substantial estimation errors for recent periods. On the other hand, the alternative method improves estimation accuracy for the given small sample size, but contains estimation uncertainties significant enough not to be yet applied to the compilation of the FFA.

5. Conclusion

This paper presents the alternative extrapolation method of RBO in the DB pension scheme, which takes into account the effects of interest rate changes and examines the extent to which the alternative method would improve estimated figures in the FFA. While in theory the alternative method would improve the accuracy of estimates, in practice it still lacks robustness, should it be adopted by the FFA, partly because of the small number of sample.

This paper offers two implications from a statistical compilation point of view. First, as the alternative method is not robust enough at the moment, the FFA continues to use the current method but to re-examine estimates as more data observations accumulate. Second, even without improving the accuracy of estimates, statisticians need to explicitly explain source data and compilation methods to the public so that statistics users will be able to make an educated guess regarding directions of revisions in the data.

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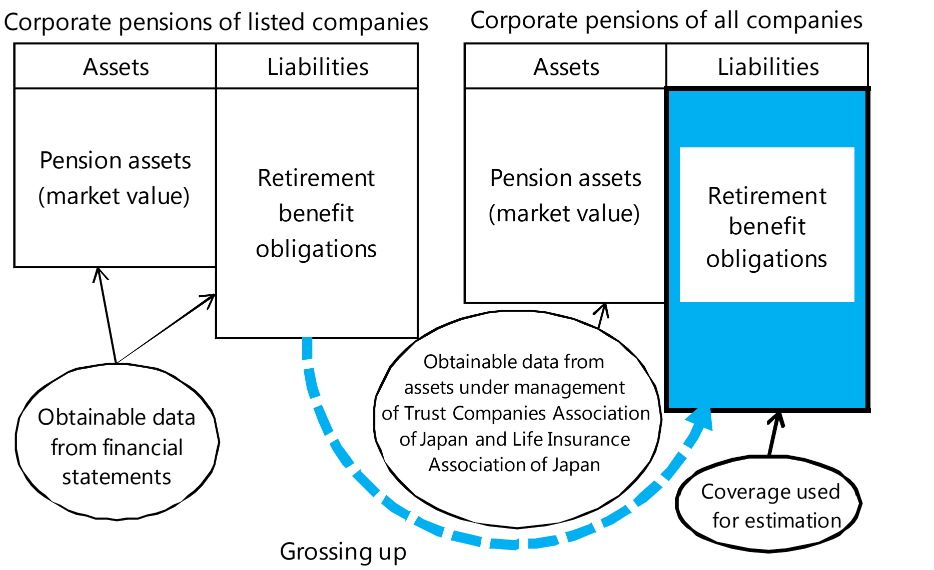
Annex : Compilation Methodologies for Stocks and Flows of DB Pension Liabilities

To compile the economy-wide DB pension liabilities, the FFA aggregates figures for pension liabilities of more than 3,000 mainly listed firms and grosses up to the total population in the economy by using pension assets as a benchmark.



The aggregated figure for pension assets of all companies is obtainable from asset management associations (trust companies and life insurance companies). The gross-up rate can be calculated by dividing the figure with the aggregates of pension assets of our more than 3,000 sample firms. The RBO of all companies is then derived by multiplying the gross-up rate with the aggregated amount of RBO of the sample.

$$\left(\begin{array}{c}\text{Retirement benefit obligations}\\ \text{of all companies}\end{array}\right) = \frac{\text{Total assets under management of all companies (market value)}}{\text{Total pension assets of listed companies (market value)}} \times \left(\begin{array}{c}\text{Retirement benefit}\\ \text{obligations of listed companies}\end{array}\right)$$

Claims of pension funds on pension managers are calculated as the difference between pension assets and liabilities.

$$\left(\begin{array}{c}\text{Claims of pension funds}\\ \text{on pension managers}\end{array}\right) = \left(\begin{array}{c}\text{Pension entitlements}\\ \text{of all companies}\end{array}\right) - \left(\begin{array}{c}\text{Pension assets}\\ \text{of all companies}\end{array}\right)$$

Transaction flow is the amount of pension entitlement employees earn through their service in a relevant period (service cost) plus money earned by investing their pension assets (interest cost) minus pension paid to pensioners in the period (actual pension benefits). The service cost and interest cost are obtained from our sample firms and grossed up with the same rate used in RBO.

$$(\text{Transaction flow}) = \left\{ \begin{pmatrix} \text{service cost} \\ \text{of listed companies} \end{pmatrix} + \begin{pmatrix} \text{Interest cost} \\ \text{of listed companies} \end{pmatrix} \right\}$$

$$\times \frac{\text{Total assets under management of all companies (market value)}}{\text{Total pension assets of listed companies (market value)}} -$$

$$\begin{pmatrix} \text{Actual} \\ \text{pension benefits} \end{pmatrix}$$

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Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

The compilation and analysis of Chinese government balance sheet[1]

Guihuan Zheng and Yue Dan,
People's Bank of China

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

The Compilation and Analysis of Chinese Government Balance Sheet[1]

Abstract

To maintain economical and financial stability, it is of great importance for the government to compile balance sheet, provide accurate data and detailed accounting information, and assess government operational risk. Firstly, this paper discussed both theoretical and practical problems while compiling government balance sheet. Secondly, based on China's current situation and international accounting rules, this paper drew up the government balance sheet in 2010-2014. Finally, this paper analysed the situation of Chinese government assets and liabilities.

Keywords: government balance sheet, compilation, analysis

[1] This research is finished by the research team of "Theoretical Issue and Policy Implications of Accounting for Assets and Liabilities of the Government".
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Contents

1. Introduction

To maintain economical and financial stability, it is of great importance for the government to compile balance sheet, provide accurate data and complete information, and assess government operational risk. From the current situation, there have been many researches on Chinese government balance sheet, but the theoretical basis and accounting system of the government balance sheet are incomplete. It is of practical significance to form a standardized balance-sheet accounting system that conforms to both international standards and China's statistic accounting status, and will be able to provide theoretical guidance for compiling government balance sheets.

The compilation of government balance sheet is a huge and complicated project, which requires thorough studies on accounting principles. Also, the particularity and complexity of China's national conditions greatly increase the difficulty.

Firstly, the paper discussed and analysed both theoretical and practical problems, including definition of government sector, classification of assets and liabilities, verification of accounting principles, connection of accounting theory system and SNA, etc. Secondly, after studying accounting principle of Chinese government balance sheet, it used accounting and statistic statement data to compile for Chinese government balance sheet in 2010-2014, which followed both international standards and China's statistic accounting status. Finally, it analysed Chinese government assets and liabilities based on time series data over the five years.

Compared with other relative domestic researches, the table compiled by the research group shows the following advantages: it follows international standards, and it uses more detailed statement data and performs rigorous accounting on theoretical basis. At the same time, there are still some gaps with international accounting standards: not all accounting statements are using accrual basis, resulting in a relatively weak database; and it lacks detailed survey data of non-financial assets.

2. The compilation and application situation of government balance sheet in domestic and overseas

From the current situation, the official statistics sector of some developed countries regularly publish their government balance sheet, such as Canada, the United States, the United Kingdom, Japan, Australia and New Zealand. These countries establish a complete system of national economic accounting according to the SNA guidelines, and regularly calculate the government assets and liabilities in broad sense. It helps to comprehensively understand the situations, such as government's fiscal health, government debt ratio, financing capability, financing costs, government debt risk and currency risk, and national debt sustainability problems. Eurostat combines SNA system with actual situation of EU countries to design the European System of Accounts (ESA). UK, France, Germany and other EU countries develop accounting system of government assets and liabilities under SNA. It aims to understand the situation of government assets and liabilities, and control government operational risk by keeping track of the member countries' deficits and liabilities. It also helps to analyse monetary policies in different member countries.

There are also several domestic researches about government balance sheets: the World Bank and China Ministry of Finance once studied the problem of government potential pension liability; Statistics and Analysis Department of PBoC, Chinese Academy of Fiscal Sciences, and National Bureau of Statistics have also conducted related topics; many scholars have conducted researches on that, including theoretical basis, statement compilation and application. In particular, research groups led by Jun Ma, Yuanzheng Cao and Yang Li respectively, have conducted a series of important studies about government balance sheet, and announced the results in 2012. It is the first time to publish Chinese government balance sheet and apply it in policy analysis in domestic.

The above researches make an aggressive exploration on Chinese government balance sheet, and major breakthroughs are achieved in compilation and application. But the theoretical basis and accounting system of the government balance sheet are incomplete. It is mainly manifested in the lack of unified accounting principles. Also, the definitions of institutions, assets, instruments and valuation are not unified and clear. Especially the government balance sheet is unable to reflect all of the assets, hidden liabilities and contingent liabilities, and it lacks foresight. For example, it's worth thinking about how to classify the assets under SNA standards and define government sector with Chinese characteristics.

Therefore, the previous researches are calculation and estimation based on existing statements, rather than theoretical accounting. Accounting should be based on strict accounting principles, involving data structure and classification. And accounting results are related which should be real, accurate and comparable. But calculation and estimation are different from accounting. They are mainly based on mathematical calculation methods, and involve a lot of subjective judgments. Due to the lack of theoretical basis, different calculation methods will lead to great differences in results. In addition, there is a problem that calculating basis and data structure do not match the SNA account system.

3. The theoretical and practical problems of Chinese government assets and liabilities accounting

Accounting principles are the key issues to be studied when compiling government balance sheet, in order to achieve a comprehensive accounting and avoid duplicates. Firstly, determine the definition and connotation of government sector so that the government balance sheet can not only fully reflect the scale of government assets, but also be in line with international standards. Secondly, determine the scopes and classification of assets and liabilities. Thirdly, determine the principles of accounting, valuation and consolidation.

The accounting principles of government balance sheet are based on macroeconomics theories and public finance theories. Concepts such as classification of institutions, accounting scope of assets and liabilities, principle of valuation and data consolidation are all generated under public finance theory. An accounting theory system is internationally formed on the latest edition of *Government Finance Statistics Manual 2014* launched by IMF, which has complete economic theoretical foundation and rigorous accounting method. However, there is something quite different from abroad: definition of Chinese government sector, scopes of the assets and liabilities, their impacts on economic and financial stability.

3.1 Definition of Chinese government sector

First of all, a rigorous scientific definition of the government sector is necessary to accurately control the scale of government liabilities. The definition is based on the national economic accounting framework of the United Nations, and combines international experience with China's national conditions. It also follows the principle that government obligations should match with the resources at its disposal. So the accounting results of government liabilities could not only conform to the actual situation of China, but also be in line with the international standards.

In general, the government sectors are consisted of institutions whose main activity is to perform government function. The key lies in the delineation of government department and economy department. It's worth thinking about the following questions: is it the government in narrow sense or broad sense, or the public sector in more extensive sense or the comprehensive government? What are their subsectors made up of? How are they classified and what are the standards and purposes? In this regard, public institutions and social organizations are of wide ranges. It should be discussed which of them to be included, what the criterion is, and which level of government sector they should be included in. Large state-owned economy is another problem to be consider, whose resources are all at the disposal of the government. It needs to determine whether state-owned enterprises should be included in government sector and what the criterion is.

3.2 Classification of assets and liabilities

In general, assets can be divided into two parts: non-financial assets and financial assets. All of the liabilities are financial liabilities.

For assets, according to China's Constitution, natural resources belong to the state or the collective. Since it is impossible to take all resources into account, a criterion is needed to help determine which resources to be considered as government assets. For liabilities, the scope and classification of liabilities should be based on China's reality. For example, with the rapid development of current financial markets, financial products are innovating and boundaries between financial instruments are increasingly vague. So it's worth thinking about how to classify these innovative instruments.

3.3 Accounting principles

How to determine accounting principles, which include accounting basis, valuation methods and consolidation principles, is the key problem in the process of compiling the balance sheet. It will directly affect the data quality, and is one of the most difficult parts in the research.

The accounting bases of government balance sheet mainly include cash basis and accrual basis. In comparison, accrual basis can be more accurate when measuring the scale of government assets and liabilities. It also reveals the hidden liabilities under cash basis, and clearly shows the operating costs and correspondences of the government. However, Chinese government use cash-basis for budget accounting all along. So there are some difficulties in converting cash basis to accrual basis. Therefore, both accounting principles and data availability should be taken into account when compiling government balance sheet. For some institutions with small asset scales, weak influences and high adjustment costs, an overall cost-benefit analysis is needed when deciding whether to change accounting basis simultaneously or adjust it in the consolidated statements.

The valuation methods include historical cost, replacement cost, net realizable value, present value, fair value and other techniques. There are a great number of difficult problems to be studied in the evaluation determination. For cultural heritages, tourism assets, intangible assets, and contingent liabilities, simple valuation method may lead to distortions in the value and advanced valuation methods need to be introduced, due to the lack of an active trading market and the difficulty in assessing historical and cultural value.

The number of China's government sector is huge, and the functions and transactions are complex. So the following problems need to be solved when determining the consolidation principles. The first is how to determine the levels of consolidation. For example, state-owned enterprises possess huge state-owned assets, but how can they reflect in the consolidated statements of government balance sheet. The second is how to ensure the consistency of accounting and accounts.

3.4 Connection of Government-balance-sheet accounting system and SNA

The compilation of China government balance sheet is based on the basic framework of national economic accounting. It's worth thinking about how to link with SNA in aspects such as accounting principles, accounting methods, data sources and accounting results. Following technical issues should be focused on:

1. Standards matching. There are some differences between the government financial statement rules which are defined in GFSM and the SNA.

2. Data matching. Information in statistics, accounting, and business field should be treated under the principles of national economic accounting and relative accounting rules, in order to ensure the data sources in government balance sheet and national economic accounting are consistent.

3. Accounting results matching. The accounting results and existing data of national economic accounting should be consistent, so that the flow and stock accounting of national economic accounting are unified.

4. The framework of Chinese government balance sheet

4.1 Bases and standards

It combines international standards with China's actual situation, also refers to the practices of other countries.

The internationally recognized standards for government balance sheet are *System of National Accounts 2008* (SNA2008) formulated by the United Nations and other organizations, and *Government Finance Statistics Manual 2014* published by International Monetary Fund (IMF). In the aspect of government balance sheet compilation, the main contents of these two international standards are the followings: definition and classification of government sector and instruments, accounting methods for stock and flow, and sample tables that clearly reflect the accounting results.

Internationally accepted tables are adopted. The main line on the main table shows the agents, which are government sector; the column shows the subjects: government assets, liabilities and balancing items. Among them, assets are divided into non-financial assets and financial assets. According to the international prevailing guidelines, only financial liabilities are listed in liability items. Balance items include net assets and net financial assets.

4.2 Accounting scope and classification of government sector

The compilation of the government balance sheet requires clear definition of the government sector scope. It is generally divided into three levels: government sector in narrow sense, in broad sense and public sector.

Government sector in narrow sense, namely, the administrative sector, include the central government sector, local government sector, national social security fund, and national social insurance fund.

Government sector in broad sense consist of the above sector and government-controlled non-profit organizations. The non-profit organizations in China mainly include the government-controlled public institutions and associations.

Public sector is composed of the government sector in broad sense and public companies. Public companies generally refer to the government-controlled enterprises, including public non-financial institutions (state-owned enterprises) and public financial institutions (including the central bank, state-owned policy and commercial finance companies).

4.3 Accounting scope and classification of assets and liabilities

Assets are generally divided into two parts: non-financial assets and financial assets. Non-financial assets consist of fixed assets, inventory, valuables and non-produced assets. The classifications are in line with international standards. Considering the specialty of the accounting system of administrative institutions and characteristics of the government assets in China, two sub-items – "public infrastructure and public infrastructure construction in progress" are added in the "fixed assets".

Financial assets include reserve assets, currency and deposits, debt securities, loans and loans of financial products, shares and other equity, insurance technical reserves, financial derivatives and employee stock options, other receivables / payables, other financial assets. The classification of financial liabilities is the same as financial assets.

5. The compilation of the Chinese government balance sheet

5.1 Data source

Data of the government balance sheet is mainly from accounting and statistical statements, except for some non-financial assets. A number of surveys are carried out in order to supplement the information of the basic stock data.

5.2 Valuation of non-financial assets

For non-financial assets, house, public infrastructure, public infrastructure construction in progress, land resources are revaluated respectively by different methods. Other non-financial assets, such as machinery and equipment, are evaluated by their net book values using accounting and statistic statements.

5.3 Compilation of balance sheet

After supplements of basic data using survey data or estimation, tables are drawn out in different levels through decomposition, classification, consolidation and netting method. Then assets and liabilities of different government levels are showed in international statement form. The results are present in graph 1.

First is to coordinate different accounting systems. The accounting systems are different in different institutions of the Chinese government. The administrative institutions use cash-basis accounting while some of the state-owned enterprises and non-profit organizations use accrual-basis accounting. The differences in accounting standards lead to inconsistency of initial data, so adjustments are required.

Second is to coordinate different classifications of assets and liabilities. The initial data of the balance sheet comes from statements based on accounting standards. And its assets and liabilities items are classified according to the liquidity, such as current assets, long-term investments, fixed assets, intangible assets and deferred assets. But the government balance sheet is compiled under the accounting principles of the new national economic accounting system. The main line on the main table shows the agents, which are government subsectors; the column shows the subjects of assets and liabilities, which are divided by function. So the former items need to be reclassified under the standards of national economic accounting system.

6. The analysis of Chinese government balance sheet

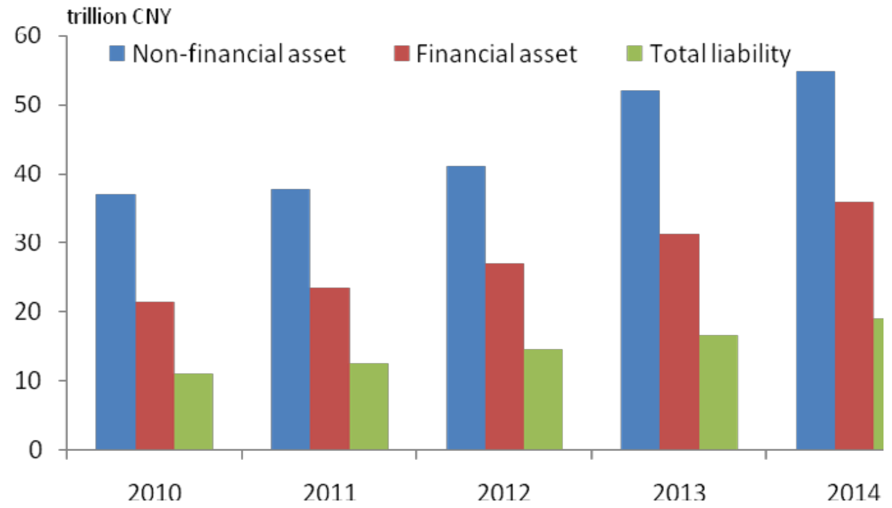
6.1 Ever-increasing scales VS Slowdown growth rates

Rapid growth of total asset scale: Over the past five years, the expansion of government sector assets and liabilities has played an active role in supporting the steady growth of economy. While China's economy is growing at a high speed, the scale of government assets continues to expand. At the end of 2014, the total assets of China's public sector reached 347.3 trillion RMB, with an average annual growth rate of 14.6% (in 2010-2014) which is larger than the economic growth rate at the same period, and the ratio to GDP increased from 4.9 to 5.5. For the government in broad sense, its total assets reached 131.4 trillion RMB with an average annual growth rate of 9.3% for the past 5 years; for the government in narrow sense, its total assets reached 91.0 trillion RMB, with an average annual growth rate of 11.7%.

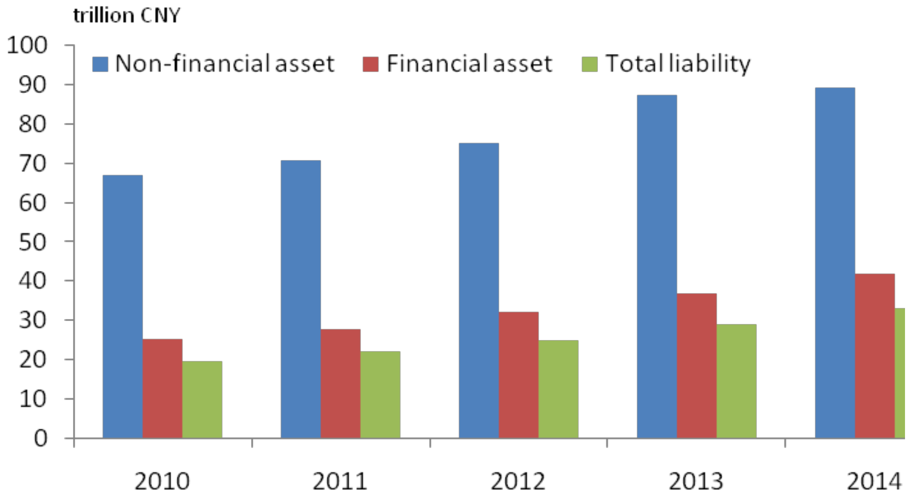
Declining growth rate of total liabilities: The growth trend of total liabilities is basically in line with the assets, and the growth rate of total liabilities is larger than that of the assets. At the end of 2014, the total liabilities of China's public sector reached 233.5 trillion RMB. The growth rate dropped from 26.6% in 2011 to 13.2% in 2014, with an average annual growth rate of 18.3% which is larger than that of the assets. In China, public companies are responsible for most of the government liabilities, while the liabilities from administrative institutions are limited. For the government in broad sense, its total liabilities reached 33.1 trillion RMB with an average annual growth rate of 14.2% for the past 5 years; for the government in narrow sense, its total liabilities reached 19.1 trillion RMB, with an average annual growth rate of 15.1%.

Steady increase in net-asset scale: At the end of 2014, the total net assets of China's public sector reached 113.8 trillion RMB, with an average annual growth rate of 8.6% (in 2010-2014) which is 0.6 percentage points larger than the economic growth rate at the same period. For the government in broad sense, its net assets reached 98.3 trillion RMB with an average annual growth rate of 7.9% for the past 5 years; for the government in narrow sense, its net assets reached 71.9 trillion RMB, with an average annual growth rate of 10.9%.

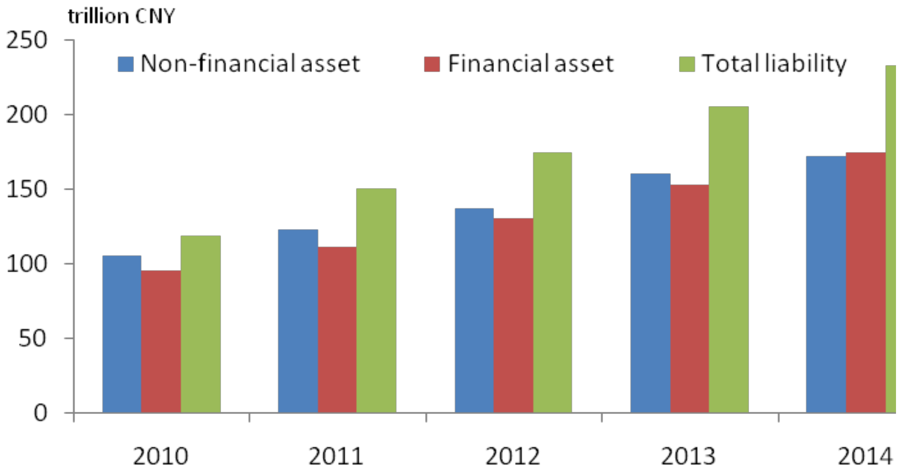
Graph 1 Government asset and liability scale in narrow sense



Graph 2 Government asset and liability scale in broad sense



Graph 3 Asset and liability scale in public sector



6.2 Broad categories of assets & increasing financial assets ratio

Affected by their functions, different sector have great differences in asset class.

The proportion of financial assets in public sector is larger than that of non-financial assets. For public sector, the proportion of non-financial assets in total assets of the public sector dropped from 52.5% to 49.7% in 2010-2014, while the proportion of financial assets increased steadily from 47.5% to 50.3%. Non-financial assets in public sector are mainly fixed assets (such as buildings and structures) and non-productive assets (mainly land resource). For public sector, the proportion of fixed assets, non-productive assets and inventory in non-financial assets reached 57.9%, 25.1% and 10.1% respectively at the end of 2014. Financial assets are mainly loans from public finance companies. At the end of 2014, the proportions of loans, other receivables and central bank reserve assets in financial assets were 38%, 17.9% and 15.6%, respectively.

The government assets in broad sense are mainly non-financial assets, but its proportion has declined. For government assets in broad sense, the proportion of non-financial assets and financial assets in total assets were 68.2% and 31.8% respectively at the end of 2014, with a 4.4 percentage points decline in the proportion of non-financial assets from the end of 2010. The proportions of fixed assets and non-productive assets in non-financial assets were 60.9% and 38.4% respectively, which were larger than that of public sector. Financial assets are mainly state-owned enterprises' rights and interests. At the end of 2014, the proportions of shares and other equity, currency and deposits, other receivables in financial assets were 60.8%, 25.8% and 10.6%, respectively.

The local governments control most of the non-financial assets. In China, most of the non-financial assets are controlled by the local governments, which consist of some fixed assets, such as public infrastructure and land resources. The land system in China is special, which cuts apart in urban and rural areas, and separates ownership rights from use rights. Besides the farmlands, such as state-own farms, forest farms and pastures, construction lands are also important parts of non-financial assets of local governments. At the end of 2014, the total assets of local governments and non-market non-profit organizations they control reached 99.4 trillion RMB, with a proportion of 75.6% in government assets in broad sense. While its non-financial assets reached 82.0 trillion RMB, and its proportion was 91.6%.

The structure of government assets in narrow sense is similar to the government in broad sense. For government in narrow sense, the proportions of non-financial assets and financial assets in total assets were 60.5% and 39.5% respectively at the end of 2014. Among them, the proportions of fixed assets and non-productive assets in non-financial assets were 37.8% and 62.2%, respectively. While the proportions of shares and other equity, currency and deposits, and other receivables in financial assets were 69.7%, 23.6% and 4.0%, respectively.

6.3 Sector differences in debt structure

The proportion of currency and deposits is the largest in public sector. For public sector, the proportions of currency and deposits, and other payable receivable in total liabilities were 42.3% and 18.6% respectively at the end of 2014, reduced by 9.2 and 0.3 percentage points compared to the end of 2010; the proportion of shares and other equity in total liabilities was 11.7%, increased by 0.1 percentage points than that of 2010.

Loan and shares are included in government debt instruments of broad sense, but excluded in that of narrow sense. For government in broad sense, the proportions of debt securities, shares and other equity, insurance technical reserves, and other payables in total liabilities were 31.2%, 27.8%, 20.3% and 15.1% respectively at the end of 2014.

Government liabilities instruments in narrow sense are mainly bond and insurance technical reserves. For government in narrow sense, the proportions of debt securities, insurance technical reserves, and other payables in total liabilities were 54.1%, 35.2% and 10.4% respectively at the end of 2014.

The liabilities structure needs further optimization. Loans and other traditional indirect financing instruments play an important role in the China's government financing process, while the impacts of national debt and local government debt are relatively limited. For China’s government liabilities in broad sense, the proportions of debt securities and loans were 31.2% and 5.3% respectively at the end of 2014. But for the U.S. government liabilities in broad sense, debt securities and loans reached 15.3 trillion USD and 157 billion USD respectively at the end of 2012, with proportions of 76.8% and 0.1% in total liabilities.

6.4 Fluctuation in asset price has a great impact on the value of non-financial assets

In recent years, the growth of China's economic is under pressure, and GDP growth rate gradually declined from 10.6% in 2010 to 7.3% in 2014. The asset price fluctuation increases, especially the average sales price of office building, whose decline greatly affects the value of non-financial assets, such as land resources and buildings. And then the growth rate of government assets appears to be falling. For government in broad sense, the value of buildings and structures was 0.7% below year-ago levels by the end of 2014, while it was 9.9% above of 2013; the value of land resources was 4.9% above year-ago levels, while it was 37.3% above of 2013. Since cash basis is mainly used in China as the basis of budget accounting standard system, it is difficult to be objective and comprehensive while considering the impacts of asset price fluctuation on the fiscal balance. And non-financial assets account for a large percentage of the whole assets, the impacts of asset price fluctuation on robustness of the government liabilities are worthy of attention.

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Stock (Trillion Yuan)		Government in narrow sense					Government in broad sense					Public sector				
		2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
1	**Total asset**	**58.4**	**61.2**	**68.4**	**83.5**	**91.0**	**92.1**	**98.4**	**107.1**	**124.2**	**131.4**	**201.1**	**235.2**	**268.0**	**314.7**	**347.3**
11	Non-financial asset	37.0	37.8	41.3	52.1	55.1	66.9	70.8	75.2	87.4	89.6	105.5	123.3	137.2	161.1	172.6
111	Fixed asset	14.2	15.9	17.5	19.5	20.8	43.4	48.3	50.5	54.0	54.5	69.5	79.0	86.1	94.3	99.9
112	inventory	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.4	0.4	7.6	10.4	12.6	15.5	17.5
113	Non-productive asset	22.9	21.8	23.8	32.7	34.3	22.9	21.9	23.9	32.8	34.4	27.0	27.2	30.4	40.6	43.3
12	Financial asset	21.4	23.4	27.1	31.4	35.9	25.2	27.6	31.9	36.8	41.8	95.6	111.9	130.8	153.6	174.7
2	**Total liability**	**10.9**	**12.5**	**14.5**	**16.5**	**19.1**	**19.4**	**21.9**	**24.8**	**28.9**	**33.1**	**119.2**	**150.9**	**174.9**	**206.2**	**233.5**
21	Financial liability	10.9	12.5	14.5	16.5	19.1	19.4	21.9	24.8	28.9	33.1	119.2	150.9	174.9	206.2	233.5
3	**Net asset**	**47.5**	**48.7**	**53.9**	**67.0**	**71.9**	**72.7**	**76.5**	**82.3**	**95.3**	**98.3**	**81.9**	**84.3**	**93.1**	**108.5**	**113.8**
31	Net financial asset	10.5	11.0	12.6	14.9	16.8	5.8	5.8	7.1	7.9	8.7	-23.6	-39.0	-44.1	-52.6	-58.8

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On the determinants of firms' financial surpluses and deficits[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

On the determinants of firms’ financial surpluses and deficits

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According to macroeconomic predictions firms are expected to be net borrowers: the net change of their financial assets should be smaller than the net change of their financial liabilities. However in the last years firms were often net lenders in countries such as Japan, the UK, Germany and the Netherlands. On the contrary firms remained on average net borrowers in countries such as France, Italy and the US. We investigate the sources of corporate sector surpluses and deficits using panel data techniques. Our statistics include 18 industrial countries over the period 1995-2014. We find that firms’ surpluses and deficits are linked to national output gaps, ratios of corporate investment to GDP, private consumption, net foreign direct investments and companies’ profits. This econometric evidence is robust to the inclusion in the regressions of variables such as oil price, firms’ leverage, countries’ financial openness.

Keywords: Net lending/borrowing, corporate sector, corporate saving glut, panel data.

JEL classification: E2, G3, F6

1. Introduction and motivation

According to macroeconomic predictions, non-financial corporations should usually act as net borrowers – with the net acquisition of financial assets smaller than the net incurrence of financial liabilities – in order to satisfy their financial needs and to realize investments. This status of firms is generally counterbalanced by the household net lender behavior which channels the financial resources to firms directly or throughout the financial system.

Contrary to these expectations, in the last years corporate net lending prevailed in several countries. In 2014 UK firms reported a financial surplus of 0.8 percent of GDP. In 2013 the surplus was 2.8 per cent for Irish firms, 6.9 per cent of GDP for the Dutch corporate sector and achieved 4 per cent of GDP for German firms. The Economist wrote a note on "The Corporate Saving Glut" already in 2005.

The goal of this paper is to shed light on determinants of corporate surpluses and deficits in the main industrial economies. The evidence is tricky to interpret and there are still few contributions on the subject. In the literature different explanations have been proposed.

André et al (2007) studied corporate net lending in the period 2001-2005 in the main OECD countries and found among the explanatory factors the fall of corporate investment, the growth of net foreign investment abroad, and increasing profit shares, possibly related to wage moderation and low interest rates. The increase of net lending was judged as partly temporary. IMF (2006) addressed the issue looking at corporate high savings in G7 countries. The excess debt and the accumulation of physical capital during the 1990s were considered two relevant culprits of net lending but other cyclical and structural factors also played a role, such as firm's high profits, a lower relative price of capital goods, the choice of companies to purchase assets abroad and to increase their cash holdings.

Firms' net lending became even higher after the global financial crisis and recently Gruber and Kamin (2015) analyzed the phenomenon in G6 economies conducting panel regressions over long time horizons (1961-2001; 1961-2006; 1961-2013). Their main result is that the increase of the corporate saving glut is related to lower investment. The weakness in investment spending was particularly intense after the global financial crisis but corporate investment was disappointing also in the years preceding the collapse of Lehman Brothers. Gruber and Kamin emphasize that corporate payouts to investors in the form of dividends and equity buybacks have also increased: this is inconsistent with the idea that prudent firms were cutting investments to strengthen their balance sheets.

However the opinion that firms reduce their investments because of financial issues is widespread in the literature. Armenter and Hnatkovska (2014) develop a theoretical model to explain the occurrence of firms' net lending putting the attention on the precautionary motive: firms accumulate financial assets in order to avoid being financially constrained in the future.

In emerging countries firm surpluses have been sometime explained by credit constraints[1], but also in industrial economies banks could not be able to reach all the segments of firms. Brufman et al. (2013) focus on the role of financial constraints to analyze the excess of savings, using micro data on firms for France, Germany, Italy, UK and Japan over the period 1997-2011. The excess of saving is related to a decline of investments. Moreover firms reduced leverage and the share of operating assets in total assets. These trends were stronger among the more credit constrained and the less dynamic firms.

While there is a broad consensus on the effect of investments on net lending/net borrowing, the evidence is more uncertain for consumption. A slowdown of consumption might induce firms to reduce their investments diverting resources towards the accumulation of financial assets. As already mentioned another possible explanation of firms' net saving is their internationalization. Globalization caused deindustrialization in rich countries. Firms invested abroad, where expected returns are higher, because of lower wages and looser regulation. Therefore firms cut external finance inside the domestic borders and collected financial resources abroad.

Taking into account the previous literature, the novelty of our paper is the analysis of corporate net lending/ net borrowing in a sample of 18 countries over the years 1995-2014. Through econometric techniques, we study the variables which, ceteris paribus, may better contribute to explain the non-financial corporations behavior. After this introduction, Section 2 discusses the main issues on financial accounts and accounting identities, and summarizes how globalization of production may influence net lending/borrowing. Section 3 describes the dataset and focuses on

1 Looking at 18 emerging countries, Caballero et al. (2015) claim that firms often act like financial intermediaries to gain from carry trade type activities where capital controls, particularly controls on inflows, are diffuse.

the aggregate evidence on firms' net lending/borrowing in the last 20 years. Section 4 reports some econometric estimates along with a discussion of the empirical results. Conclusions follow.

2. A glance at national accounts definitions

In this paragraph we summarize some definitions of the variables used in the paper. Our indicators are mainly based on the System of National Accounts.

The national accounts describe the economic process, from the production and generation of income, through its distribution and redistribution along with its use for final consumption. The last part of the process involves the use of saving and the accumulation of non-financial and financial assets. In national accounts the economy is divided into institutional sectors, which are characterized by homogeneity in functions, choices, and decisions. Among the sectors, non-financial corporations collect the units involved in production of goods and non-financial services. Firms' output, net of intermediate consumption and taxes less subsidies on products, defines the gross value added (the net definition requires the subtraction of consumption of fixed capital). The sequence of accounts showed in Table 1 describes the formation of non-financial corporation's net saving and its relationship with net lending/net borrowing. In particular:

Net lending/net borrowing balance = Saving – Investment (1)

The sequence of accounts is completed by the financial account, that shows how firms invest net lending in the different financial instruments or, viceversa, how firms collect liabilities – loans, shares and other equity, bonds – to fund the net borrowing needs. This implies that net lending/net borrowing from capital account is equivalent to net lending/net borrowing from financial account:

Net lending/net borrowing = Saving–Investment = Financial Assets flows - Financial Liabilities flows (2)

In national accounts transactions are based on the notion of residence. The residence identifies the territory where business activities take place. Globalization increased interactions across national economies and made more ambiguous the definition of residence. Production patterns changed as firms organised their activities in the most cost-effective way (UNECE, 2011): we may refer to phenomena

Table 1 - A Simplified scheme of non-financial corporation accounts

Production Account	Output - Intermediate Consumption -/+ Taxes less subsidies on products Gross Value Added
Income Account	- Compensation of Employees - Other taxes/subsidies on production Gross Operating Surplus - Consumption of Fixed Capital Net Operating Surplus
Distribution of Income Account	+ Total property income, receivable + Social Contributions + Other current transfers - Property Income paid - Current taxes on income, wealth - Social benefits - Other current transfers Net saving
Capital Account	+ Consumption of Fixed Capital Gross saving - Gross fixed capital formation - Change in Inventories - Acquisition less disposals of non-produced non-financial assets Net Lending/Net Borrowing

such as global value chains and the increase of foreign direct investments (Cappariello and Felettigh 2015 and Federico 2016). Similar features invested financial markets and increased interconnections between financial systems (Infante, Pozzolo, Tedeschi 2012; Bartiloro and di Iasio, 2012). In the organization of economic activity the importance of national borders weakened and challenged in turn the ability to measure economic phenomena. The activity of multinational enterprises (MNEs) is difficult to capture both for national statisticians and policy considerations (UNECE, 2011). For instance prices for goods and services exchanged between group entities differ from market prices, introducing distortions in the value of trade (Eggelte et al., 2014).

The high presence of MNEs may play an important role in explaining net lending of non-financial corporations in some economies. If a company decided to move its production in another country through a subsidiary, to exploit lower production costs, any investment run by the MNE through its subsidiary would be recorded in the foreign country. In the national account system, the acquisition of the subsidiary – the foreign direct investment abroad – would affect only the financial account of the parent company country, reducing cash holdings and increasing shares and other equities in the asset side (with a symmetric impact on the rest of the world sector). Since the investment is made by the subsidiary, the capital account of the parent company country remains unaffected, while the investment is recorded in the host country. The earnings generated by the subsidiary are assigned to the headquarters, thus improving the distribution of income account and in turn net lending (Eggelte et al., 2014). In case of reinvested earnings, e.g. to fund an expansion of investments of the subsidiary, they are still recorded in the distribution of income account of the parent company (improving the net lending position) and correspondingly increase the shares and other equity item in the financial accounts. This statistical rule implies an improvement of the net lending position of the parent company country and a corresponding worsening of the net borrowing/lending of the corporate sector of the subsidiary country, reducing the current account balance. In brief, we confirm the importance of taking into account net foreign direct investments to analyse firm net lending/borrowing.

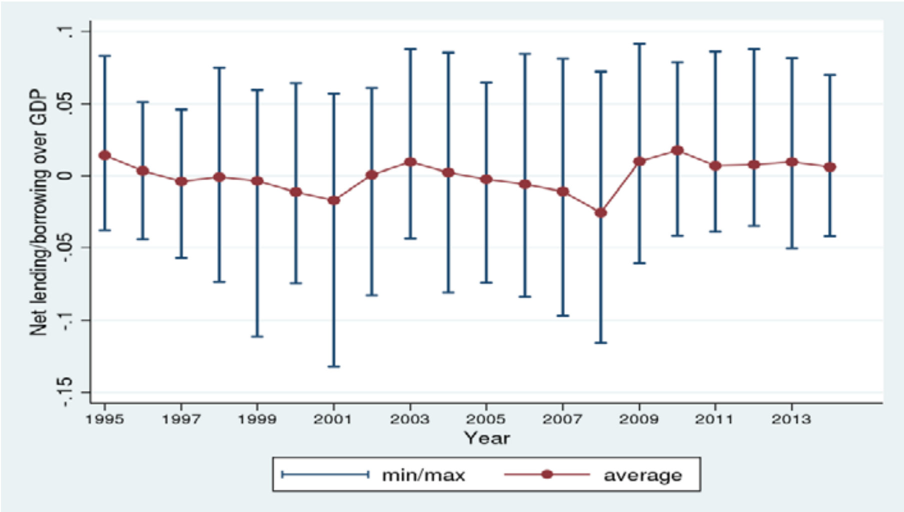
3. Descriptive statistics

Our data set includes 18 countries, 16 European nations plus the US and Japan. We collected data from 1995 to 2014 following the ESA2010 and SNA2008 standards2. In the last 20 years the pattern of non-financial corporation net lending/borrowing may be split into four phases (figure 1). First, net borrowing prevailed during the bubble of 1995-2001, when firms raised new capital exploiting the positive phase of the Stock Exchange. Second, from 2002 to 2003 the burst of the bubble led to the prevalence of net lending, as underlined by IMF (2006). Later on the world economy came back to a positive growth and net borrowing reappeared, reaching its local maximum in 2008. Finally, the global financial crisis caused the "Great Recession" while the debt sovereign crises was accompanied by recessions or low growth in many European countries: therefore from 2009 to 2014 firms came

[2] We take net lending/net borrowing figures from the national financial accounts; in many countries there are some discrepancies with corresponding figures taken from capital accounts (see Cagetti et al 2012 on the US).

back to net lending.3 When net borrowing prevailed – e.g. in 1999, 2001 or 2008 – the dispersion of countries was greater than that observed when net lending predominates, e.g. in 1995 or 2014.

Figure 1 Non-Financial corporations net lending/borrowing
(averages, 1995-2014)



The average behavior of firms hides a strong heterogeneity across countries. For this reason we now distinguish between net lender and net borrower nations (which are to be meant as countries whose non-financial corporation sectors behaves respectively as net lender or net borrower).

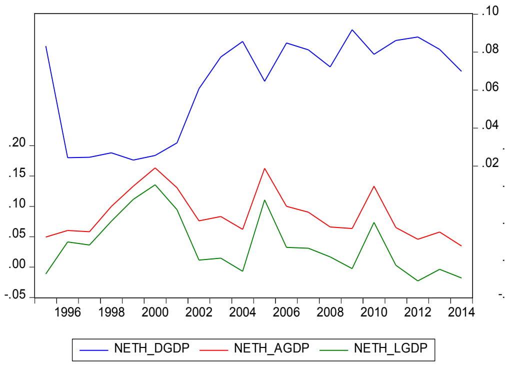
In our sample, there are eight countries where firms were net lenders in most of the years. This was the case of Germany, Denmark, Ireland, Switzerland, the Netherlands, Finland, the UK and Japan (Figure 2). Taking into account the average of 1995-2014, net lending was 6 per cent of GDP in the Netherlands, 3 per cent in Japan and Denmark, 2 per cent in Switzerland and 1 per cent or less in the remaining countries. While the Netherlands, the UK and Denmark show a net surplus in all the years (except for 2008 and in some cases around the 2012 sovereign debt crisis), firms in Germany display a positive saving in almost the years except from 2000 and 2008 for Germany in which liabilities ratio on GDP were higher than the assets ratio on GDP; firms in Switzerland and Germany display a positive saving in almost the years

[3] This may be interpreted as a sort of rebalancing analogous to that of current account balances after the financial crisis (see Cesaroni and De Santis, 2015).

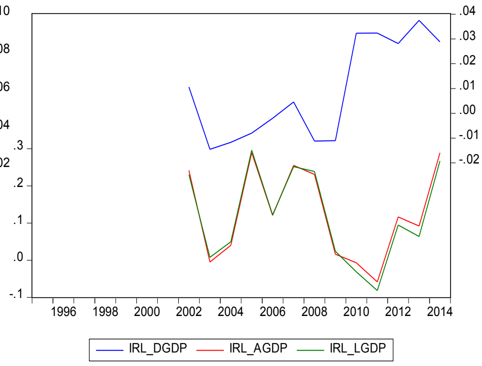
In the rest of our sample firms are mostly net borrowers (Figure 3). Taking into account the average of the period 1995-2014, net borrowing was 3 per cent of GDP in Portugal and Greece, 2 per cent in Spain and Italy, 1 per cent in

Figure 2 Countries where non-financial firms are net lenders, 1995-2014*

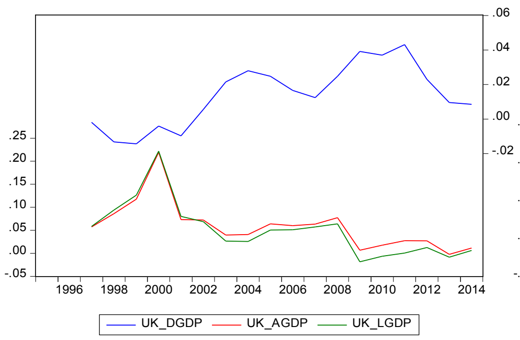
Netherlands



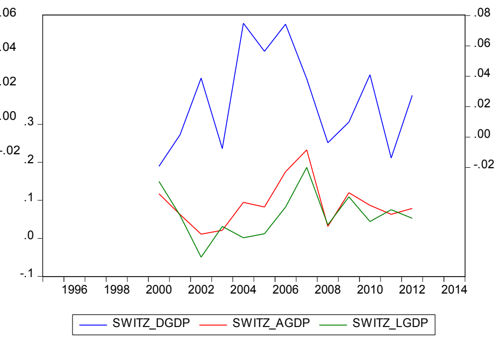
Ireland



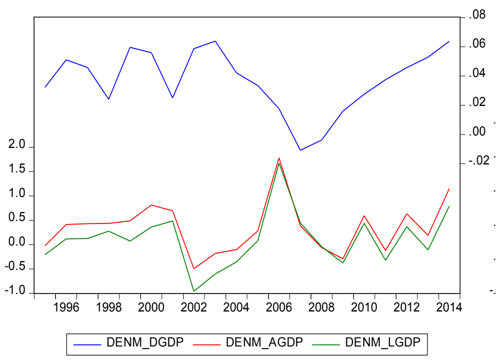
United Kingdom



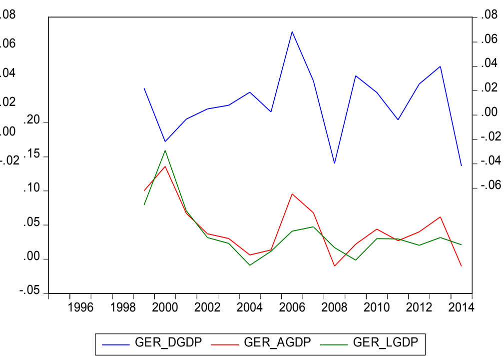
Switzerland



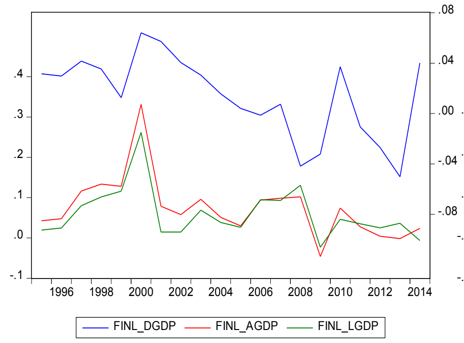
Denmark



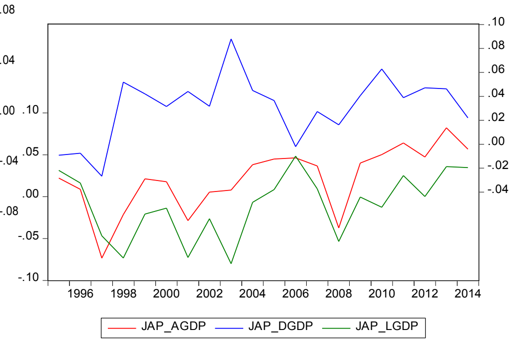
Germany



Finland



Japan

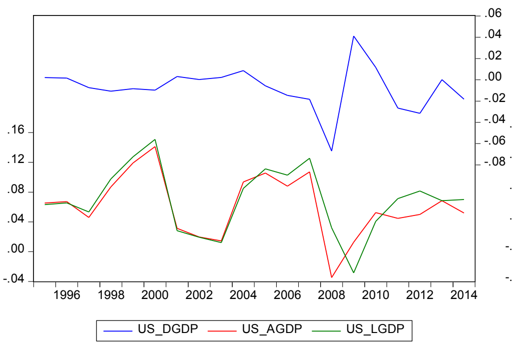


* The blue line is firms' net lending as a percentage of GDP - right hand scale. The red line is the net change of firms' financial assets as a ratio of GDP - left hand scale. The green line shows the net change of firms' financial liabilities as a ratio of GDP - left hand scale.

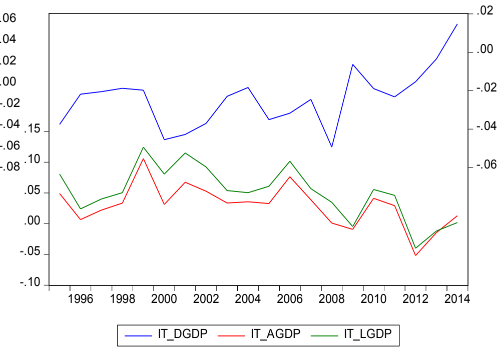
Austria, France and Sweden. Net borrowing was on average smaller than 1 per cent in Belgium, Norway, and the US. The yearly evolution of net borrowings shows differences across countries linked to the different impacts of the global financial crisis and the European sovereign debt crisis.

Figure 3 Countries where non-financial firms are net borrowers, 1995-2014*

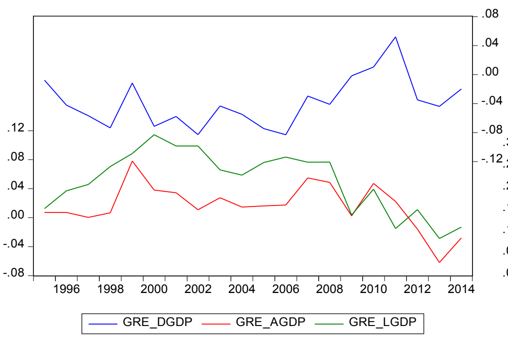
United States



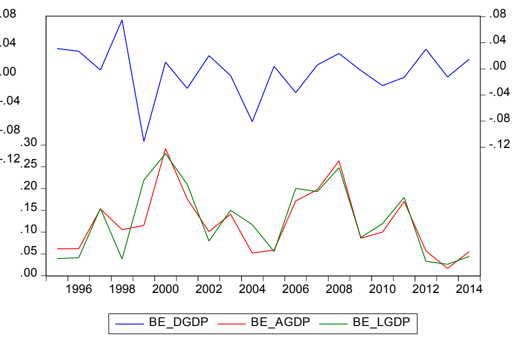
Italy



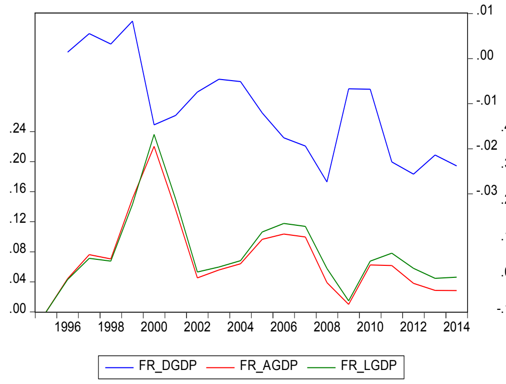
Greece



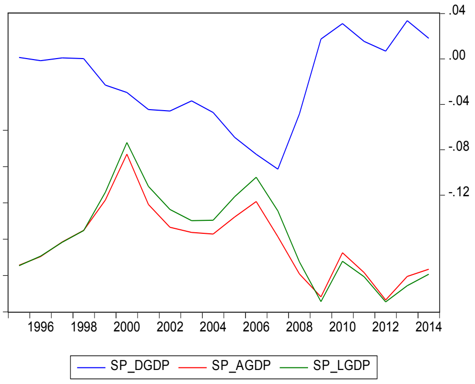
Belgium



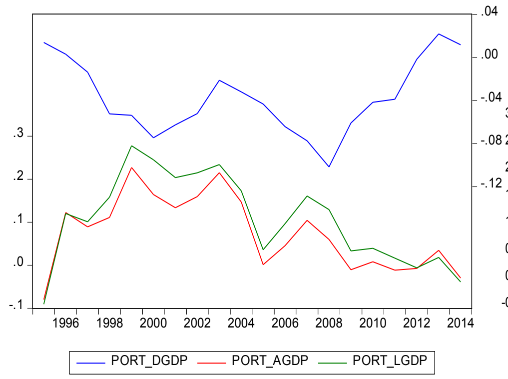
France



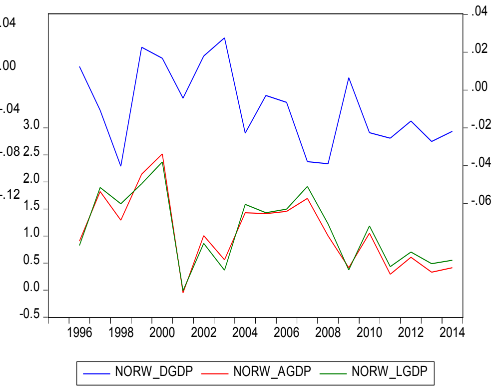
Spain



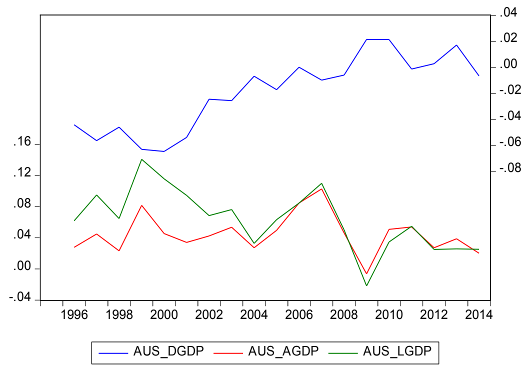
Portugal



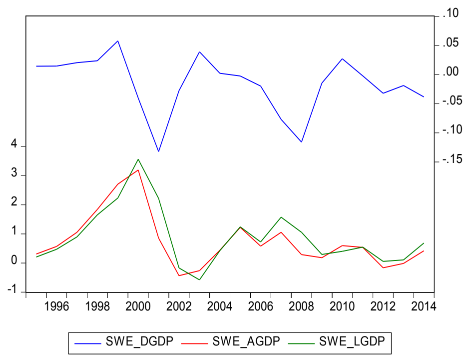
Norway



Austria



Sweden



* The blue line is firms' net lending as a percentage of GDP - right hand scale. The red line is the net change of firms' financial assets as a ratio of GDP - left hand scale. The green line shows the net change of firms' financial liabilities as a ratio of GDP - left hand scale.

Our data set includes indicators coming from different sources. Net lending and net borrowing are taken from the national financial accounts available in the OECD statistical database. Balance of payments statistics come from the Milesi Ferretti

(2015) archive. Table 2 reports a description of the variables together with their expected sign in the regressions.

Now we discuss how our explanatory variables may be associated to non-financial corporations' net lending/borrowing.

Output gap. The output gap is a summary indicator of the cyclical stance. An expansionary phase of the business cycle, measured by a positive output gap, corresponds to a high effective demand. The increase in demand will induce firms to invest thus lowering their surpluses or increasing their net borrowing. The output gap should also catch the impact of financial crises.4

Table 2 - Data description and variables definition

Variable	Description	Expected sign
Net lending/net borrowing (NBLGDP)	Net lending/net borrowing as a percentage of GDP.	Dependent variable
Output gap	(Effective GDP – Potential GDP)/Potential GDP*100.	Negative
Net FDI/GDP	Net foreign direct investment as a ratio to GDP.	Positive
Investment/GDP	Gross investment rate of corporate sector as a ratio of GDP	Negative
Consumption/GDP	Share of private consumption to GDP.	Negative
Profits/GDP	Profits after net interest and taxes as a ratio to GDP: profits are defined as the sum of gross operating surplus and property income minus the sum of interest rate paid and taxes (as in IMF 2006).	Positive
Oil price	Price of Brent in US dollars.	Negative
Interest rates spread	Long term – short term interest rates on deposits.	Positive
Leverage	Loans and bonds issued by firms as a ratio of total financial liabilities.	?
Financial openness	The sum of financial assets plus financial liabilities/GDP	?

[4] We are conscious that output gap estimates are subject to a degree of uncertainty and can vary depending on the method adopted. We use the OECD database where the production function approach is used to estimate potential output.

Net FDI to GDP ratio. For each country this variable measures the difference between flows of outward foreign direct investments and flows of inward foreign direct investments. As discussed in the introduction and in paragraph 2, a positive value of net FDIs should be associated to greater net lending/smaller net borrowing.

Investment to GDP ratio. As in the case of the output gap, a greater investment/GDP ratio should lower net lending and increase net borrowing by firms.

Consumption to GDP ratio. Similarly to investment, a greater consumption/GDP ratio should lower net lending and increase net borrowing by firms.

Profits to GDP ratio. Profits should be positively linked to net lending, as higher profits decrease the need of firms' to raise new financial liabilities. This choice may be rationalized in the framework of the pecking order theory (Myers and Majluf 1984).

Oil price. This control variable is a proxy for supply shocks, a rise of oil price should make firms' costs greater, thus leading to smaller net lending or greater net borrowing.

Interest rate spread. We use this indicator as a proxy of uncertainty. According to Campbell and Shiller (1991), the yield spread between longer and shorter term interest rate predicts a future change in interest rates, due to expectations of an higher monetary policy short-term rate. Therefore a higher spread can be interpreted as a proxy of uncertainty over future economic conditions, which might imply a liquidity hoarding by firms as a response.

Leverage. This variable might influence non-financial corporations' net borrowing/lending but its sign is not easy to determine a priori. Firms wanting to raise investment might fund their decisions increasing their debt level and therefore the leverage ratio: in this case we would expect a negative relationship between the leverage ratio and net lending/borrowing On the other hand, high-leverage positions may have a negative impact on investment and therefore a positive impact on net lending, predicting a balance-sheet adjustment for highly indebted non-financial corporations (see IMF 2006). Furthermore, high-leverage positions may affect investments through the financial accelerator mechanism (Bernanke and Gertler 1989), by reducing firms' net worth and collateral.

Financial openness. It is difficult to select the effects of a greater financial openness on net flows of financial assets and financial liabilities as both the variables might be influenced in the same way.

All our original variables are expressed in US dollars. We also included country dummies in the regressions. Most of the independent variables are lagged one period to manage issues of endogeneity.

Table 3 - Descriptive statistics

	Observations	Mean	Std. Dev.	Min	Max	Unit of measure
Net lending/net borrowing (NBLGDP)	336	0.00015	0.0391	-0.13	0.092	Ratio
Output gap	361	-0.247	3.088	-15.81	9.206	Percentage
Oil Price	360	55.96	33.76	14.19	113.04	US dollars
FDI_net_GDP	360	0.081	0.253	-0.996	1.075	Ratio
Investment/GDP	335	0.119	0.022	0.042	0.169	Ratio
Leverage	346	0.647	0.212	0.342	1.423	Ratio
Consumption/GDP	335	0.549	0.0723	0.384	0.708	Ratio
Financial openness	340	5.68	5.59	0.84	36.62	Ratio
Profits/GDP	335	0.21	0.076	0.0059	0.373	Ratio
Spread	317	1.611	2.109	-5.44	21.93	Percentage

Table 3 reports some descriptive statistics on the dependent and independent variables used in the econometric section. In line with Figure 1, on average net lending prevails, as the NLBGDP variable is slightly positive over the period when all countries are considered. Furthermore, the indicator spans from a minimum value of -13 per cent – a very high net borrowing reached by Sweden in 2001 – and a maximum value of a net lending of 9 per cent reached by the Netherlands in 2009. The ratio of corporate investment to GDP is around 12 per cent while the ratio of private consumption to GDP is about 55 per cent. The net flow of FDI is on average positive as our sample includes advanced economies. The profit share of the corporate sector is on average roughly 20 per cent while the leverage is around 65 per cent.

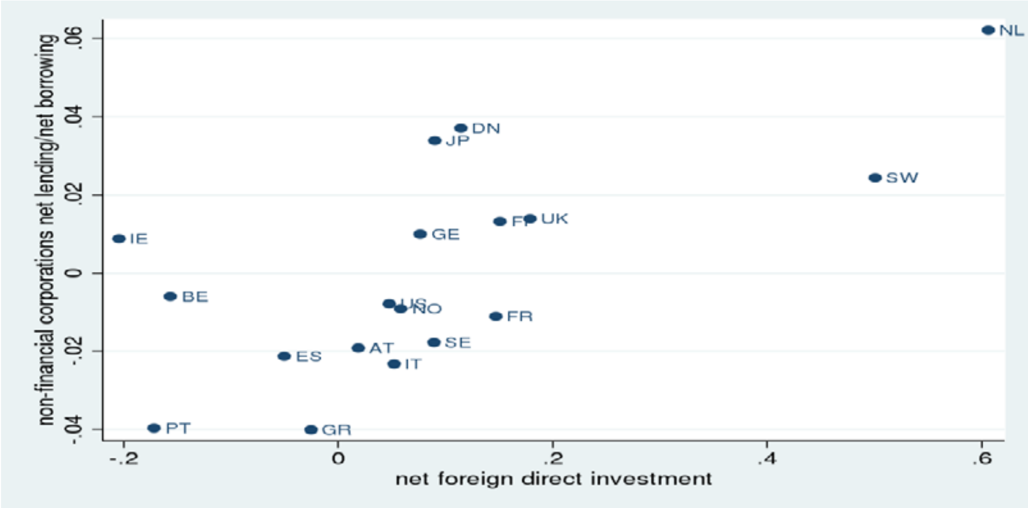
Table 4 - Correlation between net lending/borrowing and main independent variables (1995-2014)

	NLB/ GDP	Net FDI/ GDP	Out- gap(l1)	Inv/ GDP(l1)	Fin- open(l1)	Cons/ GDP(l1)	Oil Price	Spread	Leve- rage	Profits/ GDP
NLB/GDP	1.00									
Net FDI/GDP	0.48	1.00								
Outgap_l1	-0.23	-0.17	1.00							
Inv/GDP (l1)	-0.15	0.01	0.25	1.00						
Finopen (l1)	0.28	0.31	0.00	-0.05	1.00					
Cons/GDP (l1)	-0.21	-0.13	-0.19	-0.39	-0.32	1.00				
Oil Price	0.05	0.16	-0.10	-0.15	0.54	0.04	1.00			
Spread	0.11	-0.03	-0.43	-0.35	0.07	0.26	0.23	1.00		
Leverage	-0.04	0.02	-0.03	-0.25	-0.09	0.21	-0.09	0.29	1.00	
Profits/ GDP	0.26	0.43	-0.05	0.24	-0.07	0.09	-0.06	-0.19	-0.23	1.00

To give a first look at the linkages among data, Table 4 reports the correlations between our dependent variable – the ratio of net lending/borrowing to GDP – and the regressors. As expected the correlation between investments ratio to GDP, consumption ratio to GDP and output gap, on one side, and NLBGDP, on the other side, is negative. The correlation between profits/GDP and NLBGDP also goes in the predicted positive direction since higher profits are associated with higher firms surpluses. Quite the opposite the correlation of leverage and the dependent variable is very low and negative.

Figure 4 reports a scatter plot of net lending/borrowing, on the vertical axis, and FDIs on the horizontal axis, taking into account for each country the average values over the periods 1995-2014.

Figure 4 Net lending/borrowing and net FDIs (averages 1995-2014)



Countries with high net direct investments abroad tend to be associated with thrifty firms. The picture is therefore coherent with previous evidence (Eggelte et al., 2014): countries with a large number of multinational enterprises, like the Netherlands and Switzerland, have more likely non-financial firms behaving as net lenders.

4. Empirical results

To analyze the determinants of firms' surpluses and deficits, we estimate a panel fixed effects model for the 18 countries considered over the period 1995-2014. Our baseline equation takes the form:

$$Y_{it} = \beta_i + \beta_0 * outputgap_{it} + \beta_1 * FDI_{it} + \beta_2 * consgdp_{it} + \beta_3 * Igdp_{it} + \beta_4 * profitsgdp \\ + \beta_5 * control_{it} + e_{it}$$

where the dependent variable y is firms' net lending/borrowing as a ratio of GDP. FDI is the ratio of net foreign direct investment to GDP; *Igdp* is the ratio of corporate investment to GDP and *profitsgdp* is the share of firms' profits. Leverage is given by loans and bonds issued by firms as a ratio of total financial liabilities. Control is a group of control variables such as oil price, interest rate spread, consumption, output gap and financial openness.

Table 5 reports the results of our regressions. We used six different models.

The first model includes four variables, namely, FDIs, investments and controls for oil price, consumption and output gap. The output gap has a negative sign, as expected. The greater the output gap – i.e. the difference between real and potential GDP – the smaller firms' net lending and the greater their net borrowing. The net foreign direct investments are positively associated to net lending/borrowing. If outward FDIs investments are larger that inward FDIs, firms will tend to register a greater net lending (see Palenzuela and Dees, 2016 for a similar approach). The ratio of investment to GDP has a negative influence on net lending/borrowing as in Gruber and Kamin (2015). Consumption also has a negative coefficient, although not statistically significant. Oil price has a negative effect: a higher cost of oil increases firms' costs, thus leading to a smaller net lending or to a greater net borrowing.

The second model adds the share of corporate profits to GDP as regressor. This variable enters the regression with a positive sign: greater profits contribute to increase firms surpluses, both through a larger accumulation of financial assets and a smaller need of raising financial liabilities. As far as the previous independent variables are concerned, we got the same results of the model in the first column; moreover the consumption/GDP ratio is now statistically significant.

The third model adds the interest rate spread to the previous regressors with the aim to control for uncertainty. The interest rate spread enters with a positive and statistically significant coefficient: an increase of uncertainty pushes firms towards accumulating financial assets or reducing their liabilities. The coefficients of foreign direct investments, of corporate investment and of private consumption confirm the signs and statistical significance found in model 2, while the output gap is not significant.

The fourth column adds firms' leverage as a new independent variable. The effect of this variable on net lending/borrowing is negative. A higher leverage implies greater flows of financial liabilities, thus reducing firms' surpluses or increasing their net borrowing. The other variables confirm the previous results with the exception of the output gap.

The fifth column considers an indicator of financial openness as an alternative to foreign direct investments, following the choice of Caballero et al (2015). This variable is statistically significant and enters with a positive sign, confirming the role of internationalization: a greater financial integration contributes to increase firms' surpluses. The other coefficients are in line with those of the previous models.

The sixth model includes a dummy for the years 2008-2011 (the crisis years) and an interaction term between leverage and the crisis dummy. We try to capture a different effect of leverage on net lending/borrowing during the global financial crisis. Coherently with our discussion in the previous section, on average leverage has a negative association with net lending/borrowing of firms since an increase in debt would imply greater flows of financial liabilities to fund investment spending. But the global financial crisis and the debt sovereign crisis in European countries required a rebalancing phase for the most leveraged firms. This is suggested by our interaction term: during the crisis leverage is positively associated with net lending, signaling a hoarding of liquidity to cope with high debt level. Since the outbreak of the financial crisis, non-financial corporations underwent a decline of the ratio of debt to total assets (see ECB 2012). The decline reflected both demand and supply-side factors which affected credit to corporate sector. For the demand side, lower levels of economic activity, in particular lower capital formation, contributed to a reduction in external financial needs. Deleveraging is furthermore consistent with the idea of a balance sheet recession (Koo 2001 and 2012).

Table 5 - Baseline regressions
(fixed effects estimator, 1995-2014)

Dependent variable Net Lending/Borrowing	[1]	[2]	[3]	[4]	[5]	[6]
Output gap_l1	-0.001*	-0.002**	-0.001	-0.001	-0.001	-0.002*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
FDI / GDP	0.039***	0.031***	0.034***	0.027**		0.023**
	(0.00)	(0.01)	(0.01)	(0.01)		(0.01)
Investment/GDP _l1	-0.918***	-0.956***	-0.918***	-0.89***	- 0.903***	-0.813***
	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.11)
Oil price	-0.0001*	- 0.0001**	- 0.0001**	- 0.0001***	-0.0002***	-0.0001**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Consumption/GDP_l1	-0.079	-0.257**	-0.314**	-0.264**	-0.302**	-0.265**
	(0.11)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Profits / GDP_l1		0.2481***	0.218***	0.201***	0.238***	0.183**
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Spread rate			0.003**	0.003***	0.003**	0.003***
			(0.00)	(0.00)	(0.00)	(0.00)
Leverage				-0.037**		-0.040**
				(0.02)		(0.02)
Financial Openness_l1 (over GDP)					0.002***	
					(0.00)	
Crisis dummy						-0.042***
						(0.01)
Leverage*Crisis						0.062***
						(0.02)

Constant	yes	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes	yes
R2	0.19	0.30	0.34	0.32	0.31	0.33
Observations	307	307	299	299	299	299
Groups	18	18	18	18	18	18
(standard errors in parenthesis)						

***, ** and * denote significance at the 1%, 5% and 10% respectively

4.1 First robustness check: splitting the countries

As said, our previous results refer to countries that show a great heterogeneity of firms' net lending and net borrowing and one might envisage that surpluses and deficits may be influenced by different variables. Therefore we split our sample into two different subsets: 8 countries where firms are net lenders and 10 countries where firms are net borrowers over the period 1995-2014 (as shown by Figures 2 and 3). The goal of the exercise is to analyze if determinants of firms' surpluses are different from those of deficits.

Table 6 Splitting the countries
(fixed effects estimator, 1995-2014)

Dependent variable: firms' net lending/net borrowing	Net lender countries	Net borrower countries
Output gap_l1	-0.002* (0.00)	-0.000 (0.00)
FDI / GDP	0.030** (0.01)	0.041 (0.04)
Investment/GDP _l1	-0.939*** (0.26)	-1.020*** (0.28)
Oil price	-0.0003*** (0.00)	0.000 (0.00)
Consumption/GDP_l1	-0.335** (0.16)	-0.158 (0.20)
Profits / GDP_l1	0.138 (0.14)	0.213** (0.10)
Spread rate	0.001 (0.00)	0.002* (0.00)
Leverage	-0.036 (0.03)	-0.041* (0.02)
Crisis dummy	-0.040* (0.02)	-0.041** (0.02)
Leverage*Crisis	0.065* (0.04)	0.055** (0.02)
Constant	yes	yes
Country fixed effects	yes	yes

R2	0.31	0.18
Observations	127	172
Groups	8	10
(standard errors in parenthesis)		

***, ** and * denote significance at the 1%, 5% and 10% respectively

For net lender countries (first column of Table 6) macroeconomic variables – such as the output gap, foreign direct investments, investments and consumption – confirm the results obtained for all the countries and reported in Table 5, while profits and leverage are statistically not significant. On the contrary, the net borrowing of firms (second column of Table 6) is associated with investments but also with profits and leverage. Our interpretation is that balance sheet variables matter for net borrowers firms while they are not able to influence the choices of net lending companies. Finally the crisis dummy (for the years 2008-2011) and the interaction between leverage and crisis are associated in a similar way with firms structurally in surplus or in deficit. In other words, the crisis weakened the demand conditions, worsening the firms economic results, this in turn reduced net lending and contributed to a reduction of new borrowing in all the countries.

4.2 A robustness check along the time period

Up to now, our regressions took into account twenty years, characterized by different macroeconomic conditions. Now we study if the links between firm net lending/borrowing and our explanatory variables have been different during the Great Moderation years and in the Great Recession years.

Table 7 - Splitting the time period
(fixed effects estimator, 1995-2006 and 2007-2014)

Dependent variable: firms' net lending/net borrowing	1995-2006	2007-2014
Outgap_1	-0.002	-0.001
	(0.002)	(0.002)
FDI/GDP	0.023**	0.033
	(0.011)	(0.028)
Investment/GDP_l1	-1.010**	-0.982**
	(0.395)	(0.391)
Oil price	-0.0003**	-0.0003**
	(0.0001)	(0.0001)
Consumption/GDP_1	-0.496***	-0.283
	(0.240)	(0.321)

Profits/GDP_l1	0.408**	0.047
	(0.139)	(0.129)
Spread rate	0.0007	0.0025**
	(0.002)	(0.001)
Leverage	-0.094**	0.035
	(0.040)	(0.029)
Constant	yes	yes
Country fixed effects	yes	yes
R2	0.30	0.19
Observations	158	141
Groups	18	18
(standard errors in parenthesis)		

***, ** and * denote significance at the 1%, 5% and 10% respectively

Our Table 7 reports the results of the estimates for the period 1995-2006[5] (first column) and the time span 2007-2014. We use the last model of Table 5 (column 6) which contains all the independent variables. Looking at the years 1995-2006 we confirm the correlation among foreign direct investments, domestic investments, consumption, profits, leverage and the left hand side variable as in the whole sample. As far as the period 2007-2014 is concerned, domestic investment confirms their association with surplus and deficits of firms. In this subsample uncertainty, proxied by interest rate spreads, is also statistically significant, showing that during the two crises firms took into account interest rates differentials in setting their financial plans. Overall some variables look more robust during the Great Moderation years than during the Great Recession period, this is the case of foreign direct investment which experienced a fall during the crisis period more likely due to the fall in business expectations.

5. Conclusions

Traditional corporate sector theories predict that firms run deficits to finance investment projects. However since the mid-1990s in many industrial countries non-financial corporations registered financial surpluses while in other countries companies remained net borrowers.

In this paper we tried to detect the causes of firms' surpluses and deficits, focusing on the role of the output gap, aggregate demand components, net foreign

[5] 2006-2007 is a kind of divide between the *good days* and the crisis time. First signals of the crisis emerged during 2007, meanwhile it was the Lehman collapse in 2008 to raise markets volatility and uncertainty in many developed economies and to mark the inception of financial crisis. Our decision to break the sample in 2006 is more conservative, at the same time the results are almost unaffected choosing as a breaking year 2007.

direct investments, profits, and leverage. In the econometric exercises the dependent variable is the difference between the annual flow of firms' financial assets and the annual flow of financial liabilities.

Studying 18 industrial countries from 1995 to 2014, the paper reached five main conclusions.

First, there is a negative association between output gaps and firms' surpluses and deficits. A higher (more in the positive) output-gap is linked to smaller firms' surpluses and greater deficits. This is reasonable as the output gap is an indicator of the cyclical stance.

Second, looking at demand components, firms' greater investments and higher private consumptions, both as a ratio of GDP, are associated to greater deficits and smaller surpluses. This evidence coincides with that found in previous studies on the impact of investment on firms' flows of financial assets and liabilities. In our regression the association of investment with firms' surpluses and deficits is more robust than that of private consumption.

Third, net foreign direct investments show a positive association with non-financial corporations' net lending: firms that strongly invest abroad tend to reduce their net borrowing. In the Netherlands, Japan, the UK, Germany and other countries large multinationals have a strong influence on the aggregate financial position of the corporate sector.

Fourth, profits are positively linked with net lending: a high profitability reduces the need to collect financial liabilities. This behavior is consistent with the pecking order theory of financing choices.

Fifth, leverage is negatively related to firm net lending/borrowing. An higher leverage ratio implies greater flows of financial liabilities. However the interaction between our leverage variable and a dummy for the crisis period of 2008-2011 obtains a positive coefficient. In these years firms tried to deleverage after the excesses of the years preceding the global financial crisis.

Overall, investments and profits are the variables that have the most robust influence on firms' net lending/net borrowing. The results of the regressions are robust to the use of different control variables such as oil price, a measure of uncertainty, financial openness. In the future we would like to enlarge the set of countries analyzed and to consider other explanations of non-financial corporation net lending/borrowing. We also would like to discriminate better between the real and the financial variables that are associated to net lending/borrowing. We leave these subjects to future research.

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Probability-of-default curve calibration and validation of internal rating systems[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Probability-of-default curve calibration and the validation of internal rating systems

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Abstract

The purpose of this article is to present calibration methods which give accurate estimations of default probabilities and validation techniques for evaluating calibration power. Applying both these aspects to real data produces accurate verification and conclusions. The empirical analysis was based on individual data from different sources (from the years 2007 to 2012), i.e. from Prudential Reporting, The National Court Register, AMADEUS, and Notoria OnLine.

This article deals with the issue of rating system calibration, i.e. allocation of rating classes to entities in order to ensure that the calibration power of the division created is as high as possible. The methods presented can be divided into two groups. The first contains methods for approximating conditional score distributions for defaults and entities with a good financial standing to a parametric distribution which can be expressed with the use of a density function and distribution functions. The second group covers a number of variants of regression on binary variables denoting the default status of a given company. The use of k-fold cross-validation and repetition of calculations for different master scales and differing data sets means that the results should be highly robust against distribution of the variable in the training set.

Keywords: probability of default, calibration, rating

JEL classification: C13, G24

Contents

Introduction

Appropriate risk assessment is one of the most important aspects of the activities of financial institutions. In 1999, the Basel Committee on Banking Supervision published several proposal for changes to the current regulations in terms of the capital adequacy structure of financial institutions, which contributed to the preparation of the New Capital Agreement, known as Basel II. The main modification proposed was the reinforcement of the risk management process in the banking sector. One of the key changes in this area was the introduction of the possibility of internal risk management, and therefore the determination of minimal capital requirements. In particular, the bank can select among three approaches. The first of them, which is a continuation of the approach contained in the previous regulation, obliges the bank to maintain the ratio between the minimum capital requirements and the sum of risk-weighted assets at the level of 8%, where the weights are determined by the national regulatory body. As part of the second approach, called IRB (*Internal Rating Based*), the bank is obliged to prepare an internal estimation of the likelihood of the obligation not being fulfilled (*probability of default*). The other risk parameters, such as the loss coefficient arising from the failure to fulfil the commitment (*loss given default*) and the exposure at the time of insolvency (*exposure at default*) are provided by the regulatory body. The third and at the same time the broadest approach, known as Advanced IRB, enables banks to estimate all risk parameters.

Each bank is obliged, using one of the IRB approaches, to estimate the likelihood of insolvency for each loan granted. A popular method of achieving this is credit scoring. Financial institutions can use external scoring or rating assessments (*external rating approach*); however, they are applicable to only a small number of the largest business entities. In the vast majority of cases an internally developed risk assessment method (*internal rating approach*) is used. The use of the bank's own rating boards, called master scales, is a common practice. Entities with low risk levels are grouped together and assigned to one rating class. Each rating class has a top and bottom threshold expressed by the default probability, as well as an average value. The allocation of a given entity to one of the rating classes automatically determines its *default probability*, which is equal to the average value for the given class. The number of classes depends on the bank's individual approach; however, at least seven classes are required for solvent entities. Usually, lower probability values are assigned to the "upper" classes, which are denoted by digits or appropriate abbreviations, such as "AAA". This is, therefore, a process of discretization of the default probability estimations. On the one hand this approach causes a certain loss of accuracy; on the other it has several important benefits. Firstly, it facilitates further aggregate analysis, simplifies the reporting and model monitoring process. Secondly, it allows for expert knowledge to be used by way of relocation of entities to higher or lower rating classes.

The *default* probability determination model and the master scale are known as the rating system. This is used to forecast the default probability of each entity, expressed by a rating class. There are two approaches used to establish a rating system. The first, called PIT (*point in time*), assumes maximum adjustment to changes resulting from the business cycle. The default probability estimation includes individual and macroeconomic components. A high level of migration of units to lower classes is expected in a period of economic growth, and to higher classes at a time of crisis. The second approach, known as TTC (*trough the cycle*), maximally reduces the influence of the macroeconomic component. All changes are only determined by changes in the individual estimation component, while the percentage share of entities should remain relatively unchanged (Heitfeld, 2005). There is also a broad range of intermediate hybrid approaches, which include individual elements of both the above methods.

This article deals with the issue of rating system calibration, i.e. the allocation of rating classes to entities in order to ensure that the calibration power of the division created is as high as possible. At first, the shape of the function depicting the transition of score into default probability is estimated. The methods presented can be divided into two groups. The first contains the methods for approximating the conditional score distributions of defaults and entities with a good financial standing to their parametric distribution, which can be expressed with the use of a density function and distribution functions. Taking into consideration that these distributions are usually skewed either rightward or leftward of the median, only those types of distribution that allow for a description of both density function asymmetry variants with the use of the appropriate parameters (e.g. asymmetric Gauss distribution, asymmetric Laplace distribution, skew normal distribution and scaled beta distribution) are described. On this basis, and with the use of Bayes' formula, it is possible to define PD values. These methods are recommended for the purpose of calibrating a score which is not interpreted as a probability (e.g. the score as a result of discriminant analysis).

The second group covers a number of variants of regression on binary variables denoting the default status of a given company. These are universal methods which facilitate the calibration of a score which can be interpreted as a probability (e.g. the score as a result of logistic regression). Firstly, apart from the most popular transition functions (probit and logit), others have also been suggested: cauchit and the complementary log-log function. Another alternative is the application of Platt scaling and Box-Cox transformations to the explanatory variable. The polygonal curve model can also be used for each regression, and a further option is the quasi-moment-matching method and isotonic regression. Based on the probability values found, the rating is allocated with the use of a master scale with set threshold values for individual classes.

Regarding the fact that the main purpose of using the rating system is risk assessment determined in terms of probability, the verification of calibration power is the main part of validation. As noted by Blöchlinger and Leippold (2006), inappropriately calibrated probabilities result in significant losses, even if differences seem to be small. This is a difficult task, because it is impossible to assess the real probability for every assessed unit; in statistical terms it is a latent variable. To solve this problem, it is necessary to use rating classes that are intended to include units of similar risk. Therefore, calibration validation is a comparison of valued *ex-ante* probabilities and the observed *ex-post* indicators of insolvency for particular classes, as well as the verification of the significance of statistical differences between those indicators.

While validating model calibration, it is worth testing the calibration power of individual classes, as well as the entire rating system. Testing individual classes mainly involves the binomial test, with all its modifications. A crucial aspect here is to take into consideration the *default* correlation between entities. Therefore three additional tests will be carried out: the *one-factor-model,* the *moment matching approach* and *granularity adjustment*. While assessing the calibration power of the rating system on the basis of multiple tests carried out on individual classes, the error of decreasing the value of the established *p-value* level is made. One solution to this problem is to use the Bonferroni or Sidak correction. Another method is to follow the Holm, Hochberg or Hommel procedures. The most popular test of the entire rating system is the Hosmer-Lemeshow test, which involves examination of the differences between observed and the estimated default probability. For the purpose of this research, the Spiegelhalter and Blöchlinger tests were also used; these facilitate verification of the calibration power achieved in a different manner to the Hosmer-Lemeshow test.

The basic purpose of this article is to present calibration methods which provide accurate estimations of default probabilities and validation techniques of calibration power. Using those both aspects on real data provides accurate verification and appropriate conclusions. The subject matter of this article is important and actual, as there is no consensus among practitioners regarding the selection of calibration methods and ways of testing them, so the comparison of methods constitutes a significant added value. According to the author's best knowledge, some methods will be used for the first time with regard to rating systems calibration. This also confirms the significant value of this work.

Two main research questions will be addressed. The first seeks to verify whether there is a calibration method that gives estimations of probabilities of significantly better quality in logistic regression than others. One of the main assumptions of the new regulation was that banks should be free to select a method for insolvency probability estimation. Logistic regression is the method usually used by banks. This method is also recommended by some Analytics[1]. Comparing the precision of estimates obtained by means of different approaches will provide an unambiguous evaluation of the quality of the models used.

The second question concerns rating system structure: does the number of rating classes really impact calibration quality? Breinlinger et al. (2003) proved that by increasing the number of classes, at other fixed parameters, the amount of minimum capital requirements decreases. They also found that with a large number of classes it is impossible to meet assumptions concerning the monotonicity of insolvency probability. This might be caused by a significant worsening of estimation calibration. A detailed determination regarding the number of rating classes used is a rarely mentioned but crucial problem, especially for the rating system structure process.

The conclusions presented in this article are mainly directed to banking sector employees concerned with identifying the best way to calibrate internal credit risk systems. A detailed presentation and comparison of different methods allows for a comparison of particular approaches and the selection of the best one. The part of this work that concerns the testing process may be a valuable source of information for validators of risk models.

Data description

The empirical analysis was based on the individual data from different sources (from the years 2007 to 2012):

- Data on banking defaults are drawn from **Prudential Reporting (NB300)** managed by Narodowy Bank Polski. The Act of the Board of the Narodowy Bank Polski no. 53/2011, dated 22 September 2011 concerning the procedure for and detailed principles of the handing over by banks to the Narodowy Bank Polski data, indispensable for monetary policy, for the periodical evaluation of monetary policy, evaluation of the financial situation of banks and banking sector risks.
- Data on insolvencies/bankruptcies come from a database managed by The **National Court Register (KRS)**, which is the national network of official business register.
- Financial statement data (**AMADEUS (*Bureau van Dijk*); Notoria OnLine**). Amadeus (Bureau van Dijk) is a database of comparable financial and business information on Europe's biggest 510,000 public and private companies by assets.

[1] CRISIL Global Research & Analytics, *Credit Risk Estimation Techniques*.

Amadeus includes standardized annual accounts (consolidated and unconsolidated), financial ratios, sectoral activities and ownership data. A standard Amadeus company report includes 25 balance sheet items; 26 profit-and-loss account items; and 26 ratios. *Notoria OnLine* is the standardized format of financial statements for all companies listed on the Stock Exchange in Warsaw.

The following sectors were taken from the Polish Classification of Activities 2007 sample: section A (Agriculture, forestry and fishing), K (Financial and insurance activities). The following legal forms were analyzed: partnerships (unlimited partnerships, professional partnerships, limited partnerships, joint stock-limited partnerships); capital companies (limited liability companies, joint stock companies); and civil law partnerships, state owned enterprises, foreign enterprises.

For the definition of the total number of obligors the following selection criteria were used:

– the company is existent (operating and not liquidated/in liquidation) throughout the entire respective year;
– the company is not in default at the beginning of the year;
– the total exposure reported to be at least 1.5 Mio EUR for each reporting date.

The dataset, after its initial preparation and while keeping only those observations upon which the model can be based, contained 5091 records. However, the number of observations marked as "*bad*" was 298 (Table 1).

General statistics for 2012

Source: author's own calculation Table 1

Number of Obligors	Thereof Insolvent	Thereof defaulted	Insolvency Rate	Default rate
5091	28	298	0,55%	5,85%

The preliminary stage was the implementation of the scoring model with the use of the *Nehrebecka approach (2015)*. On the basis of this model, point scores were achieved for each enterprise. The value of the *score* was interpreted by an undefined scoring model. This approach is based on the assumption that this dependence (which is not necessarily linear) is monotonic; that is, that a lesser value correlates to a higher probability of the default state.

The *score* distribution was rescaled so that the values fell between 0 and 1. This is caused mainly by the application of the root in certain calibration methods. With this modified variable *score* and a variable binary defining the *default* state, a validation of the discriminatory power of the model was carried out. AUC, AR, the Pietra index, the *Information Value* index, and the Kolmogorov-Smirnov test were used. A master scale employed by KBC bank (9 classes) in 2011, for corporate clients in Pekao bank (9 classes) in 2013, in Millenium bank (14 classes) in 2011, and in ING bank (19 classes) in 2012 was used. From the research point of view, it is extremely interesting to ascertain whether the quality of the calibration depends on the master scale.

Calibration and verification using a test for the whole rating system

The results presented present the assessment of the function of the transformation of the *score* into a *default* probability, which was used to create a rating for the units. Special attention should be paid to the shape of the function for low probability values, as typically the majority of classes used in master scales cover the first 20% of the probability of the *default* state. The relatively small differences in models for low probabilities will result in relatively large changes in the rating structure. The tests which were carried out allow us to assess the various calibration methods.

1. The quasi-moment-matching method [Tasche, 2009]

In order to use the *quasi-moment-matching* method, the target PD value must be established, assumed as the participation of the units in the *default* state of the total units, and the target value of the AUC (*Cumulative Accuracy Profile*), which has been determined according to the following formula:

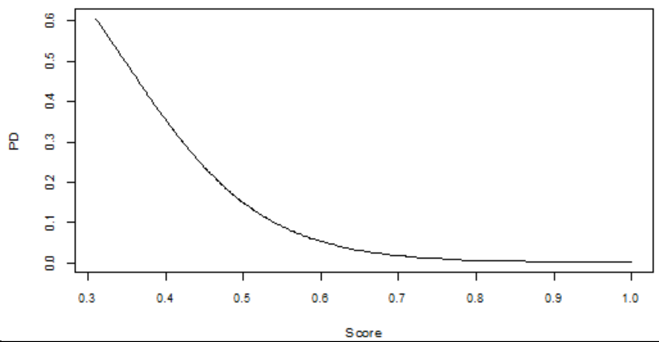
$$AUC = (n_D n_{ND})^{-1} \sum_{i=1}^{n_D} \sum_{j=1}^{n_{ND}} \delta_{y_j}(x_i) \qquad [1]$$

where: n_D - the number of defaulted borrowers, n_{ND} - number of surviving (non-defaulted) borrowers, $\delta_w(z) = \begin{cases} 1 & where \quad z \leq w \\ 0 & \text{where} \quad z > w \end{cases}$.

To numerically estimate the parameters the Broyden, or Newton, was used. The calculated probability of default is shown in Graph 1.

The transition of the score into probability of default using the quasi-moment-matching method

Source: author's own calculation Graph 1



2. Methods of approximating parametric distribution

2.1. Skew normal distribution

The approximation of conditional *score* distributions in families with symmetric distributions is a fallible method. A better approach is calibration of asymmetric distributions. This approach has not been universally applied in the context of the development of *score* mapping functions for conditional PD distributions. In this paper, three methods of estimating the values of these parameters were used. The first of them (MLM1) used the approach described by Dey (2010), involving the numeric estimation of the parameters μ, σ and λ of the *skew normal distribution*:

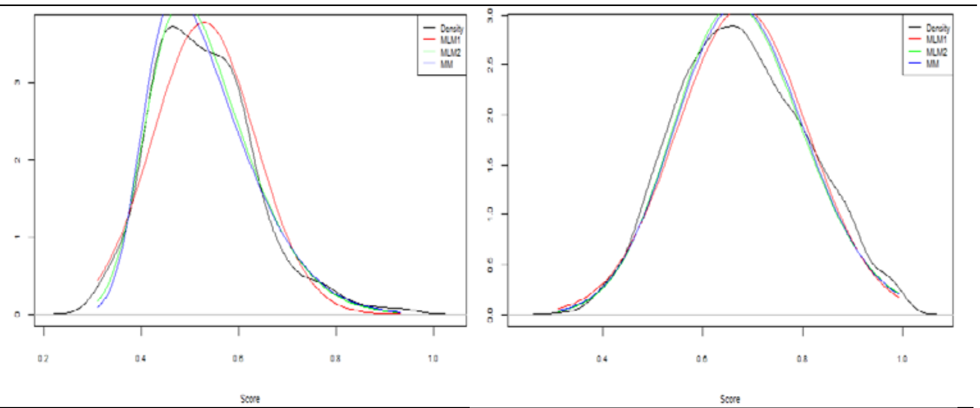
$$f(x) = \frac{2}{\sigma} * \phi\left(\frac{x-\mu}{\sigma}\right) * \Phi\left(\lambda * \frac{x-\mu}{\sigma}\right) \qquad [2]$$

where: $\mu -$ mean, σ – variance, λ – skew, $\phi()$ – density of standard normal distribution, $\Phi(\quad)$ – distribution.

A major problem with the numeric estimation of parameters is the high absolute values of the estimators. This means that the density function is very „steep", which is liable to cause so-called *overfitting*, excessive matching of the model to the data. To avoid this, the starting point should be a low value and a maximum of two steps should be allowed for the iteration of the algorithm. The second method (MLM2) involves the estimation of parameters for which the sum of the density function logarithm is the highest. This is the maximum likelihood method proposed without additional adaptations, as in Dey. Theoretically, the parameters of both methods should be equal. The third method is based on the method of moment (MM).

Empirical density and skew normal density function

Source: author's own calculation Graph 2

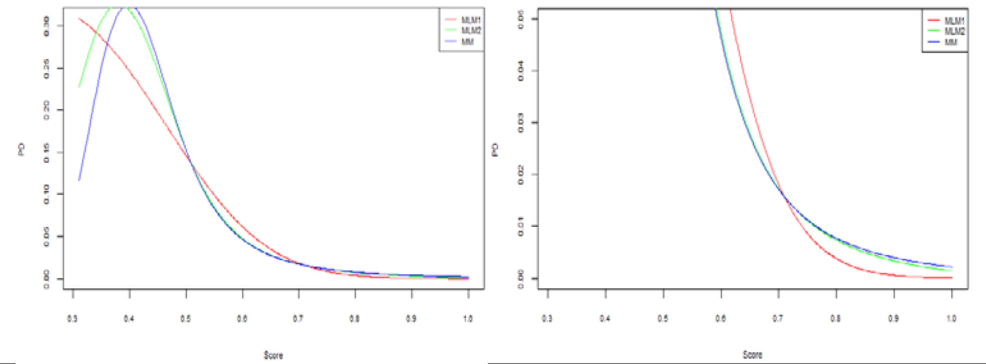


The distribution parameters for units in the default / non-default obtained by maximum likelihood method proposed proposed by Dey and calculated numerically are not equivalent. An empirical density chart with estimated parameters is presented in Graph 2, whereas a chart of the transformation from score into PD is presented in Graph 3. The bimodality of the distribution for default units causes a significant divergence between the estimated and empirical distribution, caused by the lower values of their averages. In the case of a single mode distribution observed for units not in the default state, this problem does not occur, and the estimated distribution is nearer to the empirical equivalent. When analysing the lowest values of probability for high score values, the greatest probability is observed for the method of moment (MM), and the lowest for the MLM1 method. There is a point at about 0.72 from which the above relation is reversed. When the shape of the graph is known along the whole axis from 0 to 1, it can be seen that another point exists at which the relation is reversed, equal to 0.52. In the analysis of the highest PD values for MLM2 and MM, an increase in probability is observed in the score value below 0.4. This is most likely a result of overfitting.

The transition of score into probability of default using the skew normal distribution method

Source: author’s own calculation

Graph 3



2.2. Scaled beta distribution

In order to apply the method to the investigation of the distributions (*default / non-default*) using scaled beta distribution, a numeric method was employed for the calculation of the set of non-linear equations (MLM1); the second method (MLM2) was used in a numeric search for the maximum likelihood function, while the third and fourth methods (MM1 and MM2) were applied to the estimation of parameters using the method of moment. These two methods were distinguished by different estimations of the length of the segment of subsets in the distribution $(b-a)$ based on two methods:

$$\widehat{(b-a)} = \sqrt{\widehat{Var(X)}} * \sqrt{6 + 5 * (\hat{\alpha} + \hat{\beta}) + \frac{(2 + \hat{\alpha} + \hat{\beta}) * (3 + \hat{\alpha} + \hat{\beta})}{6} * \widehat{\gamma_2}} \quad [3]$$

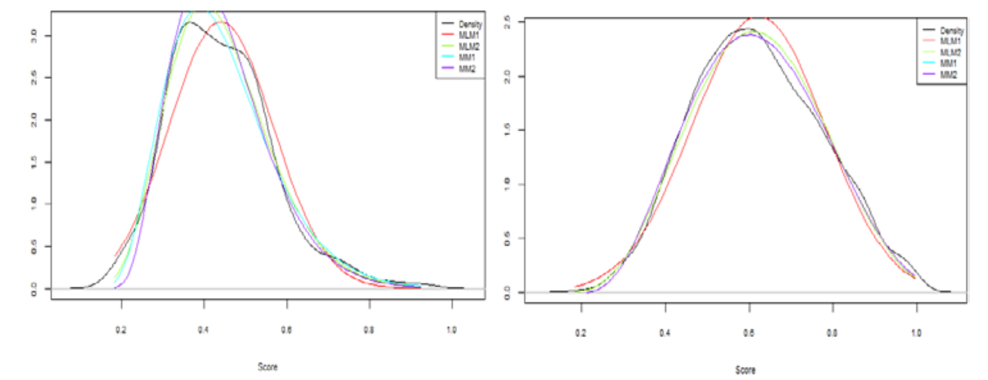
$$\widehat{(b-a)} = \frac{\sqrt{\widehat{Var(X)}}}{2} * \sqrt{(2 + \hat{\alpha} + \hat{\beta})^2 * \widehat{\gamma_1}^2 + 16 * (1 + \hat{\alpha} + \hat{\beta})} \quad [4]$$

where: empirical skew $(\widehat{\gamma_1})$, empirical kurtosis $(\widehat{\gamma_2})$, parametrs $(\hat{\alpha}, \hat{\beta})$.

An empirical density chart with estimated parameters is presented in Graph 4, whereas a chart of the transformation from score into PD is presented in Graph 5.

Empirical density and scaled beta density function

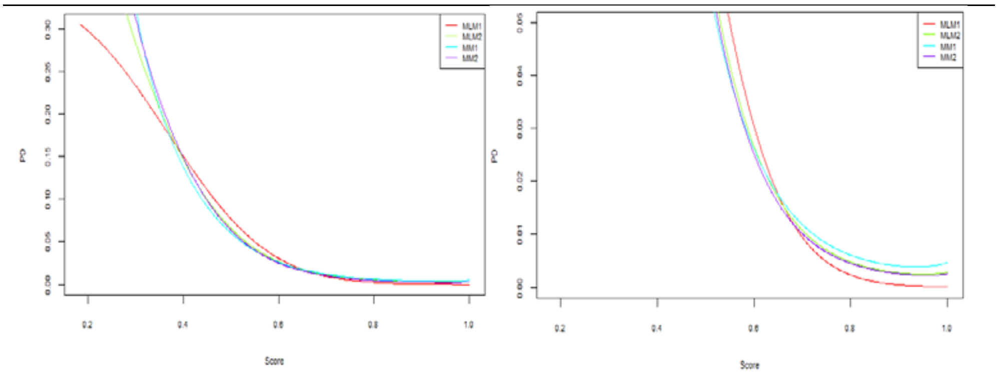
Source: author's own calculation Graph 4



Typical shapes display functions with estimated parameters, as in the maximum likelihood function and the method of moment. Here it is worth noting the difference between the initial values of probability of default. For large *score* values, estimations of probability using the MLM1 method approach 0, whereas the MM1 method gives estimates at an average level of 1%, and these values rise only slightly along with an increase in the *score*.

The transition of score into probability of default using the scaled beta distribution method

Source: author's own calculation Graph 5

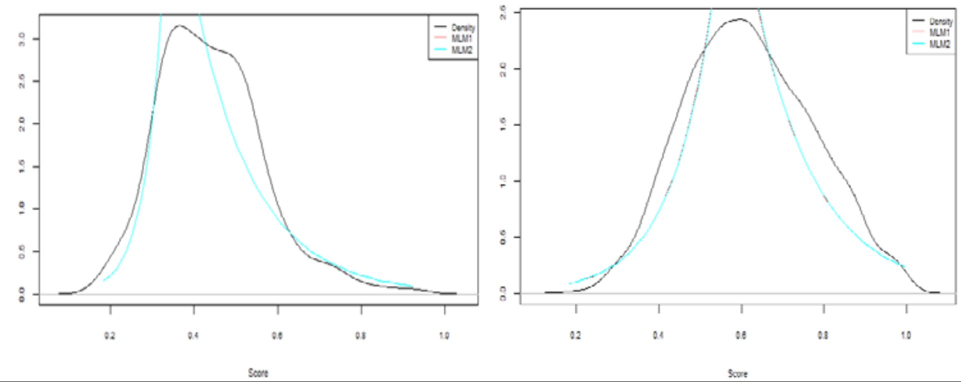


2.3. Asymmetric Laplace distribution

A further approach was proposed by Bennett (2003), who presented a method for approximating the empirical distribution to the asymmetric Laplace distribution and the asymmetric Gauss distribution. The estimate of the parameters achieved using the first method (MLM1) is the result of an algorithm proposed by Bennett, and the second (MLM) is the result of an algorithm searching for the maximum likelihood function. The results of the estimation of distribution parameters achieved by both of these methods is presented in Graphs 6 and 7.

Empirical density and asymmetric Laplace density function Source: author's own calculation

Graph 6

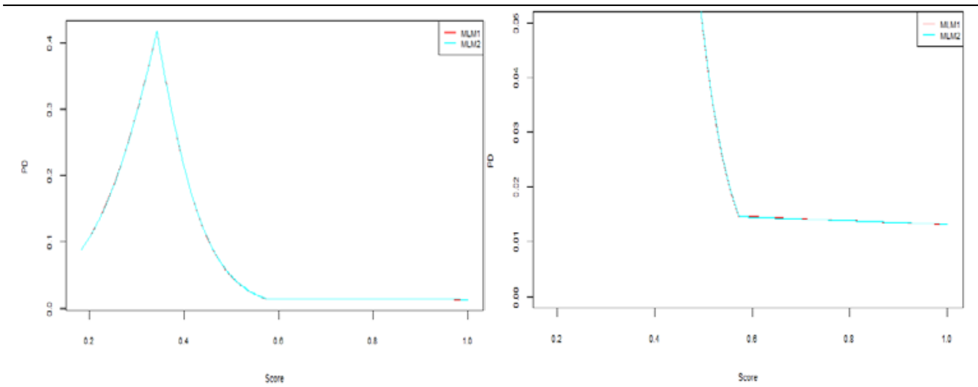


For a sample *score* distribution, significant differences were not noted in the estimates of parameters achieved using the Bennett method and the numeric method of searching for the maximum likelihood function. For a population of units not in the *default* state, parameter estimators have identical values. The adaptation of the Laplace distribution to a greater degree takes into account the mode of the adapted distribution. The bimodality of the distribution for units in the *default* state causes the previously discussed adaptation of the distributions to be shifted towards the lesser mode. An undoubted advantage of using this distribution is the adaptation to the larger mode, meaning that the method is resistant to the bimodality of the distribution and to changes of moment in the distribution due to the observation of outliers. One flaw of the distribution, however, is the increased mass of probability in the central part of the distribution, giving a high kurtosis value. The peaked shape of the density function creates characteristic distortions in the function mapping the *score* into PD.

The transition of score into probability of default using asymmetric Laplace distribution

Source: author's own calculation

Graph 7

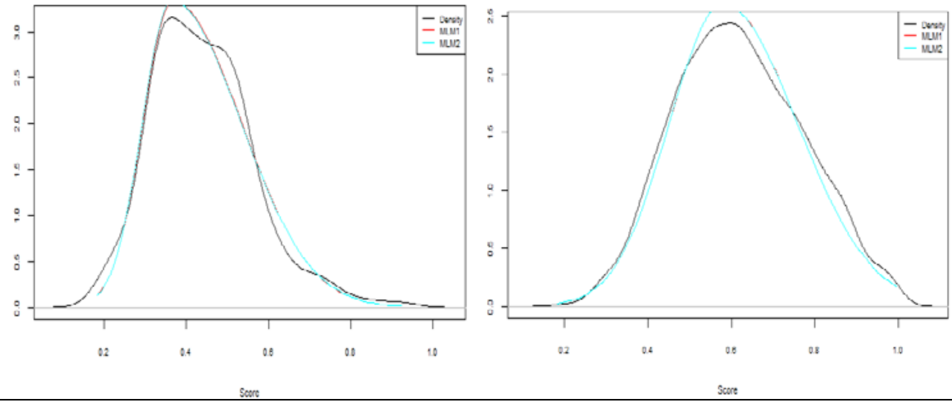


2.4. Asymmetric Gauss distribution

This method assumes the calibration of the empirical distribution to an asymmetric Gauss distribution[2] with three parameters. For the estimate, the method presented by Bennett (MLM1) and the numeric estimate of the maximum likelihood function (MLM2) were used. An empirical density chart with estimated parameters is presented in Graph 8, whereas a chart of the transformation from score into PD is presented in Graph 9.

Empirical density and asymmetric Gauss density function

Source: author's own calculation — Graph 8

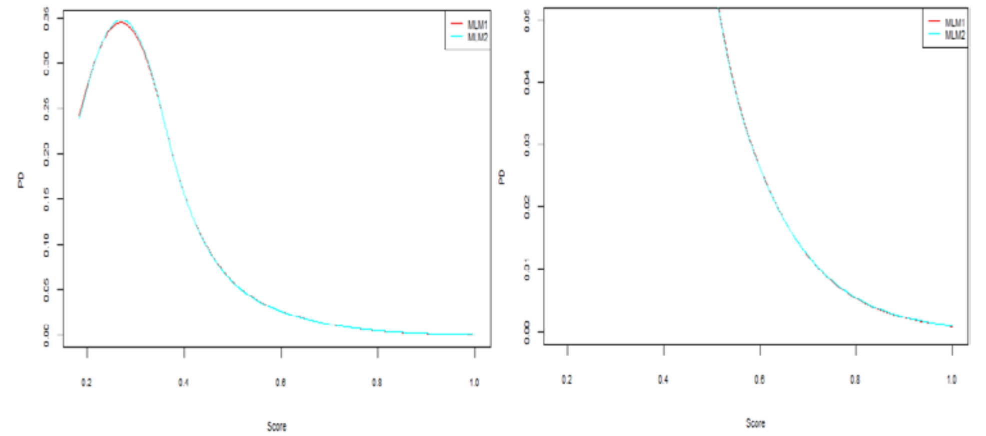


The estimates of parameters achieved using MLM1 and MLM differ, but these differences are minimal. For example, the estimator of the θ parameter for units not in the *default* state for the MLM1 method equals 0.3662, while for the MLM method the same parameter equals 0.364. The relative symmetricity of both empirical distributions creates small differences between the values of the σ_l and σ_r values. For the *score* distribution for units in default, the proportion of standard deviation for *scores* less than θ to standard deviation for arguments greater than θ is 1.15, whereas for the distribution for units not in *default,* this proportion is 0.85. The low value of the bias of the empirical distribution means that this approach does not significantly differ from the probit model, a particular case of the asymmetric Gauss distribution with equal σ_l and σ_r parameters.

[2] $f(x) = \frac{2}{\sqrt{2\pi}(\sigma_l+\sigma_r)} * \begin{cases} \exp\left[-\frac{(x-\theta)^2}{2\sigma_r^2}\right] & \text{gdy} \quad x > \theta \\ \exp\left[-\frac{(x-\theta)^2}{2\sigma_l^2}\right] & \text{gdy} \quad x \le \theta \end{cases}$, where θ, σ_l,σ_r are the model parameters.

The transition of score into probability of default using asymmetric Gauss distribution

Source: author’s own calculation Graph 9



3. Regression analysis and other methods

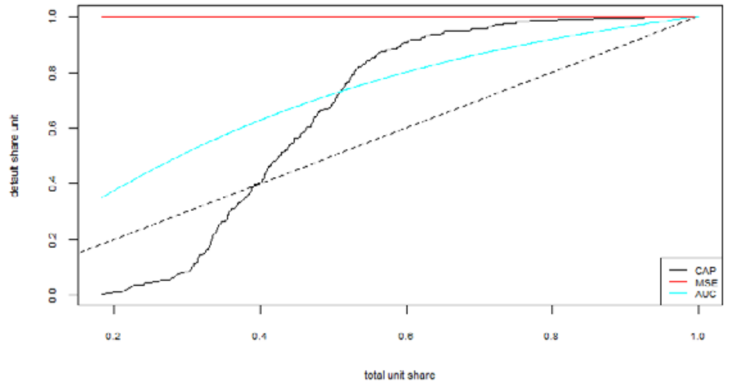
3.1. An approach based on ROC and CAP curves

The method proposed by Van der Burgt involves the estimation of the κ parameter, defining the CAP[3] curve. A derivative of this function allows us to calculate the transformation function of the score into PD. For the estimation of the parameter, two methods were used. The first, MSE (*Mean Square Error*), proposed by Tasche (2009), involves the minimisation of the sum of the squares of the remainders between the empirical CAP curve and its equivalent parameter. The second method (hereinafter referred to AUC – *Area Under Curve*) assumes the use of the dependence between the area under the ROC (AUC) curve and the CAP (*Cumulative Accuracy Profile*) curve, and generates an estimate of the parameter based on this. The results achieved using these two methods are presented in Graphs 10 and 11.

[3] An interesting approach was proposed by Van der Burgt (2007), which involved the approximation of the CAP function with one κ parameter indicating the concavity of the function: $C_{\kappa}(u) = \frac{1-\exp(-\kappa*u)}{1-\exp(-\kappa)}$.

Empirical and two parametric CAP curves

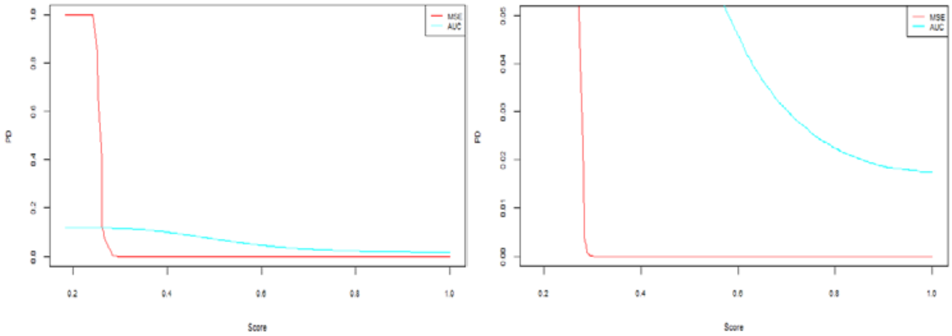
Source: author's own calculation Graph 10



For a given model, the CAP curve has a quite unusual shape - a dynamic growth of the value of the CAP function above the diagonal curve is observed only at 0.4, whereas this normally takes place at the beginning of distribution coordinates. This presents an interesting problem for the algorithm estimating the CAP curve parameter. An estimate using the method of minimising the sum of the squares of remainders defined the parameter as equal to 1000. In turn, the method using AUC gave a result equal to 1.92. The greater the value of the curve parameter, the less flat is its form, which is why the CAP curve obtained using the method of minimising the sum of squares of remainders has a steeper shape and more quickly approaches 1. A chart of the transformation from score into PD is presented in Graph 11.

The transition of score into probability of default using a method based on the calibration curve CAP

Source: author's own calculation Graph 11



For the AUC method, the transformation function of the *score* into PD takes on a sigmoid shape, although the maximum values are significantly lower than those observed in the previously described methods. The maximum size depends on the accepted unconditional probability of default. It should also be noted that the minimum values of probability obtained using the AUC method are greater than analogous values derived from the use of the MSE method. This is an especially relevant property in the context of assigning rating classes.

For the MSE method, the shape of the function is most certainly incorrect, as the vast majority of units will be assigned extreme values of probability, nearing either 0 or 1. An effect of this is the assignment of units to extreme classes, either the best or the worst. In spite of this, it was decided not to disqualify this approach. It is not out of the question that the case under consideration is in some way specific, and that for another data set the transformation function may have a gentler shape.

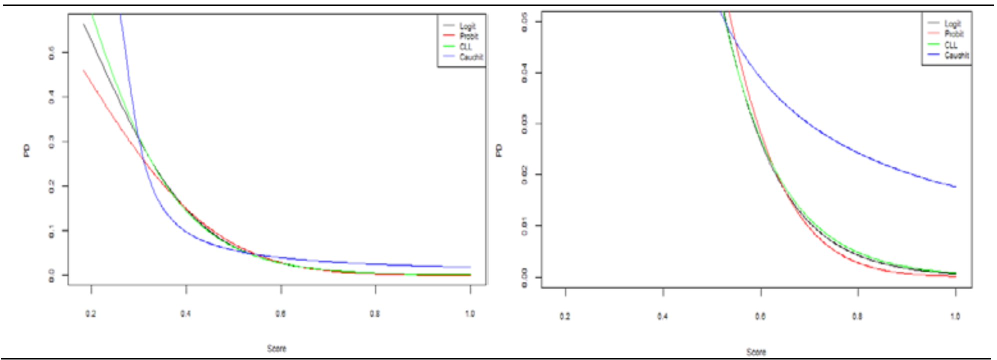
3.2 Logit and probit model, complementary log-log (CLL) function, cauchit function

Another method for the estimation of the function mapping *score* into PD involves the use of linear regression with a binary explanatory variable. One example of a study which addressed the issue of the construction of a transformation function from a synthetic *score* indicator into PD is the work done by Neagu et al. (2009). The authors concentrated on finding an alternative to the basic approaches of the logit and probit models, in which PD value is explained by the *score* constant and variable. As the authors themselves noted with regard to the example analysed, these models overestimate the probability of *default* for units with a low *score*, and underestimate for those with a high *score*. This results mainly from the bias of the *score* distribution. In order to return the distribution to a normal state, the Box-Cox (B-C) and Box-Tidwell (B-T) transformations were used on a variable *score*. The use of these transformations is certainly an interesting operation, which allows us to approximate the asymmetrical distribution to a symmetrical one. It is also worth noting that various distributions „react” differently to this transformation. It is harder to obtain a symmetrical shape when transforming a left-bias distribution, as the change in the transformation parameter results in a greater change in bias with regard to the absolute value and also to the diagnostic statistics of the Anderson-Darling test.

For the article, four transformation functions were used; logit, probit, CLL, and cauchit (Graph 12).

The transition of score into probability of default using the method of linear regression with different transition functions

Source: author’s own calculation — Graph 12



The use of the cauchit transformation function gives the least ambiguous classification (the steepest curve). The probabilities obtained with this method are as a rule the largest among the analysed transformation functions. The initial (lowest) probability values obtained using the probit function method are lower than those obtained by the logit function. The use of the CLL function gives similar results to those obtained with the logit function. Concurrent with a decrease in the *score*, the values of probability rapidly rise, reaching their highest values at a certain moment. It is worth noting the *score* values, as the probabilities are relatively low. This is crucial in the context of the use of a master scale; a regression using the cauchit function significantly inflates these probabilities. This may cause a significant difference in the classification of units to higher rating classes, which usually require a very low probability.

3.3 Platt scaling

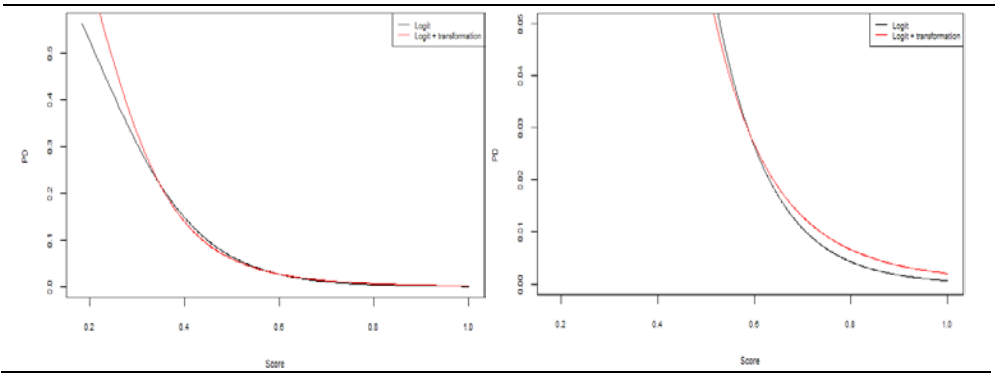
The use of the logit model was also suggested by Platt (1999). Initially, his method was used to transform the results of an SVM (*Support Vector Machines*) study, belonging to the [-∞, +∞] category, for probabilities within a closed range [0, 1]. The use of the Platt correction for the sample analysed does not significantly influence its results. This is caused mainly by the high number of observations (4112) for which the model was estimated. A significant influence will be observable on the basis of only a few samples.

3.4 Transformation function

For each transformation function a separate regression was performed (with a different set of parameter results) on the transformed *score* variable, using the Box-Cox and Box-Tidwell transformations. As was the case with Neagu, the Hosmer-Lemeshow test was used as the optimisation criterion. The differences in the shape of the function in both approaches are meliorated by the regression parameters. The differences between the transformation *score* function into PD for the logistic function, both taking and not taking into account the transformation, are shown in Graph 13.

The transition of score into probability of default using logit regression and logit regression with different transition functions

Source: author’s own calculation — Graph 13



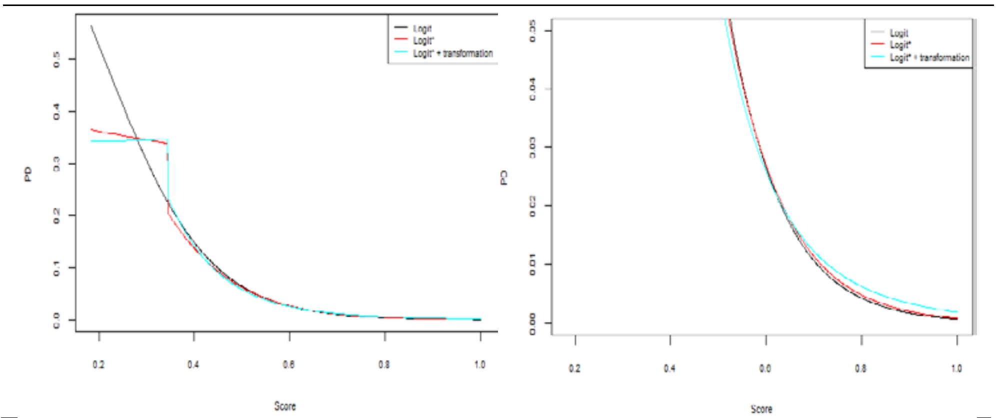
Based on analysis of the graphs of both functions above, it can be seen that the shape of the function has been modified. The function taking into account the transformation begins to grow later, meaning that for a greater number of units, low values of probability will be observed. The growth of the value of this function is also highly dynamic, meaning that from a *score* near 0.38 the probability values are higher than in the model without the transformation. Furthermore, the shape of the function is gradually flattened out and in the segment from 0 to 0.23 probability values are considerably lower.

3.5 Broken curve model

A further modification of linear regression is the application of a broken curve model. The approach proposed by Neagu assumed a search for a point for which the difference between the results of a „*normal*" linear regression and the actual percentage of units in *default* for a given *score* is the highest. Establishing the method used to calculate the last value was a serious problem, as the authors did not give an unambiguous definition of it. For the purposes of this article it was decided that the value of this function for the *score* (s) is equal to the proportion of units in *default* whose *score* fell within the range $\left[s-\frac{sd(score)}{10};s+\frac{sd(score)}{10}\right]$. This amount was next weighted with the value of the density function at point (s). If the value of the density function were not weighted, this method would most often identify a point equal to the *score* value of units not in default with the highest *score* for that group of units. The application of weighting means that the point identified belongs to the „central" part of the distribution wherever the differences are relatively high, although certainly not the highest. This method is resistant to possible outlying points. Additionally, in the broken curve model (as a separate model), an algorithm for searching for Box-Cox and Box-Tidwell transformation parameters has been taken into account, based on a principle identical to those previously described. In contrast to the approach proposed by Neagu, the algorithm was not applied in several steps until a certain criterion was achieved. For optimisation reasons, this algorithm was applied only once, regardless of the values of the function of probability at the extreme ends of both ranges. The results of the model of a broken curve for the function logit is shown in Graph 14.

The transition of score into probability of default using a broken curve model with logit regression and logit regression with different transition function

Source: author's own calculation. Logit* - Logit (broken curve) Graph 14



This same algorithm for searching for the point with the greatest weighted difference meant that the discontinuity points of the functions obtained using both methods were equal. The use of the broken curve causes the value of probability, concurrent with a decrease in *score* values until the breaking point is reached, to increase more quickly in comparison with the standard approach. From this moment onwards, as the *score* values further decreased, the increase in the probability value was significant. The application of the Box-Cox and Box-Tidwell transformations did not cause significant differences other than an increase in the maximum value of probability. When analysing the dependences for low probability values, it can be seen that in comparison to normal linear regression, the application of the broken curve model means that for a greater number of observations, the estimate of the probability of default is obtained at a very low level. In other words, the normal logistic regression overestimates this probability for units with high *score* values.

3.6 Isotonic regression

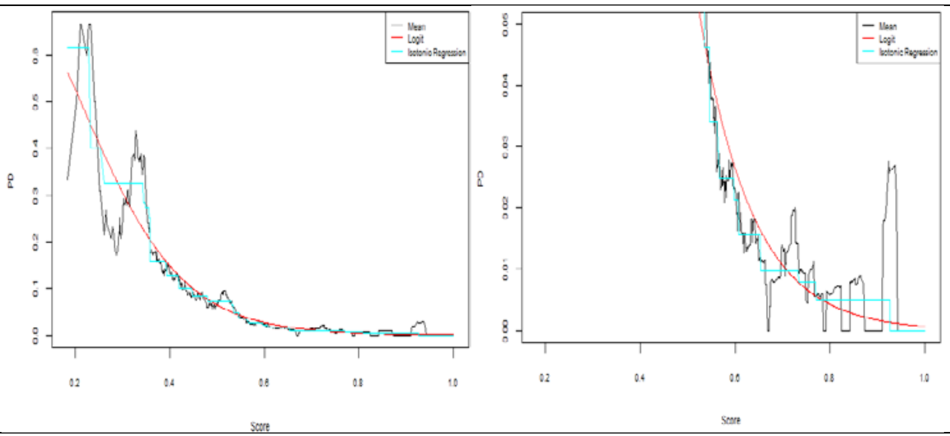
Another approach was presented by Zadrozny and Elkan (2002). The transformation function of the *score* classifier into a probability value may be achieved by the use of isotonic regression. This method can be described as a problem of minimising the weighted sum of error of an estimate (measured as the square of the difference between the estimate and the actual value), with the assumption that the function is non-decreasing.

The shape of the curve obtained by the use of isotonic regression primarily reflects the empirical average of the proportion of units in *default* with a similar *score* value. In accordance with the assumptions of this method, wherever this proportion decreases, the function decreases, and where an increase in proportion is observed, this function remains at the same level. It is worth noting the irregular shape of the average error curve. The stepped shape means that none of the approaches which lead to a sigmoid shape are able to correctly reflect this. An effective solution to this problem is the application of a broken curve or isotonic regression, which theoretically best reflect the actual, irregular shape of the curve. A significant limitation of this approach is the impossibility of expressing the results in the shape of a function. The only viable option is expression as a function, assuming a given value for a defined range. A further flaw is the method's high sensitivity to *default* for units with a high *score* value. The occurrence of such observations means that all observations with a lower *score* value will have a slightly inflated probability of *default*.

The transition of score into probability of default using isotonic regression

Source: author's own calculation

Graph 15



4. Verification using a test for the whole rating system

After estimating the *score* transformation function into the probability of *default*, each unit is assigned a rating, using for this purpose the master scale employed by a given bank. Next, for each rating class an actual default rate is calculated, as the proportion of units in *default* to units in a given rating class. This data is next used to calculate quality tests for calibration of the rating system. There is a risk that the above analysis may in large part be dependent on the *score* distribution for the population of bankruptcies and units in good financial condition. It has also been noted that for one subpopulation, this distribution is bimodal, which is not necessarily the rule for other data sets. This feature may have a substantial impact on the results obtained and the conclusions reached on their basis. To avoid this error, a *k-fold cross-validation* was applied. This involves the division of the original set into *k* subsets. Next, one subset is chosen as a test case, and the rest are treated as a training cases. The estimates obtained for the training cases were then verified with the test case. This step was repeated *k* times for another test case. In the validation set, the shape of the transformation function was estimated, and was next applied to the test case. Subsequently, the *k* obtained for such sets of units, along with the rating assigned to them ,were combined in one set of data based on the average (i.e., the average number of units in a given rating class), on which a calibration test was performed. A value of 4 was assumed for *k*, which on the one hand allows us to obtain relatively resistant results, and on the other does not significantly extend the process of calculation.

Generally, a higher quality of adaptation is observed for master scales with a smaller number of rating classes (Table 3, Table 4, Table 5, Table 6). For a master scale with 9 classes (KBC and Pekao), lower statistical results are observed in a Spiegelhalter test, higher *p-values* for the Hosmer-Lemeshow test, lower values for the shape component of the Blöchlinger test, and as a result lower values for the general statistics and higher *p-values* for this test are observed. This dependence is caused by the fact that with a less granular range, individual rating classes include „wider" ranges of probability of *default*, leading to an increase in the averages of probability in the initial classes. As has been mentioned previously, the lower the values of probability are, the slower the convergence to an χ^2 distribution is. A further consequence is an increased number of this observances, a fact which is crucial in the context of the asymptomatic properties of calibration tests. The more precise the range, the greater the variance in the ranks of the proportion of defaults, as the measurement becomes more precise and more biased away from the average. With a large number of observations in a given class, the influence of outliers on the actual value of probability for a given class lessens. In other words, the variance of deviation of the actual proportion *default*s decreases from the average estimate, meaning that the estimate must be more precise (better calibrated). It must be remembered, however, that the aim of the creation of a rating scale is not to maximise the calibration power of the model it uses. On the assumption that further such dependences can be obtained, and are highly likely to be correct, the most adequate division is one which defines several classes, in extreme cases as few as one. Such an approach is not appropriate. The reason for using master scales is, after all, to maximise business potential, and not to maximise the broadly understood efficiency of the model.

In terms of Spiegelhalter test statistics and their equivalent *p-values* of ratings ranges using all master scales, on average the highest quality calibration was observed for regression with a cauchit transformation function in the case of master scales comprising 9 classes (KBC, Pekao) for the model approximating the asymmetric Laplace distribution (Laplace-MLM1, Laplace-MLM2), the skew normal approximation method (Skewnormal – MLM1), the scaled beta distribution (Beta – MLM1), and the approximation method using the ROC curved (ROC-AUC). The use of Platt's correction brings excellent results. A dependence was observed in which the normal method of moment delivers as a result a lower quality of adapted probabilities. The relatively large differences between both methods in the approximation of the ROC curve should also be stressed. Unambiguously for all master scales, a *p-value* equal to 0.000 is observed for the ROC (ROC-MSE) method of approximating the curve. Additionally, in the case of the Millenium Bank master scale, a *p-value* equal to 0.000 was also noted for the QMM method, and for regression accounting for a broken curve with transformation functions other than *Logit (Broken curve)* (logit, probit, cauchit and CLL).

In performing an analysis of the *p-value* of the Hosmer-Lemeshow test for a range using all master scales, the highest quality is observed for a regression taking into account a broken curve with the *logit* transformation function. In each case, a value equal to 1 is observed. This is especially important for „large" master scales, in which for the majority of models the *p-value* was equal to 0.000. It should also be noted that the simple application and interpretation of the results of this test is problematic, as for values of observed probability near 0 or 1 the values of the test statistics approach infinity. For the model of approximation with an asymmetric beta distribution, both of the method of moment deliver an average statistical test value higher by 2*10^12. This is to be expected, as in this method a relatively small number of units is assigned to a relatively high number of classes. If in a particular case this is one unit which is not in default, the probability of default observed for this class with one unit will equal 0, in turn delivering a high statistical test value. Conclusions on the quality of calibration based on the Hosmer-Lemeshow test may thus be made more difficult. For this reason the application of different, alternative approaches such as the Blöchlinger test is exceptionally valuable.

In terms of the general value of the statistics in the Blöchlinger test and their resultant *p-values*, the worst quality of calibration was obtained when using the two methods of approximating the ROC curve. In turn, the best quality was observed for regression taking into account a broken curve with a logit transformation function, regression with a logit curve, probit, CLL, and cauchit with the Box-Cox transformation. With the exception of regression, for all of these models the quality of calibration rises with the increase in the granularity of the range.

Summing up, the calibration power of the entire rating system was obtained with different calibration methods and different master scales using three tests which took into account k-fold cross-validation. The use of these tests allowed us to study several aspects of high-quality calibration. The Spiegelhalter test verifies the extent to which the estimate of probability for units diverge from the observed proportion of defaults in a given group of units. The shape of the test statistics is regular and is the result of a process of standardisation. A similar zero hypothesis is obtained by the Hosmer-Lemeshow test, though the unit is the rating class, and the statistics have an χ^2 distribution. The Blöchlinger test verifies two basic elements of high-quality calibrations – a size component measured as the average of probability of default with regard to the average proportion of defaults for the entire sample, and a shape component measured as the deviation from the observed ROC curve.

In comparing the quality of calibration to normal logistic regression, a set of methods with a significantly better precision of estimates was identified. There are also methods which always give better calibrated estimates of probability when compared to all of the methods applied in the tests. These are regressions that take into account a broken curve with logit transformation, logit regression, probit, CLL, and cauchit with the Box-Cox transformation.

A further conclusion is the considerable improvement in calibration that is achieved when the Box-Cox transformation is taken into account for the regression analysed. A significant increase in the average *p-values* for the Blöchlinger and Hosmer-Lemeshow tests is observed. The *p-values* of the Spiegelhalter test remain relatively stable.

In performing an analysis of the calibration with regard to the number of classes in the master scale, a significant decrease in the precision of the estimates of probability can be observed with an increase in the number of classes. This dependence is especially visible for the Blöchlinger test.

Conclusion

The basic aim of this paper was to present methods of calibration that allow us to obtain precise estimates of the probability of default, and techniques of validation based on their calibrating power. The use of k-fold cross-validation and repetition of calculations for different master scales and differing data sets means that the results should be highly resistant for the distribution variable in the training set.

The use of several tests allows us to take into account different definitions of high-quality calibration. The results obtained were not unambiguous, but they do allow us to answer the basic research question. First, we can say that there are methods which deliver considerably better calibrated estimates of probability in comparison with logistic regression estimators. The difference observed is relatively large and also concerns calibration of the system as a whole.

The second research question concerned the quality of calibration for different numbers of classes in the master scales. Using four different approaches (master scales including from 9 to 19 classes), whose sources were bank reports on risk, a decrease in the quality of calibration of the whole rating system was noted, in conjunction with an increase in the number of classes. This dependence is dictated first and foremost by the wider ranges of probability for particular classes, and by the properties of the statistical tests applied.

These conclusions definitely do not fully address the issue of the construction of a model that would give the best calibrated estimates. This issue is highly complex, due mainly to the lack of a single, unambiguous method of calibration and a method of estimating the correlation of default between units. A very interesting development of this study would be the use of simulation techniques and an attempt to take into account the cost (expressed in units of time) for the calculation of samples of various sizes.

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Distribution of units on rating classes for different calibration methods and calibration tests for the whole rating system based on a master scale - KBC bank.

Source: author's own calculation

Table 2

Method	Rating 1	2	3	4	5	6	7	8	9	Spiegelhalter	Spiegelhalter p-value	Hosmer-Lemeshow	Hosmer-Lemeshow p-value	Birer Score	Blochlinger Chi2	Blochlinger p-value
Master scale: Upper	0,00%	0,10%	0,20%	0,40%	0,80%	1,60%	3,20%	6,40%	12,80%							
Master scale: Lower	0,10%	0,20%	0,40%	0,80%	1,60%	3,20%	6,40%	12,80%	100%							
QMM	57	137	317	460	582	727	735	633	464	-0,3921	0,6525	9,2857	0,2328	0,0008	0,9929	0,6087
Skewnormal - MLM1	327	194	253	348	441	584	697	729	539	-0,6614	0,7458	36,4415	0,0000	0,0003	0,7943	0,6722
Skewnormal - MLM2	0	57	249	523	734	799	722	517	511	-0,4636	0,6785	8,7482	0,1882	0,0005	0,7990	0,6706
Skewnormal - MM	0	0	214	577	778	818	717	502	506	-0,3718	0,6450	7,3424	0,1964	0,0006	0,6332	0,7286
Beta - MLM1	309	187	253	347	440	592	705	757	522	-0,6189	0,7320	34,8075	0,0000	0,0003	0,6180	0,7342
Beta - MLM2	0	0	419	535	599	713	732	650	464	-0,3421	0,6339	4,3948	0,4941	0,0009	0,7244	0,6961
Beta - MM1	0	0	97	698	704	814	791	593	415	-0,1602	0,5636	5,3872	0,3705	0,0026	0,9845	0,6112
Beta - MM2	0	0	452	542	609	717	725	603	464	-0,4065	0,6578	5,6195	0,3450	0,0022	0,8965	0,6388
Laplace - MLM1	0	0	0	0	2387	416	394	345	570	-0,6560	0,7441	27,3488	0,0000	0,0010	1,4238	0,4907
Laplace - MLM1	0	0	0	0	2378	425	384	351	574	-0,6773	0,7509	26,6065	0,0000	0,0010	1,4856	0,4758
Gauss - MLM1	20	101	270	438	648	853	796	518	468	-0,4127	0,6601	9,9288	0,1926	0,0006	0,6840	0,7103
Gauss - MLM1	18	100	263	442	654	861	795	511	468	-0,3903	0,6518	9,8438	0,1976	0,0006	0,6352	0,7279
ROC – MSE	4071	0	2	6	0	3	3	7	20	163,3894	0,0000	6641797	0,0000	0,0002	123,1925	0,0000
ROC – AUC	0	0	0	0	0	1304	1487	1321	0	-0,6517	0,7427	60,3700	0,0000	0,0001	8,0220	0,0181
Logit	57	143	319	458	576	727	750	618	464	-0,3861	0,6503	8,1855	0,3165	0,0009	0,9083	0,6350
Logit - Platt	57	127	317	456	579	730	749	633	464	-0,4056	0,6575	8,5176	0,2892	0,0008	0,8725	0,6464
Logit - Box-Cox	0	20	205	492	721	861	827	561	425	-0,2960	0,6164	3,6196	0,7280	0,0013	0,9905	0,6094
Probit	231	198	268	384	482	654	712	696	487	-0,4829	0,6854	15,1820	0,0337	0,0006	0,8206	0,6634
Probit – Platt	224	193	268	372	486	646	740	704	479	-0,4965	0,6902	15,8352	0,0267	0,0005	0,8435	0,6559
Probit - Box-Cox	0	0	208	489	729	873	834	567	412	-0,2144	0,5849	3,6169	0,6058	0,0014	0,8675	0,6481
CLL	20	128	293	471	587	767	784	608	454	-0,3632	0,6418	7,5552	0,3734	0,0010	1,0587	0,5890
CLL - Platt	20	123	292	459	597	763	796	608	454	-0,3846	0,6497	7,4704	0,3816	0,0010	1,1238	0,5701
CLL - Box-Cox	0	0	80	414	772	986	906	592	362	-0,1353	0,5538	4,4086	0,4922	0,0015	0,9481	0,6225
Cauchit	0	0	0	0	0	1412	1892	587	221	-1,3317	0,9085	23,3999	0,0000	0,0019	4,7105	0,0949
Cauchit – Platt	0	0	0	0	0	1401	1903	587	221	-1,3336	0,9088	23,3383	0,0000	0,0019	4,8233	0,0897
Cauchit- Box-Cox	0	0	20	421	825	1014	874	546	412	-0,5178	0,6977	3,8313	0,5739	0,0010	0,8677	0,6480
Isotonic	99	0	0	858	1066	411	284	1071	323	-0,3861	0,6503	8,1855	0,3165	0,0009	0,9083	0,6350
Logit (Broken curve)	20	131	293	474	592	770	796	621	415	-0,3937	0,6531	0,0000	1,0000	0,0010	0,8410	0,6567
Logit - Platt (Broken curve)	20	123	286	465	597	775	810	624	412	-0,3965	0,6541	7,6606	0,3635	0,0009	1,0528	0,5907
Logit - Box-Cox (Broken curve)	0	0	214	514	759	866	801	524	434	-0,3010	0,6183	3,4684	0,6282	0,0009	0,6681	0,7160
Probit (Broken curve)	124	182	253	405	521	711	814	738	364	-0,4131	0,6602	16,1469	0,0238	0,0009	1,3129	0,5187
Probit - Platt (Broken curve)	120	166	257	401	528	705	833	740	362	-0,4305	0,6666	16,5331	0,0207	0,0009	1,1963	0,5498
Probit - Box-Cox (Broken curve)	0	20	246	508	717	856	791	540	434	-0,3116	0,6223	3,4907	0,7452	0,0009	0,6617	0,7183
CLL (Broken curve)	20	109	297	468	605	790	798	610	415	-0,3679	0,6435	7,6705	0,3625	0,0009	1,0228	0,5997
CLL - Platt (Broken curve)	19	104	287	460	617	793	804	616	412	-0,3869	0,6506	7,9413	0,3378	0,0009	1,0793	0,5830
CLL - Box-Cox (Broken curve)	0	20	220	516	729	862	796	544	425	-0,2952	0,6161	3,5131	0,7422	0,0009	0,8016	0,6698
Cauchit (Broken curve)	0	0	0	0	444	1858	1118	377	315	-0,3242	0,6271	20,5298	0,0001	0,0006	1,3413	0,5114
Cauchit - Platt (Broken curve)	0	0	0	0	436	1863	1119	379	315	-0,3383	0,6324	20,3797	0,0001	0,0006	1,3899	0,4991
Cauchit- Box-Cox (Broken curve)	0	0	57	454	846	990	840	516	409	-0,3491	0,6365	4,9884	0,4173	0,0009	0,9112	0,6341

Distribution of units on rating classes for different calibration methods and calibration tests for the whole rating system based on a master scale - PEKAO bank

Source: author's own calculation

Table 3

Master scale / Method	Rating 1	2	3	4	5	6	7	8	9	Spiegelhalter	Spiegelhalter p-value	Hosmer-Lemeshow	Hosmer-Lemeshow p-value	Birer Score	Blochlinger Chi2	Blochlinger p-value
Upper	0,00%	0,15%	0,27%	0,45%	0,75%	1,27%	2,25%	4,00%	8,50%							
Lower	0,15%	0,27%	0,45%	0,75%	1,27%	2,25%	4,00%	8,50%	100,00%							
QMM	120	204	247	350	405	555	647	791	793	-0,5914	0,7229	11,4721	0,1193	0,0014	2,1780	0,3366
Skewnormal - MLM1	435	191	208	258	309	419	527	807	958	-0,7709	0,7796	17,5370	0,0142	0,0006	3,0928	0,2130
Skewnormal - MLM2	0	120	257	392	528	674	649	706	786	-0,6506	0,7424	7,2802	0,2957	0,0010	1,8239	0,4017
Skewnormal - MM	0	57	235	429	572	700	648	695	776	-0,5730	0,7167	5,0380	0,5389	0,0011	1,5082	0,4704
Beta - MLM1	410	194	201	252	311	440	522	824	958	-0,7236	0,7654	20,0760	0,0054	0,0006	3,0029	0,2228
Beta - MLM2	0	125	380	398	423	555	639	784	808	-0,5223	0,6993	5,9251	0,4316	0,0014	2,4325	0,2963
Beta - MM1	0	0	252	484	525	620	698	807	726	-0,4499	0,6736	3,8312	0,5740	0,0033	1,7101	0,4253
Beta - MM2	0	176	361	407	447	572	602	761	786	-0,6658	0,7472	4,7846	0,5717	0,0029	1,8959	0,3875
Laplace - MLM1	0	0	0	0	0	2595	334	414	769	-0,9539	0,8299	27,1495	0,0000	0,0018	3,3986	0,1828
Laplace - MLM1	0	0	0	0	0	2595	334	414	769	-0,9678	0,8334	26,7992	0,0000	0,0018	3,3952	0,1831
Gauss - MLM1	82	132	230	330	459	626	751	762	740	-0,6307	0,7359	7,8222	0,3485	0,0012	1,3339	0,5133
Gauss - MLM1	77	123	236	337	460	635	752	759	733	-0,6080	0,7284	6,0849	0,5299	0,0012	1,6055	0,4481
ROC – MSE	4071	1	2	5	0	2	2	3	26	180	0,0000	6 641 597	0,0000	0,0009	123	0,0000
ROC – AUC	0	0	0	0	0	548	1250	1605	709	-0,6436	0,7401	74,9658	0,0000	0,0001	3,9866	0,1362
Logit	121	205	250	351	407	547	647	791	793	-0,5873	0,7215	11,3454	0,1242	0,0014	2,1635	0,3390
Logit - Platt	118	199	242	359	402	552	648	799	793	-0,6015	0,7263	11,3506	0,1240	0,0014	2,2556	0,3237
Logit - Box-Cox	0	75	195	381	521	671	736	824	709	-0,5233	0,6996	4,8129	0,5680	0,0019	1,3651	0,5053
Probit	344	190	222	283	340	478	565	818	872	-0,6410	0,7392	16,8767	0,0182	0,0010	2,2248	0,3288
Probit – Platt	327	197	212	278	354	475	573	824	872	-0,6523	0,7429	17,1691	0,0163	0,0010	2,2585	0,3233
Probit - Box-Cox	0	85	207	369	517	665	736	824	709	-0,4639	0,6787	4,7023	0,5825	0,0020	1,3534	0,5083
CLL	92	171	248	334	442	572	669	808	776	-0,5734	0,7168	7,4560	0,3830	0,0016	1,8116	0,4042
CLL - Platt	88	161	247	338	438	585	671	808	776	-0,5899	0,7224	5,5149	0,5974	0,0016	1,7104	0,4252
CLL - Box-Cox	57	151	244	353	456	596	674	817	764	-0,5534	0,7100	4,7905	0,6855	0,0017	1,5555	0,4594
Cauchit	0	0	0	0	0	358	1809	1477	468	-1,6106	0,9464	31,4054	0,0000	0,0028	2,8728	0,2378
Cauchit – Platt	0	0	0	0	0	353	1807	1484	468	-1,6083	0,9461	31,3468	0,0000	0,0027	2,9616	0,2275
Cauchit- Box-Cox	0	0	20	251	581	825	888	882	665	-0,8234	0,7949	6,6585	0,2473	0,0017	1,3600	0,5066
Isotonic	99	0	0	605	872	541	493	858	644	-0,5873	0,7215	11,3454	0,1242	0,0014	2,1635	0,3390
Logit (Broken curve)	92	171	248	341	435	581	663	841	740	-0,7253	0,7659	0,0000	1,0000	0,0019	1,3469	0,5099
Logit - Platt (Broken curve)	88	152	256	338	438	585	674	841	740	-0,6461	0,7409	6,2755	0,5080	0,0016	1,6754	0,4327
Logit - Box-Cox (Broken curve)	0	58	219	390	554	687	722	780	702	-0,5486	0,7083	3,5685	0,7348	0,0016	1,5399	0,4630
Probit (Broken curve)	219	189	218	295	358	529	640	900	764	-0,6941	0,7562	8,3422	0,3034	0,0017	1,8322	0,4001
Probit - Platt (Broken curve)	194	197	220	292	363	513	655	914	764	-0,7091	0,7609	9,1188	0,2442	0,0017	1,6645	0,4351
Probit - Box-Cox (Broken curve)	0	98	246	377	528	649	722	783	709	-0,5604	0,7124	4,6394	0,5908	0,0016	1,4342	0,4882
CLL (Broken curve)	85	146	263	335	450	589	683	828	733	-0,6220	0,7330	5,6898	0,5764	0,0016	1,6982	0,4278
CLL - Platt (Broken curve)	81	144	243	351	442	596	684	838	733	-0,6390	0,7386	4,7138	0,6948	0,0016	1,5243	0,4667
CLL - Box-Cox (Broken curve)	57	143	252	358	456	602	697	817	730	-0,6090	0,7287	4,5928	0,7095	0,0016	1,7440	0,4181
Cauchit (Broken curve)	0	0	0	0	80	1260	1444	825	503	-0,6300	0,7357	18,6548	0,0003	0,0014	1,7638	0,4140
Cauchit - Platt (Broken curve)	0	0	0	0	77	1257	1450	825	503	-0,6396	0,7388	18,6037	0,0003	0,0014	1,7865	0,4093
Cauchit- Box-Cox (Broken curve)	0	0	57	326	611	817	859	795	647	-0,5949	0,7240	5,8131	0,3248	0,0015	0,9582	0,6194

Distribution of units on rating classes for different calibration methods and calibration tests for the whole rating system based on a master scale - Millenium bank

Source: own calculation

Table 4

Master scale	Rating																				
Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Spiegelhalter	Spiegelhalter p-value	Hosmer-Lemeshow	Hosmer-Lemeshow p-value	Birer Score	Blochlinger Chi2	Blochlinger p-value
Upper	0,00%	0,05%	0,07%	0,14%	0,28%	0,53%	0,95%	1,73%	2,92%	4,67%	7,00%	9,77%	13,61%	27,21%							
Lower	0,05%	0,07%	0,14%	0,28%	0,53%	0,95%	1,73%	2,92%	4,67%	7,00%	9,77%	13,61%	27,21%	100,00%							
QMM	4099	1	0	5	0	0	0	0	0	0	1	1	1	4	350,9	0,0000	311161324	0,0000	0,0000	139	0,0000
Skewnormal - MLM1	173	67	175	231	275	300	386	453	450	419	379	336	450	18	-0,6103	0,7292	44,5856	0,0000	0,0002	0,2987	0,8613
Skewnormal - MLM2	0	0	0	124	366	507	651	618	518	374	269	214	345	126	-0,3160	0,6240	7,2546	0,6106	0,0001	0,2918	0,8643
Skewnormal - MM	0	0	0	75	340	570	675	629	514	373	271	200	332	133	-0,2094	0,5829	3,4684	**0,9428**	0,0001	0,2257	0,8933
Beta - MLM1	158	66	167	226	271	302	403	465	444	427	390	332	445	16	-0,5556	0,7108	46,2002	0,0000	0,0002	0,3189	0,8526
Beta - MLM2	0	0	0	159	467	466	529	556	512	424	314	260	354	71	-0,1301	0,5517	12,1923	0,2027	0,0004	0,4912	0,7822
Beta - MM1	0	0	0	0	419	558	616	624	547	433	304	247	269	95	0,3747	0,3540	10,0139	0,2641	0,0012	0,3327	0,8467
Beta - MM2	0	0	0	214	447	469	550	551	502	405	309	231	339	95	0,0315	0,4874	12,8902	0,1676	0,0011	0,3382	0,8444
Laplace - MLM1	0	0	0	0	0	0	2434	326	250	235	176	148	316	227	-0,3268	0,6281	42,9160	0,0000	0,0002	0,9029	0,6367
Laplace - MLM1	0	0	0	0	0	0	2422	331	257	230	181	148	316	227	-0,3590	0,6402	40,4916	0,0000	0,0002	0,9488	0,6223
Gauss - MLM1	0	0	68	157	312	445	571	664	574	406	285	191	295	144	-0,2276	0,5900	5,5288	0,8532	0,0001	0,2063	0,9020
Gauss - MLM1	0	0	57	164	310	446	586	657	578	411	273	194	290	146	-0,1967	0,5780	5,9365	0,8206	0,0001	0,1989	0,9053
ROC – MSE	4065	1	5	1	7	0	2	1	2	1	2	5	0	20	163,6	0,0000	21795091	0,0000	0,0002	123,73	0,0000
ROC – AUC	0	0	0	0	0	0	0	1107	1010	869	711	415	0	0	-0,6269	0,7346	97,3184	0,0000	0,0000	1,1393	0,5657
Logit	0	18	93	229	337	425	519	556	525	431	314	231	339	95	-0,1583	0,5629	17,2348	0,1011	0,0003	0,2953	0,8627
Logit - Platt	0	1	103	223	334	431	515	566	523	430	321	240	332	93	-0,1818	0,5721	16,5813	0,1209	0,0003	0,3379	0,8445
Logit - Box-Cox	0	0	0	88	300	490	640	671	585	442	289	235	273	99	0,0487	0,4806	6,8660	0,6511	0,0004	0,2568	0,8795
Probit	111	46	169	222	292	343	438	502	472	435	356	287	379	60	-0,3460	0,6353	48,2051	0,0000	0,0002	0,4302	0,8064
Probit – Platt	104	44	164	222	295	343	431	502	482	443	356	290	378	58	-0,3658	0,6427	50,5933	0,0000	0,0002	0,3601	0,8352
Probit - Box-Cox	0	0	81	187	339	417	559	590	535	446	314	238	311	95	-0,0767	0,5306	6,6947	0,7539	0,0003	0,2260	0,8931
CLL	0	0	85	186	340	428	544	590	535	435	325	235	314	95	-0,0929	0,5370	7,9892	0,6299	0,0003	0,2462	0,8842
CLL - Platt	0	0	82	184	338	415	557	591	535	441	325	235	314	95	-0,1208	0,5481	7,2503	0,7016	0,0003	0,2253	0,8934
CLL - Box-Cox	0	0	82	189	340	413	559	590	535	446	314	235	314	95	-0,0914	0,5364	6,5256	0,7693	0,0003	0,2271	0,8927
Cauchit	0	0	0	0	0	0	0	1107	1513	807	327	155	129	74	-0,9210	0,8215	67,2232	0,0000	0,0007	0,8303	0,6602
Cauchit – Platt	0	0	0	0	0	0	0	1107	1503	817	327	158	126	74	-0,9280	0,8233	71,2522	0,0000	0,0007	0,6136	0,7358
Cauchit- Box-Cox	0	0	0	0	92	459	769	803	668	460	284	218	249	110	-0,2761	0,6088	8,7527	0,3636	0,0003	0,3117	0,8557
Isotonic	99	0	0	0	605	253	1066	377	318	46	704	321	138	185	-0,1583	0,5629	17,2348	0,1011	0,0003	0,2953	0,8627
Logit (Broken curve)	0	0	84	192	340	422	554	580	545	450	324	258	205	158	-0,1322	0,5526	0,0000	1,0000	0,0003	0,2920	0,8642
Logit - Platt (Broken curve)	0	0	81	184	332	416	562	591	551	450	324	261	202	158	4,2061	0,0000	1037,7944	0,0000	0,0000	0,2135	0,8987
Logit - Box-Cox (Broken curve)	0	0	0	91	327	525	639	648	572	432	270	221	229	158	4,3686	0,0000	751,6186	0,0000	0,0001	0,2276	0,8924
Probit (Broken curve)	46	41	101	228	286	368	482	542	535	503	359	297	166	158	4,1234	0,0000	1725,5089	0,0000	0,0000	0,2236	0,8942
Probit - Platt (Broken curve)	45	39	90	228	289	361	483	549	545	503	363	301	158	158	4,0675	0,0000	1682,5030	0,0000	0,0000	0,2182	0,8966
Probit - Box-Cox (Broken curve)	0	0	46	174	337	445	580	606	564	434	309	252	207	158	4,2950	0,0000	920,8078	0,0000	0,0000	0,2211	0,8953
CLL (Broken curve)	0	0	76	183	332	427	564	594	570	429	320	252	207	158	4,2776	0,0000	1045,2887	0,0000	0,0000	0,2183	0,8966
CLL - Platt (Broken curve)	0	0	57	173	330	442	566	604	560	443	320	254	205	158	4,2197	0,0000	929,5544	0,0000	0,0000	0,2166	0,8973
CLL - Box-Cox (Broken curve)	0	0	56	174	330	446	576	606	564	431	312	252	207	158	4,2892	0,0000	921,1887	0,0000	0,0000	0,2226	0,8947
Cauchit (Broken curve)	0	0	0	0	0	0	645	1439	960	447	186	142	116	177	3,8386	0,0001	224,7046	0,0000	0,0001	0,2516	0,8818
Cauchit - Platt (Broken curve)	0	0	0	0	0	0	630	1444	955	462	185	143	116	177	3,8003	0,0001	222,3489	0,0000	0,0001	0,2557	0,8800
Cauchit- Box-Cox (Broken curve)	0	0	0	0	91	500	809	819	639	449	254	191	202	158	4,1822	0,0000	454,0612	0,0000	0,0001	0,2439	0,8852

Distribution of units on rating classes for different calibration methods and calibration tests for the whole rating system based on a master scale - ING bank

Source: author's own calculation

Table 5

Master scale	Rating																									
Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Spiegelhalter	Spiegelhalter p-value	Hosmer-Lemeshow	Hosmer-Lemeshow p-value	Birer Score	Blochlinger Chi2	Blochlinger p-value
Upper	0,00%	0,01%	0,02%	0,04%	0,05%	0,06%	0,08%	0,11%	0,17%	0,29%	0,51%	0,89%	1,54%	2,67%	4,62%	8,01%	13,88%	20,00%	30,00%							
Lower	0,01%	0,02%	0,04%	0,05%	0,06%	0,08%	0,11%	0,17%	0,29%	0,51%	0,89%	1,54%	2,67%	4,62%	8,01%	13,88%	20,00%	30,00%	100,00%							
QMM	0	0	0	0	0	20	60	68	210	296	385	471	575	604	570	441	209	140	63	-0,1322	0,5526	22,4454	0,0328	0,0002	0,2005	0,9046
Skewnormal - MLM1	30	58	60	25	41	63	81	105	191	249	280	347	458	514	585	566	300	155	4	-0,5891	0,7221	84,8333	0,0000	0,0001	0,2728	0,8725
Skewnormal - MLM2	0	0	0	0	0	0	0	20	124	304	496	574	655	601	497	380	195	197	69	-0,2972	0,6168	10,4497	0,4020	0,0001	0,2080	0,9012
Skewnormal - MM	0	0	0	0	0	0	0	0	85	303	533	597	671	602	492	371	194	183	81	-0,1897	0,5752	8,5445	0,4803	0,0001	0,2414	0,8863
Beta - MLM1	20	58	46	34	26	76	67	117	187	239	286	343	451	535	602	586	292	144	3	-0,5537	0,7101	108	0,0000	0,0001	0,3310	0,8475
Beta - MLM2	0	0	0	0	0	0	0	0	184	414	426	486	575	593	567	458	232	130	47	-0,0889	0,5354	9,3763	0,4033	0,0003	0,2010	0,9044
Beta - MM1	0	0	0	0	0	0	0	0	0	391	527	554	645	636	578	423	188	95	75	0,4464	0,3277	24,3487	0,0020	0,0010	0,2922	0,8641
Beta - MM2	0	0	0	0	0	0	0	0	231	409	441	488	566	583	547	435	209	135	68	0,1112	0,4557	25,4699	0,0025	0,0009	0,2592	0,8784
Laplace - MLM1	0	0	0	0	0	0	0	0	0	0	0	2372	330	308	309	253	172	182	186	-0,2934	0,6154	44,3942	0,0000	0,0001	0,9417	0,6245
Laplace - MLM1	0	0	0	0	0	0	0	0	0	0	0	2362	340	296	321	256	163	188	186	-0,3121	0,6225	40,4449	0,0000	0,0001	0,9879	0,6102
Gauss - MLM1	0	0	0	0	0	0	20	72	146	283	406	499	679	679	542	351	171	168	96	-0,2089	0,5827	7,9660	0,7163	0,0001	0,2202	0,8957
Gauss - MLM1	0	0	0	0	0	0	20	72	137	282	410	517	667	686	535	352	170	161	103	-0,1779	0,5706	7,9472	0,7180	0,0001	0,2128	0,8991
ROC – MSE	4058	3	4	0	1	5	0	0	1	2	5	0	2	3	2	6	0	0	20	163,6131	0,0000	143246075	0,0000	0,0002	120,7016	0,0000
ROC – AUC	0	0	0	0	0	0	0	0	0	0	0	0	918	1177	1176	841	0	0	0	-0,6358	0,7376	68,1846	0,0000	0,0001	3,1924	0,2027
Logit	0	0	0	0	0	20	61	70	208	296	392	463	585	601	563	441	209	135	68	-0,1258	0,5500	23,3483	0,0249	0,0002	0,2018	0,9040
Logit - Platt	0	0	0	0	0	20	55	70	199	302	378	475	576	614	562	449	212	139	61	-0,1497	0,5595	21,4656	0,0440	0,0002	0,1984	0,9056
Logit - Box-Cox	0	0	0	0	0	0	0	20	128	299	456	535	647	662	579	414	172	122	78	0,0217	0,4914	17,7018	0,0602	0,0003	0,2399	0,8870
Probit	0	30	62	19	18	47	87	120	176	264	321	386	507	550	597	494	264	139	31	-0,3158	0,6239	132,6172	0,0000	0,0001	0,1735	0,9169
Probit – Platt	0	20	68	16	19	46	71	133	175	257	322	391	505	556	597	511	255	139	31	-0,3369	0,6319	155,0342	0,0000	0,0001	0,1751	0,9162
Probit - Box-Cox	0	0	0	0	0	0	0	0	82	249	443	594	707	689	584	412	161	110	81	0,1954	0,4225	19,6716	0,0201	0,0004	0,2643	0,8762
CLL	0	0	0	0	0	0	45	66	175	290	409	492	591	634	572	452	188	130	68	-0,0581	0,5232	30,1901	0,0015	0,0002	0,2600	0,8781
CLL - Platt	0	0	0	0	0	0	42	62	178	279	416	488	595	636	578	452	189	129	68	-0,0869	0,5346	31,6973	0,0009	0,0002	0,2503	0,8824
CLL - Box-Cox	0	0	0	0	0	0	0	0	98	271	422	566	691	699	596	417	175	103	74	0,1245	0,4504	18,1938	0,0330	0,0004	0,2389	0,8874
Cauchit	0	0	0	0	0	0	0	0	0	0	0	0	823	1764	999	329	86	50	61	-0,8665	0,8069	75,8417	0,0000	0,0006	0,5387	0,7639
Cauchit – Platt	0	0	0	0	0	0	0	0	0	0	0	0	819	1760	1007	329	86	51	60	-0,8704	0,8080	74,7127	0,0000	0,0006	0,5816	0,7477
Cauchit- Box-Cox	0	0	0	0	0	0	0	0	0	0	47	575	1020	1066	749	381	114	82	78	-0,5498	0,7088	29,6169	0,0001	0,0003	0,2567	0,8795
Isotonic	99	0	0	0	0	0	0	0	0	605	253	619	824	210	606	573	126	41	156	-0,1258	0,5500	23,3483	0,0249	0,0002	0,2018	0,9040
Logit (Broken curve)	0	0	0	0	0	0	46	65	181	300	396	489	598	633	600	452	189	5	158	-0,1230	0,5489	0,0000	1,0000	0,0003	0,3179	0,8530
Logit - Platt (Broken curve)	0	0	0	0	0	0	42	62	173	284	416	488	603	634	606	462	181	3	158	-0,0612	0,5244	16,0861	0,1380	0,0001	0,2550	0,8803
Logit - Box-Cox (Broken curve)	0	0	0	0	0	0	18	70	150	299	434	506	618	638	593	427	190	11	158	-0,0232	0,5092	6,4494	0,8418	0,0001	0,2384	0,8876
Probit (Broken curve)	0	0	20	27	30	21	47	115	169	256	334	439	535	632	649	538	141	1	158	-0,0805	0,5321	26,9415	0,0292	0,0001	0,2626	0,8770
Probit - Platt (Broken curve)	0	0	20	26	12	34	37	102	184	247	341	423	562	632	654	546	133	1	158	-0,1025	0,5408	34,4180	0,0030	0,0001	0,2582	0,8789
Probit - Box-Cox (Broken curve)	0	0	0	0	0	0	0	0	20	272	503	655	717	666	546	357	149	69	158	0,0575	0,4771	3,5298	0,9396	0,0001	0,2880	0,8659
CLL (Broken curve)	0	0	0	0	0	0	20	79	171	288	419	495	613	633	601	435	191	9	158	-0,0324	0,5129	6,7619	0,8180	0,0001	0,2290	0,8918
CLL - Platt (Broken curve)	0	0	0	0	0	0	20	72	169	282	421	494	610	650	601	441	186	8	158	-0,0568	0,5226	6,9662	0,8018	0,0001	0,2304	0,8912
CLL - Box-Cox (Broken curve)	0	0	0	0	0	0	0	0	20	243	493	656	748	684	538	358	145	68	159	0,0708	0,4718	4,1293	0,9027	0,0001	0,4228	0,8095
Cauchit (Broken curve)	0	0	0	0	0	0	0	0	0	0	0	373	1456	1186	558	248	64	58	169	-0,1263	0,5503	16,5599	0,0110	0,0001	1,2777	0,5279
Cauchit - Platt (Broken curve)	0	0	0	0	0	0	0	0	0	0	0	363	1457	1190	563	248	64	60	167	-0,1433	0,5570	16,3799	0,0119	0,0001	1,2273	0,5414
Cauchit- Box-Cox (Broken curve)	0	0	0	0	0	0	0	0	0	82	419	728	846	776	569	340	137	56	159	-0,0485	0,5193	6,8013	0,5582	0,0001	0,3755	0,8288

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Banks international asset portfolios: optimality, linkages and resilience[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Banks International Asset Portfolios: Optimality, Linkages and Resilience

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Abstract

The world economy has been living under the shadow of the latest global financial crisis. The persistence of high indebtedness levels across the world maintains these concerns on the agenda of economic institutions. This paper tries to address two main questions. First, it examines the cross country asset portfolios and uses network theory to map linkages between banking systems and discuss its resilience to shocks. Second, it assesses how distant are portfolios from an optimal diversification strategy.

Keywords: Banks, Cross-Border Asset Portfolio, Networks

JEL classification: F65, G15, G21

Introduction

Over the last decades, financial markets became more integrated and the size of cross-border portfolios increased significantly. Although the size of cross-border portfolios are strongly affected by valuation effects, international financial integration has deepened. This has been facilitated by higher liberalization of capital movements, as well as by technological progress in the communication and information industries. Nevertheless, many investors still do not seem to fully diversify their external portfolio assets, which are highly concentrated in a few non-resident countries. The high financial integration and the concentration of portfolios in few non-resident countries contributes to propagate and amplify the impact of crisis in specific economies, thus giving rise to aggregate shocks. The role of bank's portfolios is particularly important in this respect because the systemic linkages are stronger and potentially disruptive.

The literature on the propagation of financial crisis has expanded in the recent years and it is too broad to be mentioned here. On the bank dimension recent examples are Bremus and Fratzscher (2014). These authors argue that cross-border bank lending has decreased and the home bias in the credit portfolio of banks has risen in the euro area. Their results suggest that expansionary monetary policy has encouraged cross-border lending, both in euro area and non-euro area countries. In addition, improvements in regulatory policy and increases in financial supervisory power have contributed to higher cross-border lending. Papers that assess banks' international capital flows in the period of the financial crisis with view on financial stability are Hills and Hoggarth (2013) and Hoggarth, et al. (2010). In addition, in its 2012 report, the Committee on International Economic Policy and Reform (2012) signals that the procyclicality inherent in capital flows is not adequately addressed and makes a point for reinforced policy coordination. The literature on financial networks has also greatly expanded. For example, Joseph et al. (2014) analyse the network of cross-border equity and long-term debt securities portfolio investment and measure the robustness of the global financial system and the interdependence of financial markets. Finally, a paper that is important for the purpose of our study is that of Buch et al (2010). The aim of this paper is to identify optimal international asset portfolios for banks by using the mean–variance portfolio model with currency hedging. The benchmark portfolios are compared with the actual cross-border asset positions of banks from 1995 to 2003. Differences between the two portfolios are explained by some additional factors as regulations, institutions, cultural conditions / other financial frictions.

In this article we focus on the representation of the bank's international portfolio in a network setup. In this context the main cross-country portfolio linkages are represented as a directed and unweighted network, complemented by some basic measures that describe its topology and allow for a basic assessment of resilience. In addition, we operate a simple conceptual exercise where the existing portfolios are compared to those that emerge from an optimal allocation strategy.

This article is organised as follows. Section 2 briefly describes the international banking statistics database used. In section 3, the banks' international portfolios are described in December 2007 and March 2016 (the last available period), corresponding to the situation before the international financial and economic crisis and the present moment and their linkages are presented. Section 4 uses optimal portfolio theory to obtain the alternative banks' international assets allocation and discusses deviations relatively to the portfolio actually observed. Finally, section 5 presents some concluding remarks.

Data sources and description

International Banking Statistics

Data on International Banking statistics is disseminated by Bank for International Settlements which is composed by two datasets - Locational Banking Statistics (LBS) and Consolidated Banking Statistics (CBS).

These two datasets refer to the international holdings of assets by banks at a country level from a set of reporting countries. However, they address different aspects of international banking activity. LBS data are a key source of information on the currency and geographical composition of resident banks' balance sheets while CBS provides information about banking systems' risk exposures, in particular country risk. CBS measures worldwide consolidated claims of banks headquartered in reporting countries, including claims of their own foreign affiliates but excluding inter-office positions.

Locational Banking Statistics

According to the BIS definition, Locational Banking Statistics are designed mainly to capture financial claims and liabilities of internationally active banks (i.e excluding only resident domestic banks without positions vis-à-vis non-residents of the reporting country). The statistics cover all on balance sheet positions and some off-balance sheet positions in the area of trustee business. The reporting basis underlying the statistics is the residence of the reporting banking office (conforms to balance of payments and international investment position statistics). These offices report exclusively their own (unconsolidated) business, including their international transactions with any of their own affiliates (branches, subsidiaries, joint ventures), including claims and liabilities vis-à-vis non-residents in any currency, claims and liabilities vis-à-vis residents of the reporting country in local currency as well as in foreign currencies.

The Locational Banking Statistics comprise two subsets - locational banking statistics by residence (LBS/R) and locational banking statistics by nationality. The first subset combines the breakdown by residence of the reporting bank with a full country breakdown of counterparties, whereas the latter shows a breakdown by nationality of the reporting bank. Locational banking statistics by residence were considered for the purpose of this paper. The underlying assumption is that residence is a better proxy to capture shocks taking place in specific locations. Nevertheless, the results will are qualitatively unaltered with LBS by Nationality.

The database covers the time period between 2004 and the first quarter of 2016 and is provided by the Bank for International Settlements (BIS) and similar to the published by the BIS in its Quarterly Review, but more detailed (with respect to bilateral asset positions).It comprises bilateral quarterly asset outstanding amounts for all instruments (Loans and deposits, debt securities and other assets and liabilities), counterparty institutional sectors (Banks, General Government, Households and NPISHs, Nonbank financial institutions, Non-financial corporations) denominated in all currencies, with respect to non-resident counterparty countries located in each of the recipient countries[1]. Locational banking statistics are not consolidated which means that the claims of foreign subsidiaries of reporting banks are not included[2].

A sample of twenty one countries was considered to perform this analysis: Australia, Austria, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Japan, Luxembourg, Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

For these reporting countries foreign financial claims of banks located in the territory vis-à-vis counterparty country is available, and also information of foreign financial claims of banks located in other countries vis-à-vis these reporting countries.

Mapping the network of cross-border portfolios

Bilateral portfolios

Banks bilateral cross-border asset positions are defined as bank claims against non-resident countries located in each of the countries in the sample.

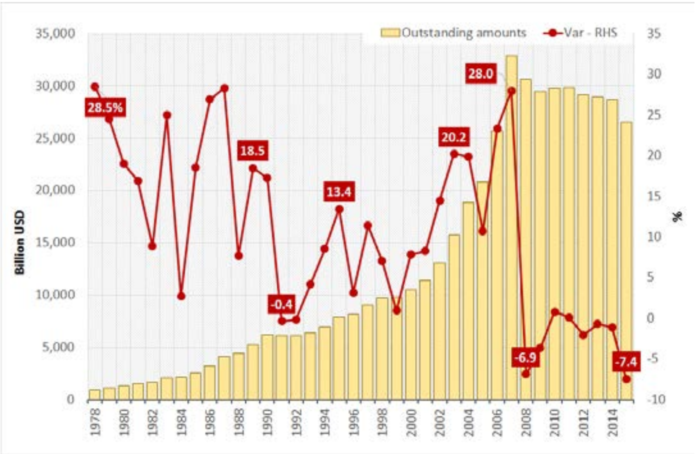
In the last decades, the banks' foreign asset positions grew significantly. According to the BIS data on the LBS/R, in 1978 the total end-of-period cross-border claims outstanding amount vis-à-vis non-residents was 883 billion of USD and in 2015, 26536 billions of USD (Graph 1).

Over the last decade cross-border claims under locational banking statistics show a different pattern, notably since the international economic and financial crises. Graph 1 evidences that, between 2005 and 2007, LBS/R rose from approximately 13,000 billion of USD dollars to 33,000 billion of USD dollars (with a maximal annual variation of 28% in 2007). In 2008, at the peak of the international financial and economic crises, the annual growth rate of cross-border claims was -6.9% (the sharpest annual decrease since 1978). Since then, LBS/R levelled at 31,000 billion of USD dollars approximately.

[1] Additional definitions and concepts can be found in *Guidelines for reporting the BIS international banking statistics*: http://www.bis.org/statistics/bankstatsguide.pdf

[2] Domestic claims of banks in the reporting countries are also not included.

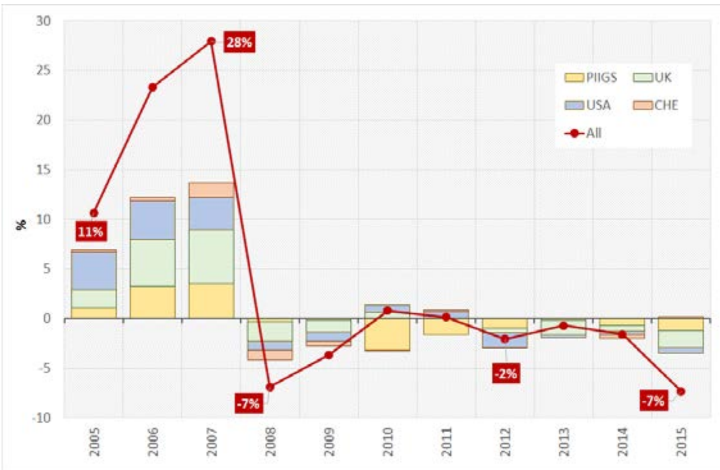
Graph 1 - Cross-border claims and annual growth



Source: BIS statistics.

Taking a geographical breakdown (Graph 2), United Kingdom (UK), PIIGS – Portugal, Italy, Ireland, Greece and Spain, USA and Switzerland, were the main contributors to the reduction recorded in 2008. With exception for 2010 and 2011, where UK and USA showed a positive change, for the remaining years all these countries contributed negatively.

Graph 2 - Cross-border claims – annual change (%) and main contributions by counterparty country



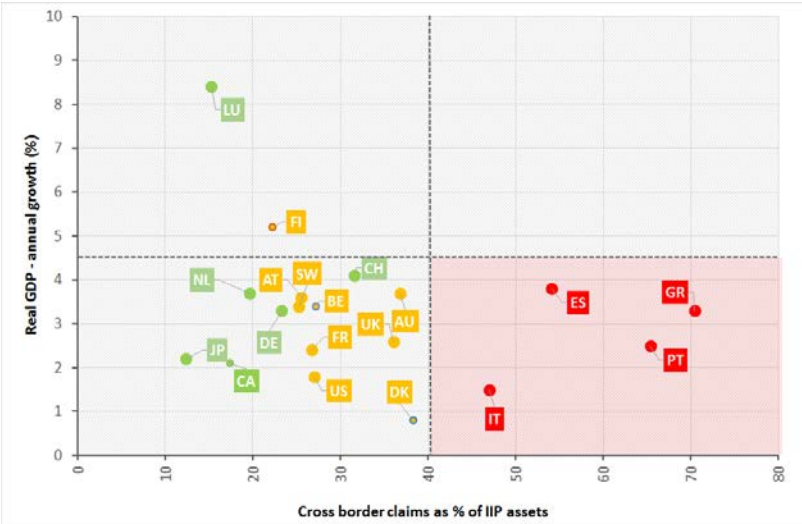
Source: BIS statistics.

Graph 3 depicts cross-border claims as a percentage of the international investment position (IIP) assets and also annual growth of real gross domestic product, for the sample of 21 countries in 2007 and 2015 (with the exception of Ireland, whose IIP for 2007 is not available).

The graph shows that PT, ES, GR and IT) were those where the cross-border claims as percentage of IIP decrease the most after the crisis.

In 2007 these economies recorded large amounts of cross-border claims in total of IIP assets (above 40%) and an annual growth of real gross domestic production below 4% (Graph 3).

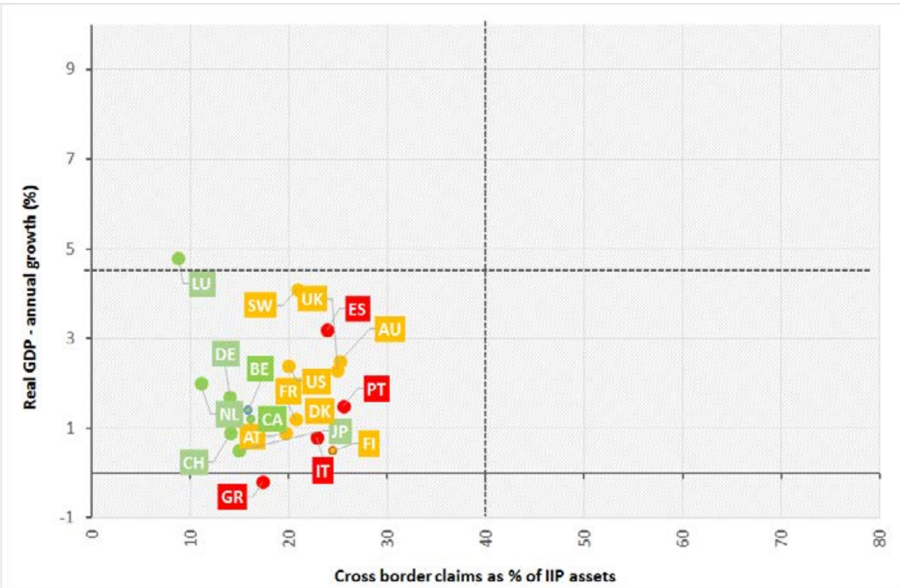
Graph 3 - Real GDP and Cross border claims as % of IIP assets by counterpart country – 2007 and 2015



2007

Source: BIS statistics.

In 2015, the cross-border claims for this set of countries, was below 30% of their total IIP assets, close to that of other countries in the sample.



2015

The whom-to-whom matrices permit tracing the debtor/creditor relationships between countries, i.e. they can be used to show asset balance sheet positions cross-classified by debtor country and creditor country. Based on the bilateral BIS statistical information on LBS/R, these matrices were constructed for the selected sample in December 2007 and 2015 (Tables 1 and 2).

Table 1: Whom-to-whom matrix cross-border claims- December 2007

DEBTOR \ CREDITOR	AU	AT	BE	BR	CA	DK	FI	FR	DE	GR	IE	IT	JP	LU	NL	PT	ES	SE	CH	UK	US
AU		0.0%	0.0%	0.2%	0.9%	0.1%	0.2%	0.7%	0.6%	0.0%	0.1%	0.0%	0.8%	0.1%	0.5%	0.0%	0.1%	0.1%	0.4%	1.2%	0.8%
AT	0.6%		0.8%	0.4%	0.4%	1.3%	1.0%	0.6%	4.5%	3.8%	1.3%	2.6%	0.1%	0.7%	1.4%	1.2%	0.8%	0.5%	1.4%	0.8%	0.4%
BE	1.2%	4.6%		1.2%	1.1%	2.0%	2.0%	7.1%	4.2%	6.8%	12.5%	3.5%	0.6%	4.1%	16.1%	4.8%	3.7%	1.7%	1.0%	4.6%	1.9%
BR	0.0%	0.7%	0.1%		0.3%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%	0.2%	0.0%	0.0%	0.3%	0.4%
CA	0.4%	0.0%	0.1%	2.4%		0.0%	0.0%	0.1%	0.1%	0.1%	1.9%	0.0%	0.1%	0.0%	0.3%	0.0%	0.0%	0.0%	0.1%	0.7%	4.6%
DK	0.1%	0.0%	0.7%	0.1%	0.0%		5.2%	0.2%	0.8%	0.1%	1.4%	0.1%	0.0%	1.1%	0.2%	0.1%	0.3%	21.3%	0.2%	1.1%	0.2%
FI	0.0%	0.1%	0.0%	0.0%	0.0%	10.1%		0.1%	0.2%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	9.1%	0.1%	0.1%	0.0%
FR	10.2%	8.6%	15.4%	6.2%	2.5%	3.1%	3.9%		14.6%	15.4%	10.2%	22.1%	12.8%	11.0%	10.8%	22.0%	20.6%	6.5%	6.1%	12.8%	6.7%
DE	6.1%	40.3%	7.0%	4.7%	4.5%	24.1%	11.9%	12.0%		19.8%	14.2%	21.4%	4.3%	29.5%	11.8%	18.7%	24.9%	13.5%	8.2%	16.9%	10.3%
GR	0.0%	0.2%	0.3%	0.0%	0.0%	0.0%	0.0%	0.3%	0.3%		0.1%	0.1%	0.1%	1.9%	0.2%	0.6%	0.1%	0.0%	0.0%	0.7%	0.1%
IE	6.3%	2.8%	2.1%	0.1%	5.2%	5.0%	2.5%	2.2%	4.3%	4.2%		9.9%	2.8%	1.0%	3.2%	3.7%	6.4%	3.7%	1.2%	6.8%	3.6%
IT	0.1%	16.5%	2.6%	1.8%	0.1%	0.4%	0.3%	4.1%	6.3%	3.0%	3.3%		0.2%	5.5%	1.2%	2.4%	3.7%	0.4%	0.8%	1.8%	0.4%
JP	21.0%	2.4%	5.5%	10.2%	11.7%	3.4%	3.9%	7.9%	8.0%	3.4%	4.0%	3.6%		8.4%	3.5%	1.0%	2.2%	4.3%	4.6%	7.2%	20.0%
LU	2.6%	4.6%	8.2%	3.7%	3.5%	6.7%	1.7%	6.7%	15.1%	6.4%	1.8%	5.9%	0.7%		3.1%	4.3%	4.9%	4.3%	6.0%	2.0%	1.7%
NL	3.3%	1.9%	20.6%	12.9%	0.7%	3.3%	1.5%	2.6%	4.3%	6.2%	5.0%	4.7%	2.3%	3.7%		3.3%	4.1%	2.6%	2.7%	9.4%	2.9%
PT	0.1%	0.3%	0.3%	3.4%	0.0%	1.1%	0.0%	0.4%	0.8%	2.0%	1.2%	0.4%	0.0%	1.1%	0.6%		2.3%	0.1%	0.2%	0.3%	0.2%
ES	0.7%	1.3%	3.0%	4.9%	0.2%	0.8%	1.6%	4.7%	1.9%	0.9%	1.4%	3.2%	0.3%	1.3%	4.7%	19.4%		1.0%	0.7%	3.4%	1.4%
SE	1.3%	0.4%	0.5%	0.7%	0.5%	16.8%	28.3%	0.4%	1.6%	0.1%	0.6%	0.2%	0.0%	0.4%	0.8%	0.1%	0.5%		0.2%	1.2%	0.3%
CH	0.6%	4.8%	5.8%	1.3%	0.8%	0.7%	0.3%	4.0%	4.2%	1.2%	1.4%	0.6%	8.3%	12.2%	5.3%	0.8%	0.3%	0.8%		9.0%	2.3%
UK	33.1%	9.2%	23.6%	16.6%	32.3%	19.7%	13.6%	36.4%	25.6%	26.2%	35.5%	18.2%	49.0%	16.5%	32.2%	16.6%	22.6%	27.2%	43.1%		41.9%
US	12.3%	1.5%	3.3%	29.1%	35.2%	1.1%	22.0%	9.6%	2.5%	0.3%	4.1%	3.3%	17.4%	1.7%	4.0%	0.6%	2.0%	2.9%	22.8%	19.8%	

Table 2: Whom-to-whom matrix cross-border claims- December 2015

DEBTOR \ CREDITOR	AU	AT	BE	BR	CA	DK	FI	FR	DE	GR	IE	IT	JP	LU	NL	PT	ES	SE	CH	UK	US
AU		0.02%	0.06%	0.29%	2.77%	0.06%	0.05%	1.45%	0.87%	0.03%	0.67%	0.00%	1.61%	0.18%	0.81%	0.00%	0.23%	0.15%	0.44%	4.66%	2.45%
AT	0.21%		0.82%	0.26%	0.27%	0.83%	0.75%	0.60%	4.33%	0.16%	0.67%	2.10%	0.01%	0.72%	0.87%	0.93%	1.42%	0.56%	1.26%	0.49%	0.32%
BE	0.58%	1.65%		0.19%	0.76%	1.11%	1.50%	3.83%	4.86%	0.54%	5.27%	1.84%	0.42%	3.02%	9.84%	1.37%	3.07%	1.01%	2.01%	4.38%	1.35%
BR	0.01%	0.17%	0.00%		0.01%	0.18%	0.00%	0.26%	0.03%	0.00%	0.00%	0.03%	0.02%	0.13%	0.03%	0.15%	1.50%	0.00%	0.01%	0.15%	0.39%
CA	2.67%	0.06%	0.06%	3.32%		0.22%	0.07%	0.27%	0.43%	0.00%	2.31%	0.01%	1.49%	1.69%	0.83%	0.00%	0.05%	0.50%	0.30%	1.93%	7.65%
DK	0.22%	0.95%	0.77%	0.02%	0.16%		7.80%	0.79%	2.10%	0.12%	0.72%	0.18%	0.05%	0.79%	0.45%	0.40%	0.86%	21.40%	0.64%	1.10%	0.32%
FI	0.21%	0.72%	0.82%	0.10%	0.55%	30.78%		1.17%	1.79%	0.01%	0.05%	0.16%	0.01%	0.58%	0.72%	0.06%	0.40%	17.03%	0.10%	1.62%	0.60%
FR	4.17%	6.86%	25.58%	7.10%	4.00%	4.93%	3.05%		10.75%	1.88%	13.61%	30.12%	15.87%	15.99%	10.32%	18.44%	29.66%	3.94%	11.64%	12.18%	6.28%
DE	6.08%	40.72%	9.96%	2.23%	5.33%	10.45%	10.68%	15.18%		54.64%	8.28%	14.86%	1.74%	24.59%	18.18%	14.37%	21.41%	13.25%	13.12%	10.15%	4.42%
GR	0.00%	0.01%	0.04%	0.00%	0.01%	0.00%	0.00%	0.02%	0.13%		0.01%	0.03%	0.00%	5.27%	0.18%	0.00%	0.02%	0.01%	0.01%	1.06%	0.01%
IE	1.16%	1.22%	2.50%	0.37%	1.32%	1.23%	0.71%	2.05%	1.58%	0.08%		7.20%	0.34%	0.91%	2.16%	1.07%	2.88%	0.65%	0.35%	3.26%	0.83%
IT	0.34%	19.45%	1.73%	0.35%	0.28%	0.41%	0.53%	5.02%	5.33%	0.51%	3.06%		0.04%	3.26%	1.22%	1.81%	8.60%	0.26%	1.19%	3.40%	0.96%
JP	30.60%	1.68%	9.79%	7.17%	10.07%	2.90%	1.64%	11.89%	8.35%	0.48%	7.34%	4.88%		11.77%	7.41%	0.46%	4.23%	7.70%	4.28%	7.97%	31.78%
LU	1.40%	3.40%	5.64%	5.38%	1.21%	1.39%	2.41%	7.31%	11.14%	2.38%	1.36%	6.52%	0.51%		3.21%	5.55%	2.54%	3.47%	5.67%	2.13%	1.08%
NL	3.88%	4.80%	21.94%	1.69%	1.78%	1.99%	5.77%	6.35%	6.87%	1.20%	12.09%	3.09%	0.88%	4.30%		2.95%	3.78%	3.69%	4.99%	10.17%	3.34%
PT	0.01%	0.04%	0.19%	0.45%	0.04%	0.12%	0.19%	0.38%	0.33%	0.36%	0.84%	1.21%	0.00%	0.59%	0.82%		3.17%	0.02%	0.19%	0.40%	0.08%
ES	0.20%	1.30%	1.93%	5.87%	0.31%	0.15%	0.56%	3.89%	1.69%	0.42%	0.99%	8.36%	0.07%	0.65%	3.48%	31.35%		0.23%	1.02%	1.93%	1.76%
SE	0.36%	0.06%	0.37%	0.48%	0.25%	30.03%	39.45%	0.29%	2.48%	0.06%	0.15%	0.06%	0.12%	1.11%	0.63%	0.04%	0.48%		0.30%	1.54%	0.88%
CH	1.28%	5.11%	2.11%	0.64%	1.70%	3.62%	2.90%	4.09%	4.06%	3.50%	1.25%	1.22%	0.69%	4.94%	2.56%	3.69%	1.36%	2.21%		6.76%	2.76%
UK	25.68%	9.43%	13.50%	15.05%	15.64%	9.24%	12.41%	28.93%	29.09%	32.75%	33.64%	17.06%	28.61%	14.16%	29.96%	17.07%	12.80%	17.54%	35.56%		32.76%
US	20.95%	2.36%	2.20%	49.04%	53.56%	0.36%	9.53%	6.24%	3.79%	0.88%	7.69%	1.07%	47.53%	5.36%	6.32%	0.27%	1.55%	6.36%	16.92%	24.72%	

Source: BIS data.

The sample represents 79% of the total amount for all the counterparty countries in 2007 and 71% and 2015. For all the outstanding amounts reported, this sample covers 84% in 2007 and 81% in 2015. Cross-border claims above 2% of the total cross-border claims reported are shaded. This matrices show that the investments of France, Germany, United Kingdom and United States represent for almost the creditor countries amounts above the threshold (above 2 per cent of the total cross-border investments).

The network representation

In this section, we use the whom-to-whom matrices previously presented to construct the network of bank´s international asset portfolios. In this respect, a directed and unweighted network for locational banking statistics is designed. The nodes correspond to the 21 individual countries (N=21) considered in the sample. The existence of an edge between two countries relies on threshold criterion that aims to reflect the importance of country j (creditor) on the total bank´s international portfolio assets (IAP) of country i (debtor). The threshold is set at 2 per cent of total bank´s international asset portfolios. Hence, the edge is directed from a country i to a country j, if country i bank´s international asset portfolio in country j is larger than the threshold. More formally:

$$\overrightarrow{a_{i,j}} = \begin{cases} 1, & if\ \frac{IAP_{i;j}}{IAP_j} > 0.02 for\ each\ country\ i \neq j, j = 1,2, \dots 21 \\ 0, & otherwise \end{cases}$$

where $A = [a_{i,j}]$ is the NXN connectivity or adjacency matrix.

The choice of this threshold ensures that the resulting network easy to interpret and visualise, while capturing the relevant interrelations between nodes.

The analysis in this paper disregards the strength of the edges identified using the binary information contained in the data (unweighted network). Since the network is directed, every node has two different degrees: indegree and outdegree. The indegree is the number of incoming edges, whereas the outdegree is the number of outgoing edges.

Formally, the number of indegrees is given by:

$$d_s^{in} = \sum_{r=1}^{N} \overrightarrow{a_{ji}}$$

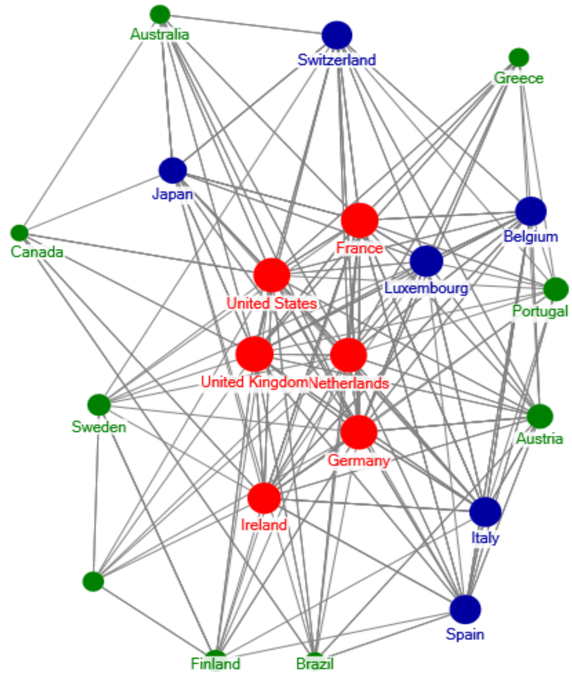
And the number of outdegrees is given by:

$$d_s^{out} = \sum_{r=1}^{N} \overrightarrow{a_{ij}}$$

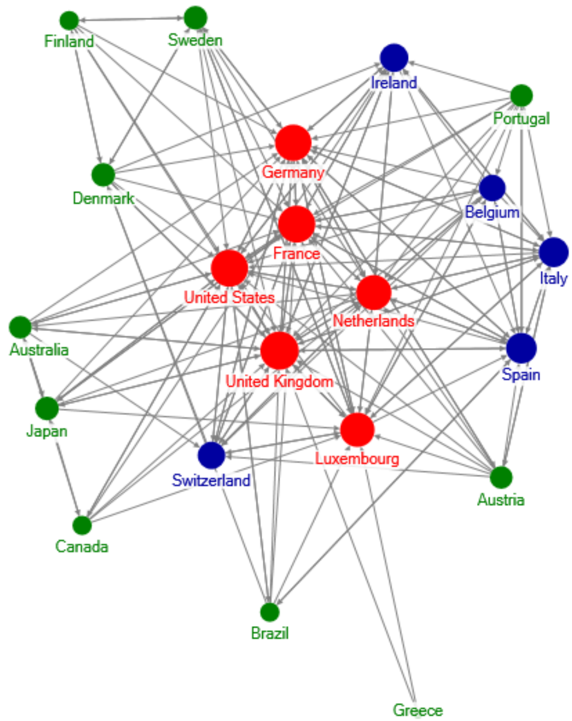
Figure 1 shows the network representations for bank´s international asset portfolio for two distinct periods: December 2007 (before the financial crises) and March 2016 (the most recent available period).

As previously mentioned, the network is directed and the arrows represent the edges, pointing towards countries which threshold is above 2% of the total banks asset holdings.

Figure 1: Network graphs of bank´s international asset portfolios in 2007 and 2016.



2007



2016

The size of each node is proportional to its total degree (sum of indegree and outdegree) and the color of the node is mapped to its indegree, with “Green”, “Blue” and “Red” indicating less than 5 in degrees, between 5-14 in degrees, more than 15 degrees, respectively. The network graphs are based on the Harel-Koren fast multi-scale algorithm and are drawn with the use of NodeXL (see Hansen et al. (2010), an open-source template for Excel for analysis complex networks (http://nodexl.codeplex.com/).

Each country is represented by a circle (node) with arrows (edges) directed from the investor (debtor) to the counterparty country (creditor - who holds the bank´s international assets). In this setup, a force directed layout algorithm is typically used to determine the location of the nodes in the network visualisation. All network graphs in this article are based on the Harel-Koren fast muti-scale alogorithm (Haren and Koren 2002) and are drawn with the use of NodeXL (Hansen et al. 2010). The colour of each node is mapped to its indegree, with "Green", "Blue" and "Red" indicating less than 5 in degrees, between 5-14 in degrees, more than 15 degrees, respectively.

Larger countries tend to have bigger nodes and to locate in the center of the network, because they hold an important amount of the bank´s international asset portfolios. Smaller economies tend to locate in the outer layers of the network. Usually its banks invest their international assets abroad and the other countries do not invest there. Given the construction of the network, it is natural that the large are at the centre but there are other things. Ireland is in this group, there are some interesting linkages between the countries outside this core group.

Between 2007 and 2016 there are some changes in the number of edges and in the position of nodes in the network. In 2007, there are six core countries (with more than 15 indegrees) – UK, USA, DE, FR, IE and NL. In 2016, there are five core countries - UK, USA, NL, FR and LU. (DE and IE are not core countries in the first quarter of 2016 but LU). Austria increased the number of indegrees in 2016.

Metrics

The examination of aggregate network measures provides some additional insights about its structure .Table 3 provides some metrics on the network in 2007 and 2016.

Table 1: Network overall metrics

	2007	2016
Nodes	21	21
Total Edges	291	171
Average degree	13.14	10.60
Average Geodesic Distance	1.27	1.54
Eigenvector Centrality	0.05	0.05

Beyond the number of nodes and edges, other metrics are displayed in table 3. These measures aim to describe the entire network, i.e., they consider not only the position and importance of each node but also the complete set of interactions that establish the key properties of the whole network.

A very simple aggregate metric is the average degree of the network, which measures its average connectivity. In the first quarter 2016, there was a decrease in the average degree, compared to 2007 which means that, on average, each country has lower number of creditor / debtor relations. Therefore, the network became less complex and weakly connected.

The average geodesic distance is the average over all nodes of the length of the shortest path between two nodes increases between 2007 and 2015. This indicator is lower in 2015 when compared to 2007 meaning that in 2015, these 21 economies are less integrated.

The eigenvector centrality is an aggregate metric that characterises how a network is centred around one or a few important nodes by examining the differences in centrality between the most central node in a network and all others. This measure ranges between and allows us to take basic inferences regarding the resilience of the network to shocks.

Optimal cross-border portfolios

In this section we perform a stylized exercise aiming at the identification of what would be the banks' optimal cross-border portfolios. This is a conceptual exercise because the decision of banks relatively to where assets should be placed depends on more parameters than past observed volatility and return. For example geographical proximity, historical and political linkages certainly play a role. In addition, the exercise does not consider the possibility of short portfolios, i.e., banks' having liabilities versus other locations, or holding assets in the domestic banking system. These options are to be tried in a future version of the paper.

In order to compute the optimal cross-border portfolio we apply the standard theory that assesses the return and risk components of banks' portfolio choices.

The portfolio risk comes from the covariances of its different assets, while the marginal contribution to return variance is measured by the covariance between the asset's and portfolio's return rather than by the variance of the asset itself.

On the basis of this model, banks located in each country will decide in which countries to invest their assets in order to maximise asset returns. However, in their decision risk component is integrated to avoid excessive exposure to external market risk.

In order to determine the optimal portfolio, it is assumed that asset returns follow three main indicators equally weighted: i) the change rate of the individual stock market country indexes for all the countries in the sample; ii) exchange rate change; iii) change rate of dividend yiels (10 years). These data was obtained on a daily basis between 1st January 2001 and 25 February 2016 but it was considered that banks take portfolio investment decisions with information regarding the latest 1.5 years.

Next, the main steps of the derivation are briefly sketched. The expected return for an asset i is given by the average during the time period considered:

$$\overline{R}_i = \sum_{t=1}^{N} \frac{R_{i,t}}{N}$$

Where N denotes the numbers of observed returns of asset i, and $R_{i,t}$ denotes the t^{th} observed return of asset i.The portfolio is given by a linear combination of the different asset returns. Thus, the expected return is expressed by:

$$\overline{R}_p = E[R_p] = \sum_{i=1}^{N} x_i \overline{R_i}$$

where $x_i = \frac{1}{N}$ denotes the proportion of asset i held in the portfolio. It is assumed that there is no short selling, i.e., capital can only be obtained with recourse of own savings, $x_i > 0, \quad i = 1,2,...N$. In addition, total asset´s proportion has to be equal to the total capital available: $\sum_{i=1}^{N} x_i = 1$.

The risk of each asset i is defined by its dispersion - the standard deviation:

$$\sigma_i = \sqrt{\sum_{t=1}^{N} \frac{\left(R_{i,t} - \overline{R}_i\right)^2}{(N-1)}}$$

And the correspondent portfolio is given by:

$$\sigma_p = \sqrt{\sum_{j=1}^{N} x_j^2 \sigma_j^2 + \sum_{j=1}^{N} \sum_{\substack{k=1 \\ k \neq j}}^{N} \left(x_j x_k \sigma_{j,k}\right)}$$

Where $\sigma_{j,k}$ denotes the covariance between asset j and k:

$$\sigma_{j,k} = \mathrm{cov}\left(R_j, R_k\right) = \sum_{t=1}^{N} \frac{\left(R_{j,t} - \overline{R_j}\right)\left(R_{k,t} - \overline{R_k}\right)}{(N-1)}$$

Moreover, ρ is the correlation coefficient between assets A and B which is always between -1 and 1 and is expressed as follows:

$$\rho = \frac{\mathrm{cov}\left(R_A, R_B\right)}{\sigma_A \sigma_B}$$

The optimal diversification model finds the composition of all the portfolios that correspond to the efficiency criterion defined for a given set of assets, and construct the corresponding efficient frontier. It minimizes the risk for a given return or maximizes the return for a given risk, which can be written as follows:

$$\begin{aligned} &\underset{\{p\}}{Min}\, \sigma_p^2 \\ &s.to. \quad E\left[R_p\right] = E \\ &\qquad\quad \sum_{i=1}^{N} x_i = 1 \end{aligned}$$

The constant correlation model is applied to calculate the optimal portfolios. This method is based on an optimal ranking of the assets, established over the simplified correlation representation model. To determine the optimal portfolio, the Sharp ratio is calculated for all the available assets:

$$SR = \frac{E[R_i] - R_f}{\sigma_i}$$

Where $E[R_i]$ denotes the expected return on asset i; R_f denotes the risk-free rate; and σ_i denotes the standard deviation of the return of asset i.

The results are classified from the highest value (more desirable) to the lowest value (less desirable) to hold in the portfolio. A threshold is determined to decide which assets will be part of the optimal portfolio (those above the threshold) assets below the threshold will be excluded. The cut-off point C^* is computed as follows:

$$C^* = \frac{\rho}{1-\rho+i\rho} \sum_{j=1}^{i} \frac{R_j - R_f}{\sigma_j}$$

Where R_j denotes the expected return on security j, σ_j denotes the standard deviation of the return of asset j, and ρ denotes the constant correlation coefficient:

$$\rho = \frac{\sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} \rho_{i,j}}{\frac{N(N-1)}{2}}$$

Where $\rho_{i,j}$ denotes the correlation between assets i and j; and N denotes the number of assets in the portfolio. N was used earlier for the number of returns observed for each asset.

The weight of each asset is expressed as:

$$x_i = \frac{Z_i}{\sum_{i=1}^{N} Z_i}$$

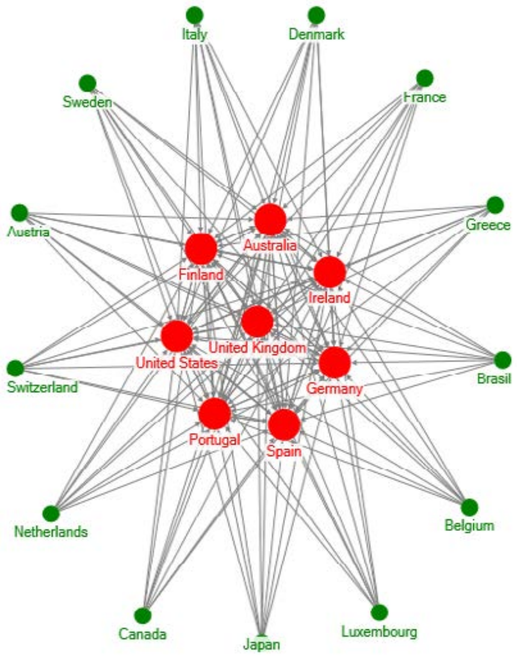
where $Z_i = \frac{1}{\sigma_i (1-\rho)} \left[\frac{(R_i - R_f)}{\sigma_i} - C^* \right]$

We show the results using the network representation that emerge from the optimal portfolios before and after the crisis. The first period before the crises is considered between January 2006 and June 2007. The period after the crises corresponds to June 2012 and November 2013.

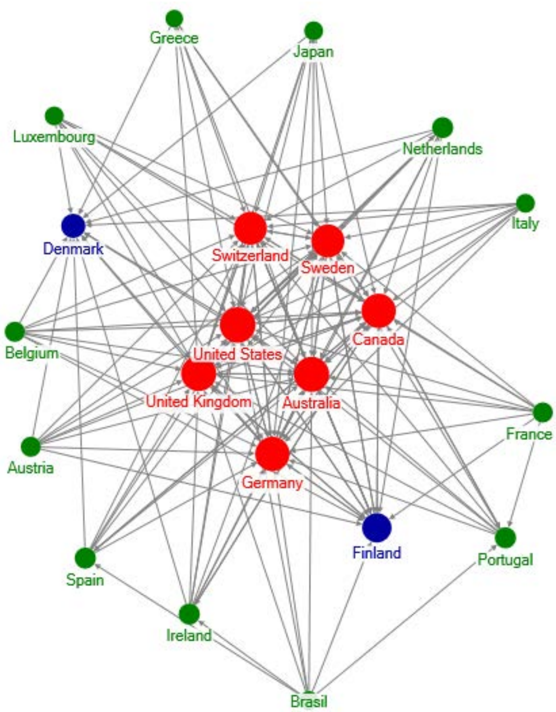
The comparison of the optimal portfolios with those that actually existed must be cautious because other aspects determine bank's international decisions. For example, the deviations between the actual and the benchmark portfolios may be attributable to factors that affect the risk and returns from cross-border asset holdings as Regulations, institutions and information costs that produce frictions as in Buch et al. (2010). Another caveat relatively to the concept of a global optimal portfolio allocation should be mentioned. The optimal portfolio is based on a partial equilibrium approach because it assumes that decisions of reallocation towards some country can always be implemented. However, even if it is optimal to reallocate towards some country, the supply of assets available may be limited, especially if the destination country is small and most source countries are reallocating in the same way. Therefore, the excess demand for the assets increases their price and reduces the implicit rate of return, leading to a new optimal portfolio.

Nevertheless, some insights emerge from the exercise performed. In order to highlight these differences we make use of the network presented in section three – Mapping the network of cross-border portfolios to map the linkages that would arise from banks' international optimal asset portfolios (Figure 2).

Figure 2: Network graphs of bank´s optimal international asset portfolios in 2007 and 2016.



2007



2013

The size of each node is proportional to its total degree (sum of indegree and outdegree) and the color of the node is mapped to its indegree, with "Green", "Blue" and "Red" indicating less than 5 in degrees, between 5-14 in degrees, more than 15 degrees, respectively. The network graphs are based on the Harel-Koren fast multi-scale algorithm and are drawn with the use of NodeXL (see Hansen et al. (2010), an open-source template for Excel for analysis complex networks (http://nodexl.codeplex.com/).

There are deviations between the actual and the optimal portfolio. The number of core financial linkages is higher in the optimal portfolio, meaning that banks should engage in stronger geographic diversification. There are also differences in terms of the core countries. Under the optimal portfolio, countries should invest more outside the euro area countries, UK and US.

As it would be expected, the optimal portfolios are similar for all countries, thus the network shows more symmetry. In fact, if all countries broadly face the same set of alternatives, the optimal portfolio should be nearly the same. However, it is interesting to see to what extent has the optimal portfolio changed after the international economic and financial crisis. The results show that comparing these two different time periods (between and after the crises) the core countries diminished from 8 countries (DE, UK, PT, US, FI, IE, ES, AU) to 7 countries (DE, AU, CA, CH, UK, US, SE). It means that there were four countries, namely PT, ES, IE, FI that reduced the importance in the network, three countries - CA, CH and SE were considered as core countries after the crises, and Denmark also increased its importance.

Table 4 shows the metrics of the network for the optimal portfolio network.

Table 4: Optimal portfolio network overall metrics

	2007	2013
Edges	21	21
Total Edges	160	160
Average degree	12.38	12.57
Average Geodesic Distance	1.32	1.31
Eigenvector Centrality	0.048	0.048

The overall metrics suggest that there is a stabilization of the two networks in terms of the number edges, average degree and eigenvector centrality.

The average degree level increased between 2007 and 2013, and average geodesic distance decrease (from 1.32 to 1.31). The centralization of eigenvector centrality may shed some light regarding changes in the resilience of the networks (it does not change from 0.048).

Final remarks

Although financial markets became more integrated over the years, after the economic and financial crises there was some reduction of the cross-border assets and questions relating to the reshaping international banks portfolios of and its resilience to shocks emerged in the policy-debate.

The whom-to-whom portfolio matrices provide basic information regarding the identification of the main linkages. In this context, network theory offers convenient visualization tools that provide interesting insights in terms of the cross-border banks' portfolio. In addition, it is interesting to assess how large are deviations between actual portfolios and those that would result from the optimal portfolio theory.

The paper concludes that with the financial crises the international linkages between countries changed and the number of core countries diminished. Some countries moved their position in the network. In particular, vulnerable economies deviated from the centre after the financial crisis.

When comparing to the optimal portfolio it deviates significantly from the actual one (before and after the crisis) more diversification needed. More countries appear in the centre. The network that corresponds to the optimal portfolio has also changed with the crisis. In 2013, the core countries changed – Portugal, Spain and Ireland deviated from the centre while new countries – Canada, Sweden and Switzerland became the core countries.

The analysis performed in this paper is admittedly very preliminary and important caveats limit the interpretation of results. However, the utilization of network methods in connection with the concept of an optimal global portfolio seems to be a promising avenue for further research.

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Comparison of BIS derivatives statistics[1]

Philip Wooldridge, BIS

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

September 2016

Comparison of BIS derivatives statistics

Philip D Wooldridge[1]

A lot of information about derivatives is collected in various international datasets, mainly by the BIS, but demands from users for better derivatives statistics raise questions about what should be collected. The first phase of the G20 Data Gaps Initiative (DGI), which was launched in 2009 to close data gaps revealed by the crisis, recommended improvements to credit derivative statistics, and the second phase, launched in 2015, recommended investigating other improvements to derivatives statistics (IMF-FSB (2015)). Each set of derivatives statistics collected by the BIS was designed for a particular analytical use. Consequently, the statistics are neither closely integrated nor easily combined. Also, changes in derivatives markets pose challenges to the uses that the statistics were originally designed to meet (Tissot (2015)). There may be scope to increase the benefits of existing derivatives statistics, and reduce the overall costs, by merging some datasets and streamlining others.

This note is intended to motivate discussions about possible changes to BIS derivatives statistics. It follows up on recommendation 6 from the second phase of the DGI, which asks the BIS to review the derivatives data collected for the international banking statistics and the semiannual survey of over-the-counter (OTC) derivatives markets. The note provides background for these discussions by summarising what statistics are currently collected, highlighting overlaps in coverage, analysing key differences in definitions, and discussing the prospects for obtaining aggregated data from trade repositories. It points to some possible improvements but does not recommend specific changes; more analysis of the uses of derivatives statistics is needed before deciding on recommendations.

The note focuses on outstanding positions: the fair and notional value of derivatives contracts at a point in time. Overlapping coverage and differing definitions are mainly issues for statistics on positions. The case for streamlining statistics on turnover in derivatives markets is weaker because currently very little information is collected about turnover.[2]

Summary of existing statistics

Under the auspices of BIS-hosted committees, particularly the Committee on the Global Financial System (CGFS), the BIS compiles outstanding derivatives positions in

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2 The turnover of foreign exchange and interest rate derivatives is captured in the BIS Triennial Central Bank Survey (covering over-the-counter markets, albeit at a triennial frequency) and the BIS exchange-traded derivatives statistics (covering organised markets, at a monthly frequency).

five different sets of statistics. These are explained briefly below and summarised in Tables 1 and 2.[3]

Locational banking statistics (LBS). The LBS capture the gross fair value of reporting banks' derivative assets and liabilities, on an unconsolidated basis. However, derivatives are not separately identified; they are reported under "other instruments", mixed with equities and instruments other than loans, deposits and debt securities. These "other instruments" are broken down by country and sector of counterparty as well as currency.

Consolidated banking statistics (CBS). In the CBS, banks report their derivatives positions on a consolidated basis. Derivative assets with a positive fair value are reported separately from other assets, and contracts with the same counterparty may be netted where covered by a legally enforceable bilateral netting agreement.[4] Derivative assets are broken down by country of counterparty, but derivative liabilities are reported without any breakdown. The notional amount of protection sold through credit derivatives is reported under guarantees extended (after subtracting cash collateral), broken down by country of counterparty.

Institution-to-aggregate granular statistics to be reported to the **International Data Hub** (IDH) as part of Phase 3 starting in 2017.[5] For the IDH Phase 3 statistics, banks will report derivatives on a consolidated basis and, in the derivatives template, contracts with the same counterparty will not be netted. Derivatives will be reported at gross positive and negative fair value as well as the notional amount, broken down by instrument and asset class. The notional amount of foreign exchange derivatives will be reported with additional breakdowns by currency, maturity and direction of the position. No break down by counterparty will be reported.

Coverage of derivatives statistics Table 1

	Unconsolidated positions (residence basis)		Consolidated positions (nationality basis)	
	All sectors on all sectors	Banks on all sectors	All sectors on all sectors	Banks on all sectors
All markets	IIP[1]	LBS	IFRS	CBS IDH-3
Exchanges	XTD			
OTC markets		OTCD (turnover)		OTCD (outstanding)

CBS = BIS consolidated banking statistics; IDH-3= International Data Hub Phase 3; IFRS = international financial reporting standards; IIP = international investment position; LBS = BIS locational banking statistics; OTCD = BIS OTC derivatives statistics; XTD = BIS exchange-traded derivatives statistics.

[1] Resident sectors on non-resident sectors, ie excluding positions of residents on other residents.

[3] More information is available on the BIS website under derivatives statistics. See also the CGFS's reports on derivatives statistics, eg CGFS (1996) and CGFS (2009).

[4] Derivative assets exclude credit derivatives not held for trading, which instead are reported as risk transfers at notional value.

[5] For more information about the data to be collected in Phase 3, see FSB (2014) and Tracy (2016). Data reported to the IDH are not published and are made available only to participating supervisory authorities.

Breakdowns of derivatives statistics — Table 2

		Classification by counterparty			
		No breakdown	Sector	Country	Sector and country
Classification by underlying asset	No breakdown	OTCD (net)		CBS	LBS (other) IIP
	Asset class[1]	IDH-3	OTCD (gross)		
	Specific asset	XTD	OTCD (CDS)		
Memo:	Long/short[2]	IDH-3 (FX)	OTCD (CDS)		IIP (FX A9)

[1] Commodity, equity, credit, foreign exchange (FX), interest rate. [2] Direction of position.

OTC derivatives (OTCD). In the OTCD statistics, banks and other derivatives dealers report gross positive and negative fair values as well as notional amounts, on a consolidated basis. OTC derivatives are broken down by sector of counterparty (but not country) as well as by instrument, currency and asset class. Credit default swaps (CDS) are reported with additional breakdowns by sector and rating of the underlying reference entity, as well as region of counterparty. Derivatives are also reported at net market value – after netting contracts covered by a legally enforceable bilateral netting agreement – but only for OTC derivatives in aggregate and for credit derivatives, and without any other breakdown.

Exchange-traded derivatives (XTD). The XTD statistics are compiled at a contract level, in contrast to the other BIS derivatives statistics, which are compiled from balance sheet information. Positions are not consolidated; indeed no information about the counterparties to each contact is available. The BIS calculates the notional value of open interest, broken down by instrument and asset class.

In addition to BIS derivatives statistics, national data on derivatives are collected for the international investment position (IIP). Under the methodology in BPM6 (IMF (2009)), derivative assets and liabilities are captured at gross fair value, on an unconsolidated basis. Only positions with non-residents are reported, broken down by resident sector.[6] In addition, supplements to the IIP recommend the collection of notional values for foreign exchange and all financial derivatives, with breakdowns by resident sector and currency.[7]

Overlaps in coverage

Each set of statistics provides information about derivatives positions that is not available in other statistics, but some overlap to a greater extent than others. Overlap is highest between the IDH-3 and OTCD statistics and lowest between the XTD and other derivatives statistics.

The IDH-3 and OTCD statistics provide similar information at an aggregate level. They both provide information about asset classes (eg commodities, equities, credit, foreign exchange, interest rate) at fair and notional values. They are both compiled

[6] Sector of resident counterparty on total non-residents.

[7] See appendices A9-I-1b, A9-I-2b, A9-II-1b, A9-II-2b and A9-III-2b of BPM6.

from balance sheet information on a consolidated basis. In principle the IDH-3 statistics are broader in coverage because they capture exchange-traded as well as OTC derivatives, but the OTCD statistics are reported by a larger sample of banks.

There is some overlap between the CBS and OTCD statistics. The fair value of derivative assets and liabilities is available from both. The notional amount of credit protection sold is available from the CDS statistics and captured within guarantees extended in the CBS. However, different breakdowns are collected. For example, the OTCD statistics provide information about the sector of banks' counterparties, and the CBS about the country of their counterparties. Moreover, whereas netting practices differ across reporting countries in the CBS, netting agreements are taken into account in a consistent way in the OTCD statistics, which consequently are more comparable across reporting countries.

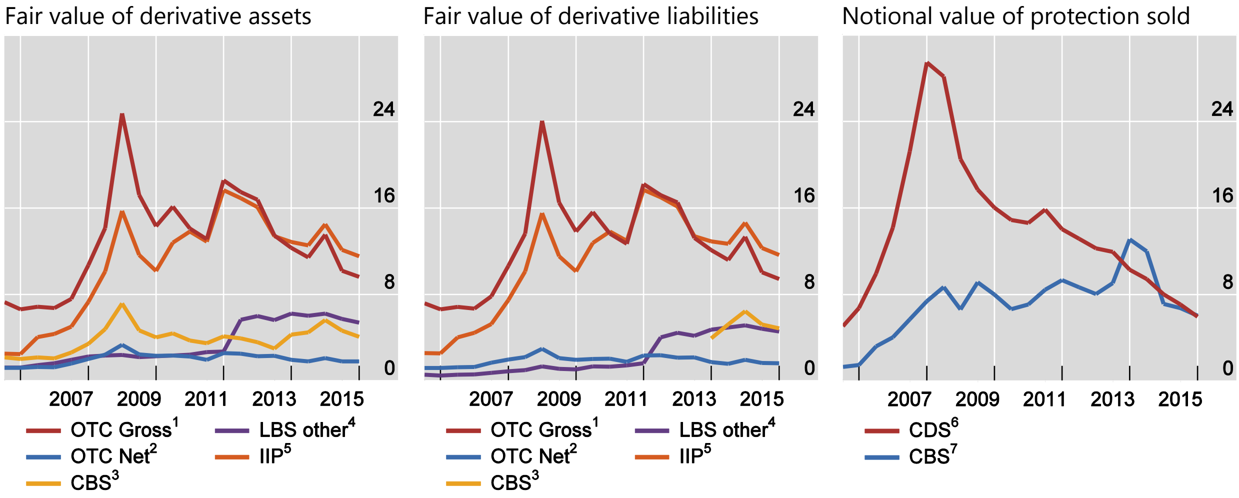
Graph 1 compares derivatives reported in the CBS and OTCD statistics. As shown in the left-hand panel, derivative assets in the CBS lie above the OTCD statistics reported at net fair value but below those at gross fair value. This confirms that banks follow different netting practices across CBS-reporting countries. The centre panel shows similar discrepancies for derivative liabilities. The right-hand panel illustrates that while historically the CBS were a poor proxy for the CDS statistics on credit protection sold, since 2014 the two series have tracked each other more closely, perhaps owing to improvements in reporting in the CBS.

In principle the counterparty details in the CBS and OTCD statistics overlap with those in the LBS, where derivatives are reported by country and sector of counterparty as well as currency of the underlying asset. However, derivative assets and liabilities

Derivatives statistics

Outstanding positions, in trillions of US dollars

Graph 1



[1] Gross fair value of outstanding OTC derivatives. [2] Net fair value of outstanding OTC derivatives. [3] Not adjusted for discontinuities in coverage, notably in 2013–14 when banks started to report derivative assets on counterparties in their home country. [4] Other instruments, including derivatives. Not adjusted for discontinuities in coverage, notably in 2012 when banks started to report derivative positions on residents of the reporting country. [5] Financial derivatives and employee stock options. Excludes derivative positions of residents on residents. [6] Credit default swaps sold. [7] Guarantees extended.

Sources: National data; IMF; BIS consolidated banking statistics; BIS locational banking statistics; BIS OTC derivatives statistics.

are very incomplete in the LBS. First, they are not separately identified; they are part of "other instruments". Second, several of the largest LBS-reporting countries do not report derivatives, including France, Germany, the United Kingdom and the United States. Therefore, it is not surprising that "other instruments" in the LBS do not seem to be correlated with derivatives in the CBS, as shown in Graph 1.

The LBS are compiled using the same methodology as the IIP, eg unconsolidated positions on a gross basis by residence of counterparties. Therefore in principle there are synergies between derivatives in the LBS and IIP. But in practice the incompleteness of derivatives in the LBS limits these synergies, as can been seen from the weak correlation between the two shown in Graph 1.

There is little overlap between the XTD and other derivatives statistics. The XTD statistics provide more detailed information than other statistics about the assets that underlie derivatives contracts, albeit only for foreign exchange and interest rate derivatives traded on exchanges. The CDS statistics provide complementary information about the reference entities that underlie credit derivatives. Other statistics provide few details about underlying assets; instead they provide information about counterparties, which is not captured in the XTD statistics.

Differences in definitions

Any recommendations for merging or streamlining existing derivatives statistics must not only identify which details are of greatest benefit to users but must also address differences in definitions. In some datasets, similar concepts are defined differently.

Positions. One fundamental difference concerns how to measure outstanding derivatives positions. Positions can be measured at notional or fair value, on a net or gross basis, and before or after subtracting collateral. Each measure has an analytical use, but no dataset captures all of them.

Moreover, similar measures are defined differently in some datasets. For example, open interest in the XTD statistics is similar to notional amounts in the OTCD statistics – similar but not the same because in XTD markets offsetting long and short positions are cancelled, which reduces open interest, whereas in OTC markets positions are generally offset by entering a new contract, which boosts notional amounts. The shift of OTC contracts to central counterparties and associated increase in compression are further challenges to the interpretation of notional amounts (Tissot (2015)).

Net fair value is another example of a measure with differing definitions. Net fair value, which equals gross fair value minus amounts netted under legally enforceable bilateral netting agreements, can be calculated for a given asset class or across asset classes, and before or after subtracting collateral. In the CDS statistics net fair value is calculated only for CDS contracts, whereas in the OTCD statistics net fair value is calculated across all asset classes, eg gross negative fair value of interest-rate contracts can be netted against the gross positive fair value of foreign exchange contracts if permitted by the netting agreement.

In the OTCD statistics, the BIS labels net fair value as credit exposure. However, this measure does not take account of collateral and so could be said to overstate actual exposure. On the other hand, it also does not take account of the sensitivity of derivatives positions to movements in market prices and thus could be said to understate future exposure.

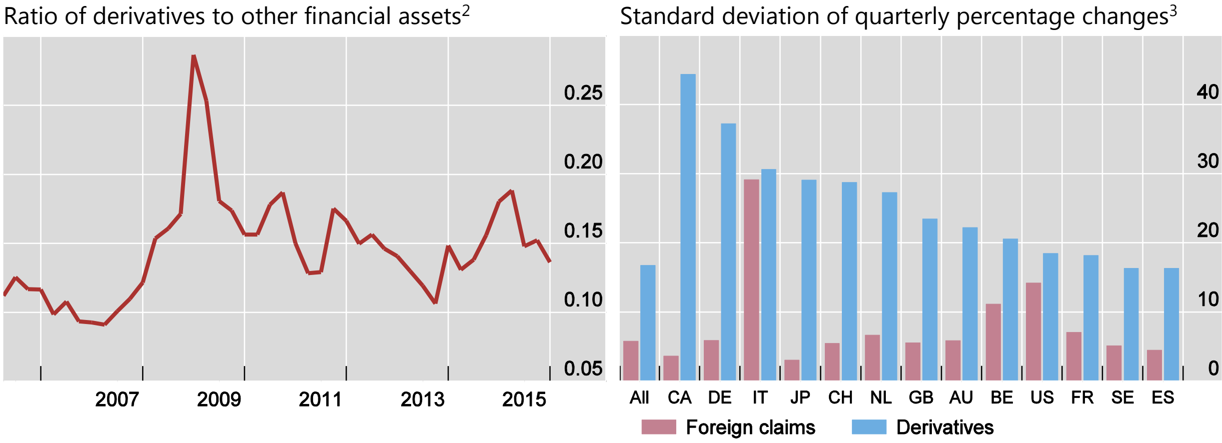
For regulatory purposes, banks are expected to adjust their current exposure by some measure of potential future exposure. In 2014, the Basel Committee on Banking Supervision (BCBS) finalised its standardised approach for measuring counterparty credit risk exposures (SA-CCR). Under the SA-CCR, derivatives exposures are calculated by summing replacement costs and add-ons that adjust for the volatility of different asset classes, multiplied by a factor of 1.4 (BCBS (2014)). Replacement costs can be calculated across asset classes – by netting set – whereas add-ons are calculated for each asset class separately.

Future exposures can be significantly different from current exposures. While derivatives do not account for a large proportion of most banks' assets, they are much more volatile than other instruments. The left-hand panel of Graph 2 shows the ratio of derivative assets to other financial assets – mainly loans and holdings of debt securities – for the foreign portfolios of banks that report the CBS on an ultimate risk basis.[8] The ratio averaged 0.15 over the 2005–15 period but jumped dramatically during periods of market stress, owing mainly to changes in the market value of derivative assets. The ratio ranged from lows of about 0.1 in 2006 to a high of almost 0.3 in late 2008, at the peak of the 2007–09 global financial crisis.

The right-hand panel of Graph 2 compares the volatility of derivative assets and other assets (as measured by foreign claims) for a selection of CBS-reporting banks. The standard deviation of quarterly percentage changes is much higher for derivative assets than foreign claims: about three times higher for all CBS-reporting banks collectively, and more than nine times higher for Canadian and Japanese banks.

Volatility of derivative assets

Foreign assets of CBS-reporting banks, on an ultimate risk basis[1] Graph 2



ALL = all CBS-reporting banks; AU = Australia; BE = Belgium; CA = Canada; CH = Switzerland; DE = Germany; ES = Spain; FR = France; GB = United Kingdom; IT = Italy; JP = Japan; NL = Netherlands; SE = Sweden; US = United States.

[1] Excluding domestic assets, ie excluding derivatives and other claims on residents of banks' home country. [2] Other assets refer to foreign claims excluding derivatives. [3] Calculated over the period end-March 2005 to end-December 2015. Quarterly changes are not adjusted for methodological breaks or movements in exchange rates.

Source: BIS consolidated banking statistics (Table B3).

[8] Any analysis of the time series properties of the CBS should be interpreted with caution because the data are not adjusted for either methodological changes or movements in exchange rates.

More generally, derivatives positions are not synonymous with risk exposures. To understand the risks borne by market participants, comprehensive information is needed about not only derivatives but also cash positions and operational activities. Such information may be available from financial statements or statistical surveys, like Australia's survey of foreign currency exposures.[9]

Location of the counterparty. Another difference across derivatives statistics is the method to identify the location of the counterparty. The LBS and the IIP refer to the residence of the immediate counterparty. The CBS refer to the residence of the ultimate obligor, after taking account of risk transfers. The CDS refer to the nationality of the counterparty, which is conceptually similar to the residence of the ultimate obligor but, in contrast to risk transfers, no criteria are provided for identifying the nationality.

For accounting and risk management purposes, banks typically base the location of the counterparty on netting sets, which bundle all contracts that are subject to the same legally enforceable bilateral netting agreement. Depending under which netting set a contract falls, the counterparty to a derivatives contract may be identified as any one of the following:

- the immediate counterparty, for example if excluded from a netting set;
- the intermediate parent, for example if the netting set covers related entities within a single jurisdiction; or
- the ultimate parent, for example if the netting set covers related entities in multiple jurisdictions but within a single corporate group.

Consolidation. A related issue is whether data should be collected on a consolidated or unconsolidated basis.[10] With the exception of the LBS and XTD statistics, other BIS statistics capture the derivatives positions of reporting banks on a worldwide consolidated basis. However, information about banks' counterparties is typically available only on an unconsolidated basis. To the extent that corporate groups transact in derivatives markets through offshore vehicles and other subsidiaries abroad, data on an unconsolidated basis may obscure a build-up of risks. That said, data on a consolidated basis may mask the complexity of derivatives markets.

Trade repositories

Looming over questions about what details and definitions from the current derivatives statistics are the most analytically useful is an even bigger question: can aggregated data from trade repositories replace current derivatives statistics? Most of the BIS derivatives statistics were introduced in the 1990s when there were few other sources of information about derivatives. Today, trade repositories are a rich source of information about derivatives. Eventually they could provide statistics that are more complete than the existing collections because trade repositories collect more details. They also capture a larger share of activity; the BIS derivatives statistics are collected mainly from banks and miss derivatives traded between non-bank

9 See Australian Bureau of Statistics (2014).

10 For a discussion of consolidation issues, see Inter-Agency Group on Economic and Financial Statistics (2015).

entities. Trade repository data are already being used for some analytical purposes. For example, the CDS statistics published by the Depository Trust & Clearing Corporation (DTCC) – a post-trade financial services company that provides clearing and settlement services – capture most of the CDS market and in some areas provide more information than BIS statistics.[11]

That said, currently there are significant practical obstacles to the aggregation and sharing of trade repository data. Work is advancing to address these obstacles. The Committee on Payments and Market Infrastructures (CPMI) and International Organization of Securities Commissions (IOSCO) are developing global guidance on the harmonisation of data elements reported to trade repositories and important for the aggregation of data by authorities, including unique transaction identifiers and unique product identifiers (CPMI-IOSCO (2015)). The Financial Stability Board (FSB) is developing recommendations for the governance of the global aggregation mechanism and is also following up on actions to remove legal barriers to the sharing of information (FSB (2015)). While conceptual work at the international level is foreseen to be completed by early 2018, timelines are not yet clear for either implementation at the national level or setting up aggregation mechanisms at the global level.

It seems reasonable to assume that, for a good number of years, aggregated data from trade repositories will not replace the current derivatives statistics. Beyond 2020, the BIS derivatives statistics are likely to remain key data sources for some purposes, such as analysing banks' balance sheets, providing global benchmarks, and monitoring trends in markets where trade repositories take longer to establish. More analysis of possible uses is needed to identify changes to the existing statistics that could increase their analytical benefits.

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Using granular security holdings data to enhance investment fund statistics[1]

Maciej Anacki and Jörg Reddig,
European Central Bank

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Using granular security holdings data to enhance investment fund statistics

IFC Conference in Basel 7-9 September 2016

Maciej Anacki and Jörg Reddig[1]

Abstract

While the banking sector was forced to deleverage during the financial crisis, the role of non-bank financial institutions in the financial intermediation process grew considerably in recent years. Among those, the largest institutions are non-money market fund investment funds, which made up almost 30% of the total balance sheet of the non-bank sector in the euro area at the end of 2015. Due to their high importance, investment funds are at the centre of macro prudential supervision. Comprehensive and reliable statistics are thus needed to analyse, inter alia, how the current low interest rate environment influences portfolio decisions or the role these funds play in the provision of funding to the economy.

This paper presents information available from the ECB's investment fund statistics, for which the National Central bank collect securities information on a granular basis and report aggregated balance sheet information to the ECB. The data are compared to a dataset on granular Securities Holdings Statistics by Sector (SHS Sector) that was recently made available. It is shown how these granular data facilitate the analysis of investment funds statistics for macro prudential purposes and what benefits arise when such micro databases are available.

Keywords: Investment fund statistics, security holdings statistics, granular data

Contents

[1] The current version has benefited from useful input and suggestions from Sebastian Ahlfeld, Antonio Colangelo, Antonio Rodríguez Caloca, and Christian Weistroffer. The views expressed in this paper are those of the authors and do not necessarily reflect those of the ECB.

1. Introduction

Investment funds play an important role in the financial intermediation process: they are relevant for interpreting money and credit developments in the euro area and they influence the stability of the financial system. Consequently, the ECB needs timely, accurate and comprehensive data on this institutional sector. Together with other monetary and financial statistics, the information gathered gives valuable indications on the behaviour of investors and their risk appetite. Moreover, the data are used to measure portfolio reallocations between monetary assets and longer-term asset classes. Investment fund statistics are also a crucial component in the surveillance of financial stability of the euro area, as investment funds provide non-bank based financing for the economy (often also referred to as "shadow banking"). In this context, the monitoring of investment fund behaviour is crucial for the analysis of investor behaviour, its implications for financial sector development and the identification of risks in the financial system.

Since 2008 the Eurosystem, i.e. the ECB together with the National Central Banks (NCBs), has compiled harmonised data on the assets and liabilities of investment funds resident in the euro area. While the NCBs collect information on the holdings of securities by investment funds on a security-by-security basis, the ECB receives the country data – as a secondary reporting – only at an aggregated level. The data collection was set up to enable the ECB to monitor the behaviour of investment funds for the purposes of monetary policy and financial stability analysis. Investment fund statistics serve these types of analysis very well. However, due to the setup that the ECB receives the statistical data only on an aggregated basis, it is less flexible when information for ad-hoc queries are need which were not foreseen when the statistics were developed. Recently, however, the Eurosystem started the collection of granular information on the holdings of securities by euro area residents. These detailed information on individual securities and their holders are made available to users in the securities holdings statistics database (SHSDB) and it allows them to analyse the data in very flexible ways.

Securities represent the largest part of the balance sheet of investment funds. Thanks to the SHSDB, granular data on securities can be used to break down aggregated developments and analyse them in greater detail. Additionally, new indicators can be derived which were beyond the scope of the aggregated data collection. In this respect the granular information does not only complement the existing data but it expand the possibilities how investment funds data can be analysed. Additionally, the granular securities data allow for the calculation of indicators, for example to monitor the level of systemic risk in fund sector.

However, prior to using new granular securities data to enhance existing investment fund statistics, it is important to assess the compatibility of the two data sets and to investigate whether any differences which might hamper validity of such a comparison. Therefore, this paper compares available information on the security holdings of investment funds from both the aggregated and the granular statistics. Afterwards it is described how the granular information can be used to enhance the information available on aggregated investment fund statistics. To do so, the next section gives an overview of the importance of investment funds in the euro area financial system. Section 3 goes on to describe the aggregated investment fund statistics while section 4 gives an overview of the newly available data on security holdings statistics by sector (SHS Sector). In section 5 both statistics are compared to each other to assess their compatibility. Afterwards, section 6 shows how the granular information can be used to calculate new indicators based on micro data. The final section concludes.

2. The role of investment funds as financial intermediaries

To better understand the importance of investment funds in the financial system, it is useful to analyse the services they provide to the economy. Investment funds are financial intermediaries that raise funds from private and institutional investors by issuing shares and/or units, and that invest these proceedings in financial and non-financial assets. By doing so, they offer two main services to the general public: on the one hand, they provide investors with the opportunity to buy shares of a diversified pool of assets with a professional risk management; on the other hand investment funds make available funding to other sectors such as monetary financial institutions, non-financial corporations and the general government. They conduct their funding activities by purchasing financial assets such as debt and equity securities, but they also invest in real estate, commodities, bank deposits and financial derivatives.[2] This business model is reflected in the aggregated balance sheet of euro area investment funds as shown in Table 1. On the liability side it shows that 87 % of the funding received is generated by issuing investment fund shares/units. These funds are mainly used to invest in debt securities, in equity and in other investment fund and money market fund shares which together add up to 83 % of the total assets of this sector.

Balance sheet of euro area investment funds Table 1

ASSETS	% of total assets	LIABILITIES	% of total assets
Deposits and loans claims	6%	Deposits and loans taken	3%
Debt securities	37%	Investment fund shares	87%
Equity	30%	Other liabilities	10%
Investment fund / MMF shares	16%		
Non-financial assets	3%		
Other assets	9%		

Source: ECB.

At the end of 2015, investment funds represented 16 % in assets of the financial system in the euro area, making it the second largest individual sector after the MFI sector (see also chart 1). Particularly in recent years, the size of the investment fund sector has increased substantially. Since 2009, the total assets of the funds resident in the euro area have almost doubled, reaching a total of more than €10.3 trillion at the end of 2015. Chart 2 shows the significantly different growth rates in selected financial sectors. It is especially striking how large the increase in the size of the investment fund sector was as compared to the MFI sector which stagnated during

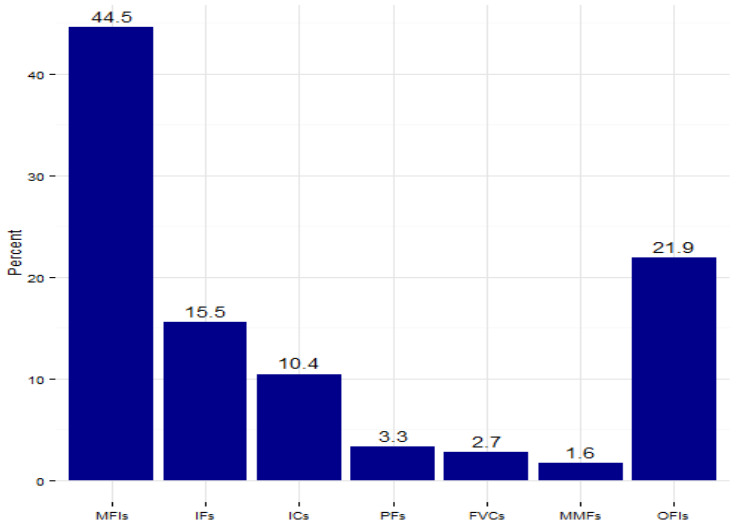
2 Some fund, however, use financial derivatives also for hedging purposes.

the past six years. While a large part of this increase can be attributed to rising assets prices, a second major reason is the inflow of cash into the sector in the wake of the financial crisis. Even when banks were distressed, investment funds could still buy debt and equity securities and thus provide financing to financial and non-financial corporations, making data on investment funds even more relevant for the ECB's assessment of the financial system of the euro area.

This section highlighted the important role that investment funds play in financial intermediation in the euro area, their relevance for interpreting money and credit developments and their growing share in non-bank based financing for financial and non-financial sectors. In order to obtain the information necessary for the analysis and make them available to the general public, the ECB collects data in its investment fund statistics which will be described in the next section.

Size of the financial sectors in the euro area

Chart 1

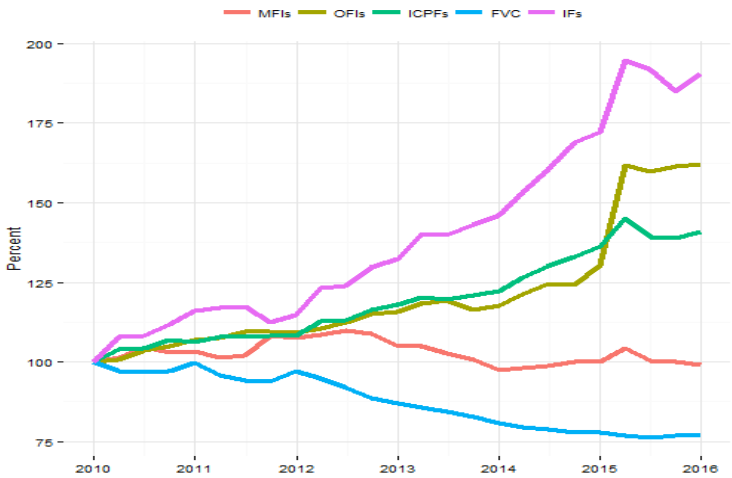


Source: ECB.

Notes: The chart shows the percentage share of the institutional sector of the total financial sector in the euro area. The sector of monetary financial institutions (MFIs) is still the largest financial sector in the euro area. The investment fund (IF) sector is the second largest individual sector since the other financial intermediaries (OFI) sector is a collection of several sub-sectors. The insurance corporation (IC), pension fund (PF), financial vehicles corporations (FVC) and money market fund sectors complete the financial sector of the euro area.

Cumulated growth rates of selected financial sectors

Chart 2



Source: ECB.

Notes: The chart shows the percentage share of the institutional sector of the total financial sector in the euro area. The sector of monetary financial institutions (MFIs) is still the largest financial sector in the euro area. The investment fund (IF) sector is the second largest individual sector since the other financial intermediaries (OFI) sector is a collection of several sub-sectors. The insurance corporation (IC), pension fund (PF), financial vehicles corporations (FVC) and money market fund sectors complete the financial sector of the euro area.

3. The ECB data collection on investment fund statistics

Since December 2008, the ECB has collected and published harmonised data on the assets and liabilities of investment funds on an aggregated basis. [3] These statistics are reported by individual investment funds which are resident in the euro area to the NCBs in accordance with Regulation ECB/2013/38 (hereafter *the investment fund regulation*).[4] This Regulation does not cover money market funds, which according to the European System of Accounts (ESA 2010) are a part of the sector of monetary financial institutions. Pension funds are also not part of the investment fund sector since they constitute a sector of their own. Subsequently to the data collection, the NCBs send their nationally aggregated data to the ECB in line with the Guideline ECB/2014/15 on monetary, financial institutions and markets statistics.

While the ECB receives and publishes the data from the NCBs aggregated by instrument and sector, it is important to stress that the NCBs have access to much more detailed data: they receive individual data for each investment fund. Moreover,

3 See also: European Central Bank (2010c) and European Central Bank (2015*a*).

4 The ECB maintains and publishes a list of all investment funds registered in the euro area, which can be found here https://www.ecb.europa.eu/stats/money/mfi/html/index.en.html.

it is mandatory for funds (since end-2014[5]) to report security-by-security information. This means that funds transmit lists of individual securities held for which publicly available identification codes exist.[6] For securities without such a publicly available identification code, the relevant NCB can decide to collect the data on an aggregated or a security-by-security basis, while all other balance sheet items are normally collected on an aggregated basis.

These input data are available at a very granular level for security positions and on an aggregated level for the other balance sheet items. Based on these, the NCBs compile various categories of assets held and liabilities incurred by investment funds and transmit the aggregated information to the ECB. As is common practice with regard to aggregated data collections, the compiler of the statistics is required to aggregate the holdings of securities by type of instrument (i.e. debt or equity security), maturity, currency, issuer, sector or geographical location. Aggregated positions usually serve a specific analytical purpose, for which they are very useful. However, when new questions arise, these statistics might not be fit for other purposes. In this case, the analyst might have to rely on information which was not targeted at the specific problem and might only work as a proxy for missing data. In addition, surveys might have to be conducted to fill the data gaps. These, however, can be very costly, cover only a small sample which might not be representative and do not allow for observing the phenomenon of interest over a longer period of time (especially backwards).

In the medium term, aggregated statistics can, of course, be adjusted to satisfy new data needs. Nevertheless, changing the reporting templates is a difficult and costly process not only for the compilers of the data but also for the reporting agents. Therefore, the Eurosystem has committed itself to keeping the reporting templates for statistical data collections fixed for at least five years, so that reporters do not have to adjust their systems every time a new data requirement comes up. In times of crisis, however, data users cannot wait for the next iteration when aggregated statistics are be updated. They need prompt access to relevant data in order to conduct necessary analyses. This is one reason why there is a strong trend in the Eurosystem towards the collection of micro data. Because when granular data is already available, it is very simple to respond to new requests. It merely requires carrying out the appropriate aggregations. Thus, micro data allows for very flexible analyses that can even answer questions that might only arise in the future. How granular information on security holdings are collected in the Eurosystem is described in the next section.

4. SHS Sector Statistics

The financial crisis of 2008 to 2009 and the events surrounding the collapse of Lehman Brothers in particular have highlighted the need for a database with granular information on holdings of securities which needs to be readily available to

[5] There are backdata available for previous periods; however, these are not collected under the harmonised SHS regulation.

[6] In the euro area, the publically available identification code is normally the International Securities Identification Number (ISIN).

policymakers.[7] Following the establishment of a harmonised ECB Regulation on securities holdings statistics[8], a new collection of security-by-security data has been started in early 2014. The first data available in that collection refer to holdings of securities as of end-December 2013.[9]

SHS Sector data include information on holdings of debt securities, listed shares and investment fund shares/units by main institutional sectors[10] in individual countries. The quarterly dataset covers (i) holdings by euro area investors and (ii) holdings of securities issued by euro area issuers held in custody with euro area custodians for clients resident outside the euro area.

Chart 3 shows the holdings of securities by euro area investors as covered by the SHS Sector data collection. The total holdings increased until 2015-Q1 and stabilised afterwards. The developments have to a large extent been driven by the increasing prices in the equity markets, which also impacted the holdings of investment fund shares/units.

The SHS Sector database, which is operated by the ECB together with Deutsche Bundesbank, includes granular data, on a security by security level, which allows analysts to merge the collected data with other available sources of reference and price data on securities. This feature enables users to slice and dice the data across multiple dimensions, with the main limitation being the availability of reference data on securities. In particular, such information is derived from the Centralised Securities Database, a multi-purpose platform jointly operated by the ESCB and currently containing reference information on over six million outstanding debt securities, equities and investment fund shares.[11]

The SHS Sector data may in particular be used to analyse the behaviour of a specific sector from two complementary perspectives – on the one hand from the perspective as a holder and on the other as issuer of securities. It makes the data particularly suitable for analyses that focus on investment funds, for which securities form a significant portion of asset as well as the liability side of the balance sheet. The next section compares data collected in both investment fund and SHS Sector statistics with each other in order to assess how well they are aligned.

[7] See: European Central Bank (2015b).

[8] Regulation of the European Central Bank of 17 October 2012 concerning statistics on holdings of securities (ECB/2012/24) and Guideline of the European Central Bank of 22 March 2013 concerning statistics on holdings of securities (ECB/2013/7), both with further amendments.

[9] SHS Sector holdings by domestic investors have been collected by the ESCB on a voluntary and "best-effort" basis since early 2009. Moreover, even prior to 2009, some euro area countries had national collection systems for securities holdings by domestic investors in place.

[10] Main holding sectors available are (i) deposit-taking corporations, (ii) money market funds, (iii) investment funds, (iv) financial vehicle corporations, (v) insurance corporations, (vi) pension funds, (vii) other financial corporations, (viii) general government, (ix) non-financial corporations, (x) households and (xi) non-profit institutions serving households. For holdings by non-euro area investors, the sector breakdown is restricted to (i) general government and central banks and (ii) other investors.

[11] For more information, see European Central Bank (2010*b*).

5. Comparison of investment fund and SHS Sector data

While micro data offer huge benefits for the analysis of macroeconomic developments, an important pre-requisite for the use of granular data sources is to check how well they are aligned with the macro aggregates which have been used so far. Only if the data match and potential differences between the data sets are identified, can the granular data be fully used to infer meaningful information on macro developments. This section will therefore compare asset data from the investment fund statistics with data from the SHS Sector statistics.

In general, data from investment fund and SHS Sector statistics should be relatively similar: as shown in Table 1, security holdings make up 87 % of the asset side of the balance sheet of euro area investment funds. For these holdings, granular data are available in the SHS database. There are, nonetheless, reasons why some discrepancies between the data sets are to be expected. Firstly, while it is mandatory in investment fund statistics to report all securities, regardless whether a publicly available identifier exists or not, in SHS Sector statistics only those securities with a publicly available identifier have to be reported. In practice, some NCBs report the securities without official identifiers on a voluntary basis. In other cases, these securities without identifiers make up for a relatively small amount of the total securities, so the discrepancies are negligible. For some countries, however, securities without a publicly available identification code make up for a large proportion of security holdings and the data are unavailable in the SHS Sector data, which gives rise for discrepancies between the two data collections. Secondly, both legal acts, i.e. the investment fund regulation and the SHS regulation, define different types of exemptions and thresholds for reporting agents, in order to minimise the reporting burden, especially for small institutions. In contrast, the investment fund regulation mandates direct reporting from the funds. This can lead to the situation in which the reporting population for both statistics is not identical. Thus, this can be a further source of possible differences for the data.

The result of the comparison of the holdings of securities on the asset side of euro area investment funds is shown in Table 2 for debt securities and Table 3 for equity securities and investment fund shares/units. For the purpose of this comparison the granular information of the SHS Sector statistics were summed up to match the available aggregated categories of investment fund statistics. The tables show the available data for the periods form 2013-Q4, which marks the first reporting of SHS Sector data under the regulation, until latest available period 2016-Q1. Based on these figures, the percentage coverage of SHS Sector statistics with regard to investment fund statistics was calculated. In the optimal case, the coverage is exactly 100 %, which means that the figures from both, investment fund statistics and SHS Sector statistics are the same. It is, however, often the case that summed-up SHSS sector data is lower than the investment fund statistic figure. In this case, the coverage is below 100 % and the cell in the table is marked in a red colour, where a higher saturation of the cell indicates a lower coverage. If, on the other hand, the calculated SHS figure is higher that the number from the aggregated investment fund statistics, the coverage is higher than 100 % and the cell is shaded in blue.

Coverage of euro area investment funds' holdings of securities with SHS Sector data in percent

Table 2

Debt securities

Issuer:	**MFIs**			**General government**			**OFIs**			**ICPFs**			**NFCs**			**RoW**			**Total**
	up to 1 year	over 1 year and up to 2 years	over 2 years	up to 1 year	over 1 year and up to 2 years	over 2 years	up to 1 year	over 1 year and up to 2 years	over 2 years	up to 1 year	over 1 year and up to 2 years	over 2 years	up to 1 year	over 1 year and up to 2 years	over 2 years	up to 1 year	over 1 year and up to 2 years	over 2 years	
2013-Q4	67%	108%	97%	100%	86%	98%				61%		62%	63%	63%	91%	65%	87%	90%	94%
2014-Q1	67%	101%	98%	101%	59%	99%				33%	0%	63%	71%	46%	87%	57%	76%	96%	95%
2014-Q2	69%	103%	95%	100%	61%	99%				6%	0%	78%	70%	39%	87%	55%	96%	96%	95%
2014-Q3	71%	107%	95%	98%	56%	99%				25%	0%	73%	74%	34%	88%	61%	97%	95%	94%
2014-Q4	71%	98%	96%	97%	43%	100%	28%	26%	46%	21%	0%	74%	67%	34%	88%	59%	97%	96%	91%
2015-Q1	75%	105%	94%	95%	36%	98%	25%	22%	42%	6%	0%	66%	59%	42%	86%	58%	99%	96%	89%
2015-Q2	59%	41%	98%	76%	46%	98%	22%	4%	30%	7%	0%	71%	63%	29%	87%	60%	38%	97%	88%
2015-Q3	74%	108%	93%	94%	60%	98%	15%	22%	32%	17%	0%	71%	64%	53%	86%	63%	97%	95%	89%
2015-Q4	81%	106%	93%	94%	31%	98%	20%	24%	37%	22%	0%	74%	60%	68%	86%	73%	91%	95%	89%
2016-Q1	77%	106%	93%	94%	24%	98%	17%	22%	37%	8%	0%	72%	62%	71%	86%	70%	90%	95%	89%
IF stocks in billion euro, 2016-Q1	26	16	329	46	7	896	10	4	322	0	0	14	10	3	293	110	37	1770	3897

Source: ECB.

Coverage of euro area investment funds' holdings of securities with SHS Sector data in percent — Table 2

	Equity securities						IF shares/units		
Issuer:	**MFIs**	**OFIs**	**ICPFs**	**NFCs**	**RoW**	**Total**	**MFIs**	**Non-MFIs**	**RoW**
	o/w listed shares	o/w listed shares	o/w listed shares	o/w listed shares	o/w listed shares				
2013-Q4	97%			101%	102%		107%	95%	65%
2014-Q1	95%			98%	102%		109%	94%	71%
2014-Q2	92%			99%	102%		108%	94%	72%
2014-Q3	95%			98%	101%		110%	94%	73%
2014-Q4	94%	94%	100%	98%	103%	100%	109%	95%	72%
2015-Q1	95%	95%	101%	97%	101%	98%	107%	96%	74%
2015-Q2	95%	95%	99%	97%	100%	92%	100%	98%	75%
2015-Q3	94%	94%	99%	97%	99%	96%	95%	99%	75%
2015-Q4	94%	94%	101%	97%	99%	96%	100%	97%	80%
2016-Q1	93%	93%	99%	97%	99%	96%	97%	98%	76%
IF stocks in billion euro, 2016-Q1	73	74	34	794	1781	2757	136	1223	231

Source: ECB.

Overall, the coverage of investment fund statistics data with SHS Sector data is high. As indicated in the totals in Table 2 and 3, the average coverage in the euro area for the periods under investigation is 91 % for debt securities and 93 % for equity securities. However, looking at the individual asset categories the picture is less favourable for some specific categories of securities. For the holdings of debt securities issued by the institutional sectors shown in Table 2, the coverage is especially low in the categories with shorter periods of original maturity. The main reason for this is that across several euro area countries the issuers of debt securities do not get official identification codes when the maturity of the securities is short. For example, if a firm issues a debt security with an original maturity of only one month, it is likely that this debt security will never be traded but it will rather be held until redemption by the initial holder. In this case, an issuer wants to avoid the fee to get a publicly available identification code for the security as this would be most useful when the debt security is traded on a secondary market. This contributes to a relatively lower average coverage of debt securities with an original maturity of less than two years in SHS Sector statistics, because information on debt securities without an official identification code is often missing from the database whereas they must be included in aggregated investment fund statistics. The impact on the total coverage, however, is limited, since the majority of debt securities have a maturity of over two years, for which the coverage between the two statistics is much higher.

The same is true for the coverage of debt securities issued by investment funds, other financial intermediaries (OFIs) and insurance corporations and pension funds (ICPFs). The amount of debt securities issued by these entities is very small. These small holdings are not fully covered as they might involve securities without official identification codes or some NCBs might apply derogations to their reporting agents. In a small number of cases there is a slight over-coverage where the volume of debt securities reported in SHS Sector statistics is higher than in investment fund statistics. These cases can mostly be attributed to differences in valuation of the securities in both data collections.

As regards equity securities shown in Table 3, the data covering the holdings of listed shares by investment funds were used for the comparison (where available in investment fund statistics), since these type of shares normally have an official identification code. Unlisted shares, on the other hand, often do not have such a code and are not included in SHS data. The table shows a very high coverage of equity securities, confirming that the two statistical data collections concur if one controls for the missing securities without publicly available identification codes in SHS Sector statistics. Also for investment fund shares/units the coverage is close to 100 % and the main differences arise from valuation differences.

Overall, the coverage of securities issued by euro area residents is relatively high with 91 % in the period under investigation. However, this paper only analyses the results from a euro area perspective. In fact there are also substantial differences between the countries in the euro area. Nevertheless, the granular information available from the SHS Sector statistics already covers the aggregated investment fund data to a large extent. Some applications how the micro data can be used to enhance the existing macro data collection are shown in the next section.

6. Using Micro Data to Enhance Investment Fund Statistics

As the comparison in the previous section has shown, the coverage of aggregated investment fund statistics data with the granular data available from the SHS Sector statistics is especially high for equity securities and to a somewhat lesser extent for debt securities. Overall, the granular data can already be very useful to gain further insights into developments at the macro level or to generate new indicators for policy advice.

In particular for the purpose of macro prudential policy analysis the granular data of the SHS Sector statistics can already be very useful: Due to the important role of investment funds in the analysis of the so-called shadow banking system, policy makers need indicators for the surveillance of these funds and their impact on the financial stability in the euro area. Before granular data on securities were available, these data needs could only be answered with an update of the investment fund statistics regulation. With the help of SHS Sector data, the available granular information can be used to create a number of indicators, without the need to address new data requirements to reporting agents. As an additional benefit, back-data for these indicators can be calculated as far back as granular information are available. This is especially useful when certain phenomena need to be monitored over time. To stress the usefulness of this approach, this section provides some examples for which the granular SHS Sector data can already be used to create indicators especially relevant for macro prudential supervision purposes.

Due to the high importance of investment funds for the financial intermediation process in the euro area, it is crucial for regulators to get a detailed overview of the risk that investment funds incur on an individual level but also, from a macro prudential point of view, analysts want to observe how high the systemic risk for the financial system is. For this, especially reliable indicators on the liquidity transformation and the leverage of investment funds are needed. With available granular data on securities, it is however possible to calculate the needed indicators.

In particular the question of liquidity is an important one for investment funds. In the case of open-ended investment funds, they allow for a daily redemption of shares/units issued. Thus, their liabilities are highly liquid. The assets they are holding, however, may not in all cases be as liquid as they cannot necessarily be redeemed on a daily basis or, for example, in the case real estate it takes longer to sell them. By using granular SHS Sector data, the remaining maturity of assets held by investment funds can be calculated. To make this very detailed information usable on a macro level, the individual assets could be allocated into "maturity brackets" which aggregate the securities with a similar residual maturity on the fund or country level. In this way the monitoring of liquidity mismatch could be analysed with a meaningful indicator that can be observed over time. The same holds true for indicators of leverage: The so-called "headline leverage ratio" can be calculated as ratio of debt (liabilities other than equity, and including money market fund shares) to financial assets.[12] This indicator could be particularly important for regulators who have the power to impose leverage limits on investment funds and thus restrict the vulnerability of the financial system.

[12] See also Bakk-Simon, et al. (2012).

Apart from the calculation of indicators for macro prudential supervision, the data collected in the SHS Sector statistics makes it possible to enhance the information available on the liability side of investment funds' balance sheet. Funds do not necessarily know who the final holders of their issued shares are. They sell these shares to investors or large custodian bank. However, these shares might be traded on the secondary market or re-sold by the custodians to their customers. With the help of the holdings data in the SHS Sector statistics, it is however possible to get reliable data on the final holder. In the context of financial stability analysis these data make it possible to measure the exposure of the institutional sectors to financial risks and for monetary and economic analysis the data allows for a detailed view on the wealth of the sectors due to the investment in securities.

Some of the calculations of the indicators described above require the access to individual security-by-security data. However, for investment fund statistics these data are only available to the NCBs and not to the ECB. To still provide the users and the general public with these indicators, the NCBs could calculate the needed indicators for their respective euro area country. Then, the investment fund statistics could be used to collect these aggregated indicators. In this way, the data needs from users can be fulfilled and no additional costs on the side of the reporting agents are incurred as the data used is already available at the national level.[13]

7. Conclusions

This paper describes how granular information can be used to enhance existing aggregated data collection. Using the recently made available data on SHS Sector statistics, it is possible to utilise the granular data to calculate new indicators which will enhance the information available for investment funds and thus improve financial stability and economic analysis for this sector. As an additional benefit, no additional information from reporting agents are required which reduces the costs significantly.

While the coverage of the granular SHS Sector data with respect to aggregated investment fund data is already quite high, there is still work to be done to improve the comparability of the statistics. Firstly, this study has focused on the euro area data. In a next step the data available for the individual countries need to be analysed to achieve greater harmonisation across euro area countries. Secondly, the comparison between the statistics has shown that, while the coverage is already high, it is not perfect. The main cause for the remaining difference is the limited availability of data on holdings of securities without an official identification code in the SHS Sector statistics. This however does not prevent the use of SHS to analyse in more detail the behaviour of investment funds, except for the analysis of specific categories like short term debt securities where the coverage of SHS is more limited.

[13] Cf. Doyle, N., Hermans, L, Molitor, P. and Weistroffer, C. (2016).

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Unique identifiers in micro-data management – the Centralised Securities Database (CSDB) experience[1]

Asier Cornejo Pérez, Javier Huerga, Frank Mayerlen, Johannes Micheler,
European Central Bank

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Unique identifiers in micro-data management – the Centralised Securities Database (CSDB) experience

Asier Cornejo Pérez, Javier Huerga, Frank Mayerlen, Johannes Micheler[1]

Abstract

The world of statistics is quickly expanding from pure macro-data compilation to micro-data management. This development brings amounts of data not seen before in official statistics. Without standardised unique identifiers such data will never deliver all its potential and data processing will quickly become unsustainable. At the same time reality shows that less standardised data sources need to be handled increasingly at least temporarily, e.g. during the start-up phase of a new data collection which starts from legacy data sets which have not been subject to standardisation efforts. As there is often no time to wait for full standardisation, it is necessary to process fully standardised and less standardised data in parallel. Modern statistical systems need therefore to produce robust and usable results with slightly imperfect and non-standardised input data and at the same time fully accurate data with fully accurate and standardised input data.

The Centralised Securities Database (CSDB) is a security-by-security database which contains reference, price and ratings data for more than six million active debt securities, equity shares and investment fund units issued worldwide. Drawing from the CSDB experience this note provides insights into the issues raised by the partial lack of unique identifiers and also shows how these issues have been addressed. Particular attention is given to the International Securities Identification Number (ISIN) and the Legal Entity Identifier (LEI). In the absence of accurate entity identification name matching may be used as a bridging technology where the Jaro-Winkler distance applied on the names of entities is presented together with stylised examples of its application.

Keywords: unique identifiers, International Securities Identification Number (ISIN), Legal Entity Identifier (LEI), euro area, debt securities, security-by-security databases, name matching algorithm, Jaro-Winkler distance.

JEL classification: C81 Methodology for Collecting, Estimating, and Organizing Microeconomic Data • Data Access

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We would like to thank all colleagues in the European System of Central Banks who contribute to the development and operation of the CSDB.

1. Introduction

The world of statistics is quickly expanding from pure macro-data compilation to micro-data management. This development brings amounts of data in very large volumes, growing data diversity, increase in data velocity and frequency together with shorter data production cycles. It is increasingly recognised that large scale micro-data is a necessary ingredient for enhanced efficiency and decision taking at all levels. At the same time it becomes evident that shortcomings in the efficient and standardised processing of micro data could become one of the fastest growing operational risks in statistics.

Without standardised unique (surrogate) identifiers large scale micro data will never deliver all its potential and data processing will quickly become unsustainable. At the same time reality shows that less standardised data sources need to be handled increasingly at least temporarily, e.g. during the start-up phase of a new data collection which starts from legacy data sets which have not been subject to standardisation efforts. As there is often no time to wait for full standardisation, it is necessary to process fully standardised and less standardised data in parallel. Modern statistical systems need therefore to produce robust and usable results with slightly imperfect and non-standardised input data and at the same time fully accurate data with fully accurate and standardised input data.

The Centralised Securities Database (CSDB) is a security-by-security database which contains reference, price and ratings data for more than six million active debt securities, equity shares and investment fund units issued worldwide. Drawing from the CSDB experience this note provides insights into the issues raised by the partial lack of unique identifiers and also shows how these issues have been addressed. Particular attention is given to the International Securities Identification Number (ISIN) and the Legal Entity Identifier (LEI). In the absence of accurate entity identification name matching may be used as a bridging technology where the Jaro-Winkler distance applied on the names of entities is presented together with stylised examples of its application.

The paper is organised as follows. Section 2 provides a brief description of the CSDB and Section 3 illustrates the CSDB experience with identifiers for securities and issuers, with a focus on the ISIN and the LEI. Section 4 presents the situation where no unique identifier is available together with the possible alternative of using bridging technologies to integrate different sources in an automated way. Section 5 provides some conclusions and recommendations.

2. A brief description of the CSDB

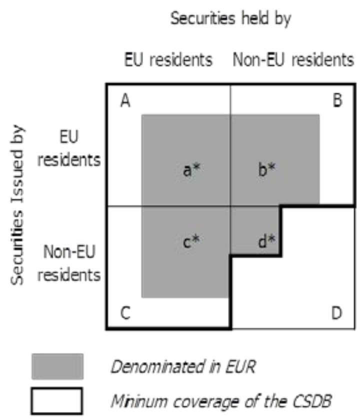
Operational since 2009, the CSDB is a security-by-security (s-b-s) database set-up to hold complete, accurate, consistent and up-to-date information on all individual securities relevant for the statistical and increasingly non-statistical use by the European System of Central Banks (ESCB). The CSDB covers debt, equity and investment fund securities together with the respective price, issuer and rating information. As an example CSDB contains reference data on securities (e.g. outstanding amounts, issue and maturity dates, type of security, coupon and dividend information, statistical classifications, etc.), issuers (identifiers, name, country of residence, economic sector, etc.) and prices (market valuation, estimated or defaulted). Moreover, the CSDB includes ratings information covering securities, securities issuance programmes, and all rated institutions (entities) independently of whether they are issuers of securities.

The CSDB covers securities issued by EU residents; securities likely to be held and transacted in by EU residents; and securities denominated in euro, regardless of the residency of the issuer and holders. Chart 1 illustrates this coverage. The CSDB currently contains information on over six million non-matured or "alive" debt securities, equities and mutual fund shares/units. In addition the database includes approximately nine million matured or "non-alive" securities (e.g. matured, early redeemed or cancelled). The number of issuers of "alive" securities is above 700,000.

Chart 1

Scope of securities covered in the CSDB

The total set falls within the heavy black line, and the sub-sets A to C. Coverage in D will be further extended as necessary, when transactions in or holdings of securities in this category are reported



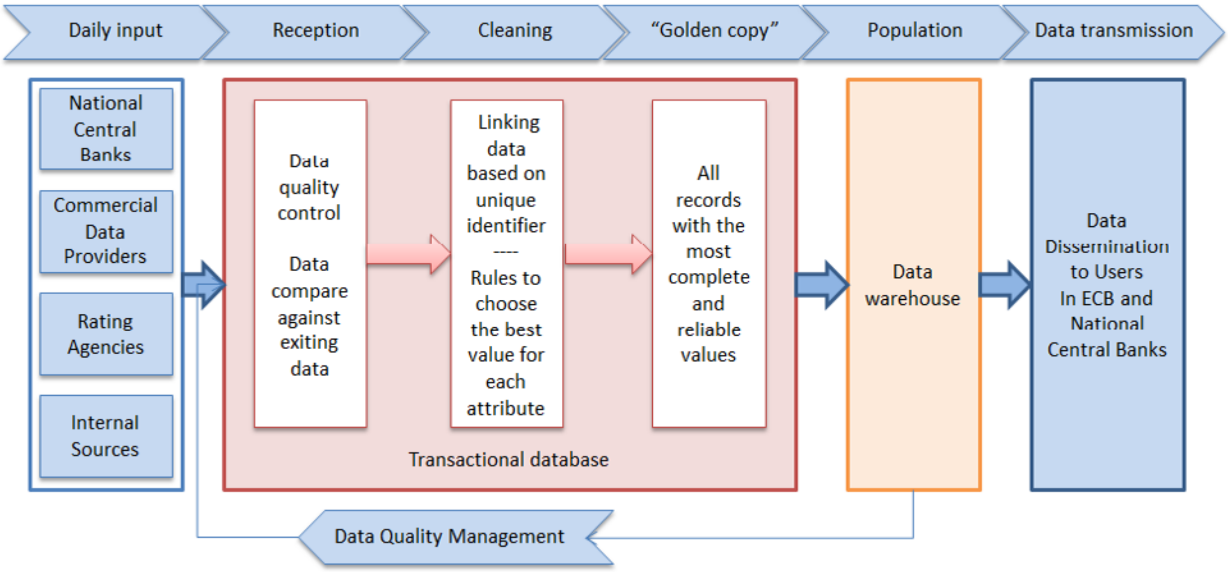
The CSDB is a multi-source system that receives approximately 2.5 million prices and 300,000 records on reference information per day from several commercial data providers. On a less frequent basis data are also provided by more than 20 National Central Banks (NCBs). Data is received automatically from all sources by the transactional system accessible via a web user interface, also called CSDB Portal. Upon reception, the data is compared against the existing or previously reported information. If unexpected changes are detected on the provision by one source, the respective data will be stopped to be further analysed by the system operators before being loaded. This avoids the loading of structurally faulty data and ensures data quality. Moreover, invalid data, i.e. data which are not compliant with the CSDB codelists, are filtered out at the start of the process.

Developed and hosted by the ECB, the CSDB is jointly operated by the members of the ESCB (the National Central Banks) and it is only accessible by them, i.e. there is no public access. Based on automatic algorithms the most reliable value for each attribute is selected by the system and gaps, in particular for prices and income, are filled with reliable estimates. To ensure the quality of CSDB data the system makes use of expertise within the ESCB in accordance with the respective Guideline of the

ECB on the data quality management framework for the CSDB (ECB/2012/21). The CSDB data processing including the data quality management loop is illustrated below.

Chart 2

Centralised Securities database information flow



Once data reception has finalised, the pooled data will usually contain some inconsistent information and so the data need to be cleaned. This "cleaning process" is automatically started by the system every evening. Cleaning is based on rules built into the system to choose the best (most reliable) value for each attribute in cases where sources might be contradictory. To finish the cleaning process, the data is enriched to fill in the gaps based on defined rules. After that CSDB data is made available in the data warehouse where a set of metrics has been created to detect inconsistencies and quality issues in the data. Different tools are made available to NCBs and the ECB to correct the data in a data quality management process that fixes the information at the root in the transactional database. This ensures data accuracy and consistency from the input to the output after finishing the data quality management process. Once the entire process is finished, data is made available to users at NCBs and at the ECB.

3. The CSDB experience with identifiers

3.1. CSDB and the unique identification of securities

The use of international standards in financial markets is not only necessary to ensure transparency but it is also one of the key features of s-b-s databases. While aggregate data may include (and hide) different non-standardised components, the compilation of s-b-s data requires the existence and application of unique identifiers.

The CSDB uses the International Securities Identification Number (ISIN) as the unique identifier for grouping instruments information. This means that any information on securities must be reported together with the corresponding ISIN of the security. In this way it is ensured that any information referred to the same security is linked through the same ISIN. In the same vain, any security related output from the CSDB is identified by an ISIN which works as the 'primary key'.

As a multi-source system, the unique integration of input data in the CSDB is key for the quality of the output. The use of multiple identifiers for securities was previously tested in the CSDB and inevitable resulted in duplication of records referring to the same security. It was not always possible to find these duplicates as different identifiers have often only partial coverage of the total population. As an example provider 1 may send a security record identified only with the ISIN code and provider 2 sends a record referring to the same security identified only with a SEDOL code. Both records have no common identification and hence would wrongly exist as 2 distinct records in the system.

It is recognised that an approach relying only on the ISIN as a security identifier may omit from CSDB a small part of the scope of securities to be covered. However, it ensures that the most relevant securities are uniquely recorded in the CSDB with the proper data integration between the different sources. Fact-finding exercises carried out in the euro area reveal that debt securities without ISIN issued by euro area residents may amount to less than 1% of the total amount outstanding, although relative relevance may be higher in particular countries and sectors. The case of listed shares without ISIN in the euro area is irrelevant. Nevertheless the amount of other types of securities such as investment funds issued without ISIN may be somewhat more substantial although this is difficult to quantify due to the very lack of a unique international identifier. On balance, the risk of 'missing securities' in CSDB due to the non-availability of ISIN codes is considered much smaller than the risk caused by potential duplications.

3.2. CSDB and the identification of entities

The CSDB contains not only security data but also the link to the issuer of the security together with a number of attributes referring to the issuer. In the absence of a unique entity identification system for issuers the CSDB had to design and implement a procedure that permits to group securities belonging to the same issuer.

This procedure, so-called "grouping", is based on several relevant elements. In the first place, the input record information received by CSDB is at security level but this record also contains data on the issuer as available to the data provider, i.e. already providing the link between security and issuer. Second, the input record should contain an issuer identifier that is unique for each data provider, although different from provider to provider, as they are mainly proprietary codes[2]. Third, all possible

[2] Not all providers have a unique code to identify the issuer, therefore, several tools have been developed to overcome that additional restriction. First, when the code does not exist, the system creates, so called 'hash codes' based on the name and the country provided. Second, when the code

links between different issuer identifiers are created and can be indirectly matched through the ISINs i.e. different issuer identifiers linked to the same ISIN must correspond to the same security and hence to the same issuer. Finally, each issuer receives an unique internal CSDB identifier for system internal purposes together with all proprietary codes from each data provider.[3]

The creation of the Legal Entity Identifiers (LEI) offers new possibilities to substantially improve the entity identification process. In the first place the LEI could be used as additional code to perform the above described grouping process. On a more ambitious view the LEI should become the primary identifier for the grouping process while other identifiers would be redundant. Nevertheless even the universal use of the LEI will not solve all problems, given that data providers may still disagree on who is the issuer of a security. For that reason the CSDB grouping procedure is expected to stay in place for the foreseeable future, while noting that the optimal solution would be have to an unique authoritative source providing the correct link between ISIN and LEI.

4. Entities identification without unique identifiers – description of a possible 'name matching' alternative

As explained above the CSDB is based on unique identifiers, using the ISIN for securities and working towards fully using the LEI for entities. But, what can be done if no unique identifier is available for a data set? There is no doubt that establishing a compulsory unique identifier is the optimal solution, but what to do in the meantime? Combining several million records via non-standardised identifiers is considered a potential risk in terms of feasibility and workload. Against this background a machine-driven and automated data integration process without unique identifiers has been investigated.

This possible alternative relies on the comparison of non-unique and non-standardised identifiers such as e.g. names, country of residence, etc. The test implementation relied on existing CSDB processes and enhanced them with bridging technologies like the Jaro-Winkler distance. The concept relies on a centralised (and self-checking) automated data cleaning process which allows the integration of data coming from multiple sources according to a single unified procedure. The overall process should be highly scalable to handle potentially substantial amounts of data. The process used to proof the concept and the main conclusions are presented below.

4.1. Process description and stylised examples

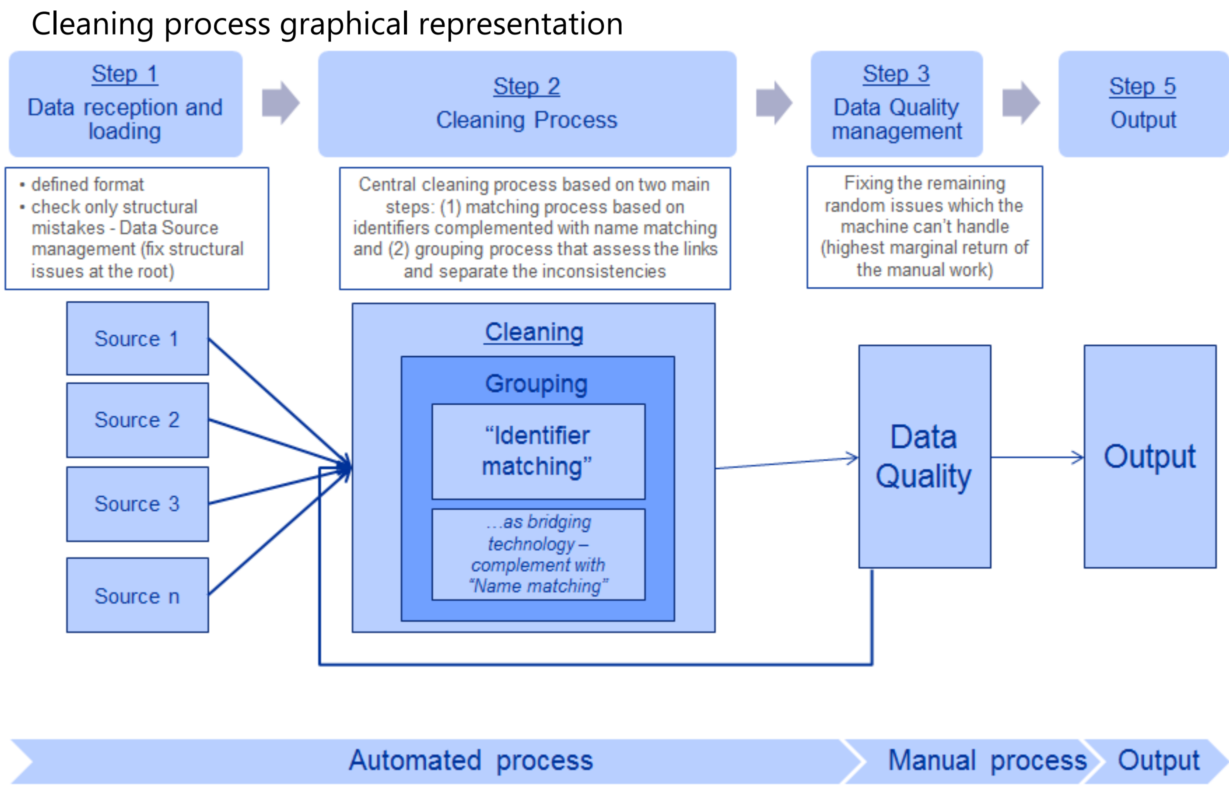
CSDB uses micro level information coming from different sources, which have identifiers that are often not unique and also not always shared across different data sources. The alternative process consists in two steps, first creating, e.g. based on the name, all feasible links between all records as provided by different sources and

is not unique for each issuer, the link between the instrument and the issuer is weaker but still used 'to join' securities issued by the same issuer if no other information is provided.

3 In case of inconsistencies between different issuer identifiers the grouping procedure creates so-called "clash groups", i.e. cases in which different data providers disagree on who is the issuer of the security. These cases need to be resolved manually.

referring to the same entity. In a second step, a 'grouping' algorithm based on CSDB technology automatically verifies these links to create a unique representation of a single entity.

Chart 3



First step – creation of links between the data sources

For the first step and in the absence of common unique identifiers the CSDB uses a name matching algorithm to map ratings data from different ratings agencies. To significantly increase the total matching grade and complement the current lack of identifier matches, an improved name matching algorithm has been tested in a recent proof of concept.

The tested name matching algorithm is a string metric based on Jaro-Winkler. The Jaro-Winkler string metric takes into account the number of matching characters and transpositions of two strings and can take any value between 0 (no match) and 1 (perfect match). Other name matching algorithms that could have been used for the same purpose are, for example, the Levenshtein distance and the n-grams.

The name matching algorithm consists of three stages:

a) String unification: This step has two purposes. First, a context-free unification is applied based on an automated process that runs for all reported data (all string lower case, unification of special characters, unification of the legal form). Second, only the part of the entity name that is relevant to describe the company is highlighted. The idea is that non-relevant parts of the name should not dominate the name matching (for example for "BP Deutschland" vs. "BD Deutschland" the country name is longer than the actual name of the company and hence dominating).

b) Apply name matching algorithm and use some special selection mechanism based on the first string letters that have been proven to be significantly discriminating between true and false matches. A threshold can be implemented to ignore all counterparty pairs where the name matching grade of the Jaro-Winkler distance is less than a certain value, e.g. 0.9.

c) Final selection: Using reference data to make a final selection from all feasible pairs of the result from the first two steps.

With the above algorithm it becomes clear that the quality of the entity reference data from the different sources in terms of standardisation and coverage plays an important role in steering the 'bias/variance trade off' between high matching rate and quality. With high quality in the reference data, the threshold in step b can be reduced, allowing for a higher matching rate (with more false positives), knowing that in step c high quality reference data can be used in the final selection.

Second step – Entity Grouping: Bringing all records together which refer to the same entity

The term 'Entity Grouping' stands for the task of disambiguating instances of real world entities in various records by grouping. The identifier and name matching algorithms have already created a large set of links between the data provided by the different sources. The Entity Grouping clusters the links between them that correspond to the same entity. The grouping algorithm can be made subject to various constraints. In the case tested, the constraint is that one identifier can only refer to one entity. A violation of this constraint is an inconsistency that cannot be resolved automatically.

The CSDB has already implemented this entity grouping algorithm called 'Party Grouping' that automatically resolves multipartite links and creates clash free (free of constraint violations) 'Main Groups'. All links, where above constraint of the uniqueness of identifiers is violated are put into a 'Clash Group'.

Box 1

Stylised examples of data integration depending of the availability of identifiers

Case 0 – Instrument integration: Multiple sources of instruments with ISIN code

This first example shows the link of different sources based on the existence of a unique identifier, ISIN for the instrument that is used by all sources. Once the link is made based on the ISIN, the most complete information of the instrument can be obtained as a result of a compounding process.

	Output	Source 1	Source 2	Source 3
ISIN	XS1831830158	XS1831830158	XS1831830158	XS1831830158
ESA 2010 Classification	F.511	F.5	F.511	F.3
Issue date	05/09/2016	05/09/2016		05/09/2016
Nominal Currency	EUR	EUR	USD	EUR

Case 1 - Multiple sources of entities with LEI code

Similarly to the first example, Case 2 shows the link of different sources providing information of entities based on the existence of a unique identifier, LEI, used by all sources. Once the link is made, the compounding process allows having complete information of the entity.

	Output	Source 1	Source 2	Source 3
LEI	918184731989134130AB	918184731989134130AB	918184731989134130AB	918184731989134130AB
ESA 2010 Sector	S.12201	S.122	S.12201	S.122
Country	IE	IE		IE
Name	Bank One Limited	Bank One Limited	Bank One Ltd.	Bank One Limited

Case 2 - Multiple sources of entities with instruments with ISIN code but no LEI

When information of the entities is not provided with a common identifier, like LEI, other alternatives can be envisaged. The data provided for the instrument can be used as an indirect link to create the entity. This example shows how the availability of the ISINs allows to create a link between internal identifiers that are not of the same type. Once the link is created, the compounding process allows having complete information of the entity.

	Output	Source 1	Source 2	Source 3
ISIN	DE1831830143 AT3426754567 XS1831830143	XS1831830158 DE1831830143	DE1831830143 AT3426754567	XS1831830158
Identifier	X,Y,Z	X	Y	Z
Identifier type		Internal	Internal	Internal
ESA 2010 Sector	S.122	S.122	S.12	S.122
Country	IE	IE		IE
Name	Bank Two Limited	Bank Two Ltd.	Bank Two Limited	Bank Two Limited

Case 3 - Multiple sources of entities with no LEI - using name matching and common identifier types

If the LEI is not available and indirect links through instruments information are not possible, the proposed process described in section 4.1 could be used: link the information provided based on the same identifier types (source 1 and 2 link with the same VAT code) complementing it with a name matching algorithm that allows linking the source 3 based on a common name and other reference data like country. Once the link is created, the compounding process can be put in place.

	Output	Source 1	Source 2	Source 3
Identifier	D,Z	D	D	Z
Identifier type		VAT	VAT	Internal
ESA 2010 Sector	S.122	S.122	S.12	S.122
Country	IE	IE	IE	IE
Name	Bank Three Limited	Bank Three Ltd.	Bank three limited	Bank Three Limited
String matching		BankThree + IE	Bankthree + IE	BankThree + IE

4.2. Use of automatic bridging technologies – lessons learnt

There is evidence that the identification and integration of micro data information on entities involves large volumes of information. Therefore, the process described above has been tested as an enhanced concept of existing CSDB procedures. When dealing with large volumes of information, any process should rely on a fully automated and machine-driven approach. To guarantee this, it is required to rely on a unique, comprehensive and stable identification like the Legal Entity Identifier (LEI). Currently, the LEI is not yet fully used by all possible sources, therefore, non-standardised identifiers need to be used, provided that they are clearly defined and also consistently implemented, maintained and applied by the different sources.

The CSDB uses the ISINs as additional identifier to link the different sources, but the use of a name matching algorithm has also proven to be useful over the years. The use during the test of a more sophisticated name matching algorithm could mitigate to a large degree the risk caused by the current non-availability of LEI and could also demonstrate the feasibility of an automated and scalable solution. In that respect the tested process described in section 4.1 has shown that further efforts should be put on improving reference data of each entity which could be used in conjunction with the name matching to enhance its precision.

5. Conclusion

Unique identifiers play a key role in micro-data data bases. In the case of securities micro-data the ISIN and LEI are the most relevant identifiers. This paper has explained how and for what purpose the CSDB makes use of the ISIN and the LEI.

However, there are situations in which the unique identifiers do not (yet) exist, are not sufficiently established or have not yet sufficient coverage. In these cases it is necessary to use automatic procedures to overcome as much as possible the problem until sufficient coverage of the unique identifiers has been reached. A procedure to deal with the absence of any unique identifier in the case of entities is presented in this note, showing that automated data integration is possible. In doing so, the procedure presented does not only demonstrate the general feasibility of the concept but also shows how automation can be applied to the largest extent.

In more general terms, this note presents evidence that the identification and integration of micro-data on assets and entities at the required scale should rely as a backbone on a fully automated and machine driven approach. To guarantee this, it is also required to rely on a unique, comprehensive and stable identification like the ISIN and the LEI. In the short-term, sophisticated matching techniques, like the CSDB grouping or the name matching algorithms may as a bridging solution temporarily complement the identifier matching and help in mitigating the risk caused by the current non-full coverage of the LEI.

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Integrating reference data for monetary policy and supervisory purposes - The European System of Central Banks (ESCB) experience[1]

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European Central Bank

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Integrating reference data for monetary policy and supervisory purposes - The European System of Central Banks (ESCB) experience

Sara Thijs and Sandrine Corvoisier[1]

Abstract

After implementing the Single Supervisory Mechanism (SSM), the integration of high quality reference data for both monetary policy and supervisory purposes in one platform at the European Central Bank (ECB) became eminent. To this end the "Register of Institutions and Affiliates Database" (RIAD) is used for jointly identifying and storing the respective reference data [enabling harmonisation of statistical tools to support policy making]. This paper first describes the integration of ESCB relevant reference data employing RIAD as a repository. Next it sheds light on the needs and general requirements of the SSM with regard to the SSM population and reference data. Finally it describes some ongoing challenges of preparing RIAD as a repository to fulfil the SSM requirements.

Keywords: Reference data – Data integration – RIAD – Monetary policy – SSM – Banking supervision – Supervisory data – Prudential scope - ESCB – Financial Institutions – Data provision – Data governance

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Contents

1. Introduction

After implementing the Single Supervisory Mechanism (SSM), the European Central Bank (ECB) – so far mainly responsible for monetary policy – together with the National Competent Authorities (NCAs) started carrying out supervisory tasks on the basis of the SSM regulatory framework[2] in order to safeguard the safety and soundness of the European banking System. Subsequently the integration of high quality reference data for both monetary policy and supervisory purposes in one platform at the ECB became eminent. Most prominent benefits entail avoiding a disconnected view on information, increasing transparency, efficiency and effectiveness by reviewing and aligning current data provision and validation processes, and reducing operational as well as reputational risk. To this end the "Register of Institutions and Affiliates Database" (RIAD) is used for jointly identifying and storing the respective reference[3] data enabling harmonisation of statistical tools to support policy making.

This paper first describes the integration of ESCB relevant reference data employing RIAD as a repository. Next it sheds light on the needs of the SSM with regard to the SSM population and reference data. Finally it describes some ongoing challenges of preparing RIAD as a repository to fulfil the SSM requirements.

2. The integration of ESCB relevant reference data

With respect to the collection, management and dissemination of reference data describing organisational units that appear as counterparties in various business contexts, the European System of Central Banks (ESCB) has set up a central repository. RIAD is a system operated by the ECB and jointly maintained by all members of the European National Central Banks and/or National Competent Authorities. It integrates and comprises the collection, dissemination and publication of several sets of reference data on (financial) institutional units that are essential for statistical departments and other user areas, predominantly market operations.

Based on RIAD the ECB publishes on its website[4] various lists of financial institutions such as Monetary Financial Institutions[5] (MFIs), Investment Funds (IFs), Financial Vehicle Corporations (FVCs), Insurance Corporations (ICs), etc., and holds information on holding companies and head offices. These lists represent the

[2] SSM Regulation and SSM Framework Regulation

[3] In the context of RIAD reference data refers to characteristics of financial institutions that are deemed to be stable over time, for example identification and address related characteristics, type, size and economic activities of the institution etc.

[4] List of Financial Institutions on the ECB's website

[5] As defined by ESA Sectors S.121, S.122 and S.123. The European System of National and Regional Accounts (ESA 2010) is an internationally compatible EU accounting framework for a systematic and detailed description of an economy (ESA website including a reference to the regulation).

authoritative and complete definition and description of several relevant reporting populations. In addition, RIAD allows monitoring demographic developments in these different populations. Further as RIAD processes information on (ownership) relationships between entities, it has become a pivotal tool for the analysis of various types of banking groups and financial conglomerates.

2.1. Data model

RIAD covers an extensive set of reference data that can be classified into four categories:

1. Identification variables that provide different types of information to identify a unit, covering 'identifier' codes as well as other descriptive variables such as name or address;
2. Stratification variables such as industry activity, institutional sector or size, usually employed for selecting or shaping fields of enquiry or reports and taking samples;
3. Demographic variables, describing the lifespan of a unit, essentially 'date of creation' and 'date of closure' and information on mergers or splits;
4. Variables describing the relationships between units (such as 'ownership' or 'control') which serve as building blocks to construct group structures.

For each value of an attribute a validity range needs to be provided. This allows for full historisation of data and retrieving snapshots of freely chosen points of reference dates.

2.2. Data provision and governance framework

The RIAD application allows different stakeholders to provide data on all or subsets of entities, covering all or a subset of attributes to perform data quality management, and subsequently make up-to-date information available to end-users. To ensure the successful operation of the RIAD application on an ESCB-wide scale, the rules on the provision and management of the data stored and processed were defined. This framework defines the actors, roles and responsibilities of each involved stakeholder and interaction(s) of RIAD with other datasets.

Currently National Central Banks (NCBs) act as the main gateway to RIAD for data on financial institutions. However, RIAD also allows for other organisations to take over the responsibility for subsets of data e.g. NCAs are technically able to link up to RIAD. To ensure a local coordination of updates and overall consistency regarding the sourcing and management of reference data, each NCB has set up a national 'hub'.

Within the national hubs data providers and data quality managers are the pivotal actors to set-up and maintain RIAD. Each national hub is supposed to have the most correct view on which data sources should be used for the various sectors and attributes, which means that statisticians are not necessarily the only actors responsible for the availability and quality of data. National arrangements may be based on combining or merging information from different business areas (e.g. statistics, supervision, market operations, or payments and market infrastructure, etc.).

To cater for this RIAD is designed in such a way that it can process input from multiple 'candidate contributions'. For each attribute national data quality managers can specify a hierarchy of these candidate contributions. Eventually all input will be condensed into a single 'authoritative' set of reference data[6].

3. New features introduced by the Banking Supervision domain

Since the start of the operation of the ECB Banking Supervision in November 2014, the SSM is responsible for the supervision of around 4,700 entities within participating Member States[7]. The respective supervisory roles and responsibilities of the ECB and the NCAs are allocated on the basis of the significance of the supervised entities. The ECB directly supervises all institutions that are classified as a 'significant institution' (SI) with the assistance of the NCAs. The day-to-day supervision is conducted by Joint Supervisory Teams (JSTs), which comprise staff from both NCAs and ECB. 'Less significant institutions (LSI)' are directly supervised by the NCAs[8].

To serve stakeholders within this new function various data sets have been developed in different business areas throughout the ECB. As a basic principle, supervisory data, including reference data, is collected by NCAs and validated by several teams within the ECB.

As the ECB Banking Supervision needed to be operational very fast, the respective data collection processes had to be rapidly implemented, most of the time via short-term solutions. Reference data for example was compiled via various tools spread over different teams (i.e. through an intensive use of MS Excel sheets). There was urgency to alleviate the burden on supervisors (both at ECB and NCAs) from cumbersome processes, and to on-board all involved stakeholders in a holistic way to ensure coordinated data sourcing and reliability of data. The backbone in ensuring coherence among all systems and processes is a comprehensive repository for reference data.

Consequently, as RIAD was an existing ESCB wide reference data platform serving user needs beyond the statistical domain, it was the logical candidate to be used as a single repository of supervised institutions containing a comprehensive set of SSM related reference data.

[6] For example, for the 'address' attribute the NCB typically assigns the input from the statistical domain as the highest in rank among all potential contributions from various stakeholders. In case a value is entered by both the statistical domain and the marketing operation domain, the value from the statistical domain will prevail and the authoritative value of the 'address' attribute will be the one from the statistical domain.

[7] A Member State is a country that is part of the European Union

[8] More information can be found on the ECB Banking Supervision website.

3.1. New attributes for supervisory purposes

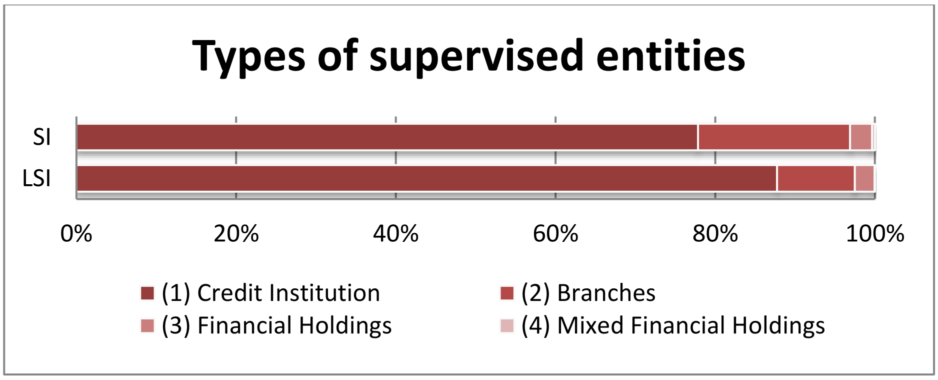
Several reference data attributes that are required for supervisory purposes were already collected for statistical purposes e.g. name, start date of an entity, close date of an entity. These attributes needed to be fine-tuned in their definition so as to be properly used by all involved stakeholders.

Further a new set of attributes needed to be added. To identify main characteristics of the supervised entities attributes describing the significance, position and type of the institution according to the SSM regulation were collected. Further attributes describing the reporting requirements including waivers granted to the institution were added. The latter serve as the metadata for supervisory reporting data collection and provide information on what data the institution is obliged to report for COREP and FINREP (Common Reporting and Financial Reporting).

3.2. The supervisory relevant population

RIAD started in 1999 with a focus on the list of MFIs[9]. This is why the SSM relevant population substantially overlaps with the institutions already recorded in RIAD, especially when it comes to financial institutions within the Euro Area. With a few exceptions, the credit institutions of relevance for supervisory information, SI or LSI, constitute therefore a sub-set of the financial institutions relevant for monetary statistics.

In the SSM Framework Regulation, the types of supervised entities are referred to as (1) credit institutions established in a participating Member State, (2) branches established in a participating Member State by credit institutions which are established in non-participating Member States, (3) financial holding companies established in a participating Member State and (4) mixed financial holding companies established in a participating Member State. The graph below provides an indication of how the 1,203 SIs and 3,336 LSIs[10] are divided over the four types. In fact the majority of the population are credit institutions (78% in case of SIs and 88% in case of LSIs). With only a few cases the mixed financial holding companies comprise a minority.



[9] In accordance with the Regulation (EU) No 1073/2013 of the ECB of 24 September 2013 concerning the balance sheet of the monetary financial institutions sector (recast ECB/2013/33) completed with the latest Guideline of the ECB of 4 April 2014 on monetary and financial statistics (recast ECB/2014/15)

[10] As of 31/03/2016

The following table shows how the supervisory population is mapped against the ESA 2010 sectors[11] classification in RIAD. Generally one can spot a large correspondence between the two classifications (implying both categorizations classify the institutions similarly), yet some discrepancies exist between how the entity is classified for statistical purposes (according to ESA 2010) and how the entity is classified according to the SSM framework. These discrepancies are challenged and subject to clarifications where necessary i.e. potential inconsistencies in either of the two classifications are analysed.

ESA 2010 Sector classification versus Type of supervised entities

Table 1

ESA Classification	Deposit taking corp. except the Central Bank (S.122)	Other Financial Intermediaries except Pension Funds and Insurance Corp. (S.125)	Financial Auxiliaries (S.126)	Captive Financial Institutions and Money Lenders (S.127)	Other
Type of supervised entity					
1. Credit Institution	84.47%	0.53%	0.11%	0.02%	
2. Branches	12.06%	0.09%	0.02%		0.02%
3. Financial Holdings		0.11%	0.89%	1.31%	0.24%
4. Mixed Financial Holdings			0.04%	0.04%	0.02%

3.3. The supervisory group perimeter

In the context of the SSM it is necessary to identify 'group structures' of supervised entities based on the prudential scope. Compared to the accounting consolidation scope (originally chosen for RIAD) the prudential consolidation scope differs in several ways. Whether an entity is subject to consolidated supervision depends on its activities or licences, the type and the location of the entity. Further, while the accounting consolidation usually only takes relationships based on capital control into account, group structures for supervisory purposes also include voting rights or management agreements.

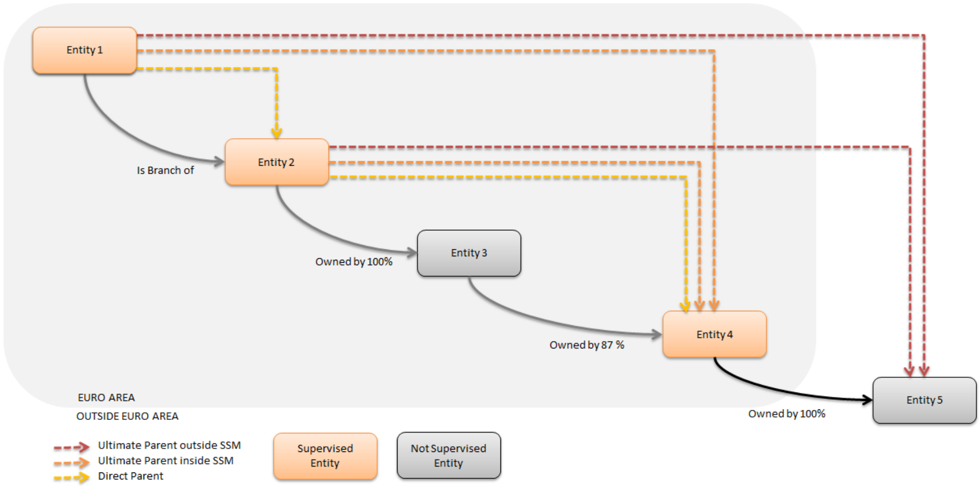
Within the prudential consolidation scope, different levels of consolidation might apply, implying that different group structures need to be modelled in a repository used for managing the respective reference data. For instance the group perimeter of the supervised entities might differ from the group perimeter of the entities subject to prudential reporting because of a different treatment of the highest level of consolidation. Also, group structures for feeing purposes entail a different treatment of financial holdings. Additionally, group perimeters including

[11] More information on ESA can be found in footnote 3

non-supervised entities are also of interest and several sub-consolidation levels exist[12].

For SSM purposes RIAD currently collects for all supervised entities the direct supervised parents, the ultimate supervised parent *within the SSM* and the ultimate supervised parent *outside the SSM*, also referred to as the 'SSM relationships'. Additionally, information on the position of the supervised entity in comparison to other supervised entities of the same group is collected. However, these SSM relationships do not hold any further information on the respective relationships (e.g. the share percentage in case of a capital ownership and whether the relationship is direct or indirect).

The graph below exemplifies how the conceptual 'SSM relationships' map to normal 'capital ownership relationships' (possibly provided to RIAD in the context of other business purposes). It demonstrates the gap between the two views and how combining them can be insightful and allows for grasping ownership structures between entities in the prudential scope.



While the direct parent in supervisory context may reflect one direct capital ownership relationship (Entity 1 versus Entity 2), it may also represent a chain of direct ownership links (Entity 2 versus Entity 4). In case Entity 3 is a corporate subsidiary, it is relevant for accounting consolidation because it controls Entity 2 and is controlled by Entity 4, however, as it is not a supervised entity it is not included in the prudential perimeter.

Further, as the ultimate parent according to the concept of control is not necessary subject to consolidated supervision – when the institution is not residing in an SSM member state (Entity 5) – the SSM relationships distinguish between an ultimate parent inside and outside the SSM perimeter. In the example of the graph, the highest prudential scope of consolidation is based on Entity 4.

[12] For instance liquidity sub-consolidation: as defined by the Capital requirements regulation and directive (CRR/CRD IV) liquidity specific sub-consolidation is triggered by a granted waiver (CRR 8.2 and CRR 8.3) and waives the solo liquidity application on those entities. Upon granting the waiver, several institutions within the European Economic Area (EEA) or within the same Member State, form a single liquidity sub-group for the purpose of meeting CRR liquidity requirements.

4. Challenges triggered by supervisory data needs

This section zooms further in some pending challenges related to integrating the SSM reference data in RIAD.

4.1. Host versus home approach

As a basic rule the data provision on reference data in RIAD follows the **host principle** i.e. all hubs are responsible for correct data provision on entities that reside or are registered within their country, including resident branches of foreign headquarters. More specifically, it is even technically not possible for users to edit entities outside their jurisdiction, for example, an Italian user (either from NCB or NCA) can only edit reference data of entities residing in Italy and cannot upload reference data for a Belgian entity. A link exists between the host part in the RIAD Code[13] and the institution of the acting user.

NCAs, however, collect and manage supervisory data based on the **home principle** i.e. they are responsible for data of the institutions they supervise. The supervising NCA, residing in the country of supervision, can be different from the NCA residing in the country of residence of the entity[14]. Technically the NCA can today not update reference data for these non-resident institutions in RIAD. As a short-term solution, the ECB intervenes in these cases and uploads the supervisory reference data in RIAD on behalf of the country of supervision. As a long-term solution, RIAD would need to adapt its data provision principles in such a way that in case the country of supervision differs from the country of residence, a user in the country of supervision would be able to view and edit a set of supervisory reference attributes. Since this solution goes against one of the basic principles of RIAD, technical implications on accessibility, combining data from various sources and confidentiality, as well as implications on the governance and data provision framework are being studied carefully.

4.2. Confirmation and approval of data

One of the main purposes of maintaining the 'significant' and 'less significant' institutions and their reference data in one repository is the publication of the list of SIs and LSIs on the ECB's website. All amendments to the respective SSM reference data (including joiners or leavers of SIs and LSIs) have to pass several steps of formal confirmation before they are recognised as being publishable in the official lists. Amendments initiated by NCAs must be confirmed by the responsible person(s) at the ECB and most of them must also be approved by the Supervisory Board (SB) and or Governing Council (GovC). Depending on the type of amendment several pre-approval or pre-publishing stages are excluded.

[13] Every entity in RIAD needs to be identified with a unique RIAD Code. The first two digits of this RIAD code represent the two digit ISO country code, i.e. the host. The second part of the RIAD Code is a freely chosen string code that is owned by the national hub. For instance IT546389, BE0009AB2674.

[14] For instance subsidiaries of significant supervised groups established in a non-participating Member State or a third country are required to report supervisory financial information as of 30 June 2016.

While currently data recorded in RIAD is viewed as 'final' to be used in reports or for publishing, the procedures for updating reference data on SIs and LSIs bring in a new concept of approval or confirmation of data. Different approval or confirmation procedures apply within the various ECB business areas and this should be reflected in the governance framework. When describing data provision of SSM reference data, processes for data input and processes for confirmation or approval of amendments should be separated. Further the repository should technically be prepared to allow for indicating whether an amendment in data is approved or not.

4.3. Start and end date of reporting requirements

To every value of an attribute in RIAD a 'validity range' is assigned, marking a start and an end date of a specific value. The current philosophy in RIAD is that there can be no values for attributes before the 'birth date' of the entity and after the 'close date' of the entity. Traditionally for statistical purposes this birth date and close date represent the timespan of legal incorporation of the entity.

In practice it appeared that the validity range of supervisory reporting requirements does not always fall within the lifespan of the entity for statistical purposes. A typical example relates to corporate actions. Institutions might be allowed/are required to report supervisory data for an entity after it has been merged into another entity[15]. Legally the merged entity should already be deregistered and thus closed in RIAD, but, for supervisory purposes the reporting requirements metadata need to be recorded in the repository after the legal close date of the merged entity.

Because the two views on the lifespan of an institution cannot always be reconciled, a proposed solution currently under review is to add in addition to the current birth and close date (referred to as the *administrative* birth and close date), an *operational* birth and close date that might lie outside the legal lifespan of an entity. This will allow for specific sets of attributes to be attached to an entity in this additional timespan.

4.4. Confidentiality of SSM related information

Due to the sensitivity of SSM related information, the SSM stakeholder required the reference data specific for supervisory purposes to be hidden from users outside the supervisory domain. To this end a more granular approach towards access rights and confidentiality in RIAD was needed.

The existing user roles define the access rights to information on entity level, implying a limitation on the viewing and editing rights to a specific set of entities. For instance NCBs can only edit entities within their jurisdiction. Complementary to the existing user roles, a new set of 'SSM' user roles specifying viewing and editing rights on attribute level was created. Consequently only users granted an SSM user role can view and/or edit the set of reference data specifically recorded for supervisory purposes.

[15] For example two entities A and B closed and merged into a new entity C. Entity A and entity B are allowed to report separately for a few months.

The limitation of viewing rights for specific sets of attributes increases the complexity of governance. Traditionally the statistical departments within NCBs are responsible for creating and closing down entities, registering corporate actions, etc. In case these users are not granted an SSM role, they would not be aware of the presence of reference data for supervisory purposes while performing data quality management tasks. (In the worst case they might for instance close an entity that is still relevant from a supervisory perspective, hereby unknowingly removing metadata for reporting requirements.) To deal with this extra complexity users should be made aware in case of an event impacting reference data not visible to the respective user. Technically one could think of means such as automatic warnings to cater for this.

5. Conclusions and way forward

This paper illustrated the urgency of integrating reference data for monetary and supervisory purposes. It described the specific characteristics of supervisory reference data and exposed various challenges intrinsic to integrating this reference data in an existing repository.

It was demonstrated that next to technical enhancements, a sound governance framework is the backbone of successful integration. Therefore, the process of integrating reference data entailed shedding light on the various data provision processes of supervisory reference data. To this end a collaboration between all involved stakeholders was set up to (1) identify and describe current processes, (2) detect inconsistencies in data and redundancy of procedures, (3) discover opportunities for improvement and (4) employ this knowledge to consent on a coordinated and integrated approach that can be incorporated in the governance framework of the repository.

Expectations are that RIAD will continue to on-board new stakeholders. For instance RIAD will host the reference data of several millions Non-Financial Corporations (NFCs) reported to the forthcoming Analytical Credit Dataset (AnaCredit)[16]. In this context incorporating SSM reference data was a valuable learning opportunity on how to efficiently cope with challenges intrinsic to integrating reference data for divergent purposes, serving numerous systems. It allowed for continuing the work towards building a holistic repository serving as a data integrator between various datasets and data sources within the ESCB.

[16] More information on AnaCredit can be found on the ECB's website (also containing a reference to the AnaCredit Regulation)

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The benefits of using large high frequency financial datasets for empirical analyses: Two applied cases[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

The benefits of using large high frequency financial datasets for empirical analyses: Two applied cases

Massimo Minesso Ferrari[§] **and Kristyna Ters**[†]

Case one: Market evaluation of monetary policy decisions: a simple approach using intraday data.

Massimo Minesso Ferrari[§]

Introduction

How do markets evaluate monetary policy announcements and how large are the shocks they convey? These are central questions for policy makers if they are interested in evaluating their decisions and quantitatively assess the outcomes of different and possibly alternative policies.

As we know, if markets were completely efficient and monetary policy was perfectly communicated by central banks, market agents should have already priced in the

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decision of the monetary authority at the time of the announcement. On the contrary, if the central banks are able to surprise the market, they might be able to generate real effects after their policies. In this short paper, that is based on the methodology applied in M. Ferrari, J. Kearns and A. Schrimpf "Monetary shocks at high-frequency and their changing FX transmission around the globe"[1], I will present a simple methodology to identify monetary policy shocks using high frequency financial data. When the precise moment of a shock is known, high frequency data allow us to pinpoint the exact moment of the event and, therefore, to correctly identify the reaction of market participants. This approach has the advantage to be fast and easily implementable but has some relevant caveats. They can be divided in two main groups: on one hand there are technical problems, connected to the size of the database used; on the other, especially for illiquid markets, the data reporting process may be inaccurate.

Why using high frequency data?

Monetary policy transmission is one of the main concern for policy makers. However, it is not always easy to understand how it works and, more interestingly, how large the shock delivered by each announcement[2] is.

Aggregate variables are reported, in the best case scenario, at monthly basis while firms data are update for listed corporations on a quarterly basis. In this setting it becomes therefore quite complicate to pinpoint exactly the effect of a single monetary policy announcement, to identify the effect of that announcement per se and to remove the impact of market overreactions or other shocks taking place in the same time interval.

[1] In that paper we looked at the market response to conventional and unconventional policies, measuring monetary policy surprises using bonds and overnight indexed swaps (OIS).

[2] The importance of this question is testified also by the huge amount of literature on the topics. Contributions are many and start from the early nineties, between them see (Bernanke & Gertler, 1995) and (Christiano, Eichenbaum, & Evans, 1999)

On financial markets, on the contrary, securities are traded daily with end-of-day quotes available on most data provider's platforms. This appears to be a solution for the previous problem reducing drastically the time interval of the analysis, and thus the number of possible overlapping shocks. However that is not entirely true. In fact, especially for the case of liquid markets such as the FX, observation at a daily basis can suffer for problems similar to those outlined before. Many authors have called for the necessity of a closer time interval to pinpoint exactly the impact of monetary policy decisions[3].

This approach has the clear advantage of focusing only on the exact moment of each monetary policy announcement and of evaluating how market reacted to that particular news. As follows from standard results of finance theory, a completely anticipated shock should be already priced when it actually takes place. With high frequency data researches can set a sufficiently narrow time window around each monetary policy announcement to check if markets are surprised or not by a specific news. Measuring the surprise on this limited time horizon allows to remove the noise deriving from other events that might influence the instrument's quote along the day and potential crowding-in or out effects. This is true not only for large economies, such as the U.S. or the euro area, but also for smaller countries. An example can clarify this point. On the 3rd of May 2016 the RBA announced a 25 bp cut in the target rate. The reaction of the Australian dollar is reported in Figure 1.

[3] See for example (Kearns & Manners, 2006), (Wright, 2012), (Rogers, Scotti, & Wright, 2015), (Gertler & Karadi, 2015) and (Ferrari, Kearns, & Schrimpf, 2016)

Figure 1: Market reaction to RBA decision of May 3 2016.

As it is clear from Figure 1 the monetary policy decision had an immediate and sharp impact on the exchange rate, evident from the sharp devaluation around 6:30 CET. However, if this policy shock is measured at the daily level, the result is quite different. The end of day quote, in fact, incorporates other events that in the day have affected the FX quote during the day leading to a much different and noisier measure of the FX change due to the monetary shock. This case is a clear example of how setting a too wide window around an event may lead to misperception of its size.

High frequency data to measure exchange rate reactions

The methodology outlined above was used in (Ferrari, Kearns, & Schrimpf, 2016). In this paper we look at the FX reaction to conventional and unconventional monetary policy decisions. In order to assess the impact of monetary policy on the exchange rate we used a minute tick database provided by Thomson Reuters. This dataset contains information on the FX, 2- and 10-year bonds and 1- and 6-month OIS for 7 countries of interest[4] from 2000 to 2015, for every calendar day. Data are reported by market

[4] Australia, Canada, euro area, Japan, Switzerland, UK and US.

participants, providing details from the number of trades to the bid/ask quote for each instrument at the minute frequency.

The dataset contains a huge amount of information regarding quotes, prices and liquidity of each instruments with hundreds of millions of entries. Between all those information we were interested in identifying the monetary policy shock related to each monetary policy decision and the reaction to that shock in the exchange rate.

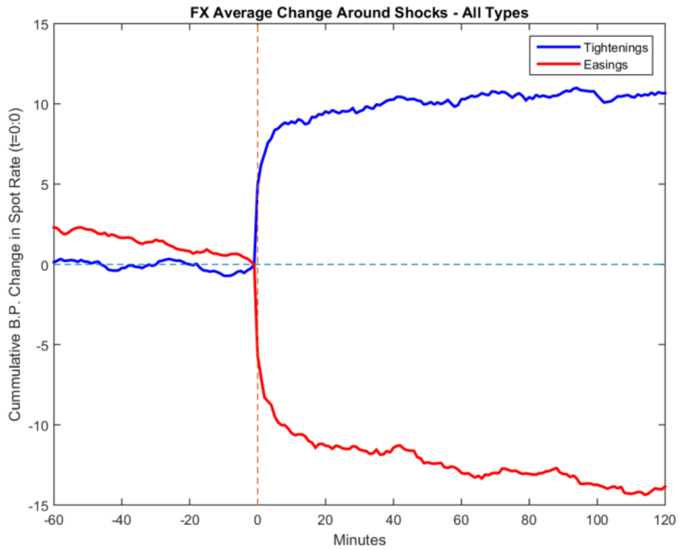

Figure 2: Cumulative basis point change around each monetary policy decision, averaged between events and countries. Source: (Ferrari, Kearns, & Schrimpf, 2016).

To do so we developed a simple procedure to select only the relevant information in the database and compute the change in each instrument's quote around each monetary policy decision. The time window we selected (20 minutes around each announcement) is tight enough to ensure that every variation within that amount of time is entirely related to the monetary policy shock itself. Therefore the measure we compute is the market perceived surprise of each move of central banks, free from the (possible) noise deriving from other events and bounds. This procedure has the advantage to be simple to implement, neat in the results and constrained only by data availability and computing power. In fact it is only necessary to know when an event takes place, to extract the data on the desired time interval around each event and to compute a measure of the shock.

There are, however, some caveats related to the nature of the dataset under consideration that will be tackled in the next section.

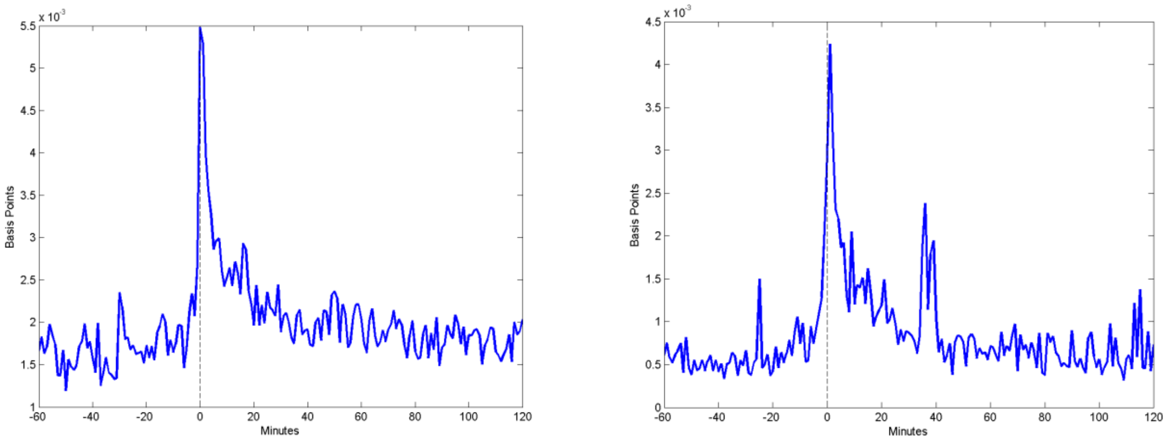

Figure 3: Intra minute absolute basis point change in 2-year bonds (left) and 1-month OIS (right), averaged across events and countries. Source: (Ferrari, Kearns, & Schrimpf, 2016).

Based on this methodology, we identify a strong response of the FX to monetary policy surprises and a sizable shock connected to each communication of central banks (see Table 1). We use these data to compute a target shock measure to the FX (using the 1-month OIS) and the change in the yield curve related to each announcement. By measuring monetary policy shocks in this way we are able to identify the impact of 1 bp monetary policy surprise on the exchange rate and how that the impact changes over time.

	Policy Rate	FX Spot	Target	Path
U.S.	7.8	17.4	1.0	2.2
Euro Area	5.5	12.6	0.9	1.1
Japan	0.0	10.3	0.2	0.3
U.K.	4.9	16.5	1.4	2.1
Australia	9.5	21.8	2.9	2.8
Switzerland	6.2	29.1	0.6	1.2
Canada	7.9	31.9	1.9	3.1

Table 1: Average absolute surprise by country. The second column reports the average absolute change in the policy rate at each monetary policy decision for each country, Column 3-5 report average absolute market surprise computed using a 20 minutes window around each shock. Source: (Ferrari, Kearns, & Schrimpf, 2016).

Problems specific to high frequency data

The procedure outlined before[5] has, as pointed out, the advantages of simplicity and clearness, delivering at the same time high precision identification of the variable of interest.

There are, however, two main sources of concerns related to its implementation.

The first problem, which is common to all big data exercises, is merely technical and related to the size of the used database. Data are double compressed in order to be easily downloadable and each part of the dataset contains the information of an entire month of trading, about 700 thousands cells (for each instrument) that are a mixture of strings and numbers. This huge amount of information makes it unfeasible to load and save the entire tick history and requires a relative high amount of time to access each element of the database. Additionally there are limitations on the platform we used (Matlab) to the amount of data of mixed type that can be saved without using complex saving methods and which take hours to run also on high spec machines. To circumvent these problems we developed an algorithm that interacts as little as possible with the database and divides data into smaller objects allowing to save and load them fasters. At the same time we implemented checks to identify missing observations or data errors.

The second order of problem is, on the contrary, deeply related to the type of data under consideration. Tick databases are compiled by data providers such as Thomson or Bloomberg using quotes reported by market participants. Data providers, however, update quotes only if a sufficient number of trades take place within the time interval (in this case the minute) and the market participant monitored. If there

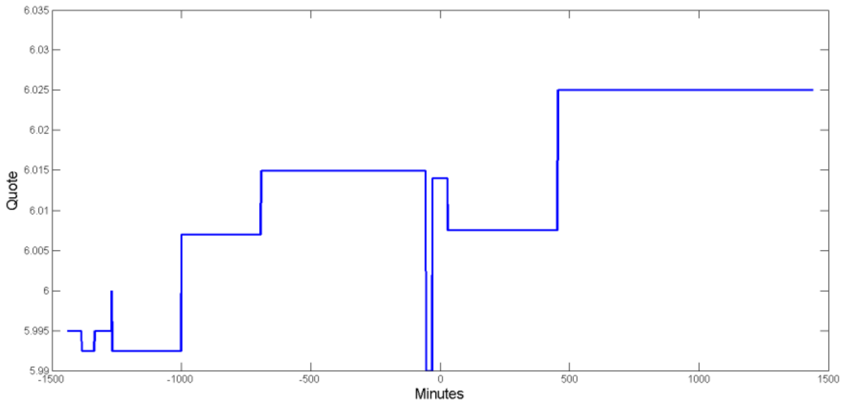

Figure 4: Example of sticky quotes from Australian 1-month OIS. Changes in one day interval around event (at time 0).

[5] It can be summarized in three steps: identify the exact timing of each shock, extract the data related to the interval around each shock and compute the shock.

are not enough trades, the quote is not updated as if there were no trades at all. This is a potential downfall for the entire methodology. In that case in fact the change in the instrument is computed as zero, while, on the contrary, there is a non-zero monetary policy shock. This issue is particularly relevant for relatively illiquid markets (such as that in Figure 4), that are populated by few and possibly smaller players.

To implement our methodology correctly it is crucial to separate those events for which monetary policy decisions are already priced in from those in which quotes are simply not updated. In the first case the observation needs to be included in the sample, because it conveys relevant policy information; on the contrary, in the second case we want to treat that observation as a missing datapoint to not dilute the sample.

In order to distinguish between the two cases we construct a secondary dataset using daily data from an alternative provider (Bloomberg Analytics). This dataset has open and close quotes at daily frequency, computed independently from Thomson Reuters. In this way it is possible to compare open and close quotes based on Bloomberg data with our own dataset. If the shock is computed we check the daily change and compare it with the Bloomberg's daily change. If the change computed out of our data is zero, while Bloomberg's is positive, we consider the observation as a missing data. In this way we are sure to minimize the impact of sticky quotes in our sample, reducing them to a negligible number of data points.

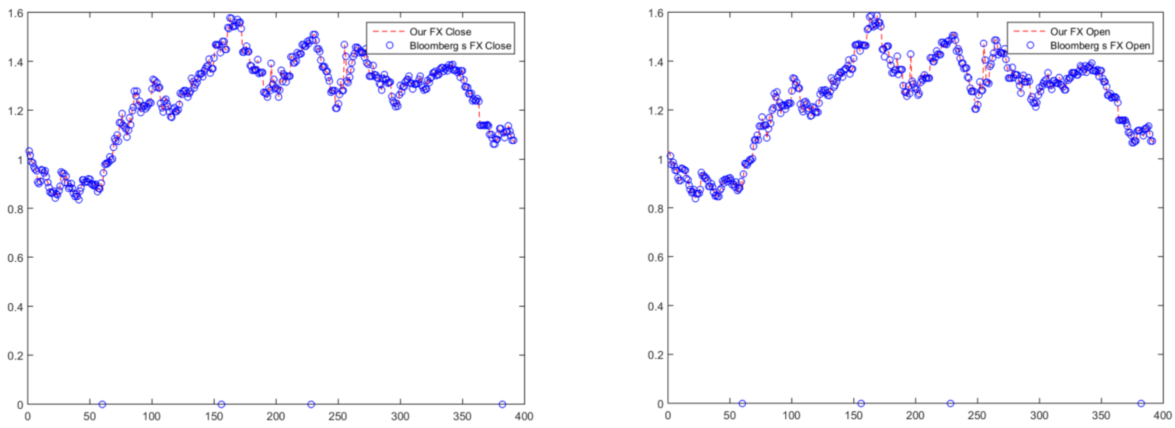

Figure 5: Daily open and close quotes from Bloomberg's data and Thomson intraday database for Euro/Dollar exchange rate. Data points overlap if measurements coincide. Source: (Ferrari, Kearns, & Schrimpf, 2016).

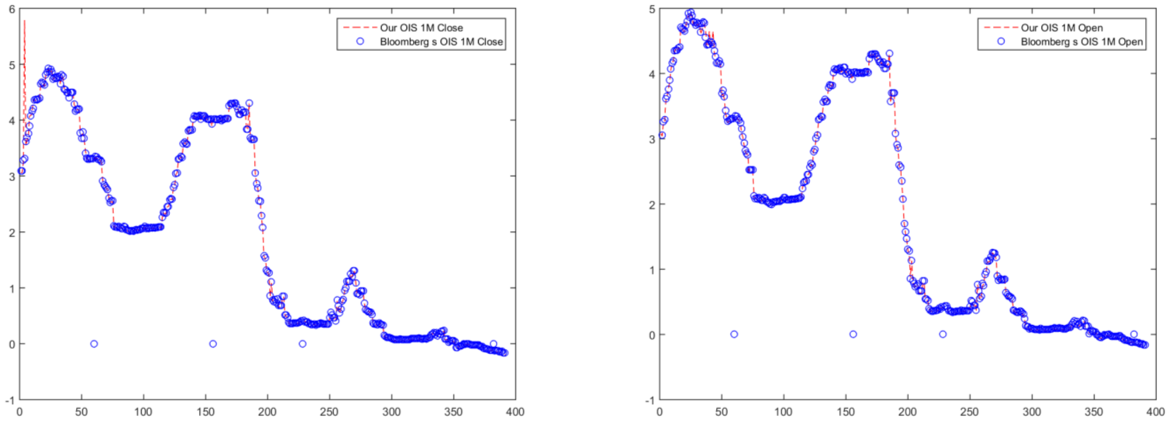

Figure 6: Daily open and close quotes from Bloomberg's data and Thomson intraday database for Euro Area 1-month OIS. Data points overlap if measurements coincide. Source: (Ferrari, Kearns, & Schrimpf, 2016).

Conclusions

High frequency data allow researchers to easily identify the impact of precisely timed shocks on market quotes. Shocks identified in this way can be used to easily assess the impact of monetary policy on market quotes.

This approach shares some of the main problems related to big data concerning mainly memory space and computing power but presents also issues that are specific to the type of data under consideration. In this setting, in fact, it is critical to understand if a shock measured as zero is generated by the reporting mechanism or if it is indeed in the data.

In the page above we have outlined a possible way to check the data quality against an independent source, in order to minimize the impact of data errors on the final estimation. With this methodology, in (Ferrari, Kearns, & Schrimpf, 2016), we were able to identify monetary policy shocks, to show the impact of monetary policy surprise on the exchange rate and how the sensitivity of markets to monetary policy increases trough time.

Case two: Intraday dynamics of euro area sovereign credit risk contagion

Kristyna Ters†

Introduction

We analyse euro area sovereign credit risk contagion effects in GIIPS[6] countries plus France and Germany from January 2008 to end-December 2011, which we split into a pre-crisis and crisis period. The use of intraday CDS and bond data lets us estimate credit risk contagion effects with substantially more accuracy than existing studies on sovereign credit markets have done. In addition, little is yet known about the transmission channels of credit risk contagion through the CDS and the bond market, and their relative importance in the euro area sovereign debt crisis. As we have data for both the CDS market and the bond market, we are able to assess the contagion impacts conditioned on the credit channel. The use of intraday data allows us to capture the intraday patterns of credit risk contagion. Indeed, shocks that may seem to affect several countries simultaneously when viewed at a daily or lower data frequency are revealed, through the lens of intraday data, to have possible origins in one particular country with clear contagion effects on other countries. Via the use of intraday data we are able to estimate the dynamics of sovereign credit risk much more accurately than in existing studies as no other empirical work so far has tested the intraday patterns of sovereign CDS and bond market credit spreads.

Our findings suggest that, prior to the crisis, the CDS and bond markets were similarly important in the transmission of sovereign risk contagion, but that the importance of

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[6] Greece, Ireland, Italy, Portugal and Spain.

the bond market waned during the crisis. We find flight-to-safety effects during the crisis in the German bond market that are not present in the pre-crisis sample. Our estimated sovereign risk contagion was greater during the crisis, with an average timeline of one to two hours in GIIPS countries. By using an exogenous macroeconomic news shock, we can show that, during the crisis period, increased credit risk was not related to economic fundamentals. Further, we find that central European countries were not affected by sovereign credit risk contagion, independent of their debt level and currency.

Data

The core data we use in our empirical analysis consists of USD-denominated five-year maturity intraday quotes on CDS contracts and government bonds for France, Germany, Greece, Ireland, Italy, Portugal and Spain. We choose this group of countries as it includes the countries most affected by the euro sovereign debt crisis, as well as Germany, which serves as the near-risk-free reference country, and France, which we consider as a low-risk control country. According to (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) when one considers the number of quotes of CDS contracts at the peak of the sovereign debt crisis in 2010, the five-year segment is the most liquid. The use of intraday data in our empirical analysis enables us to obtain much sharper estimates and clearer results with respect to market mechanisms as also shown in (Gyntelberg, Hoerdahl, Ters, & Urban, 2013). Further, (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) show that sovereign credit risk dynamics follow an intraday pattern. Our sovereign bond price data is provided by MTS (Mercato Telematico dei Titoli di Stato[7]). The MTS data comprise both actual transaction prices and binding bid-offer quotes. The number of transactions of sovereign bonds on the MTS platform is, however, insufficient to allow us to undertake any meaningful intraday analysis. Therefore, we

[7] The Italian secondary market for sovereign bonds, created by the Ministry of Treasury in 1988 and privatized in 1997.

use the trading book from the respective domestic MTS markets. The MTS market is open from 8:15 to 17:30 local Milan time, preceded by a pre-market phase (7.30 to 8.00) and an offer-market phase (8:00 to 8:15). We use data from 8:30 to 17:30. The CDS data consist of price quotes provided by CMA (Credit Market Analysis Ltd.) Datavision. CMA continuously gathers information on executable and indicative CDS prices directly from the largest and most active credit investors. After cleaning and checking the individual quotes, CMA applies a time- and liquidity-weighted aggregation so that each reported bid and offer price is based on the most recent and liquid quotes. The CDS market, which is an OTC market, is open 24 hours a day. However, most of the activity in the CMA database is concentrated between around 7:00 and 17:00 London time. As we want to match the CDS data with the bond market data, we restrict our attention to the period from 8:30 to 17:30 CET (CEST during summer). We construct our intraday data on a 30-minute sampling frequency on our data set, which spans from January 2008 to end-December 2011. The available number of indicative quotes for CDS does not allow a data frequency higher than 30 minutes. The euro area sovereign CDS markets were very thin prior to 2008, which makes any type of intraday analysis before 2008 impossible. Microstructural noise effects may come into play when high frequency data is used. However, this does not apply to our data based on a 30-minute sampling frequency because we average the reported quotes over each 30-minute interval as shown in Figure 6 (for tests, robustness checks and for a more detailed discussion please refer to (Gyntelberg, Hoerdahl, Ters, & Urban, 2013)).

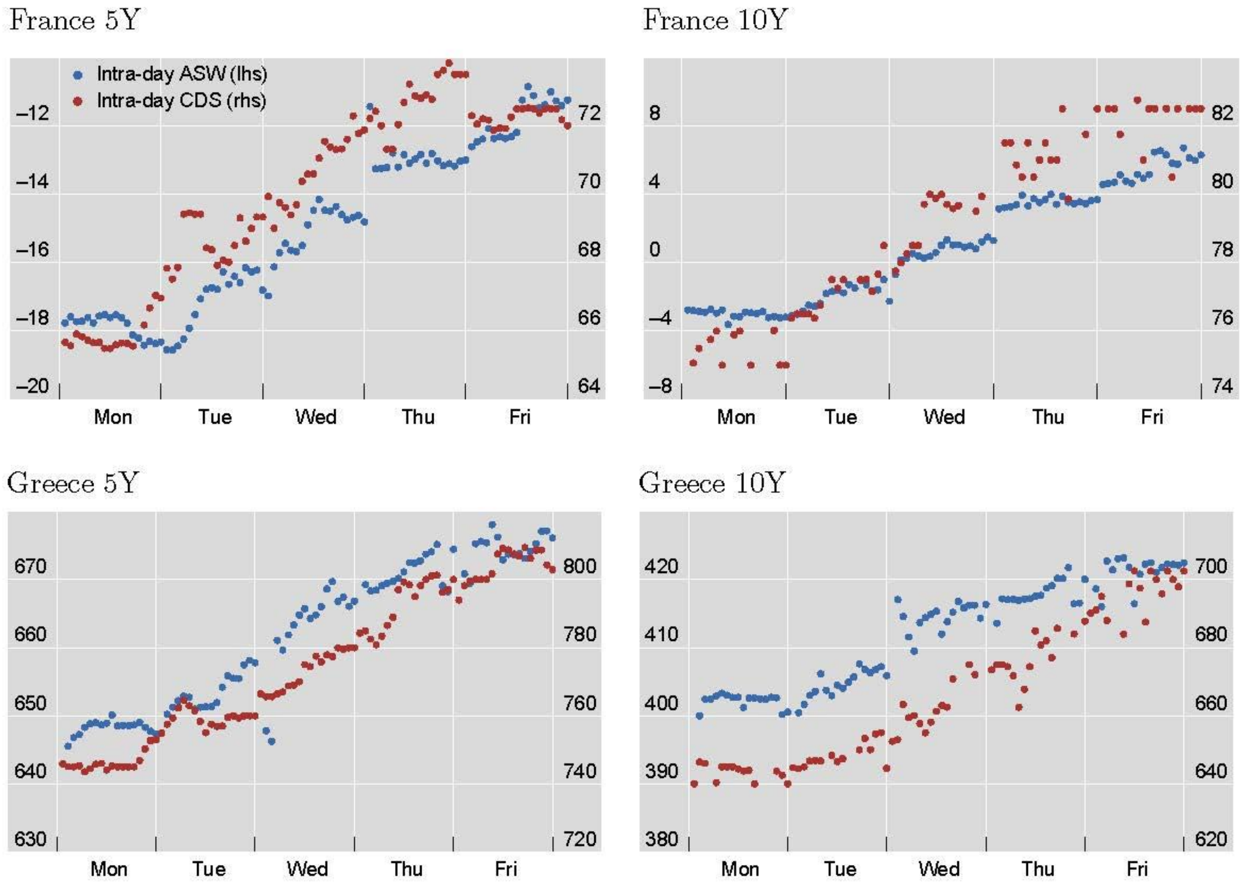

Figure 6: Sample of intraday CDS and ASW spreads. Intraday movements of CDS (right-hand axis) and ASW (left-hand axis) spreads in basis points for an arbitrary sampling period (Monday 9 August to Friday 13 August 2010). The figures show data for a 30 minutes sampling frequency, i.e. 18 time intervals per trading day.

When implementing our analysis we split the data into two subsamples. The first covers the period January 2008 to 19 October 2009 and, as such, represents the period prior to the euro area sovereign debt crisis. While this period includes the most severe phase of the financial crisis, including the default of Lehman Brothers, it is relatively unaffected by market distortions stemming from concerns about the sustainability of public finances in view of rising government deficits and therefore represents the pre-sovereign debt crisis period. The second subsample covers the euro area sovereign debt crisis period and runs from 20 October 2009 to end-December 2011. As the beginning of the crisis period, we designate 20 October 2009, when the new Greek government announced that official statistics on Greek debt had previously been fabricated. Instead of a public deficit estimated at 6% of GDP for 2009, the government now expected a figure at least twice as high. We employ CDS and bond data in our analysis in order to be able to differentiate between the transmission of sovereign risk contagion according to the credit risk channel from one country to another. Based on the no arbitrage theory the CDS and the bond yield spread both price the same default of a given reference entity, their price should be equal if markets are perfect and frictionless. Thus, in a perfect market, due to arbitrage, the CDS spread equals the bond yield over the risk-free rate. However, for this parity to hold, a number of specific conditions must be met, including that markets are perfect and frictionless, that bonds can be shorted without restrictions or cost and that there are no tax effects, etc. A further complication linked to the use of fixed-rate or plain vanilla bonds as substitutes is that it is unlikely that the maturity of these instruments exactly matches that of standard CDS contracts. To ensure proper comparability with CDS, (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) employ synthetic par asset swap spreads (ASW) for the bond leg of the basis. The use of ASW is in line with the practice used in commercial banks when trading the CDS-bond basis. By calculating ASW for our empirical analysis, we ensure an accurate cash flow matching, as opposed to studies that use simple “constant maturity” yield differences for credit risk. An asset swap is a financial instrument that exchanges the cash flows from a given security - e.g. a particular government bond - for a floating market rate. This floating rate is typically a reference rate such as Euribor for a given maturity plus a fixed spread, the ASW. This spread is determined such that the net value of the transaction is zero at inception. The ASW allows the investor to maintain the original credit exposure to the fixed rate bond without being exposed to interest rate risk. Hence, an asset swap on a credit risky bond is similar to a floating rate note with identical credit exposure, and the ASW is similar to the floating-rate spread that theoretically should be equivalent to a corresponding CDS spread on the same reference entity. Specifically, the ASW is the fixed value A required for the following equation to hold:

$$\underbrace{100 - P}_{\substack{\text{Upfront payment for bond}\\ \text{asset in return for par}}} + \overbrace{\underbrace{C \cdot \sum_{i=1}^{N_{\text{fixed}}} d(t_i)}_{\text{Fixed payments}} = \underbrace{\sum_{i=1}^{N_{\text{float}}} \left(L_i + A\right) \cdot d(t_i)}_{\text{Floating payments}}}^{\text{Interest rate swap}}, \tag{1}$$

where P is the full (dirty) price of the bond, C is the bond coupon, Li is the floating reference rate (e.g. Euribor) at time ti and d(ti) is the discount factor applicable to the corresponding cash flow at time ti. In order to compute the ASW A, several observations and simplifications have to be made. First, in practice it is almost impossible to find bonds outstanding with maturities that exactly match those of the CDS contracts and second, the cash-flows of the bonds and the CDS will not coincide. To overcome these issues, in what follows we use synthetic asset swap spreads based on estimated intraday zero-coupon sovereign bond prices. Specifically, for each interval and each country, we estimate a zero-coupon curve based on all available bond price quotes during that time interval using the Nelson and Siegel method. With this procedure, we are able to price synthetic bonds with maturities that exactly match those of the CDS contracts, and we can use these bond prices to back out the corresponding ASW. As this results in zero coupon bond prices, we can set C in Equation (1) to zero. A CDS contract with a maturity of m years for country j in time interval k of day t, denoted as Sj (tk, m), has a corresponding ASW Aj (tk, m):

$$100 - P_j(t_k, m) = \sum_{i=1}^{N_m} \left(L_i(t_k) + A_j(t_k, m)\right) \cdot d(t_k, t_i), \tag{2}$$

with Pj (tk, m) as our synthetic zero coupon bond price. For the reference rate Li in Equation (2), we use the 3-month Euribor forward curve to match as accurately as possible the quarterly cash flows of sovereign CDS contracts. We construct the forward curve using forward rate agreements (FRAs) and euro interest rate swaps. We collect the FRA and swap data from Bloomberg, which provides daily (end-of-day) data. 3-month FRAs are available with quarterly settlement dates up to 21 months ahead, i.e. up to 21 × 24. From two years onwards, we bootstrap zero-coupon swap rates from swap interest rates available on Bloomberg and back out the corresponding implied forward rates. Because the swaps have annual maturities, we use a cubic spline to generate the full implied forward curve, thereby enabling us to obtain the quarterly forward rates needed in Equation (2). Given our interest in intraday dynamics, we follow (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) and generate estimated intraday Euribor forward rates by assuming that the intraday movements of the Euribor forward curve are proportional to the intraday movements of the German government forward curve. To be precise, for each day, we calculate the difference between our Euribor forward curve and the forward curve implied by the end-of-day Nelson-Siegel curve for Germany. We then keep this difference across the entire curve fixed throughout that same day and add it to the estimated intraday forward curves for Germany earlier on that day to generate the approximate intraday Euribor forward curves. This approach makes the, in our view, reasonable assumption that the intraday variability in Euribor forward rates will largely mirror movements in corresponding German forward rates.

Finally, we need to specify the discount rates $d(t_k, t_i)$ in Equation (2). The market has increasingly moved to essentially risk-free discounting using the overnight index swap (OIS) curve. We therefore take $d(t_k, t_i)$ to be the euro OIS discount curve, which is constructed in a way similar to the Euribor forward curve. For OIS contracts with maturities longer than one year, we bootstrap out zero-coupon OIS rates from interest rates on long-term OIS contracts. Thereafter, we construct the entire OIS curve using a cubic spline. We use the same technique as described above to generate approximate intraday OIS discount curves based on the intraday movements of the German government curve. To gauge the potential impact of this assumption on our empirical results, we reestimate our model using an alternative assumption that the Euribor and OIS curves are fixed throughout the day at their observed end-of-day values. Under this alternative assumption, we obviously fail to capture any movements in money market rates within the day when we price our synthetic asset swaps. Our results remain robust. Please refer to (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) for an in-depth discussion of the construction of our intraday ASW. According to different panel unit root tests (see Appendix C in (Komarek, Ters, & Urban, 2016)) our CDS and ASW price data (displayed in Figure 7) is I(1). Therefore, we estimate our subsequent models (panel VAR and panel VARX) in first differences. For in depth results and tests please refer to (Komarek, Ters, & Urban, 2016).

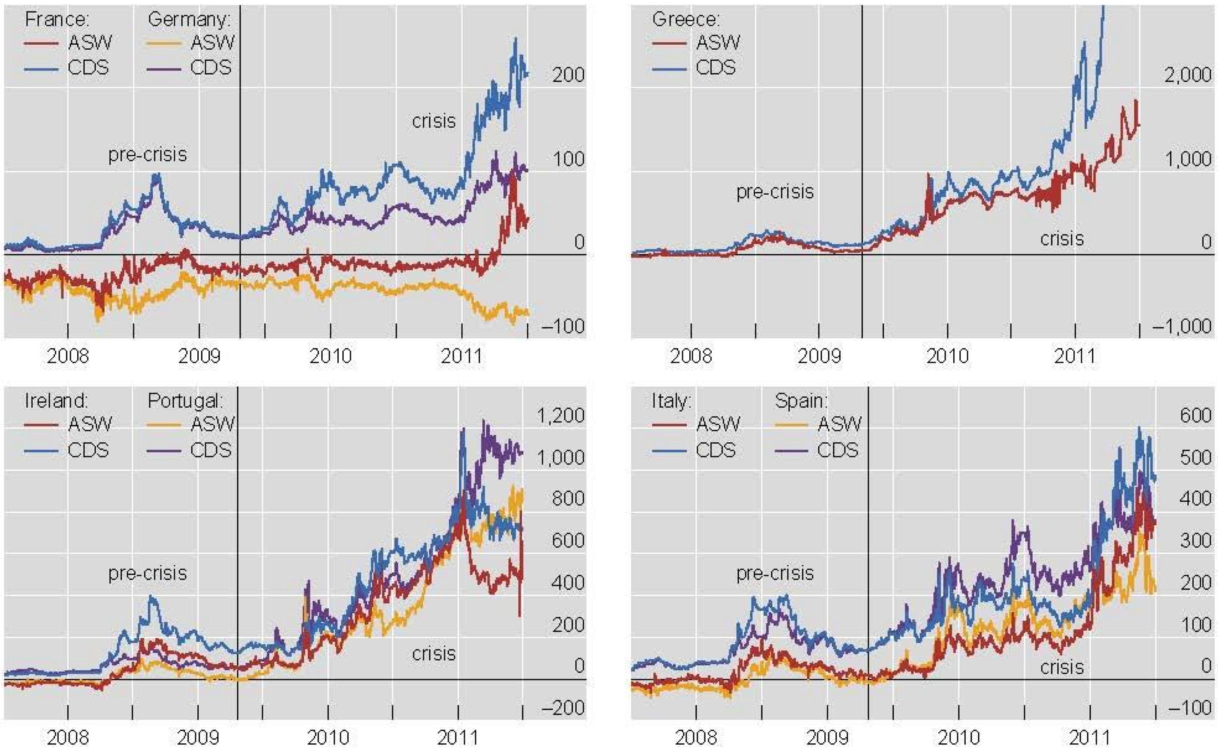

Figure 7: The figure is based on a 30-minute sampling frequency. Our split into the pre- and the crisis period is indicated by the vertical line in each figure. Due to the Greek debt restructuring the data for Greece ends in September 2011.

Our empirical analysis of the intraday CDS and bond spread dynamics will be based on a panel and time-series methodology, which means that we need to construct equally-spaced time series of spreads. After extensive initial analysis of the amount and distribution of our intraday quotes, both for sovereign CDS and bonds, we conclude that a 30-minute time interval gives us a satisfactory trade-off between data frequency and the occurrence of missing observations. In practice, this means that we use the average of the mid-quotes reported for both bonds and CDS within each half-hour interval. Figure A.2 shows that using a 30-minute sampling frequency, between 75% and 90% of the half hour intervals contain a price for 5-year CDS from 2009 onwards. The proportion of non-empty intervals is somewhat lower for the 10-year contracts, in particular towards the end of the sample. Figure 8 shows that using a 30-minute sampling interval for bonds we have in almost all cases more than 90% non-empty time intervals.

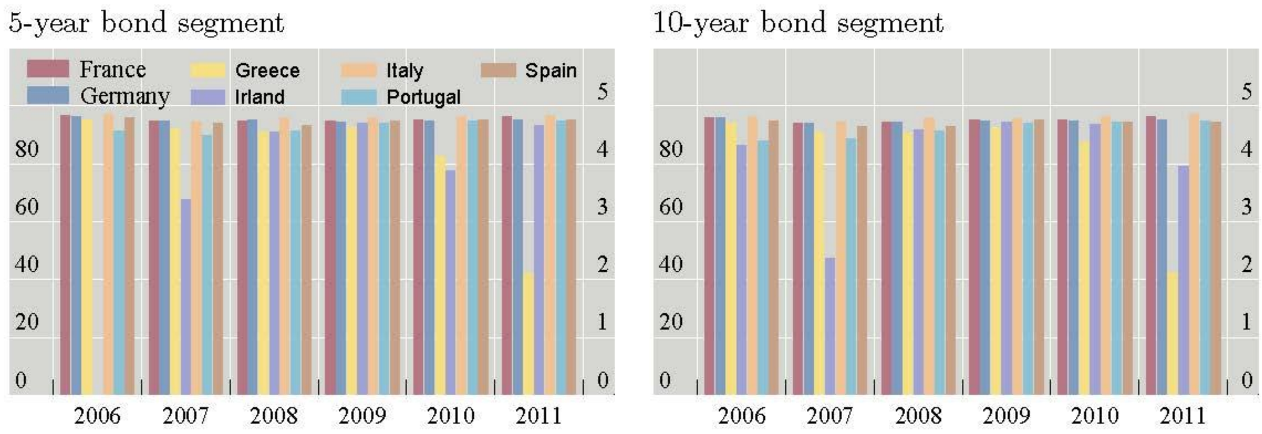

Figure 8: The figure is based on a 30-minute sampling frequency. Our split into the pre- and the crisis period is indicated by the vertical line in each figure. Due to the Greek debt restructuring the data for Greece ends in September 2011.

Conclusions

The CDS market was the main venue for the transmission of sovereign credit risk contagion during the euro area sovereign debt crisis. In contrast, we find that, prior to the crisis, the two markets (CDS and bond) were similarly important in the transmission of financial contagion, while the importance of the bond market decreased relative to the CDS market during the crisis period. We find evidence for sovereign credit risk contagion during the euro area sovereign debt crisis period, as our results show more drastic reactions to shocks in terms of magnitude and absorption compared to the pre-crisis period. Thus, our results on the responses to sovereign credit risk shocks during the crisis period confirm the contagion across euro area countries, as they result from extreme negative, systemic effects and are much larger in magnitude compared to the pre-crisis period, a fact which cannot be explained by macroeconomic fundamentals.

We find comovement effects rather than contagion during the pre-crisis period, as markets react rationally to economic fundamentals, while the responses to sovereign credit risk shocks remain moderate in magnitude. The use of intraday data substantially increases the precision of the results, as we find average timelines of financial shock contagion of one to two hours during the crisis period and 30 minutes to one hour prior to the crisis. We find a flight to safety during the crisis period in the German bond market. This is not present prior to the crisis and, interestingly, is also not visible in the French bond market. The flight-to-safety effect can be explained by market participants' lack of belief in the future path of public finances (a self-fulfilling crisis), which cannot be explained by macroeconomic news. Our results using an unexpected exogenous macroeconomic news shock suggest that, during the pre-crisis period, markets for sovereign credit risk were driven by macroeconomic news. Positive news led to a decrease in credit spreads and negative news to an increase. Using the same experiment for the euro area sovereign debt crisis period, our results show that movements in sovereign credit spreads did not respond to macroeconomic news but were rather driven by either monetary policy or exaggerations in financial markets due to lack of belief (a self-fulfilling crisis). We find that central European countries were practically unaffected by sovereign risk contagion during the crisis. Our model further indicates no difference in the responses to shocks according to debt levels or whether the country belongs to the monetary union or not. This implies that, in general, countries that lie geographically outside of the crisis region were much less affected by sovereign risk contagion. As stated by (Gyntelberg, Hoerdahl, Ters, & Urban, 2013), the fact that CDS premia are more responsive to new information may reflect the fact that the market participants in these markets on average are more highly leveraged, are more aggressive in taking positions and hence respond more quickly to new information. Thus it is crucial for policy makers and regulators to understand the dynamics in the market for sovereign credit risk, especially in the derivative market, where contagion effects are more severe during our analysed crisis sample.

In our empirical paper (Komarek, Ters, & Urban, 2016) we make use of intraday data which allows us to capture the intraday patterns of credit risk contagion. Indeed, shocks that may seem to affect several countries simultaneously when viewed at a daily or lower data frequency are revealed, through the lens of intraday data, to have possible origins in one particular country with clear contagion effects on other countries. Also, (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) discuss the advantages of using intraday data due to the higher accuracy of the results as compared with lower-frequency data. (Gyntelberg, Hoerdahl, Ters, & Urban, 2013) report that the use of daily data yields mixed results with no clear evidence in contrast to the use of intraday data. They state that they find a drastic decrease in the precision of their results with very wide confidence bands the lower the sampling frequency gets.

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Data as a critical factor for central banks[1]

Maciej Piechocki,

BearingPoint

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Data as a critical factor for central banks

Dr. Maciej Piechocki, BearingPoint

„ … it should also be clear to everyone that we are now standing only at the start of a long road in terms of data. The big challenge for statistics in the coming years is not only "many more numbers", but perhaps much more so, the reconciliation of statistical information collected in support of monetary policy and financial stability with the up-to-now rather separate world of supervisory information. It is one thing to have information, which, like blood, flows through the veins of the system, it is another to ensure that everything beats at the same rhythm and all organs in the body get all they need from the same single flow." (Mario Draghi President of the ECB, Seventh ECB Statistics Conference "Towards the banking Union. Opportunities and challenges for statistics", Frankfurt am Main, 15 October 2014")

Contents

Introduction: Increasing requirements to central banks' data management due to regulatory trends and technological innovations

Data stay a critical factor for central banks. The financial crisis showed that some of the deepest fissures were caused by gaps in data and exposed the need for high quality, comparable and timely data on the global financial network. Since then, policymakers, supervisory authorities and standard-setters across the globe have been collaborating to greater harmonize and standardize regulatory data in financial services. According to a recent BearingPoint Institute paper, urgent debate is still needed on how the world's financial services industry could be better and less onerously supervised via a smarter approach to regulatory reporting and data exchange[1].

Financial supervision and central banks momentary statistics and financial stability functions are vastly driven by data. In the aftermath of the financial crisis, a "regulatory tsunami" flooded the financial services industry. Especially after the adoption of the Basel III framework, regulatory requirements have significantly increased. New regulations such as AnaCredit, BCBS 239, Solvency 2, Dodd Frank or IFRS 9 have posed new challenges to the banking and insurance sector on global, regional and local levels. Moreover, regulations like the EMIR (European Market Infrastructure Regulation), Money Market Statistical Reporting (MMSR), the Markets in Financial Instruments Regulation (MiFIR) and the Securities Financing Transaction Regulation (SFTR) oblige the major Monetary Financial Institutions (MFIs) to report derivatives or money market data on a daily basis.

"Big data" is a common buzzword in this context. Due to new media and technologies, new data sources appeared like e.g. Internet-based data, data from Social Media, but also from official sources and internal public databases such as banking supervisory data[2]. According to a BearingPoint Institute article on big data, the amount of information available in the world increased by a factor of 100 in last 20 years.

However, in the central banking area, while no single agreed definition exists, big data has already been heralded as offering a wide range of central banking applications: from nowcasting to modelling, to early warning systems and systemic risk indicators. For some it opens a new chapter in policymaking. In a recent study, the Institute of International Finance (IIF) stated that "'RegTech', defined as 'the use of new technologies to solve regulatory and compliance requirements more effectively and efficiently' has enormous potential to … improve the quality and efficiency of supervision, and reduce risk in the system."[3]

[1] "Reforming Regulatory Reporting. From Templates to Cubes.", Dr. Maciej Piechocki, Tim Dabringhausen

[2] IFC report „Central banks' use of and interest in „big data", October 2015, p. 19

[3] Institute of International Finance, "RegTech in Financial Services: Technology Solutions for Compliance and Reporting.", March 2016, p. 3f

According to the 2015 IFC report on "Central banks' use of and interest in 'big data'" central banks have a strong interest in big data, but their actual involvement is still limited.[4]

BearingPoint is noticing two significant key trends worth looking at when discussing (big) data management in central banking in respect to financial services: the replacing of form-based collections with granular, micro-level data[5] and the need to go beyond reporting data validation, i.e. to integrate regulatory Key Performance Indicators (KPIs) into the overall operational supervisory process. However a number of further developments at central banks is observable. For example from governance perspectives central banks recently started to appoint "chief data officers" and implement harmonised "data strategies". Number of central banks are currently rethinking their data infrastructures which today are rather siloed and demonstrating the legacy of the past decades with no central approach to data handling.

Challenges for central banks

Notwithstanding the huge potential big data provides, decision making is now even harder than before, and business need adequate solutions to analyse this data.[6] A crucial point is how to mine all this information from the different sources exhaustively and at reasonable cost. Despite innovative tools and technologies like blockchain, cloud computing and machine-learning, even today plans often fail because the required processing power outweighs the potential returns or computing time is too long.[7]

The specific challenge for central banks in the sense of an effective 360° risk-based supervision is to rapidly access, effectively manage and timely process and analyse the increasing amounts of supervisory, statistical and markets (big) data. Especially the near or real-time access and efficient processing are regarded as critical factors due to limitations in human and IT resources.[8] According to the IIF report, some regulators still use outdated portal solutions and methods, which are inefficient and increase chances of introducing error.[9] The IIF recommends automated secure data transfer mechanisms based on standards like XBRL (eXtensible Business Reporting Language). But even with use of standard such as XBRL or SMDX (Statistical Data and Metadata eXchange) central banks must abandon "paper-" or "document-oriented" world and think of data in integrated and interlinked manner.

Current systems do not meet today's requirements when regulators have to deal with large amounts of data of various kinds - collected from supervised entities for statistical, prudential or stability purposes, provided by information providers or obtained from internal research and analysis. Such data span from granular micro information on single mortgage loans, securities traded and counterparties affected to macro-economic analysis of countries or regions to form-based collections of financial and risk data or ad-hoc supervisory exercises.

[4] IFC report „Central banks' use of and interest in „big data", October 2015, p. 1

[5] IFC Working Paper No. 14, "Big data: The hunt for timely insights and decision certainty", February 2016, p. 15

[6] BearingPoint Institute Issue 002, "Seeing beyond the big (data) picture, p.3-4

[7] Ibid., p. 6

[8] IFC report „Central banks' use of and interest in „big data", October 2015, p. 11

[9] Institute of International Finance, "RegTech in Financial Services: Technology Solutions for Compliance and Reporting.", March 2016, p. 22-23

Some of this data will remain only in the perimeter of the central bank some will be remitted to other stakeholders such as the European Supervisory Authorities (ESAs), country governments, the International Monetary Fund (IMF) or the Bank for International Settlements (BIS), some will be disseminated to the wider public or research community.

Therefore, it is mission-critical for regulators to

• effectively handle the large amounts of increasingly granular data from various sources, i.e. rethink existing IT system architectures and landscapes

• gain transparency on the status of the reporting agents in the collection and dissemination process

• consider interlinkages between micro and macro data sets in "going beyond the aggregates" from macro and financial stability perspectives

• get a timely overview of relevant micro and macro developments in the financial markets and

• execute reliable trend analyses on KPIs and Key Risk Indicators (KRIs) based on validated collected data

Essentially, it is a question of scalability in various dimensions across the usual value chain or "lifecycle" of processing supervisory data, as investigated in detail in an article published in Banque de France's Financial Stability Review.[10]

The expanding requirements have proved to be a great challenge and cost driver for IT departments of regulators. IT infrastructure and processes have to be optimised in order to collect, process, analyse and disseminate supervisory and statistical data from different sources and in various formats. But process automation and innovative solutions are required to increase quality and efficiency of supervision, to reduce expenditures, operational burdens and time to market for new supervisory requirements.

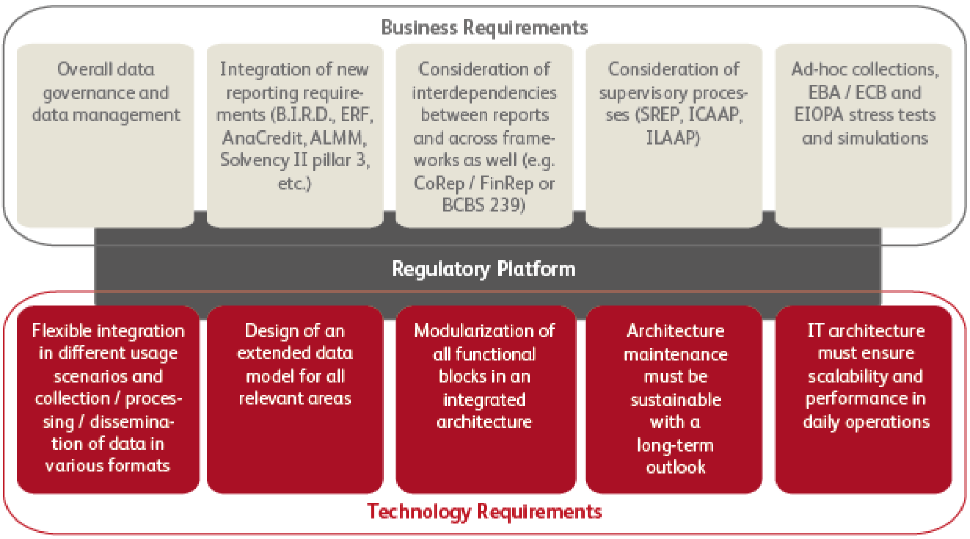

FIGURE 1: REQUIREMENTS FOR FUTURE-ORIENTED REGULATORY PLATFORMS

[10] Mark d. Flood, H.V. Jagadish, Louiqa Raschid: "Big data challenges and opportunities in financial stability monitoring", Banque de France Financial Stability Review, No. 20, April 2016.

Innovative approaches – shared utilities, integrated platforms for data management and analytics and Regulatory-as-a-Service (RaaS)

In view of the developments as described before, it is undisputable that it is mission-critical for central banks to reshape their data management and further automate industrialise processes of handling data. Automation helps to minimize risk, reduce errors, and increase transparency and thereby to deliver a better basis for decision-making.

According to a BearingPoint Institute article[11], a new information value chain is needed for reporting which helps to increase efficiency of supervisory processes, minimize risk, allocate resources effectively and improve the basis for decision-making by higher transparency and faster availability of data. We further notice a trend to shared utilities, Regulatory-as-a-Service.

A prominent example is the Austrian solution, where the national central bank, Oesterreichische Nationalbank (OeNB) and the supervised banks joined forces to stepwise replace the template-driven model and use innovative technologies to create a new regulatory value chain. The initiative is based on greater harmonization and integration of data within banks as well as greater integration of the IT systems of the supervisory authority and the supervised entities. The way it works is through a common data model (GMP) developed by central bank in cooperation with Austrian bank and a shared utility, called Austrian Reporting Services GmbH (AuRep), which is co-owned by the largest Austrian banking groups. This model allows cost-sharing of compliance as well as standardization of data collection.

AuRep runs on a common platform, which works as the central interface between the banks and the OeNB. Granular bank data sets are captured automatically for supervisors to interrogate in whichever way they want, whilst the banks retain control over their commercially sensitive data, maintaining only the so-called 'passive data interface' on the AuRep platform.[12]

Other regulators are also aware of the limits of the template-based reporting and see the benefits of an input approach with granular datasets. While the Banca d'Italia has been providing such a shared data model named PUMA2 for some decades recently the European Central Bank (ECB) has also launched an initiative to evaluate a European "input approach". The Expert Group on Statistical and Banking Data Dictionary was established to develop a Banks' Integrated Reporting Dictionary (BIRD), which defines a harmonized model for input data as well as rules for the transformation of input data to reporting data. BIRD should be seen as a blueprint for the banks. It forms the conceptual basis of an input approach, i.e., a data model for the organization of the regulatory reporting process within the banks. The approach is similar to the Italian and Austrian model.

Besides harmonized data definitions, new and high-performing supervisory data management platforms are necessary allowing for timely and efficient collection, analysis and sharing of the data.

[11] BearingPoint Institute, "Reforming regulatory reporting: are we headed toward real-time?", 2015

[12] Ibid., p. 6

These platforms could be deployed for instance as a closed solution for the regulator, as an open solution also for firms providing them advanced portal functionality as a service (RaaS or Regulatory-as-a-Service) or even as a shared services platform like in the Austrian case.

With regards to functional scope, new generation platforms should provide functionality for highly automated processing of data and regulatory business intelligence including statistical analysis, monitoring and controlling supervisory Key Risk Indicators (KRIs).

Conclusion and outlook to the Central Banking Big Data Focus Report

Central banking statistical stability or supervisory function have been increasingly driven by (big) data, but little has changed in the methodology of supervisory data collection and management, which is still widely reliant on the document-oriented approach. This is intrinsically time-consuming, costly and complex. Data gaps still exist and so data remains a critical factor for central banks. Innovative solutions are necessary, to effectively handle "Big Data".

The Central Banking Big Data Focus Report is a joint initiative of the Central Banking Journal and BearingPoint. The report builds upon the results of the recent IFC survey and takes a closer look at how central banks actually handle the challenge of data collection and analytics with regard to technical platforms and standards, resources and data governance.

The report investigates the concrete action plans of central banks regarding data management challenges in light of FinTech/RegTech developments and the objective of transparent and effective risk-based supervision but also plans for central banks statistics for "going beyond the aggregates" especially for the micro-granular data handling. Finally, central banks are evaluated how the BCBS 239 principle in an adapted version would apply to them today.

The focus report will draw on views from central bankers, industry experts, academics and observers to look at:

- Financial stability and supervisory applications
- Direct uses in economics and modelling
- Who should 'own' big data?
- Resourcing and budgets
- Future developments
- Operational challenges – gathering, structuring, storing and processing data

The Central Banking Big Data Focus Report aims at giving a clear picture of where central banks stand today with supervisory data management and defining fields of action. The results will be publicly available in Q4 2016.

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The Bundesbank's House of Micro Data: Standardization as a success factor enabling data-sharing for analytical and research purposes[1]

Patricia Staab,
Deutsche Bundesbank

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

The Bundesbank's House of Microdata

Standardisation as a success factor enabling data-sharing for analytical and research purposes

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Abstract

To improve the sharing of microdata between Directorates General, the Bundesbank created a **House of Microdata (HoM)** on the basis of the existing statistical data warehouse infrastructure. The infrastructure uses the global statistics standard SDMX, which provides a powerful information *model for data-driven systems*.

By using coordinated code lists, the SDMX **generic multidimensional approach** offers an ideal means of linking, comparing and consolidating microdata. The HoM data can be used for any kind of dataset: for statistical as well as non-statistical data, and for aggregates as well as microdata.

Data diversity requires standardisation – the HoM provides a suitable framework.

The Bundesbank's IMIDIAS initiative

The Deutsche Bundesbank is one of the largest statistical data producers in Germany. It has collected monetary, financial, external sector and other statistical data for many years now. The data covering the fields of banks, securities, enterprises and household finance are used to produce **aggregated data** which are relevant for macroeconomic analysis. For decades, the microdata needed for this process were essentially viewed as just a by-product. Recently, this assessment has undergone a major change.

On the one hand, **research and analysis** focus more on understanding complex interactions between actors/sectors and market segments as well as the interaction between the financial sector and the real economy. Data providers are therefore faced with higher demands in terms of horizontal and vertical consistency, granularity and comparability.

On the other hand, several financial crises have seen **macroprudential issues** become increasingly important and a new core business of central banks. The questions arising from distribution and structural analyses as well as risk assessments require rapid and detailed examination of several datasets.

This demand cannot be met using aggregated data. In order to provide more direct access to the Bundesbank's **quality-tested administrative microdata** for both policy analysts and researchers, the Bundesbank launched its large-scale **IMIDIAS (Integrated Microdata-based Information and Analysis System)** initiative.

In 2013, the Bundesbank's Directorate General Statistics received the mandate to coordinate the IMIDIAS initiative[1] and to provide its key components:

- The **House of Microdata**: A central data warehouse, based on a generic multidimensional data concept and able to hold all microdata with high potential for analytical purposes
- The **Research Data and Service Centre (RDSC)**: A service unit dedicated to supporting internal and external data analysts and researchers.

This paper focuses on the House of Microdata. For a description of the RDSC, see S Bender, and P Staab, (2015), as well as http://www.bundesbank.de/Navigation/EN/Bundesbank/Research/RDSC/rdsc.html.

The House of Microdata

As seen in Figure 1, all data stored in the HoM are extracted from pre-existing operating systems. The HoM stores **clean copies of the data**, thus leaving the pre-existing processes unchanged. Direct access to the HoM is only granted to internal Bundesbank users, on a need-to-know basis and in compliance with confidentiality regulations. External researchers are obliged to use the services of the Research Data and Service Centre.

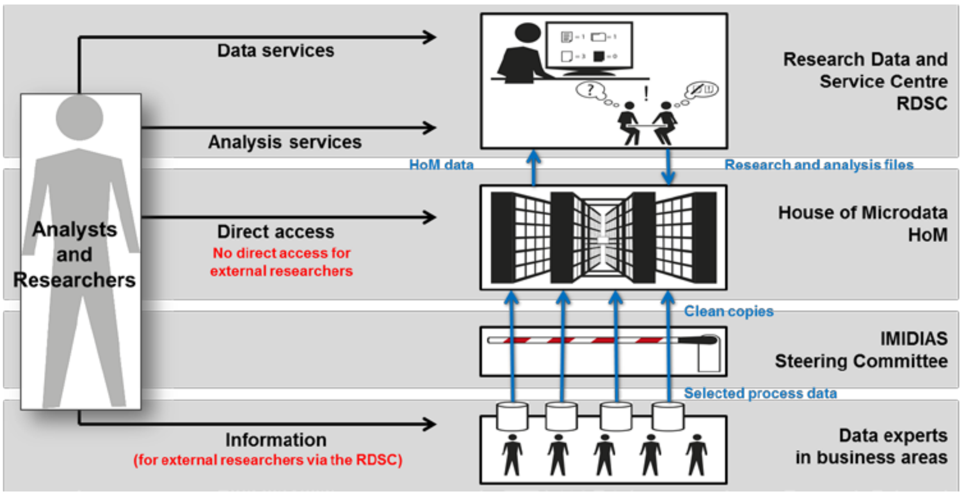

Figure 1: Schematic overview of IMIDIAS

Technically, the HoM is based on the **central statistics information system** already in use by the Bundesbank's DG Statistics. It consists of a data warehouse based on the international SDMX standard and its environment – several programs and interfaces to import, manage, search, present, analyse and export data.

[1] See also Irving Fisher Committee on Central Bank Statistics (2015), pp 40-41 for a description of IMIDIAS and the House of Microdata.

SDMX[2] is a global standard of the international statistics community, sponsored by its major institutions (the BIS, Eurostat, the ECB, the IMF, the OECD, the UN and the World Bank), and providing a data exchange format and generic multidimensional data model. The Bundesbank has been using this standard as a basis for its central statistics information system since 2003; a comprehensive statistical toolset for operational and analytical tasks is therefore already in place.

The central statistics information system has also been open to Bundesbank data pools outside the DG Statistics; several such datasets are already successfully integrated. It can largely be used independently of the DG Statistics and without the programming support of the Statistical Information Management Division. Standardised interfaces ensure that users can employ their own evaluation instruments rather than the information system's statistical toolset. In addition, a growing number of software products are available that make use of SDMX.

Statistical Standardisation via SDMX

From the 1990s up until the present day, several financial crises have led to the formation of global data initiatives under the guidance of institutions such as the IMF, the BIS, the FSB, the OECD, the ESRB and the G20. Besides the identification and elimination of data gaps, the initiatives also encouraged ongoing progress in data harmonisation: the creation of international statistical standards and codes as well as the streamlining of contents, methods, classification and procedures.

One such initiative was SDMX (Statistical Data and Metadata Exchange), which was launched by the sponsoring organisations the BIS, Eurostat, the ECB, the IMF, the OECD, the UN and the World Bank to standardise the international data exchange between statistical offices and central banks from 2001. SDMX did much more than just provide a universal data format for the exchange: it also created a **generic information model** for any kind of statistical data.

The core concept of SDMX is an astonishingly simple **building block approach**, in which a dataset is described as a multidimensional data cube. The number as well as the content of the cube's **dimensions** can be chosen according to the specific dataset. For each dimension, a list of possible entries – the **code list** – has to be defined. Then, any specific value within the dataset is identified by its **key**, which is the combination of corresponding dimension codes (see Figure 2). Dimensions, code lists and keys are called **metadata**, whereas the values are the actual **data**.

[2] For further information on SDMX, see the official site for the SDMX community at https://sdmx.org/

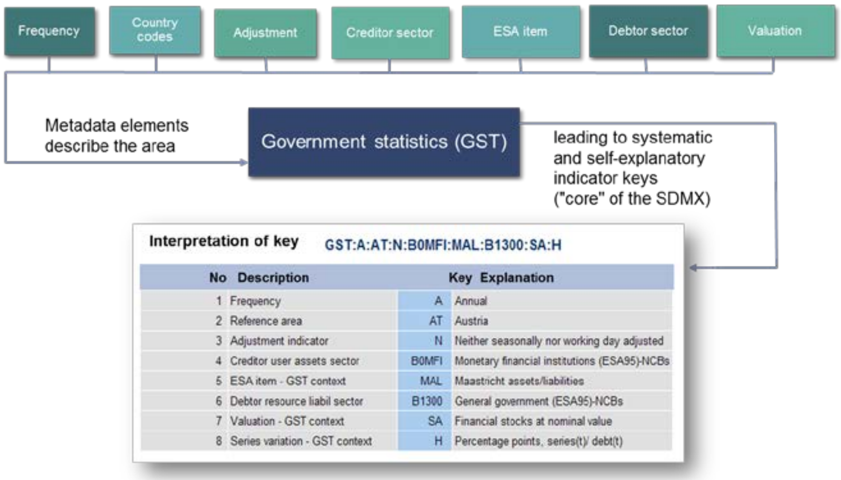

Figure 2: SDMX in a nutshell

The SDMX concept not only facilitated the creation of SDMX *self-explanatory* data structure definitions for all the datasets the sponsoring institutions needed to exchange. On top of that, it enabled the participants to implement *data-driven systems* to handle the data exchange. Establishing a new data flow between two institutions via SDMX consists of two steps (see Figure 3). In step 1, the Sender provides the metadata – the definition of the structure of the new data – to the Receiver. Once the data structure definition has been imported into the Receiver's SDMX-based system, the system is able to handle any SDMX dataset complying with the pre-defined data structure. In step 2, the Sender sends the SDMX data file, which is then processed accordingly.

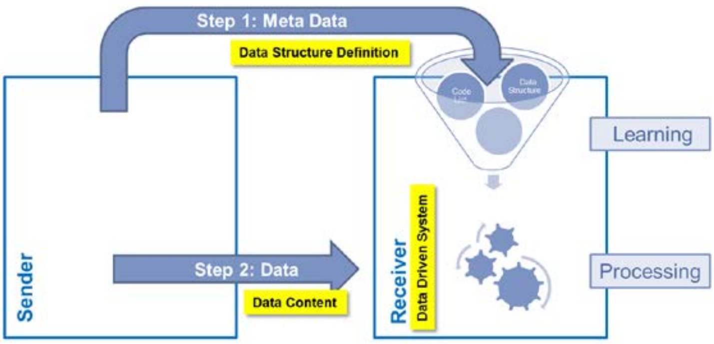

Figure 3: Data exchange between SDMX-based data-driven systems

Currently, SDMX (ISO standard as of 2005) is the standard used by the international statistics community not only for the **exchange** but also for the **publication of data**. The data exchange between the sponsoring organisations and their member states, especially the national statistics institutes (NSIs) and national central banks (NCBs), is based on SDMX. On top of that, many data portals as well as internal systems are organised as **SDMX data hubs**. The success of the standardisation initiative can therefore be seen on the websites of several international organisations. Just a few examples are the ECB Statistical Data Warehouse (http://sdw.ecb.europa.eu/), the OECD Statistics site (http://stats.oecd.org), and the Principal Global Indicators site (http://www.principalglobalindicators.org).

The SDMX building block approach makes it possible to store very different datasets side by side within the same data warehouse without having to integrate them semantically. However, integration is possible when datasets are defined in such a way that they **share a dimension**, ie they use the same definition of the dimension and agree on the same code list. Possible examples are the bank or security identifiers, but also the NACE classification codes.[3]

By sharing one or more dimensions, datasets are interconnected. An SDMX-based data warehouse can thus grow into a landscape of interconnected datasets (see Figure 4). The first building blocks of such a landscape have already been formed in the HoM.

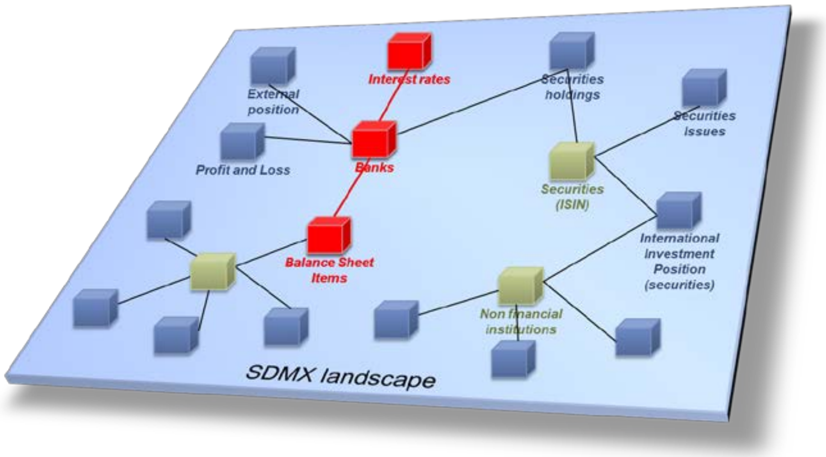

Figure 4: Example of an SDMX landscape

To conclude, the SDMX concept provides the framework necessary for data standardisation, while allowing for data variety.

- It is **generic:** The number and meaning of dimensions can be chosen freely; it can therefore be used for any kind of dataset (statistical and non-statistical data, aggregated and microdata).
- It is **multidimensional** by design and therefore offers the possibility of sharing dimensions and code lists. Thus, SDMX offers an ideal means of linking and comparing data from different sources.

A current example of an SDMX-based data warehouse is the Bundesbank's HoM. The successful integration of data into the HoM can be seen as proof of concept for the usage of SDMX. The following section describes the *status quo* regarding this data integration.

[3] International standard classification of all economic activities.

HoM: *Status quo* of data integration

All data to be integrated into the HoM are to be identified by the **IMIDIAS Steering Committee,** which consists of the data-using and data-providing DGs of the Bundesbank, as well as the DGs IT and Legal Services.

In 2014, the first coordinated and standardised **inventory list** of microdata sets at the Bundesbank, comprising the data of all relevant business units, was compiled under the Steering Committee's guidance. A **potential analysis** of datasets on the inventory list then led to the identification of **twelve data assets** to form the first wave of HoM contents. The main criteria used to assess the potential were relevance, sustainability, legal requirements and costs.

The IMIDIAS concept foresees a regular recurrence of the inventory list as well as the potential analysis; a second wave is to be launched in 2016.

For each data asset to be integrated, a content project was initiated. All content projects comply with a common framework (see Figure 5) and are coordinated by the IMIDIAS project office.

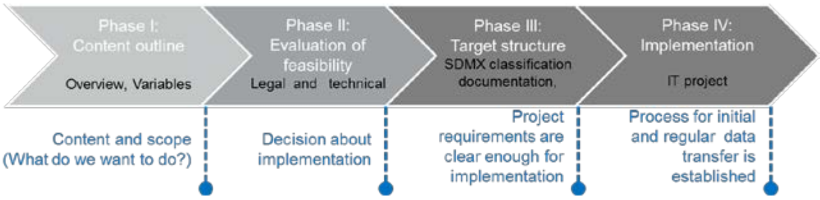

Figure 5: Phases of an IMIDIAS content project

Currently, nine content projects are at different phases of implementation and three content projects have been successfully completed.[4] The data sources already integrated are: Monthly Balance Sheet Statistics, Profit and Loss Accounts and Master Data of Banks. These data sources can be connected along the corresponding dimensions, which have been coded using the same code lists.

Conclusion

The **House of Microdata** is an integral part of the Bundesbank's **IMIDIAS** solution to address the current and future needs of researchers, analysts and policymakers. The underlying infrastructure is built upon the international statistics standard **SDMX** for data and metadata.

SDMX is **generic** and can therefore be used for statistical as well as non-statistical data, and for aggregates as well as microdata. SDMX is **multidimensional**; using coordinated code lists, it offers an ideal means of linking, comparing and consolidating microdata.

[4] To be completed: documentation of datasets for users.

The House of Microdata enables bank-wide data integration and a **common information model** - the key success factors are standardisation and harmonisation.

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Fan Chart: The art and science of communicating uncertainty[1]

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Central Bank of Malaysia

[1] This paper was prepared for the meeting. The views expressed are those of the authors and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Fan Chart: The Art and Science of Communicating Uncertainty

Ahmad Razi and Po Ling Loke[1]

Abstract

Economic forecasting is an important aspect of policy decision-making. While the baseline forecast is important, a good understanding of the risks, in terms of their bias and uncertainties, surrounding the baseline forecasts is equally important. This paper aims to discuss these risks and uncertainties in two parts. First is on quantifying these risks and uncertainties through the representation of fan charts. In particular, the paper focuses on the technical derivation the balance of risks surrounding the inflation forecasts for Malaysia, incorporating the uncertainty of each of the variables affecting inflation outlook i.e. the risk factors. The paper highlights several methods discussed in the current literature and suggests alternative methodology using financial market volatility indicators and time-varying coefficients to incorporate the uncertainty of the risk factors in a dynamic manner. Second, the paper discusses the assessment of these risks and uncertainties surrounding the forecasts. With the derived probability distributions of the forecasts, vast amount of information can be derived from the fan chart. The paper presents the use of probabilistic assessment to quantify the balance of risks of the forecasts or the likelihood of it falling within certain a range, and discusses the relevance of these analyses for policy making.

Key words: Forecast uncertainty, fan chart, balance of risks, two-piece normal distribution
JEL classifications: C19, C53, C82, E37, E59

[1] All views expressed and errors made are those of the authors and do not necessarily represent the views or policy stance of Bank Negara Malaysia. The authors are grateful to Rubin Sivabalan, Farina Adam Khong, Tan Jay Sern and Eilyn Chong for their assistance and comments on the paper.
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1. Introduction

While discussions on uncertainties surrounding economic forecasts have always been an important agenda for central bankers, the debates on the point forecasts usually take the centre stage in policy forums. The assessment and communication of uncertainties surrounding the forecasts, however, gained prominence following the publication of fan charts by the Bank of England in 1996, aimed to improve communication and shift the discussions from the accuracy of the point forecasts to the subjective assessment of risks and uncertainties surrounding the medium-term outlook.

In the past two decades, numerous methodologies have been introduced on the derivation of the fan chart especially on quantifying forecast uncertainty. This paper will build upon the existing literature and contribute by providing variations to existing methodologies in calibrating the degree of uncertainty of the point forecasts. More specifically, this paper focuses on the systematic derivation of fan chart which incorporates the uncertainty of the forecasting model(s) and also the uncertainties and bias of the assumptions used in the forecasting model(s) i.e. the risk factors. The construction of the fan chart is based on the two-piece normal distribution (to take into account the balance of risks surrounding risk factors) and volatility indicators to reflect the uncertainty in forecasting the risk factors, which would in turn affect the uncertainties surrounding the baseline forecasts. Given the dynamic nature of Malaysia's inflation forecasting model which involves lags of both dependent and independent variables, we also propose the use of time-variant coefficients to impute these uncertainties into the inflation fan chart.

While the methodology is fairly statistical in orientation, appropriate subjective judgement is necessary to ensure consistency in the impact of the various risk factors to the forecasts. For example, when constructing the fan charts for both growth and inflation, the assessment on the common risk factors affecting the two variables need to be consistent and in line with theoretical foundations.

The fan chart, depicting the probability distribution of the forecasts, contains vast amount of information on the risk factors affecting the forecasts and the uncertainties surrounding it. Assessment of the fan chart enables policy makers determine the sources of the upside and downside risks, and perform probabilistic assessment of the forecasts being over a range of different outcomes, as well as the likelihood of the forecasts being above, below or within certain threshold levels. This information is very helpful for central banks when deciding monetary policy towards securing stable growth path and maintaining price stability. In particular, the paper also discusses how the different approaches of the probabilistic assessment on the fan chart can promote different discussion on risks and uncertainties surrounding the forecasts and support policy decision-making.

The remainder of the paper is structured as follows. Section 2 provides a brief overview on communication of uncertainty and the methodologies used in constructing fan charts. Section 3 detailed the methodology used to derive the fan charts in Malaysia, including the variations that have been introduced to the existing methodology. This is followed by the assessment of risks and uncertainties surrounding the forecasts using the fan charts in Section 4. Section 5 concludes.

2. Literature review

Assessing and communicating uncertainty has often been highlighted by policy makers as a crucial but difficult task. Good understanding of forecast uncertainty is important to provide policy makers with all the information that are available regarding the key economic variables to support forward-looking policies. In addition, well-thought communication of forecast uncertainty is important to help anchor public expectations on the outlook of the economy.[2]

Forecast uncertainty can generally be presented in three ways - 1) quantitative assessment using fan charts where distributions of all possible outcomes are presented; 2) scenario analysis which presents the forecasts for next most probable scenarios using different sets of assumptions; and 3) sensitive analysis where the forecast is estimated based on the changes in one key assumption or shock.

While most central banks may assess uncertainty using all the three methods, fan charts are commonly used as a communication tool for forecast uncertainty. A study by Franta et al (2014) shows that central banks especially the inflation targeters, communicate their inflation forecasts with the help of fan charts. The study also highlighted the different methodologies used by these inflation targeters to produce fan charts, stem mainly from two approaches. The first approach, as implemented by central banks such as the Czech National Bank, is based on past forecast errors assuming a normal distribution of the forecasts. Fan charts constructed in this approach, however, only reflect the uncertainty in the forecasting model(s) and have minimal economic meaning. Therefore, to enrich the economic representation in the fan charts, central banks such as the Bank of England and Risksbank, impute the assessment of the uncertainty of the risk factors affecting the forecasts into the construction of fan charts and allow for asymmetric distribution of the forecasts with the assumption of a two-piece normal distribution.[3] In this approach, the fan chart does not only serve as a communication tool, but also facilitates discussions among policy makers on the impact of the uncertainties of the risks affecting the forecasts.

In the recent two decades, much research has been done in this area, proposing various new methodologies of constructing the fan chart. Franta et al (2014) for instance, proposes that use of Bayesian vector autoregression model (BVAR) to allow for risk asymmetries and to incorporate the expert judgment in the form of a non-negativity constraint on the nominal interest rate. Jordà and Marcellino (2010) proposes the construction of the confidence bands using the joint predictive density to summarise the range of the possible path the predicted variable might follow for a given confidence level.

While calibrated differently, most fan charts represent a density forecasts i.e. a probability distribution of the forecasts at each forecast period. It covers not only the most probable outcome of the variable (baseline forecasts), but also illustrates a range of different possible outcomes at different confidence levels.

3. The Science: Methodology in constructing fan chart

The framework on the construction of fan chart discussed in this paper is employing the second approach, built upon the methodologies introduced in Blix and Sellin (1997) and Elekdag and Kannan (2009).

As proposed by the two papers, for the construction of the Malaysia fan charts, the distribution of the forecasts is assumed to be two-piece normal (TPN).[4] This is an important assumption to allow for the

2 As discussed in Aikman et al (2010).

3 Even though both Bank of England and the Risksbank assume asymmetry in the construction of the fan charts, the methodology employed by both central banks are very different. According to Blix and Sellin (1997), the Bank of England's fan chart is based on a "top-down" approach where the MPC members determine the degree of uncertainty and asymmetry of the fan chart while the Risksbank's fan chart is based on a "bottom-up" approach where the degree of uncertainty and asymmetry of the fan chart is derived from the uncertainty and skew of the risks factors.

4 See John (1982).

asymmetry of balance of risks surrounding the baseline forecasts, which is more realistic and relevant for discussions on the risks and uncertainties surrounding the forecasts in policy forums. Under the TPN, it is assumed that the standard deviation above and below the central projection need not be the same. Therefore, for the construction of fan chart under TPN, the upper and lower standard deviations, σ_1 and σ_2, need to be first derived.

For that, three key parameters of the distribution of the forecast at each period need to be computed. First is the central projection i.e. the mode of the variable. Second is the degree of uncertainty of the central projection which will be reflected as the width of the fan chart. And third is the skew of the distributions of the forecasts which will also illustrate the balance of risks of the forecasts.

As commonly used in the literature, the central projection is the baseline forecast which can be obtained from internal forecasting model(s). This is the mode of the distribution and represents the most probable outcome that is anticipated. For Malaysia's inflation fan chart, this is the baseline inflation forecast using all the baseline assumptions in the core forecasting model.

The degree of uncertainty reflects how uncertain we are about the forecast; the more uncertain we are, the wider the width of the fan chart. This, essentially is the forecast error of the baseline. However, as proposed by Blix and Sellin (1997), the degree of uncertainty should also reflect how uncertain we are compared to historical period or previous forecast rounds. This uncertainty can arise from the uncertainty surrounding the key assumptions in the forecasting model(s), identified as risk factors. This, as proposed, can be imputed by adjusting the historical forecast errors with a multiplicative factor which will reflect the relative uncertainties of these risk factors.

The degree of uncertainty of the baseline forecast, σ_y^2 can therefore be represented as the variance of historical forecast errors[5] of the distribution, σ_e^2, adjusted for the uncertainties of the risk factors.

$$\boldsymbol{\sigma_y^2 = \sigma_e^2 \ \frac{\sum w_i x_i}{\sum w_i \bar{x}_i}} \qquad \textbf{--- (1)}$$

where w_i is the elasticity[6] of the key assumptions while x_i and $\bar{x}_i$ are the current and historical measure of uncertainty of the risk factors.

In this regard, one of the main contributions of this paper would be on the variation on the measure of how uncertain we are as compared to historical i.e. the derivation of the multiplicative factor. Blix and Sellin (1997) has proposed the use of the variances of the risk factors as the measure of uncertainty. However, in our view this may not necessary reflect the relative uncertainty or difficulties of forecasting the assumptions, but only reflect the historical uncertainty of these factors. We also attempted to replicate the measure suggested by Elekdag and Kannan (2009) using survey-based data or option prices. We found that survey-based data can be too subjective and is highly dependent on the specific analysts' forecasts that are included. While option prices would be a good leading indicator of uncertainty, lack of actively traded options on some of the Malaysian variables becomes a constraint for this method to be implemented for the Malaysian data.

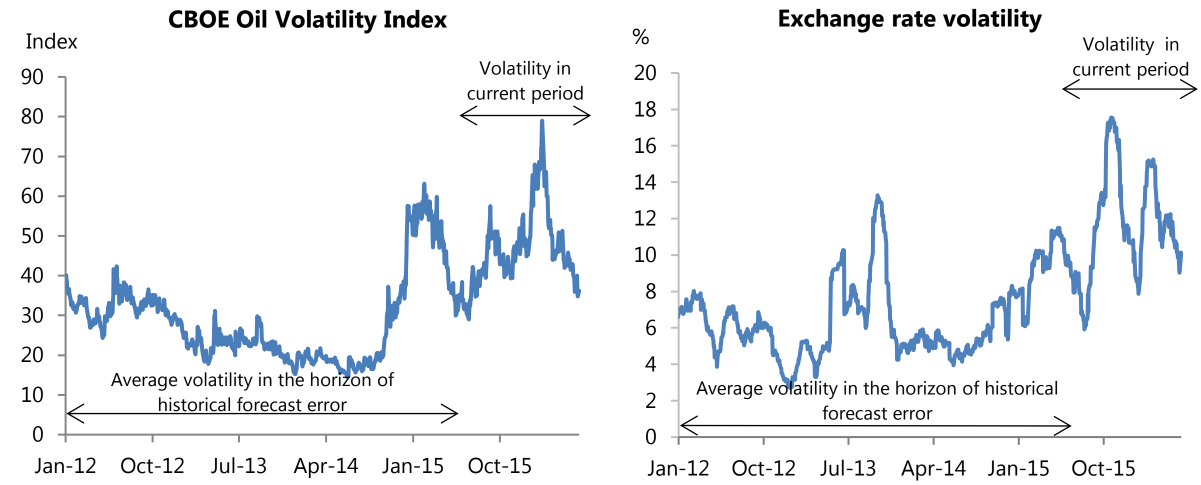
Therefore, this paper proposes a more simplified and practical variation using volatility indicators as a proxy for uncertainties surrounding the assumptions. The volatility indicators used can vary depending on the risk factors. For instance, for inflation forecasts in Malaysia, key assumptions that are subject to high uncertainty, namely the ringgit exchange rate, global oil price and domestic growth, are identified as risk factors to the inflation outlook. The uncertainty of these risk factors are proxied by the respective volatility indicators - 30-day standard deviation for the ringgit exchange rate, CBOE oil volatility index for global oil price and 12-month standard deviation of the leading indicator for domestic growth. The

5 Historical forecast errors used can be the actual forecast errors or the model forecast errors.

6 Elasticity coefficients of the key assumptions can be obtained from the coefficients of the assumptions in the forecasting model(s) or a separately estimated single equation model.

notion for this is that if these assumptions are more volatile now compared to historical, then the assumptions used are actually more uncertain and hence more difficult to forecast. This will lead to greater uncertainties surrounding the baseline forecasts i.e. a wider fan chart. For instance, in the recent period, the sharp decline in global oil prices and large depreciation in ringgit have led to increased volatility making it extremely difficult to forecast these variables as reflected in the higher relative volatility (Figure 3.1).

Volatility indicators of key assumptions — Figure 3.1



The third parameter which is the skew of the distribution, γ_y or the asymmetry surrounding the central projection, is derived as the linear combination of the skew coefficients of each risk factors, γ_i. [7]

$$\gamma_y = \sum w_i \gamma_i \qquad \text{--- (2)}$$

The skew of the risk factors can be obtained from the assessment by individual subject matter specialist on how high and how low each variable can be at each forecasting period. This would be most robust and appropriate as assessment by subject matter specialists would include all readily available information including analysts' survey and option-based data. With the maximum, minimum and mode of the variables, the upper and lower standard deviations as defined in the TPN can be computed.[8] For Malaysia, while the baseline assumptions of the risk factors are imputed in the computation of the baseline inflation forecasts, the maximum and minimum of these risk factors at each forecast period are obtained from the respective teams (Figure 3.2) to derive the skew of the risk factors that should be imputed into the skew of the fan chart based on (2).

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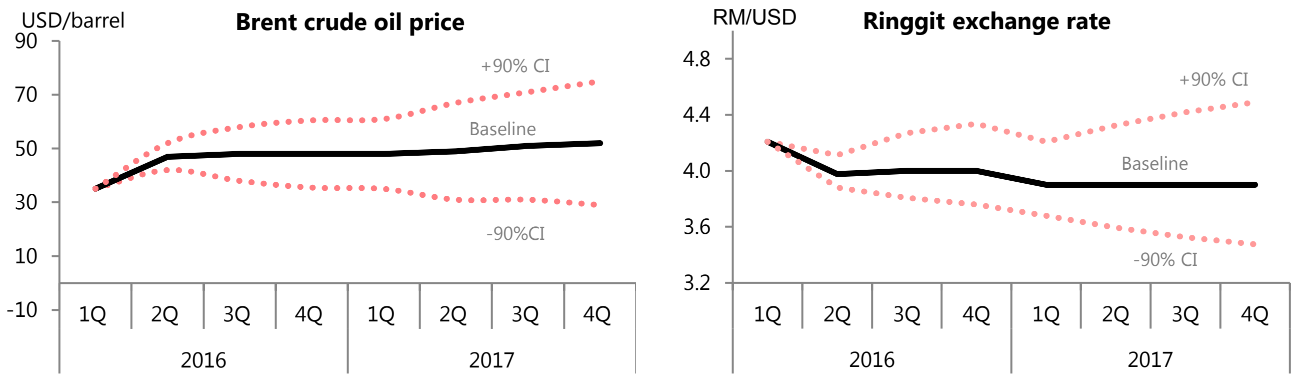
7 As proposed by Blix and Selin (1997), $\gamma = \sqrt{\frac{2}{\pi}}(\sigma_2 - \sigma_1)$ where σ_2 and σ_1 are the upper and lower standard error as defined in the TPN distribution.

8 With the assumption that the maximum is the upper 95% confidence level and the minimum is the lower 95% confidence level, σ_2 and σ_1 can be computed using the usual normal distribution formula.

Balance of risks of key assumptions

Figure 3.2



Another contribution of the paper is on the type of elasticity used to impute the uncertainties and skew of the risk factors into the fan chart. We propose the use of time-variant coefficients to reflect the dynamic effects of the different variables on the forecast variable. Time-variant coefficients i.e. the impact multiplier which changes over time, can be computed using the autoregressive distributive lag (ARDL) model.[9]

For the case of Malaysia, a simple single-equation forecasting model based on New Keynesian Philip Curve is estimated to derive the coefficients of each risks factor.[10]

$$\pi_t = \alpha_1 \pi_{t-1} + \beta_1 (y_t - y_t^p) + \beta_2 (\pi_t^* - e_t) + \beta_3 (c_t - s_t) + \varepsilon_t \qquad \text{--- (3)}$$

where y refers to GDP, y^p is the potential output, π^* is the imported inflation, ***e*** is the nominal effective exchange rate, ***c*** is the commodity prices and ***s*** is the ringgit exchange rate against the US dollar. The time-variant elasticities of these risk factors are estimated using the ARDL(1,0) model.[11] Specifically, at period *t+h,* the elasticity for risk factors *i*, is

$$w_{i,t+h} = \alpha_1^h \beta_i \qquad \text{--- (4)}$$

The coefficient $w_{i,t+h}$ varies depending on the number of forecast period h ahead.

With the properties of the TPN distribution, and the three key parameters, the lower and upper standard deviation, σ_1 and σ_2, can be derived (See Appendix for technical details) and the lower and upper values of the confidence intervals, z_1 and z_2, can be computed:

9 The time-variant coefficients are obtained by expressing the ARDL model in the moving-average representation.

10 The single-equation model illustrated is the simplified version of the internal forecasting model which contains richer lag terms for both endogenous and exogenous variables and also the wage-productivity factor and imported inflation.

11 In this simplified single equation, ARDL (1,0) is used. This will vary depending on the lags of the dependent and independent variables in the forecasting model. A more complex ARDL model would introduce a richer dynamics.

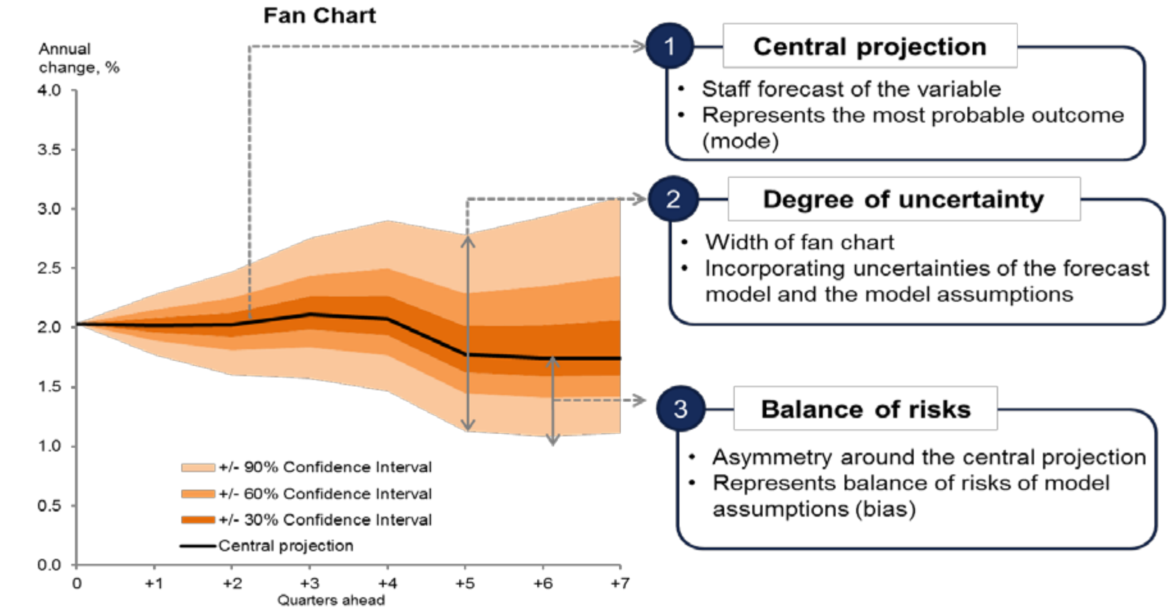
$$z_1 = \mu - \frac{\sigma_1}{\sigma_2}(z_2 - \mu) \qquad \text{--- (5)}$$

$$z_2 = \mu + \sigma_2\, \Phi^{-1}(\tfrac{1+q}{2}) \qquad \text{--- (6)}$$

where Φ^{-1} is the inverse of the standard normal distribution and q is the level of confidence.

The fan chart is usually plotted using different shades of colour to represent the different confidence intervals. The widest band usually reflects the 90% confidence interval i.e. with 90% probability that the band captures the true value of the forecast variable.

Three key parameters of the fan chart Figure 3.3



The construction process of the fan chart has thus far been fairly systematic with little subjectivity required. However, necessary judgement is needed to ensure robustness and consistency between the balance of risks of the assumptions i.e. the risk factors and that the economic relationships between the assumptions and the forecast remain intact. Like any forecasting process, it is an art.

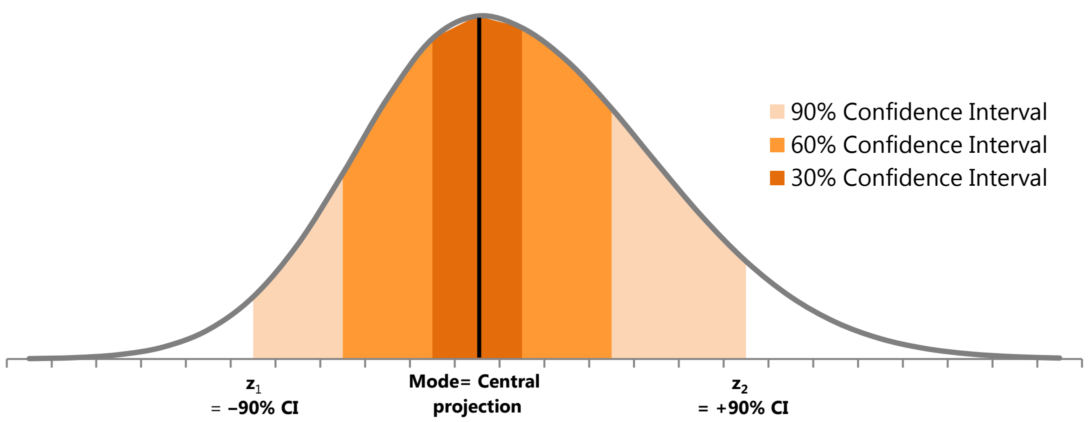
4. The Art: Assessment of the fan chart

There are abundant of information that can be derived from the fan chart. With the central projection as the staff's baseline forecasts, the width of the fan chart represents the degree of uncertainty surrounding the baseline forecast at a specific point in time; the wider the fan chart, the greater the uncertainty of the forecast. Therefore, as the forecast horizon increases, the width becomes larger as the baseline forecasts become more uncertain. Based on the method of construction, the width incorporates two types of uncertainties - the uncertainty of the forecasting model(s) and the uncertainties surrounding the assumptions used in the forecasts.

The skew of the fan chart reflects the balance of risks to the central projection. If the distribution is positively skewed i.e. upside bias, the width above the central projection will be larger than the width below. In another word, the probability of the true value to fall above the central projection is higher. Given the methodology above, the skew also reflects the net impact of the balance of risks of the risks factors on the forecasts. Therefore, the balance of risks of the forecasts can be attributed to the relevant key assumptions.

At each forecast period, a cross-section of the fan chart represents the probability distribution of the forecast at t+h, with mode μ_{t+h}, which is the baseline forecast at h periods ahead. As the widest band of the fan chart usually reflects the 90% confidence interval, the remaining 10% that is not captured by the fan chart represents the likelihood of tail-end risks events. These risks are the outlier events that are assessed to occur with very low likelihood.[12]

Probability distribution of forecast at *t+h* | Figure 4.1



As distribution of the forecasts at each period is known, the probabilistic assessment on the uncertainties surrounding the forecast can be performed to assess the balance of risks of the outlook at each period.

[12] Nonetheless, it should be noted that the impact of these events are usually large and may have prolonged impact on the forecast variables and/or macroeconomy.

In Malaysia, the main purpose of constructing the fan chart is to create a framework that assesses the risks and uncertainties to growth and inflation in a more systematic manner. Specifically, it is important to ensure that the assessments on the common risks factors of both growth and inflation are the same to maintain the consistency across the analyses done for policy making discussions.

The assessment of the fan charts can be done in two manners. One is based on the probability of the forecasts falling above or below the baseline projection, which reflects the skew of the distribution. Tracking the changes in the skew across the forecast rounds will provide us with the changes in balance of risks of the risk factors. Second, is based on the probability of the forecast falling above or below a certain range such as the inflation target or official forecast range. For instance, given the inflation forecast range for Malaysia in 2016 is 2-3%, if the probability of inflation falling below 2% for 2016 is larger than the probability of inflation being above 3%, there is larger downside risks for inflation with respect to the forecast range. More importantly, the methodology of deriving the width and the skew of the fan chart also allows us to determine the driving factors behind the changes in balance of risks compared to previous forecast rounds. Linking the uncertainty and skew of the fan chart systematically to the uncertainties and bias of the risk factors enables us to trace and explain the evolution of the risks and uncertainties surrounding the forecast. The assessment in this manner is more meaningful for central banks as it provides the MPC with the likelihood of growth and inflation breaching a certain steady growth path that may warrant policy actions.

It is also important to note that while the confidence levels around the central projection can be computed given the probability distribution, the exact level of the risk factors that lead to the specific confidence level is not able to be determined as it is a permutation of the different levels of the key assumptions. Therefore, the probability of a certain scenario occurring (with specified levels for each assumptions) will not able to be determined using the fan chart. This assessment, however, can be supported using scenario analysis and/or sensitivity analysis.

5. Conclusion

The fan chart is an important tool for policy makers especially at times of heightened uncertainty to illustrate the key risks and uncertainties affecting the outlook. Central banks like Bank Negara Malaysia do not only use the information imputed in the baseline projections for policy decision-making but also consider all the other information reflected in the fan chart. Central banks need this information to get a good gauge on the outlook of the economy to ensure policy actions are pre-emptive and timely. In addition, for central banks that publish the fan chart, it is also an important tool to help communicate to public the views of the central banks on the outlook of the economy. Bank of England for instance, illustrated the increased in uncertainty of the domestic economy via the wider fan charts published in its quarterly reports.[13]

Thus, the methodology of computing the fan chart is pinnacle in ensuring the type of information that can be derived from the fan chart. In Malaysia, the central bank recognises the importance of identifying the sources of uncertainty and hence imputed the uncertainties that are identifiable i.e. the risk factors into the construction of the fan charts. While there are many methodologies that have been proposed, most of these methods may be difficult to implement due to data availability and other constraints. Therefore, this paper attempts to provide a more simplified and adaptable variation that can be customised according to the risks specific to different economies such as emerging market economies that typically experience data availability issues.

As the literature in this area continues to grow and the methodology of deriving the fan chart continues to evolve, policy makers need to be cautious of the information that is being understood by the public. Policy makers and/or forecasters need to educate the users of the fan chart to ensure that they understand the information that can be derived from the fan chart so that the main objective of the fan chart can be achieved.

[13] Various Bank of England Inflation reports. http://www.bankofengland.co.uk/publications/Pages/inflationreport/default.aspx

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Appendix: The Two-piece Normal Distribution

The two-piece normal (TPN) distribution has been widely used in the literature on fan charts due to its asymmetric shape and the relative ease in computing the cumulative density function.

The probability density function of the TPN can be thought as the combination of two halves of two normal distributions with same mode μ but different standard deviations[14], σ_1 and σ_2. The probability density function for the TPN is therefore:

$$f(x) = Aexp\left\{-\frac{(x-\mu)^2}{2\sigma_1^2}\right\} \quad for\ x \leq \mu$$

$$Aexp\left\{-\frac{(x-\mu)^2}{2\sigma_2^2}\right\} \quad for\ x < \mu$$

where $A = \sqrt{\frac{2}{\pi}}\,(\sigma_1 + \sigma_2)^{-1}$ is a constant of proportionality introduced to ensure that the distribution is continuous and integrates to one.

The key properties of the distribution as introduced by John (1982) are:

Mean: $E(x) = \mu - k(\sigma_2 - \sigma_1)$...(1)

Variance: $V(x) = \sigma_1\sigma_2 + (1-k^2)(\sigma_2 - \sigma_1)^2$.............................(2)

Skew: $\gamma(x) = k(\sigma_2 - \sigma_1)[(2k^2 - 1)(\sigma_2 - \sigma_1)^2 + \sigma_1\sigma_2]$............(3)

where $k = \sqrt{\frac{2}{\pi}}$.

Therefore, with the mode, variance and skew of the distribution, equation (2) and (3) can be solved for σ_1 and σ_2.

From the probability density function, the probability of the being between any two points, *L1* and *L2* i.e the area under the chart can be computed.

$$P(L_1 < X < L_2) = \int_{L_1}^{L_2} f(x).dx \ = 2(\sigma_1 + \sigma_2)^{-1}[\sigma_2\Phi\left(\frac{L_2-\mu}{\sigma_2}\right) - \sigma_1\Phi\left(\frac{L_1-\mu}{\sigma}\right) + (\frac{\sigma_1-\sigma_2}{2})]$$

where $\Phi(.)$is the cumulative distribution function of the standard normal.

[14] If $\sigma_1 = \sigma_2$, then the distribution collapses to a balanced normal distribution where $\mu = mode = mean$.

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Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

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Modern informational technologies for data analysis: from business analytics to data visualization[1]

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[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

Modern informational technologies for data analysis: from business analytics to data visualization

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Abstract

Modern informational technologies encompasses a variety of tools, applications and methodologies that enable to collect data from internal systems and external sources, prepare it for sharing, analysis, develop and run queries against the data, create reports, dashboards and data visualizations.

One of such innovation system in financial landscape is Business intelligence. Its opportunities are in combining a broad set of data analysis applications, including analysis and querying, enterprise reporting of different statistic information, online and real-time analytical processing. Modern technologies also includes data visualization software and powerful environment to build interactive and visually appealing analytics to display the most important information needed to achieve one or more statistic objectives or to consolidate and arrange on a single screen the whole information on main factors of monetary policy, which can be monitored at a glance.

Using such technologies enable to make ad hoc analysis of just published data and to refine statistics implications for monetary policies needs and users requirements as well.

Keywords: Business intelligence; BusinessObjects; statistical data; Dashboards; Ad hoc analyzing; visualization.

Contents

Introduction

In the modern financial landscape it is necessary to conform to the high quality standards of the provided information and to use up-to-date technologies. Modern informational technologies encompasses a variety of tools, applications and methodologies that enable to collect data from internal systems and external sources, prepare it for sharing, analysis, develop and run queries against the data, create reports, dashboards and data visualizations.

One of such innovation system in financial landscape is Business intelligence (BI) - a technology-driven process for analyzing statistical data and presenting actionable information to help statisticians, economists, business managers and other end users make more informed business decisions or answer their own questions.

Business intelligence in financial landscape

Business intelligence (BI) is a technology-driven process for analyzing data and presenting actionable information to help end users make more informed business decisions. BI encompasses a variety of tools, applications and methodologies that enable to collect data from internal systems and external sources, prepare it for analysis, develop and run queries against the data, and create reports, dashboards and data visualizations to make the analytical results available to end users and operational workers.

BI data can include historical information, as well as new data gathered from source systems as it is generated, enabling BI analysis to support both strategic and tactical decision-making processes. Initially, BI tools were primarily used by data analysts and other IT professionals who ran analyses and produced reports with query results for business users. Increasingly, however, business executives, economists, analytics and workers are using BI software themselves, thanks partly to the development of self-service BI and data discovery tools.

Business intelligence combines a broad set of data analysis applications, including ad hoc analysis and querying, enterprise reporting, online analytical processing, mobile BI, real-time BI, operational BI, cloud and software as a service BI, open source BI, collaborative BI and location intelligence. BI technology also includes data visualization software for designing charts and other infographics, as well as tools for building BI dashboards and performance scorecards that display visualized data on business metrics and key performance indicators in an easy-to-grasp way.

BI programs can also incorporate forms of advanced analytics, such as data mining, predictive analytics, text mining, statistical analysis and big data analytics. In many cases though, advanced analytics projects are conducted and managed by separate teams of data scientists, statisticians, predictive modelers and other skilled analytics professionals.

Business Intelligence in Statistics Department

Statistics Department of Central Bank of Russian Federation uses SAP BusinessObjects Business Intelligence for several years and could achieve considerable results in the analysis and data presentation. SAP BusinessObjects BI is a platform used by SAP systems to provide the Department with a flexible route to sharing information that available for the entire Central Bank and end users. Using SAP BI, Department enables to share the information in a real time at every level – from the director of the Department to analysts, from higher executives to lower level employees, it enables better decision making in the Department.

Business intelligence is important for all spheres of statistics to offer a panoramic view of data, which can be easily accessed by anybody with valid and appropriate credentials within and outside the Bank. SAP BO can be easily customized, so that our Department may tailor it according to our needs and information can be accessed much faster.

Importance of SAP BusinessObjects BI

Here is an overview of the various facts of SAP BusinessObjects BI, and why it is important for Statistics Department.

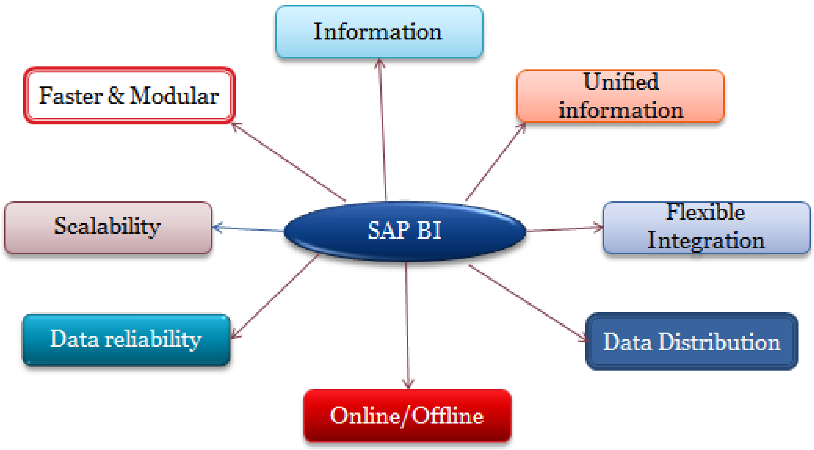


Fig.1

Information at fingertips.

SAP BusinessObjects BI provides the entire data to the user of statistic information in a simplified form, so that it can be easily understood. Searching for critical information and gaining a valuable insight is much easier this way. And this is done using common business terms, rather using than any complex semantic knowledge.

A unified information system

With SAP BusinessObjects BI, Department doesn't need to maintain several different infrastructures to collect all statistics information. All information necessary for compiling statistics in one system.

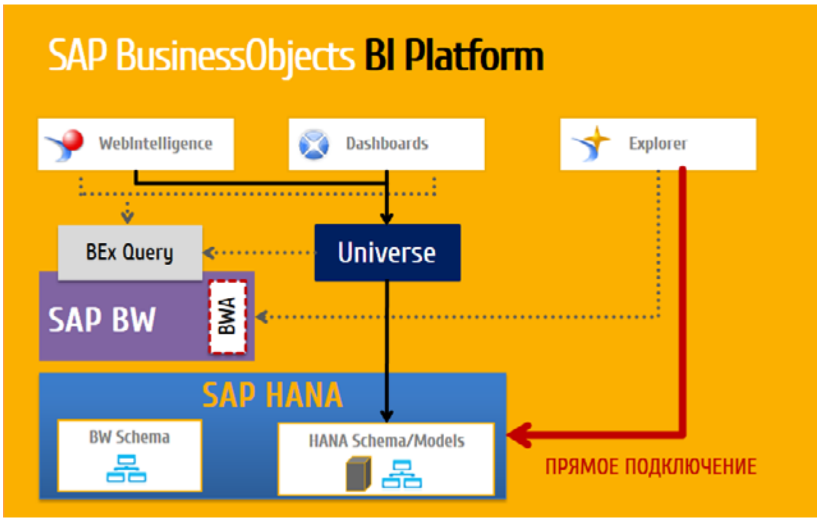


Fig.2

It allows for flexible integration and inter operability

Using SAP BusinessObjects BI the Statistics Department can integrate multiple business applications and modules and make it available to users in an easy and unified way. Users can gather data from any particular department individually in combination with other SAP modules, so a vast amount of business and statistics data can be transferred using SAP BusinessObjects BI.

Large Scale Data Distribution

With SAP BusinessObjects BI, the Department can distribute data with hundreds of thousands of people. The publishing and scheduling functionality of BusinessObjects allows to distribute vast volumes of personalized BI content to a number of employees and end users efficiently. One can share information from BI through e-mail and other platforms, while maintaining security. Exploring this BI functionality is now under way.

Offers a new insight into the data

Using SAP BusinessObjects BI, the Statistics Department gains a valuable new insight into data across various business modules. And BusinessObjects combines all the views to provide the better information.

Less work for the IT employees

Since SAP BusinessObjects BI makes everything available to all the employees in the Department to do their tasks, so there will be less demand on their Information Technology departments to do basic tasks, as this is easily taken care of by Business intelligence.

Presents information in a personalized and easy to read format

SAP BusinessObjects BI does the processing of all queries and presents the result to readers in an easy format, which is personalized and customized according to their requirements. Information is available in Microsoft Office documents and Adobe PDF documents.

It always works, whether one is online or offline

Whether users are online or off-line, SAP BusinessObjects BI is always available through browsers, applications, desktops widgets. So everyone can connected to the Statistics Department's server with the best SAP database solutions.

It is always reliable

SAP BusinessObjects Business intelligence is highly reliable because data can be gathered safely and securely and integrated with the MS office environment.

Easy and painless scalability

SAP BusinessObjects Business Intelligence is easily scalable because of its service oriented architecture. We can increase or decrease the quantity of the processed indicators and our modules and programs will still be functional.

Faster, Modular Development

It can be used not in one or two departments, but also in the whole Central Bank to make the uniform centralized platform of business analyzing.

So, using SAP BusinessObjects Business intelligence (BI) in Statistics Department of Central Bank of the Russian Federation allowing users to access, navigate, analyze, format, and share information across a corporate and business environment and to make simplify data manipulation.

Modules of SAP BI, using in Statistics Department

- **Crystal Reports** -- Enables to design and generate reports.
- **Dashboards** -- Allows to create interactive dashboards that contain charts and graphs for visualizing data.
- **Web Intelligence** -- Provides a self-service environment for creating ad hoc queries and analysis of data both online and offline.
- **Explorer** -- Allows to search information through BI data sources. Users do not have to create queries to search the data and results are shown with a chart that indicates the best information match.

Ad-hoc analyzing

Statistics Department also uses Web Intelligence is an ad-hoc query and reporting environment. Fundamentally, it is an environment that provides self-service access to data. Web Intelligence contains reporting, querying, and information analysis in one integrated product, helping end users turn business insights into effective decisions. With just a few clicks of the mouse, users of statistics can quickly access and format information as well as easily analyze it to understand underlying trends and root causes.

It contains a highly-interactive data interface that allows the report users a great deal of flexibility to view data from different perspectives. Although many report users may only need to build their reports from scratch, it is often necessary for the users to adjust reports to answer current business questions. Our users can easily edit queries and reports to reflect their latest information needs.

This is the example of the standard report of Weighted Average Interest Rates on Deposits of Individuals and Nonfinancial Organizations, which is published on the official cite of the Central Bank of the Russian Federation. The report keeps the structure at the subsequent updatings, the user needs only to hand over the new date.

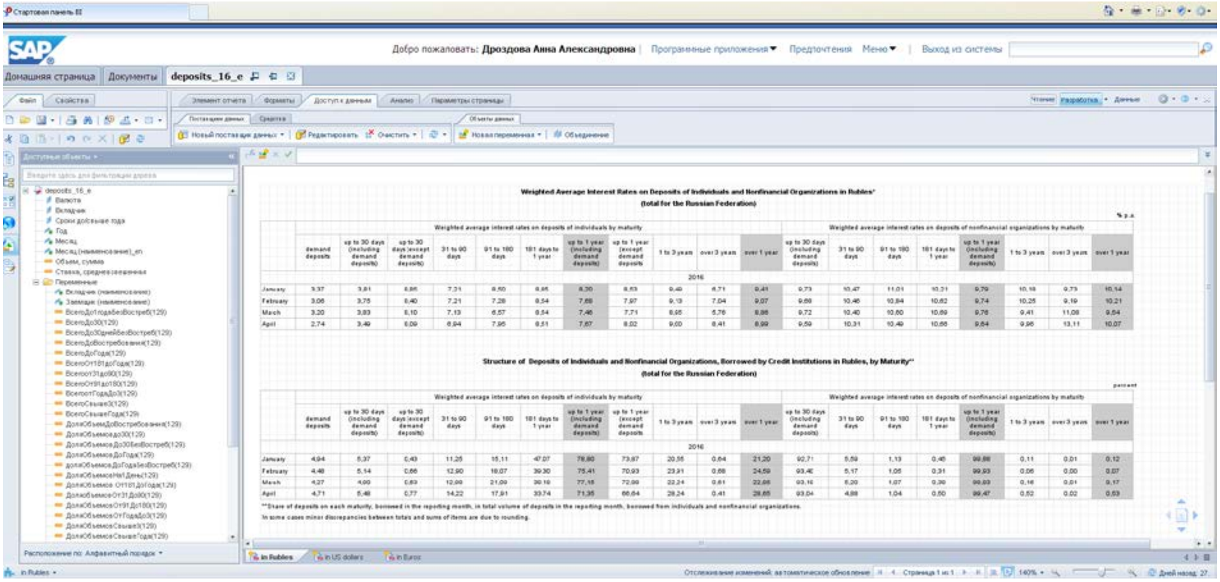


Fig.3

The following options can be taken advantage by user of Web Intelligence in Statistics Department:

- View, edit, remove report, section, or block filters;
- Format and re-size cells, tables, and charts;
- Set breaks and sorts;
- Insert calculations;
- Add rows and columns to tables;
- Create and duplicate tables and charts;
- Turn a grid into a chart or a chart into a grid;
- Create formulas and variables;
- Edit cell formulas in place;
- Recombine report objects within tables and charts.

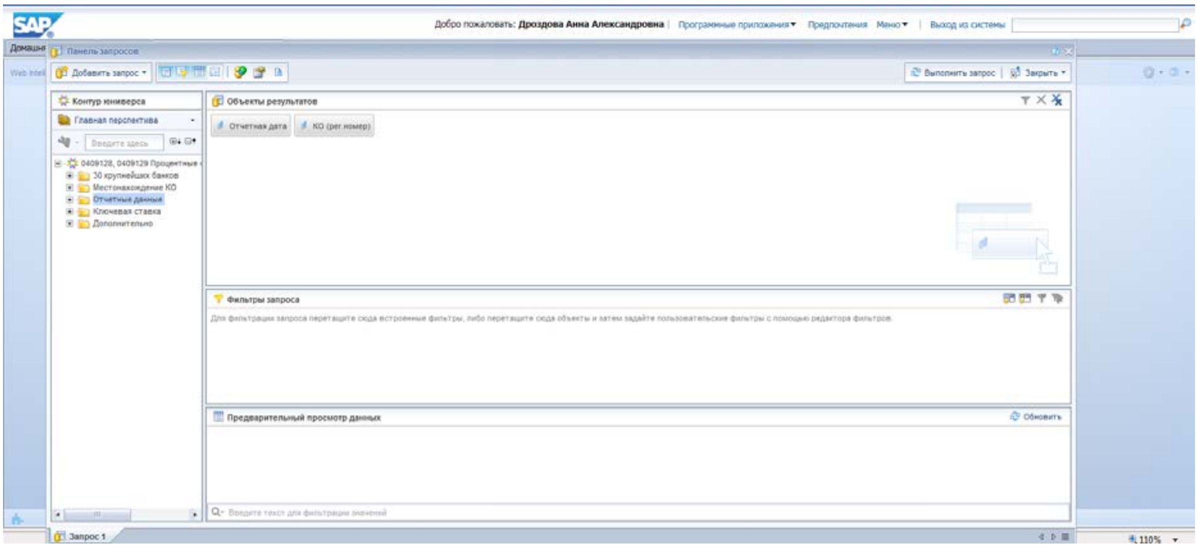


Fig.4

Therefore, all these provide users of our statistics information with self-service and interactivity to have:

- Ability to generate answers to business questions;
- Thorough business and data analysis;
- An environment that utilizes business terminology;
- Intuitive drag & drop interface for document creation;
- Powerful, online and offline ad hoc query and reporting;
- Integrated and trusted analysis for all users;
- A tool built upon a complete, trusted, and agile platform;
- Enable BI standardization via shared administration and security;
- Deliver query, reporting, and analysis globally via a single deployment;
- Extend the reach of interactivity and analysis beyond the enterprise;
- The opportunity to export the created reports in MS Office or PDF format.

Powerful, Online and Offline Ad Hoc Queries and Reporting

SAP BusinessObjects provides an intuitive interface that allows business analysts and non-technical information consumers to ask spontaneous and iterative business questions of their data using everyday business terms.

For example, the usual users can easily:

- compare indicators of the market of housing crediting for last and current year;
- look at dynamics of change of the key rate;
- allocate areas with the maximum shares of arrears on the issued credits;
- count annual rates of a gain on any indicators;
- construct the chart in one clique of a mouse;
- and so on.

On the picture given below it is enough to users to choose indicators which they want to analyze, and they will automatically be added to the chart. All this makes the statistical analysis more evident, available and clear for ordinary users.

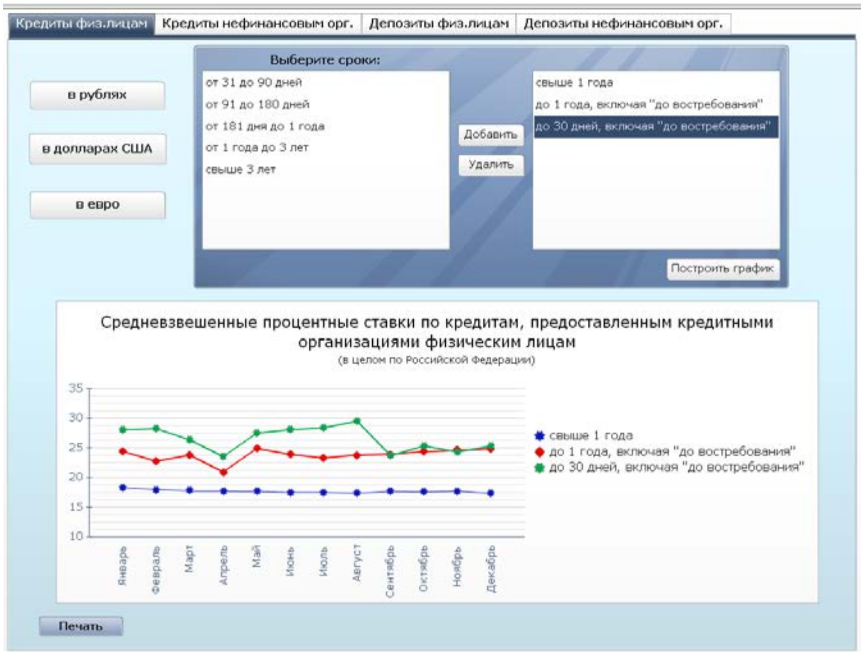


Fig.5

Integrated and Reliable Analysis for All Users

Using SAP BusinessObjects, Statistics Department delivers a unique, single Web environment to access and interact with information in online and offline mode. The interactive analysis framework ensures that a full range of users can access and analyze secure information, thereby reducing the number of tools.

Department uses SAP BusinessObjects Web Intelligence to complete these main tasks:

- Access and analyze information in a single interface;
- Easily personalize, explore, and discuss information;
- Interact with information via the interactive analysis framework.

Translation engine is also used to provide access to the statistical information and analytical report in multiple languages.

SAP BusinessObjects Dashboards

Except Web Intelligence, Statistics Department of Central Bank of the Russian Federation uses SAP BusinessObjects Dashboards – a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance.

Key Features of using Dashboards in Statistics Department

- Interactive visual modeling - sliders, gauges, filters, numerical input tools and other visual components allow users to quickly and easily evaluate multiple what-if scenarios.
- Ease of use - intuitive interface, including pre-built components, skins, maps, charts, straightforward export features - make it easy for non-technical users to develop.
- Platform independence - custom graphics and interactivity allow users of statistics information to develop and present financial models, analytical reports and business summaries for the Web, intranets, and portals. Interactive visual can run on any PC, Mac, handheld or any other device supports Flash technology.
- Ease of Excel at design-time and an available set of pre-built dashboard templates and skins.
- XML/Web-services connectivity.
- Off-line analysis.

It has to be realized that almost every tool which is being used for supporting data spread across the statistics information is simultaneously somehow connected with business intelligence solutions. Whilst business intelligence might be – as a whole – boiled down to supporting the process of transforming data into information and, then, information into knowledge usable for the Department, in point of fact almost all tasks connected with data belong to BI branch.

During using Dashboards in the Statistics Department following results were received:

- Identify negative trends. Users can observe changes of certain indicators eventually, allocate negative trends, analyze change of indicators in a section of types of economic activity or subjects of Federation.
- Improve the efficiency of newly-made indicators. The efficiency of analyzing is the common goal for all business intelligence solutions, every tool treat the question in a different way. Dashboards, for instance, support decision making with better information.
- Measure statistics indicators. It’s never easy to measure the real performance or efficiency of statistics indicators. Even if something looks good from the outside, in point of fact it might be many times worse, but the external symptoms still aren't visible. Deep analysis let economists to receive more fuller and comprehensive picture of the happening changes or deviations.
- Improve performed analysis thanks to visualization abilities. Pure data often is not enough. What is not visible in spreadsheets of values, might come out thanks to graphic visualization of analysis. Modern dashboards support therefore visual presenting of analysis statistics indicators.

Thanks to using Dashboards in Statistics Department, we could achieve considerable results.

- The first and the most important of all dashboards' features is a good cooperation with data originated from diverse and numerous sources. We need to remember that data across departments of the Central Bank are kept in diverse systems, therefore there occurs a need for having a tool able to read all of them. Our dashboards intercept and store data from multiple sources.
- All more or less complicated calculations have been automated and users don’t need to care anymore about how to perform calculations as they're prepared automatically. The only thing left is to decide which data we want to consider and in relation to which.
- Seeing what's happening in the country as a whole can give a whole picture of the enterprise. It's easy as it requires only a few clicks - it is also a feature of the newest generation of dashboards.

- Full and clarify picture for analyzing statistical data and presenting actionable information to help statisticians, economists, business managers and other end users make more informed business decisions or answer their own questions.
- Dashboards allow users to focus on what's actually important for them as well as they can immediately dives into more detailed data, if needed.

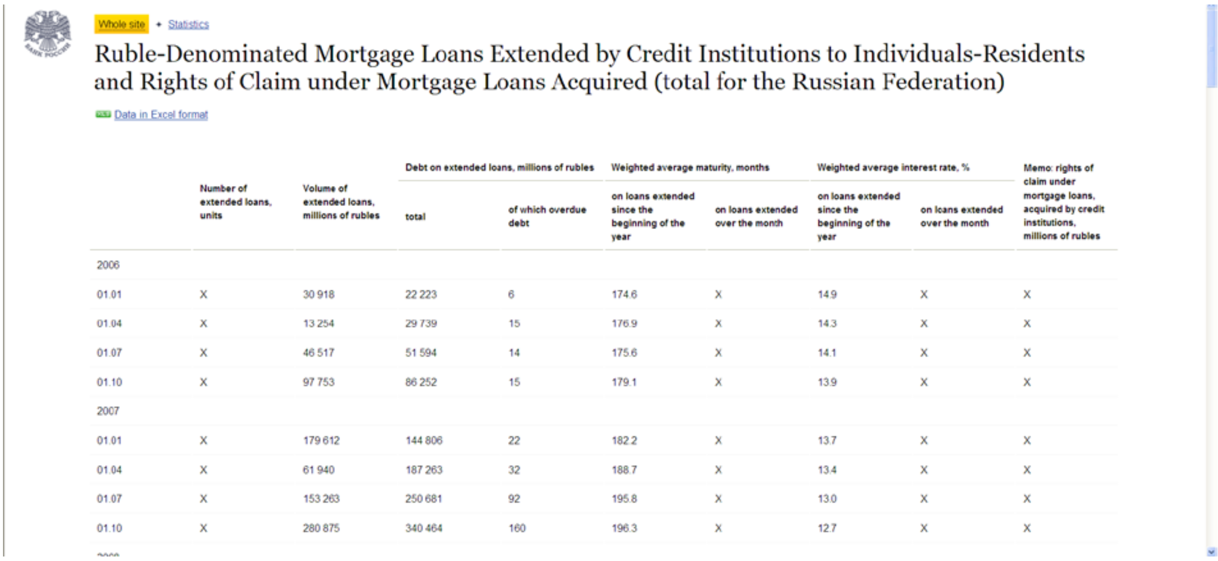
In most cases, dashboards are being used for monitoring and analyzing statistics indicators. In this case the executives can see the generalities first, and then drill through to more detailed reports.

It is possible due to increased data aggregation and graphic design - this makes dashboards clear and more transparent, and - therefore - easier to use.

For example, became possible to analyze dynamics of volumes of the Mortgage Loans Extended by Credit Institutions to Individuals-Residents. If before data were presented in the form of the huge table, now they are presented in the form of the evident schedules allowing to carry out the analysis on the chosen federal areas and regions of Russia. It is enough to user only to press on date or on the Federal district.

You can see it in the following pictures.

Before using Dashboard:


Whole site • Statistics

Ruble-Denominated Mortgage Loans Extended by Credit Institutions to Individuals-Residents and Rights of Claim under Mortgage Loans Acquired (total for the Russian Federation)

Data in Excel format

	Number of extended loans, units	Volume of extended loans, millions of rubles	Debt on extended loans, millions of rubles		Weighted average maturity, months		Weighted average interest rate, %		Memo: rights of claim under mortgage loans, acquired by credit institutions, millions of rubles
			total	of which overdue debt	on loans extended since the beginning of the year	on loans extended over the month	on loans extended since the beginning of the year	on loans extended over the month	
2006									
01.01	X	30 918	22 223	6	174.6	X	14.9	X	X
01.04	X	13 254	29 739	15	176.9	X	14.3	X	X
01.07	X	46 517	51 594	14	175.6	X	14.1	X	X
01.10	X	97 753	86 252	15	179.1	X	13.9	X	X
2007									
01.01	X	179 612	144 806	22	182.2	X	13.7	X	X
01.04	X	61 940	187 263	32	188.7	X	13.4	X	X
01.07	X	153 263	250 681	92	195.8	X	13.0	X	X
01.10	X	280 875	340 464	160	196.3	X	12.7	X	X

Fig.6

After using Dashboard:

Fig.7

There are a several examples of Dashboards of information on actual statistical data on the placed means of the credit organizations.

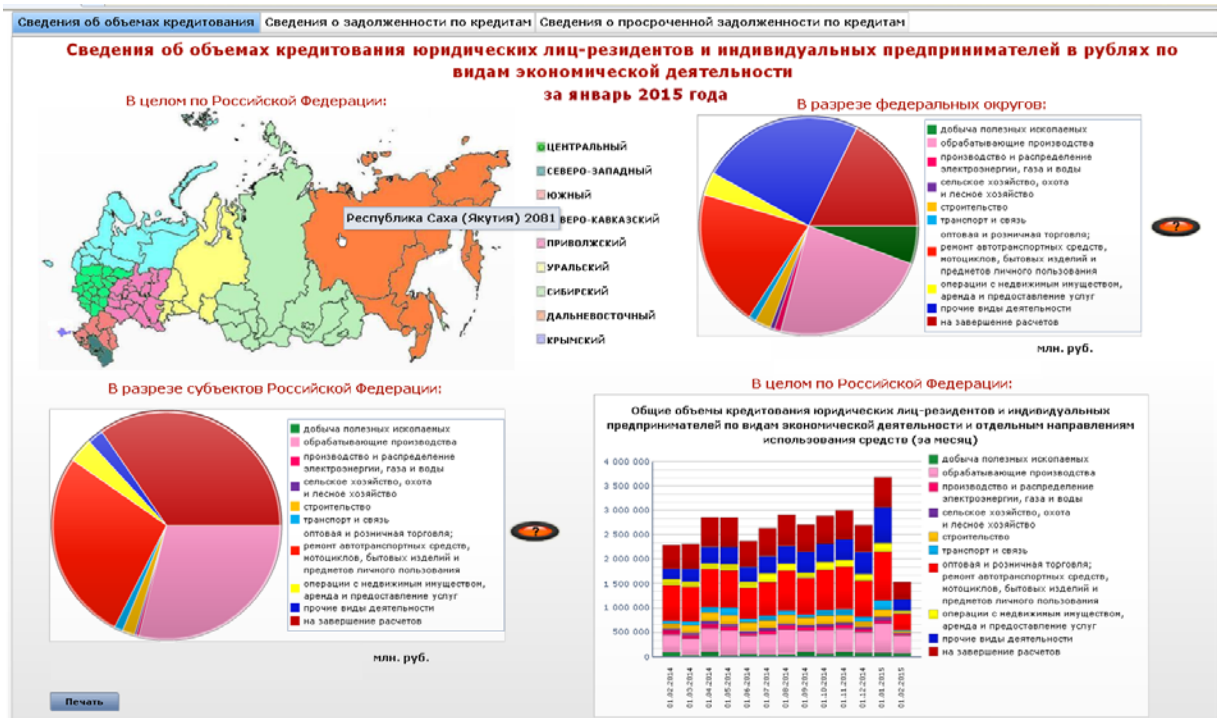


Fig.8

Using these Dashboards you can obtain evident information on:

1. volumes of the granted loans,

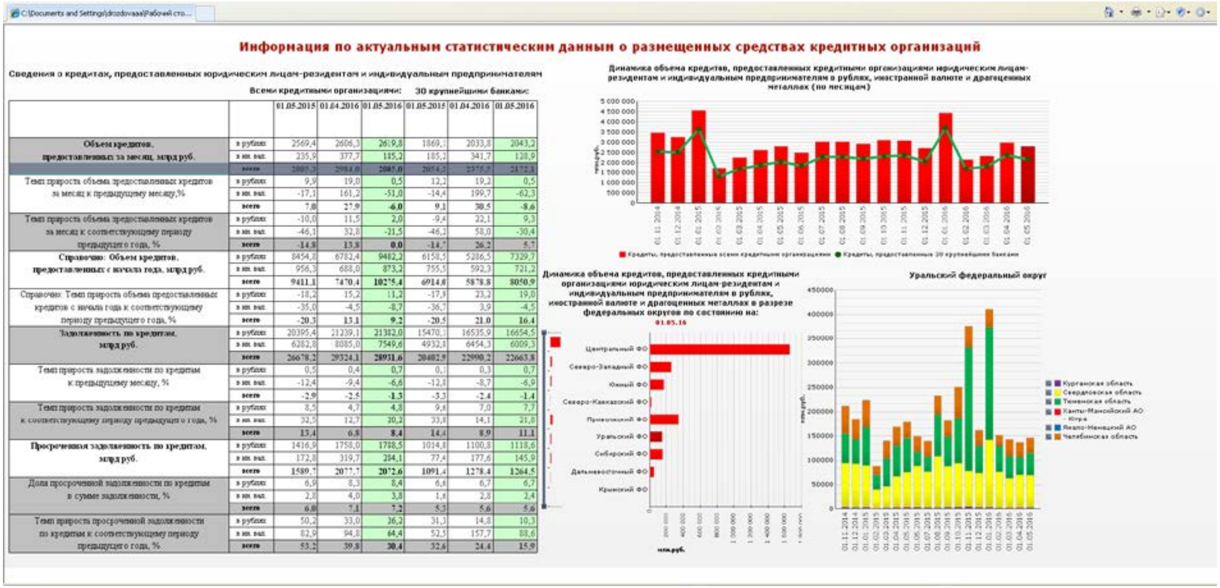


Fig.9

2. debt and overdue debt on the credits,

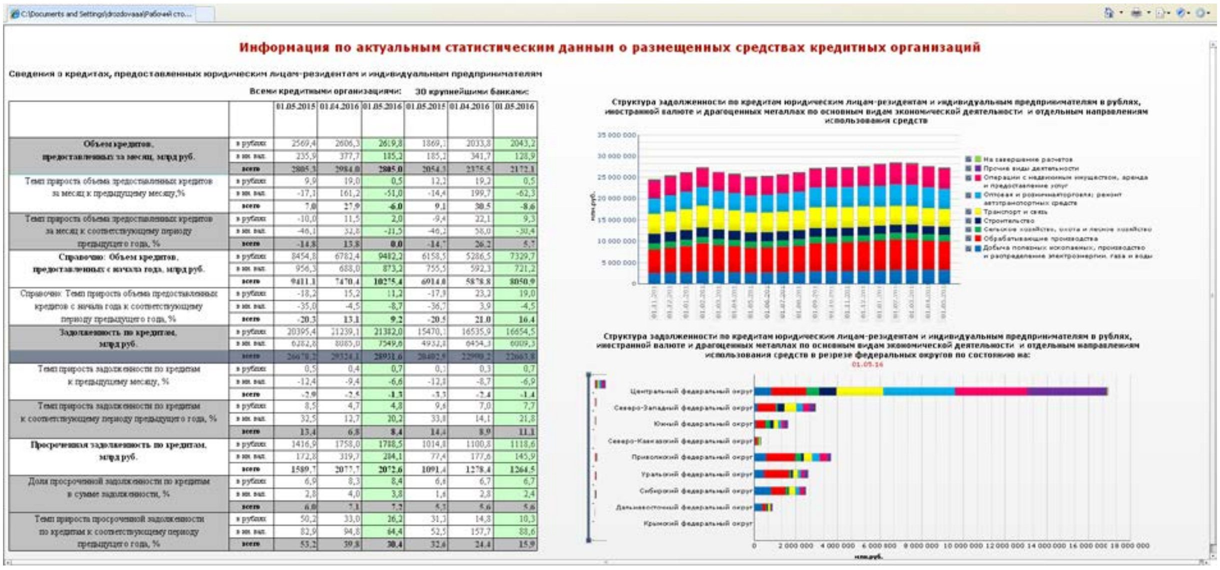


Fig.10

3. rates of a gain of volumes, debts and overdue debts,

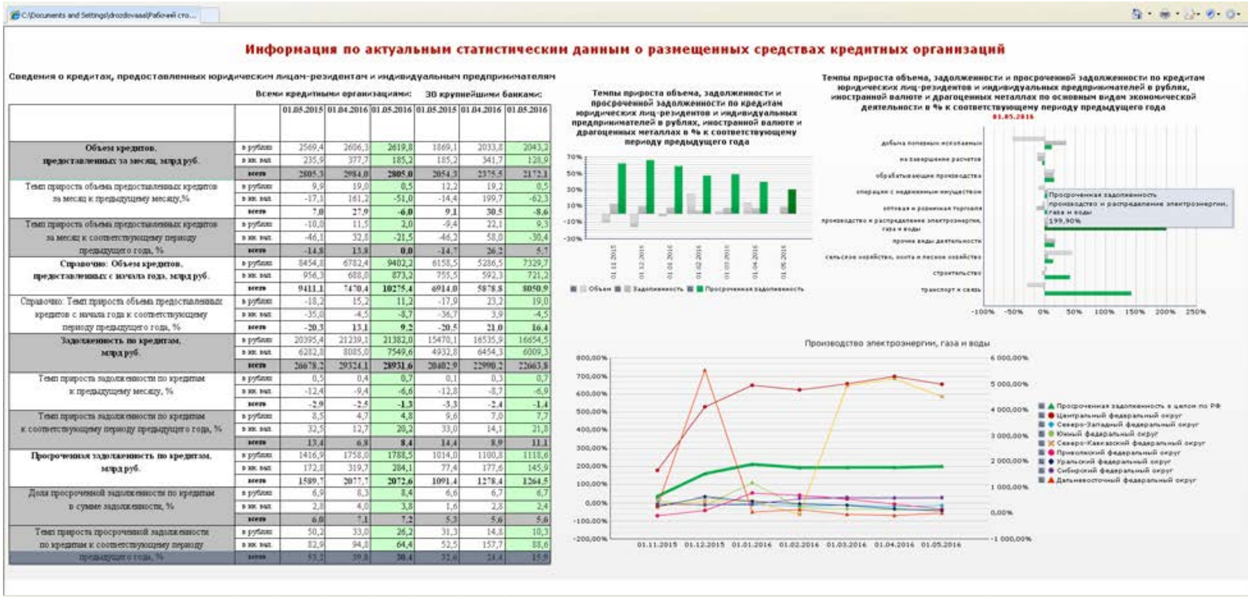


Fig.11

4. share of the overdue debt in the total amount of the debt.

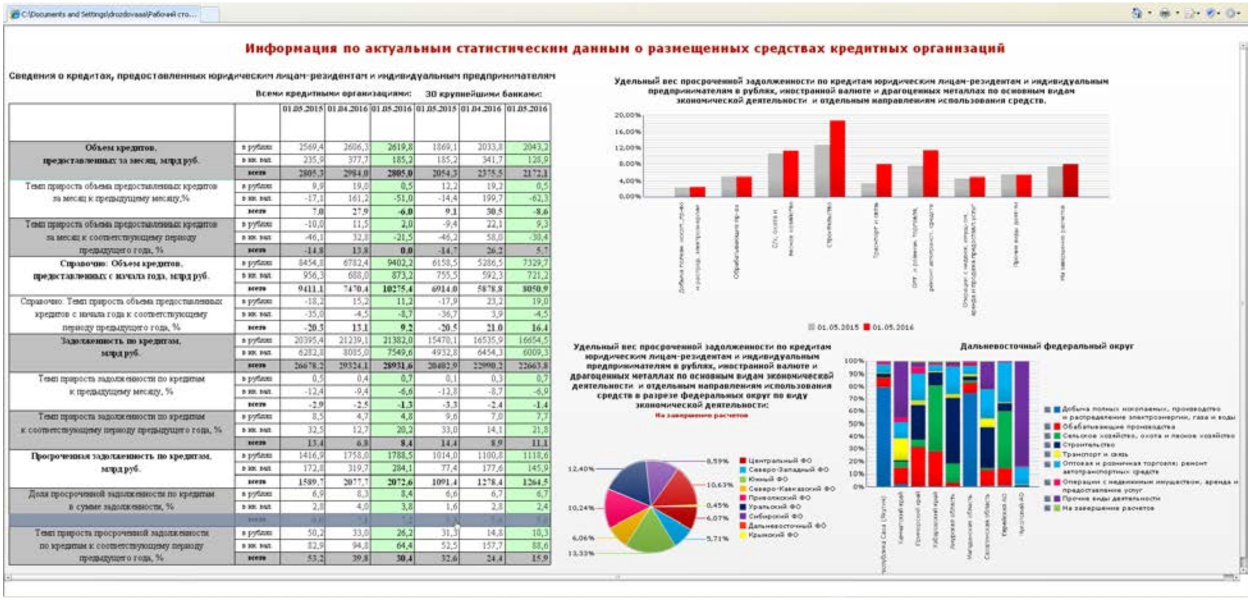


Fig.12

As we work our way from the big picture to the nuts and bolts of our dashboard design, we want to outline common features that can make our dashboard more useful. Depending on the form that user've chosen, the dashboard can be much more than simply charts on a page.

- Interactive elements highlight key information;
- User configuration let users customize their view of the data;
- Advanced visualizations make complex data easy to understand and navigate.

Features of analyzing with Dashboards

- Drill down: Ability to go from a summary metric or view to additional detail that provides more context and/or breakout of the information.
- Filters: Allow users to define the scope of the data in the dashboard to reflect their needs. Filters can either be global (refining scope for the entire dashboard) or local (refining scope for a specific chart or metric or view).
- Comparison: Ability to see two or more subsets of the data side-by-side. A line chart, for example, may let the user view two geographic regions as separate lines.
- Alerts: Highlight information based on pre-defined criteria. The alert may be activated when a metric goes outside of a particular threshold.
- Export / print: Give users the ability to pull information out of a dashboard. Export to formats that let users do more with the data like Excel and CSV rather than PDF.
- Advanced visualizations: If it is useful to show more complex data in the dashboard, a variety of advanced visualizations can help make it digestible. A few visualization types to consider include geographic map, treemap, network diagram, tag cloud, scatterplots and bubble charts.

Besides, advantages of using Dashboards can be illustrated in the comparative table.

	Paper One-pager	Paper Presentation	Excel	Online app	E-mail / text message	Large screen
Timeliness	-	-	+	+	+	+
Aesthetic	+	+		+	-	+
Mobility	+				+	-
Connectivity	-	-		+	+	+
Data detail	-	+	+	+	-	
Data density	+	+			-	
Interactivity	-	-		+	-	-
Collaboration					+	-

Fig.13

Conclusions

The opportunities of Business intelligence are in combining a broad set of data analysis applications, including analysis and querying, enterprise reporting of different statistic information, online and real-time analytical processing. Modern technologies also includes data visualization software and powerful environment to build interactive and visually appealing analytics to display the most important information needed to achieve one or more statistic objectives or to consolidate and arrange on a single screen the whole information on main factors of monetary policy performance, which can be monitored at a glance.

Using such technologies enable to make ad hoc analysis of just published data and to refine statistics implications for monetary policies needs and users requirements as well.

BI technologies provides a self-service environment for creating ad hoc queries and analysis of data for users, not having knowledge or experience in SQL query building and data base structure.

Using SAP BusinessObjects helps to reduce the expenditure on informatization of Statistics Department activities.

Further developments are aimed at designing Dashboards on all high-demanded statistics areas and using all the functionality of sharing information or data delivery in a personalized way.

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BANK FOR INTERNATIONAL SETTLEMENTS

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From the business process to the stress test - EIOPA data governance concept[1]

Katarzyna Wojtkiewicz,

The European Insurance and Occupational Pensions Authority (EIOPA)

[1] This paper was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

From business process to stress-test

EIOPA Data Governance Concept

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Abstract

Implementing secure, trustful (high quality) and efficient data governance framework adaptable to permanently changing environment was recognised in 2011 by EIOPA as the strategic objective, enabling delivery upon its mandate defined in the founding regulation[1]. To deliver against this objective, the Authority decided to implement data governance concept based on the business process management approach. The case study presents strategic choices made to define the end-to-end data governance concept, which successfully passed its exam allowing for the fast-performing impact analyses across the insurance sector in EU in response to the unexpected BREXIT vote, basing on the data collected to the Central Repository a few days earlier.

Contents

[1] EIOPA is part of a European System of Financial Supervisors that comprises three European Supervisory Authorities, one for the banking sector, one for the securities sector and one for the insurance and occupational pensions sector, as well as the European Systemic Risk Board. For more information, please see: https://eiopa.europa.eu/

1. Approach followed

The data governance concept was to provide a framework of plan and initiatives, to ensure that EIOPA derive strategic value from IT and data related investment in the short-term, mid-term, and long-term. Unlike tactical or project plans, which focus on detailed operational, day-to-day actions, strategic Data and IT planning involved making decisions about desired future outcomes, how to achieve these outcomes, how to measure them and evaluate their success.

EIOPA data governance concept was defined basing on recognition that it has to enable secure, trustful (high quality) and efficient framework adaptable to permanent changing environment. The business process management approach[2] was chosen to formulate the design and requirements for the implementation. With involvement of the key EIOPA business users and working groups composed of the subject matter experts of the National Competent Authorities (NCA), the core business process map was developed[3] providing sufficient information on the core processes consuming data to deliver upon EIOPA's mandate defined in its founding regulation. The EIOPA Data & IT Strategy report included definition of data assets to be provided to EIOPA as justified by the purpose of the specified need and identified via documented business process. This level of detail allowed for mapping of the EIOPA Business Strategy through the **business processes** defined for the whole enterprise, providing evidence for supply of a granular data to be re-used via various processes and for the extensive range of the EIOPA's deliverables.

To support the core business processes, the common rules and the processes enabling data collection and dissemination, viewed from an information technology aspect, were defined.

The EIOPA business processes description aimed to directly lead to corresponding functional and non-functional requirements, providing an overview of general rules, common processes and supportive mechanisms applicable to all domains of the EIOPA data collection and management. This approach still assists in the ongoing analysis of the processes and permanent conversion to functional and non-functional specifications and their implementations.

2. Conclusions underlying data and IT design

In this context, a range of strategic concerns had been explored leading to the conclusions justified case by case from business or technological perspective. Politically driven objectives or country reasoned positions were not included in the

[2] Business process management (BPM) is a systematic approach to making an organization's workflow more effective, more efficient and more capable of adapting to an ever-changing environment. A business process is an activity or set of activities that will accomplish a specific organizational goal. It treats the organisation as the one organism, where the business processes are standardised, reused and permanently improved with high awareness of the cross-functional dependencies and information (data) flows processed within the whole ecosystem.

[3] Business process mapping refers to activities involved in defining what a business entity does, who is responsible, to what standard a business process should be completed, and how the success of a business process can be determined.

justifications, however the concerns made were presented in the reports even if the justification provided with the opposite final conclusions.

The following leading conclusions were developed during the project:

1. EIOPA should maintain centralised, trustful and secure database.

There was a strong need justified by both IT Strategy and Data Specification reports, to maintain a centralised, trustful and secure database, providing with the scope of data needed to perform EIOPA tasks (all data assets were listed in the Data Definition annex).

The register should be the basic building block for the EIOPA database, meaning that all other data or information asked by EIOPA to NCA on an individual undertaking basis should be possible to interlink with the register.

EIOPA should be the information hub for supervisory data within the EU and it will be the keeper of the centralised database for insurance data;

2. EIOPA should collect non-aggregated data.

As stated in the defined EIOPA core processes there was an individual data need to perform particular EIOPA's tasks as described in EIOPA regulation. EIOPA would need firm level data in all its competence areas.

Following Board of Supervisors expectation expressed in March and June 2011 meetings, to assure consistency of reporting requirements across different EIOPA core processes, and to avoid reporting requests duplications, no additional structural requests for data from group supervisors was foreseen. This data need was to be covered by standard reporting based on EIOPA database.

It was underlined that EIOPA will not need a database solely for its own use, as the database covers reference data for the working of colleges, some of the content of the database had to be external facing to NCAs as well.

Furthermore, for future submissions of aggregates to ESRB on a timely basis individual firm level information would be needed from NCAs. After extensive consideration how EIOPA could conduct its tasks of supporting ESRB on the basis of non-firm identifiable (i.e. aggregates with dispersions etc.) information, this had been seen as unfeasible in terms of timing and quality unless EIOPA had been receiving firm level data.

3. Non-anonymised undertaking level data should be transmitted to EIOPA to support EIOPA core processes.

It should also be borne in mind that the report from the Joint Group on Data Requirements identified what data it was envisaged would be required by ESRB once harmonised reporting is in place. The requirements to break down data not only by country but **by sectors and types of undertaking**, and provide dispersion measures, means that this cannot be done without individual undertakings' data being analysed.

Transmission of individual data based on the Solvency II reports was considered cost efficient from the NCAs point of view. The collection costs of NCAs submitting aggregated or partial Solvency II data to EIOPA were considered to be higher as design, implementation and maintenance of additional aggregation and validation rules need to be applied.

Non in contradiction of the above, as for some core processes the need for data was more uncertain at this stage (e.g. policy area for updating SII, and for Pension area) the change management procedure should be introduced to permanently verify and update data requirements and specification.

4. Harmonise reporting data formats and data validation rules are necessary for efficient data management process.

Having in mind Board of Supervisors March 2011 decision on XBRL format and IT Strategy conclusions on data quality it was clear that all NCAs have to be in a position to accept submissions from undertakings in XBRL format. That XBRL format would include specified validations which the data has to satisfy to ensure the integrity of the data. Furthermore, it was recognised that many undertakings (not just small undertakings, although that tended to be the focus of attention) had no expertise in XBRL, hence the proposal to develop a supporting IT tool.

In terms of supervisory authorities, it was recognised in proposing XBRL that there would be a potential cost to NCAs in having to process data received in that format. However it explicitly did not rule out NCAs using existing interfaces or alternative data submission methods in addition to the capability to receive and process the harmonised XBRL files. In the discussions leading up to the paper, it was made clear that if NCAs did use alternative data interfaces, those interfaces should output the data in the harmonised format, and the data should be processed as if it was a direct submission of the harmonised data. This would ensure that the data would be of the same quality, no matter how undertakings actually provided it or how the NCA received it.

Another reason that using a consistent submission format was recommended was that it potentially would make data sharing with EIOPA more efficient/cost-effective (as this sharing could be automated once the data had passed the minimum standards and would go on the NCA's database).

The IT Strategy recommended that the use of XBRL as a mandatory technical standard for the exchange of data between Undertakings and NCAs and between NCAs and EIOPA should be approved. With this harmonisation, it was possible for EIOPA to develop a common tool, whose scope is restricted to harmonised reporting[4]. Even then, after EIOPA develops the tool for harmonised reporting, an NCA (at their own cost), should be able to separately extend the EIOPA tool to support national specifics and distribute the modified tool in the NCA domain. Additionally, with this harmonisation, it should also be possible for an NCA to develop a tool capable of supporting both harmonised and national specific reporting.

The detailed reasoning including of XBRL Taxonomy impact analysis was provided with the IT & Data Strategy Report.

5. EIOPA should start Central Repository implementation project.

It was decided that the database implementation project should start as soon as possible following principles and methodology foreseen in the EIOPA Data & IT Strategy.

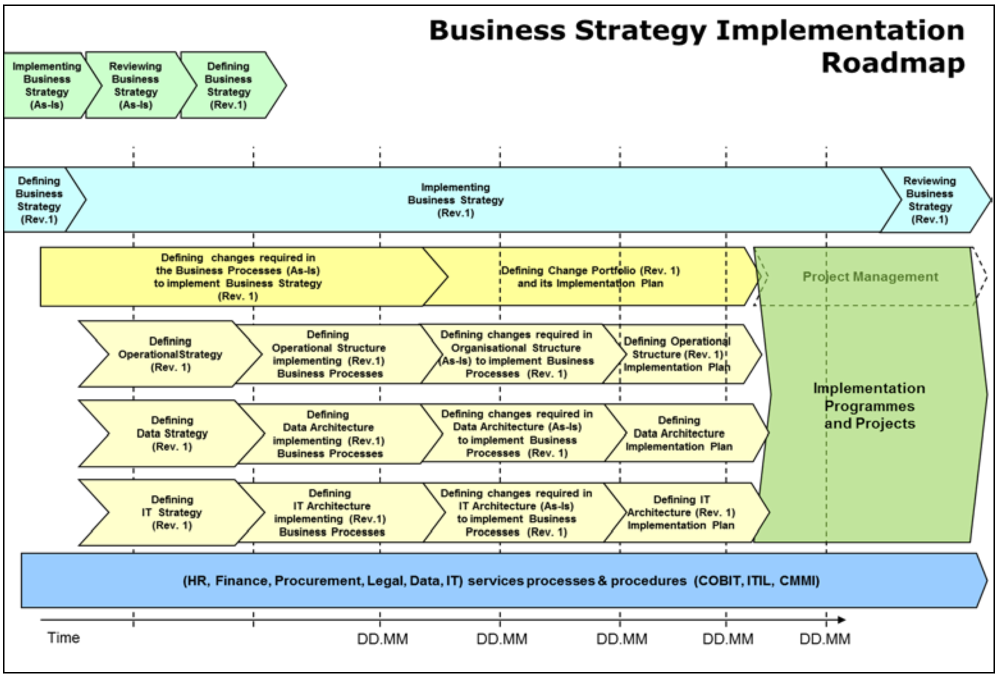
[4] The Tool for Undertaking has been already developed and released by EIOPA; up to date it is being used by the reporting agents.

3. Implementation project roadmap

The Box 1 illustrates the roadmap targeting with initiation of the Implementation Programme. It assumes regular cycle of the business processes analyses to identify and scope changes justified and accepted for implementation.

Box 1

Business Strategy Implementation Roadmap



4. Central Repository design

The Data Collection and Dissemination process defined at the earlier stage allowed for defining of data domains within the Central Repository leading to corresponding functional and non-functional requirements and presenting an overview of general rules, common processes and supportive mechanisms applicable to all domains of the EIOPA data collection and management. This approach is assisting in the permanent analysis of the processes and conversion to functional and non-functional specifications till today.

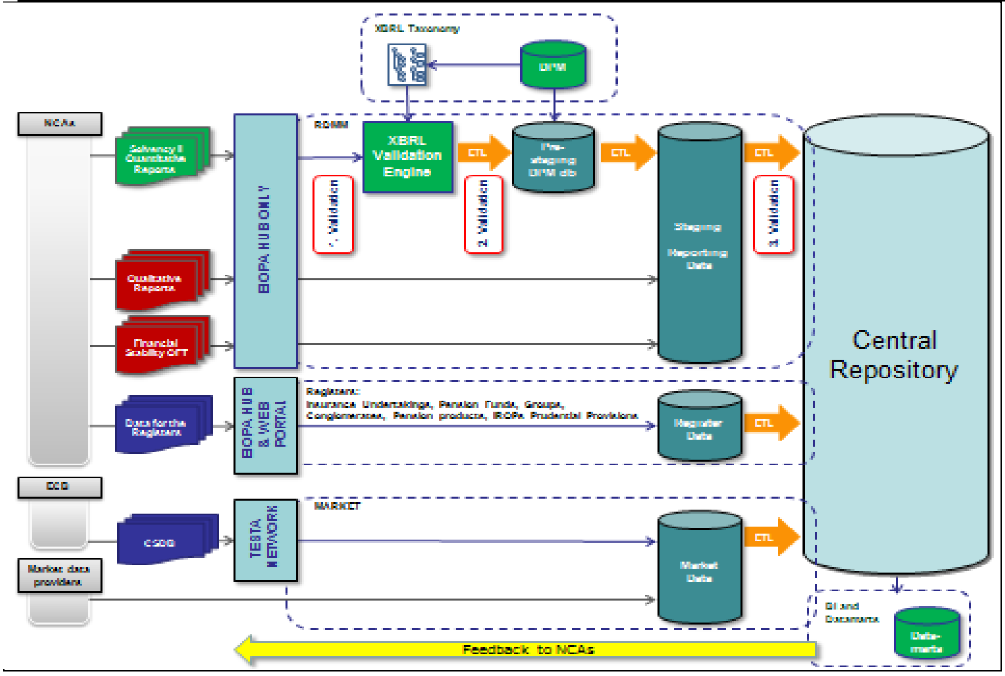
The IT & Data Strategy formulation process reviewed EIOPA's business processes map, and grouped these into the business capabilities requirement for IT & data enablement, as the following table sets out:

EIOPA business capabilities requirement for IT enablement	Table 1
Business capabilities requiring IT enablement	Description
1. Collection and dissemination of econometric data	EIOPA needs to collect econometric data (financial instrument data, consumer trend data, etc.) from a number of sources. It should need to disseminate some of this data (e.g., financial instrument data to NCAs).
2. Collection and dissemination of legal entity data relating to approved financial institutions	EIOPA needs to collect legal entity data relating to approved financial institutions, to fulfil a range of EIOPA functions from supporting the operation of the register of approved financial institutions, enable group supervision, do micro and macro prudential assessments and interventions. EIOPA should need to disseminate some of this data to NSAs that supervise groups.
3. Collection and dissemination of supervisory reporting data relating to undertakings	EIOPA needs to collect supervisory reporting data relating to undertakings from NCAs to fulfil a range of EIOPA functions from micro and macro prudential regulation to enable efficient and convergent group supervision.
4. Enable group supervision	EIOPA needs to implement functions to ensure the consistent and coherent functioning of group supervision.
5. Policy making and support	EIOPA needs to develop IT applications systems to enable the making of policy and supporting the implementation and operation of policy.
6. Operation of register of approved financial institutions	EIOPA needs to develop IT applications systems to enable the operation of register of approved financial institutions its disclosure to the public, potentially in a manner to support customised search and retrieval.
7. Macro prudential regulation (assessments, reporting and interventions) - including financial stability	EIOPA needs to undertake and report on macro prudential assessments and make related in accordance with the EIOPA mandate, enabling EIOPA to discharge its micro prudential regulatory obligations to the ESRB, European Parliament, the Council, and the Commission. This should include assessments of trends, potential risks, and vulnerabilities, as well as monitoring and assessing market developments, system risks, consumer trends.
8. Micro prudential regulation (assessments and interventions) - including financial stability	EIOPA needs to undertake micro prudential assessments and make micro prudential interventions concerning the supervision of financial institutions, in emergencies, and in cases where there is a breach of law.
9. Public disclosure	EIOPA needs to disclose certain information to the public, in order to promote transparency, simplicity, and fairness in the market. This should potentially include reporting on consumer trends, reporting on new developments and progress concerning, inter alia, intra-group transactions, risk concentration, or the behaviour of diversification and concentration effects over time.

It was decided that the Data Collection and Dissemination process requires implementation by the Central Repository, which should have the three corresponding data domains (reference data domain (registers), reporting data domain (incl. Solvency II collections), and market data domain) being supported during the whole data management cycle by collection and dissemination mechanisms and technologies automating the process.

Box 2

Central Repository logical architecture



5. Central Repository implementation

Moving to the implementation phase took place in the 2012/2013. The implementation projects (scoped into the Central Repository implementation programme) followed several phases, releasing required components of the envisaged IT architecture. The highly competent project management, dedicated business users, so the excellent IT experts' competences, were crucial for a success at this stage.

The first collections for the registers were performed in the 2013. In a course of the 2013-14 the Solvency II Preparatory Phase allowed for testing and improving of the collection mechanisms and first releases of the Central Repository. The EIOPA Guidelines mandating use of the LEI as the identifier came into force in the January 2015. In the 2015 analytical capabilities were further developed linking data collected via the Solvency II reports and cross-checking them against the Registers. In June 2016 the first regular submission of the Solvency II reports was received by the Central Repository. A few days later, an impact of the unexpected result of the BREXIT vote was analysed across the insurance sector in the EU.

Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

Eighth IFC Conference on *"Statistical implications of the new financial landscape"*

Basel, 8–9 September 2016

Breaking free of the triple coincidence in international finance[1]

Hyun Song Shin, BIS

[1] This presentation was prepared for the meeting. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the meeting.

BANK FOR INTERNATIONAL SETTLEMENTS

Breaking free of the triple coincidence in international finance

Stefan Avdjiev, Robert N McCauley and Hyun Song Shin*

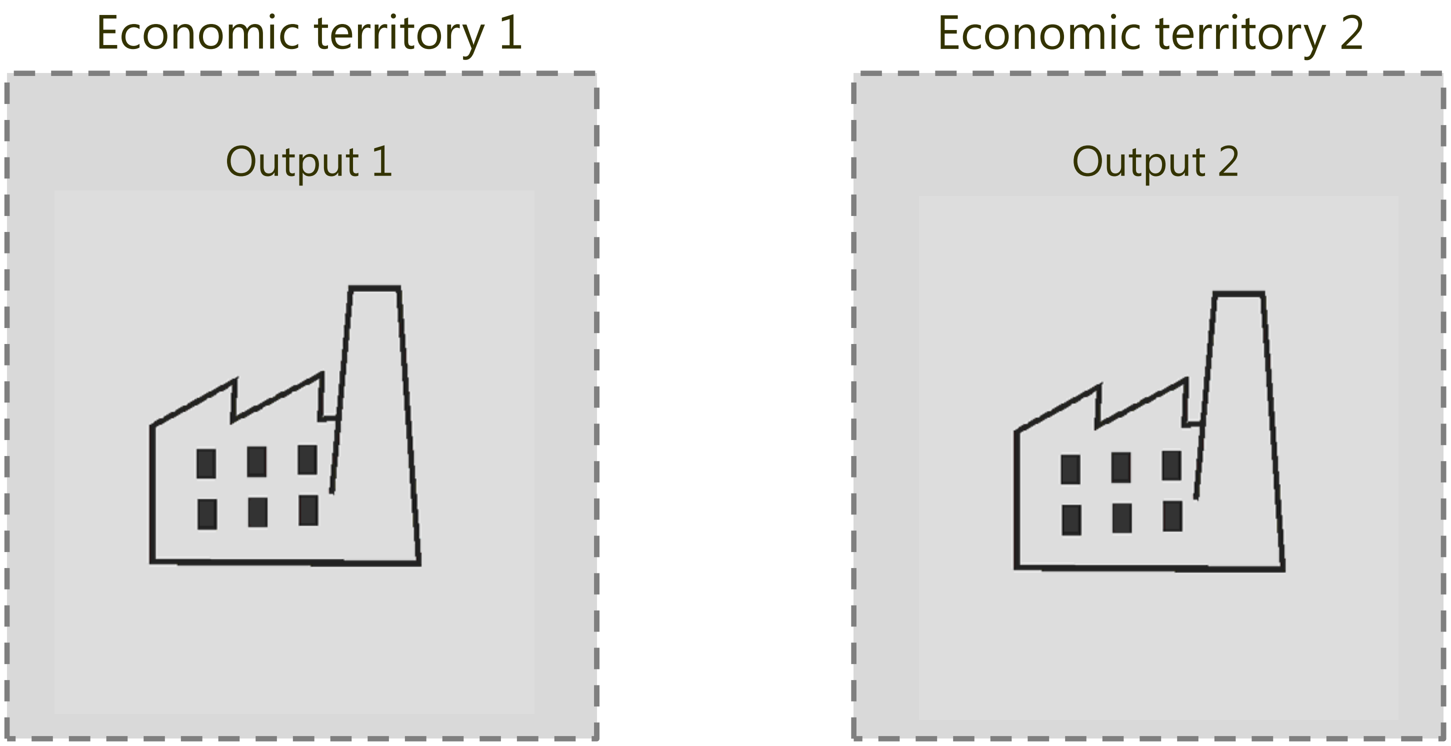
Bank for International Settlements

Panel remarks at the 8th IFC Conference

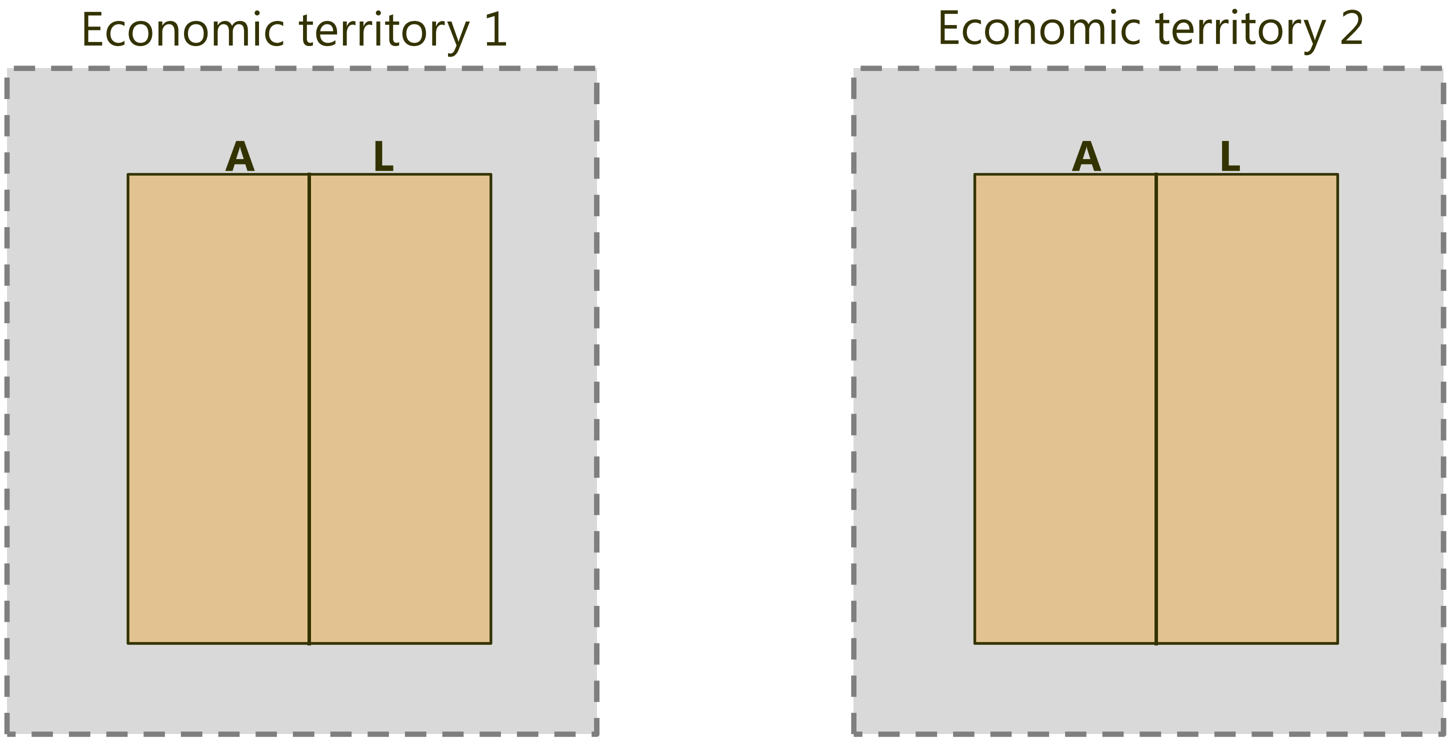
Basel, 9 September 2016

* The views expressed here are mine, not necessarily those of the Bank for International Settlements.

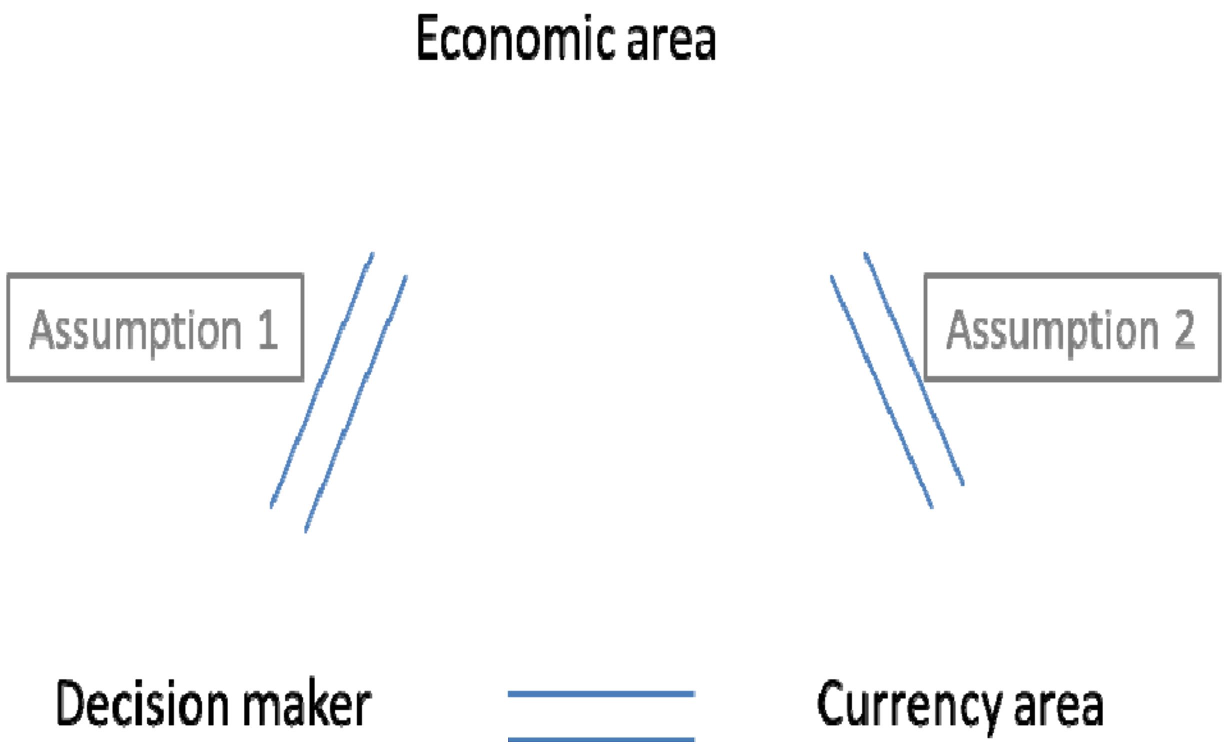
Textbook framework for international finance
Unit of analysis is national income (GDP) area



Traditional approach:
GDP boundary defines decision making unit



Triple coincidence



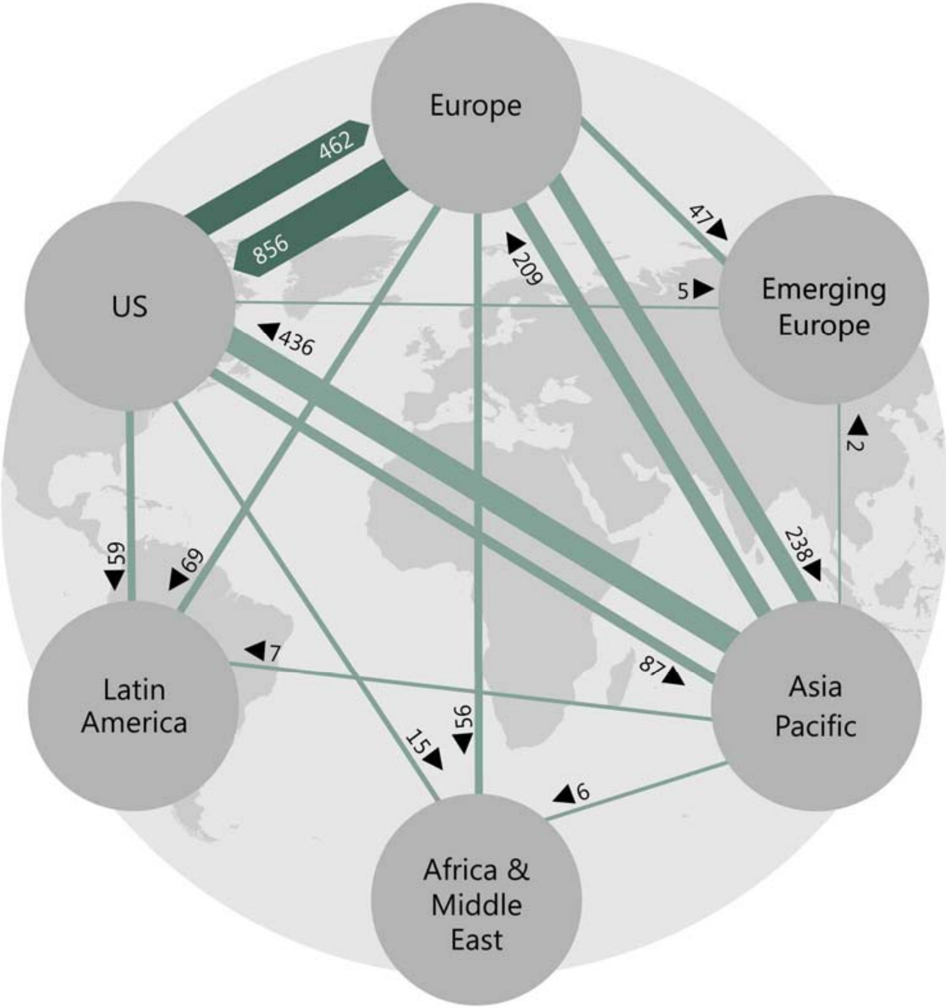
Triple coincidence can lead one stray

- Global savings glut
  - Losses from subprime were borne by European banks, not investors from current account surplus countries
- Wile E. Coyote moment for the dollar
  - Dollar appreciated with the onset of the 2008 crisis
- Korea in 2008
  - Current account surpluses and positive net external asset position
  - Yet, Korea was one of those countries hardest hit in crisis

US dollar-denominated cross-border bank claims

In billions of USD

2002

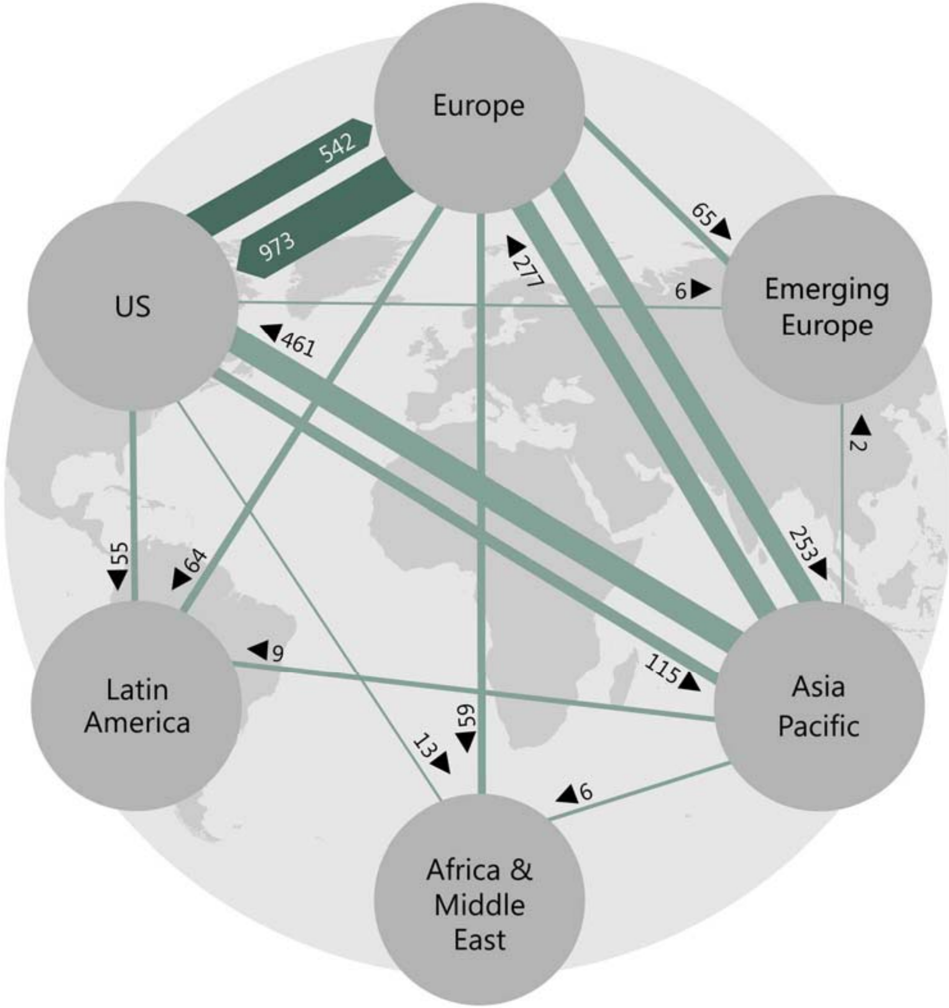


Source: BIS locational banking statistics by residence.

US dollar-denominated cross-border bank claims

In billions of USD

2003

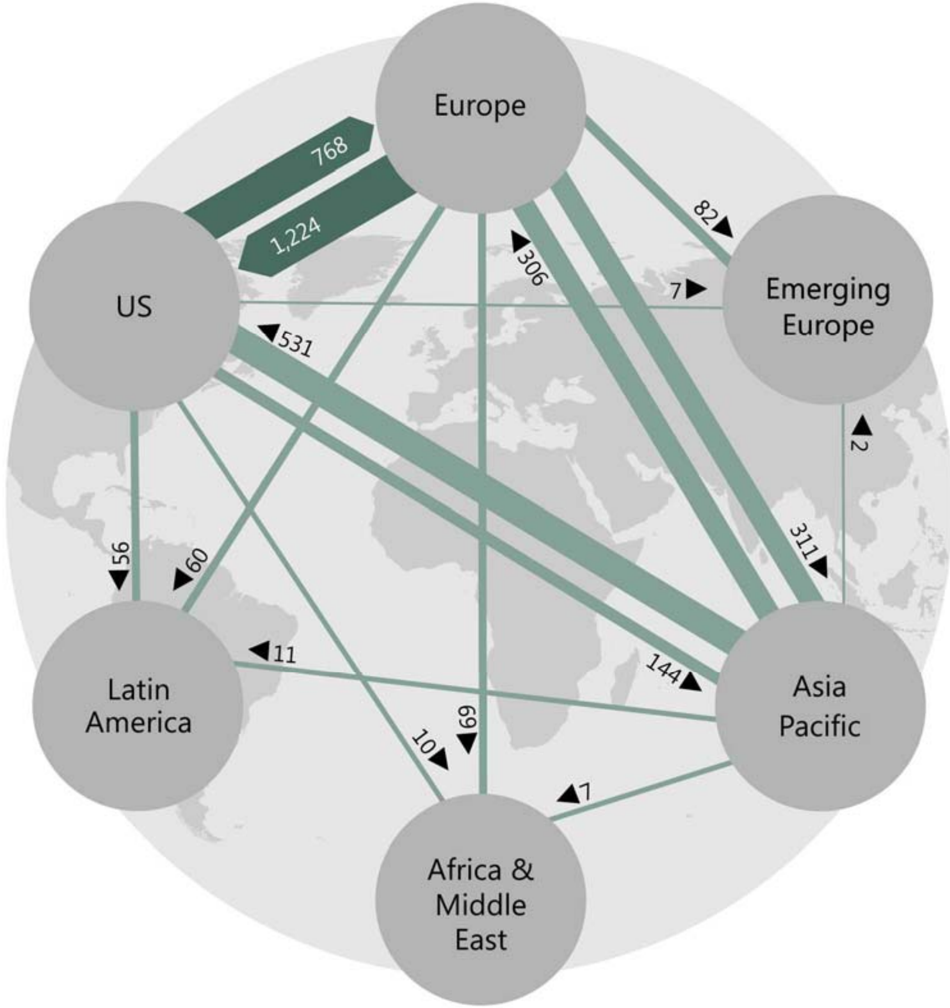


Source: BIS locational banking statistics by residence.

US dollar-denominated cross-border bank claims

In billions of USD

2004

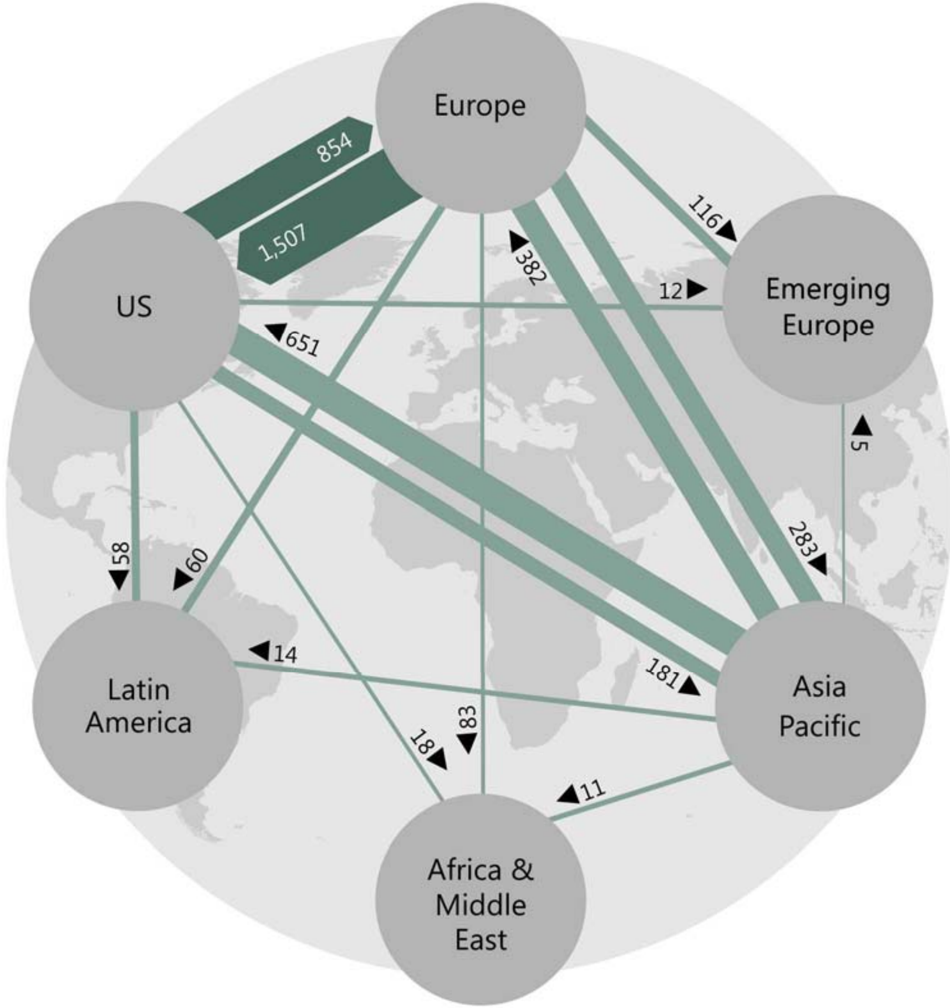


Source: BIS locational banking statistics by residence.

US dollar-denominated cross-border bank claims

In billions of USD

2005

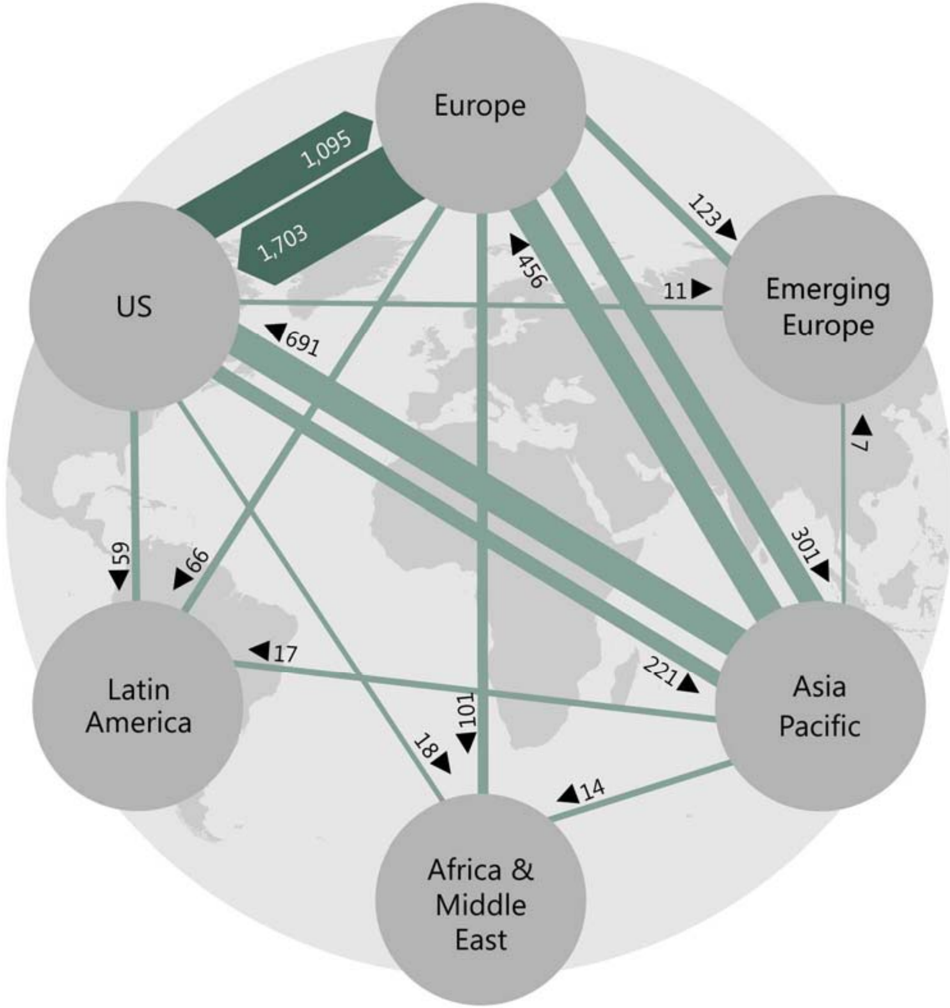


Source: BIS locational banking statistics by residence.

US dollar-denominated cross-border bank claims

In billions of USD

2006

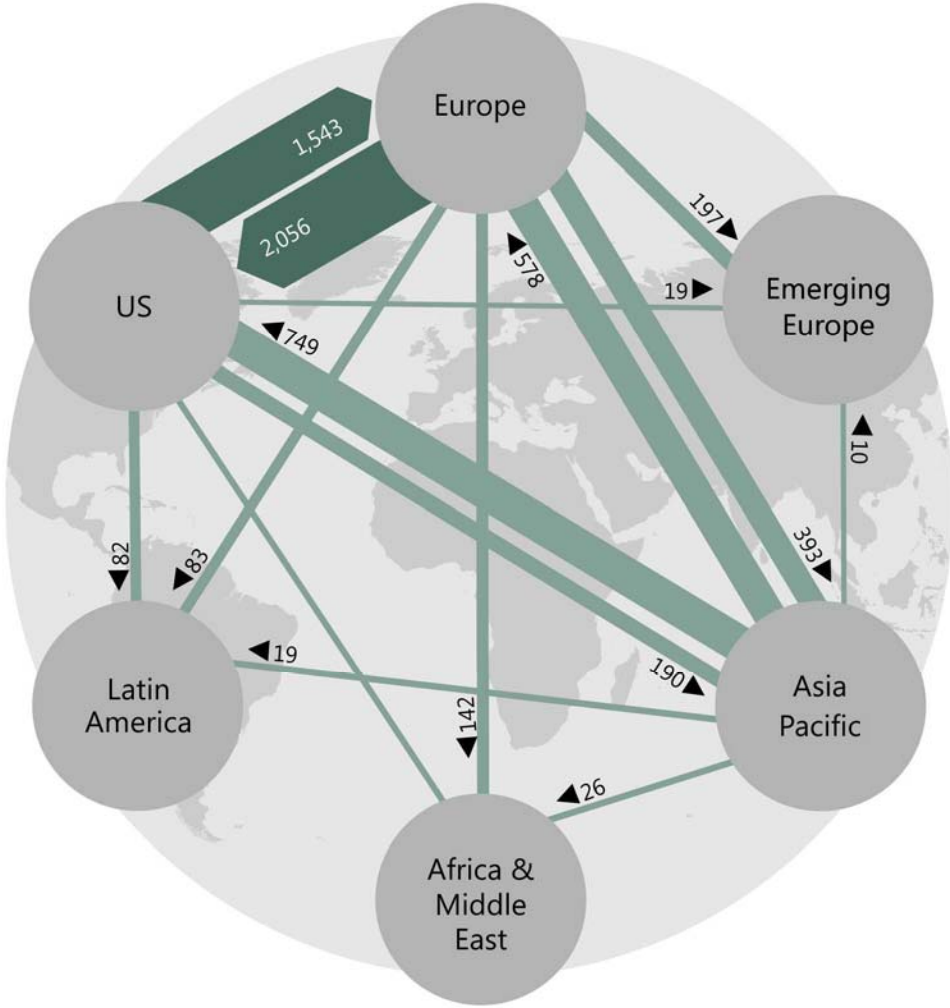


Source: BIS locational banking statistics by residence.

US dollar-denominated cross-border bank claims

In billions of USD

2007

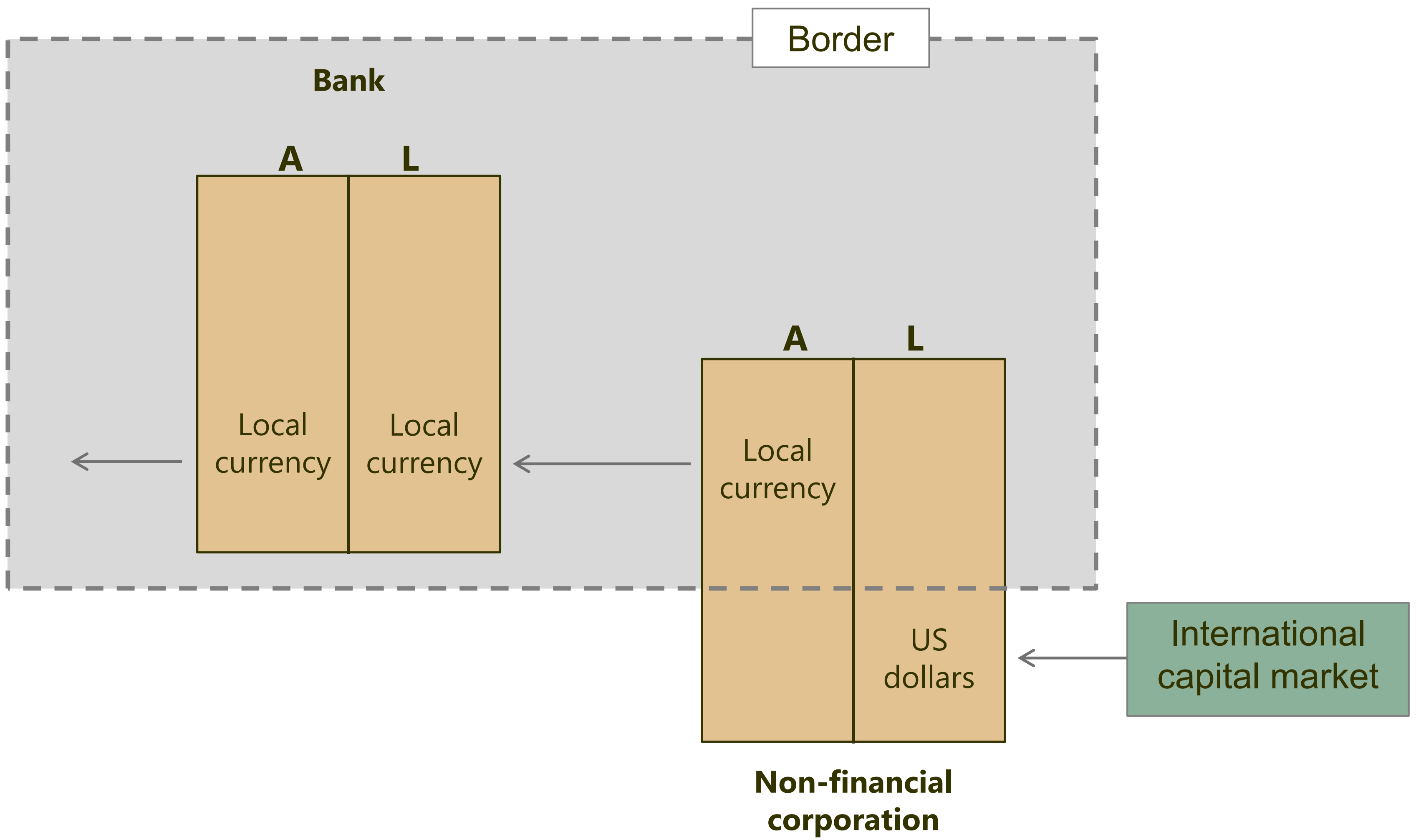


Source: BIS locational banking statistics by residence.

BANK FOR INTERNATIONAL SETTLEMENTS

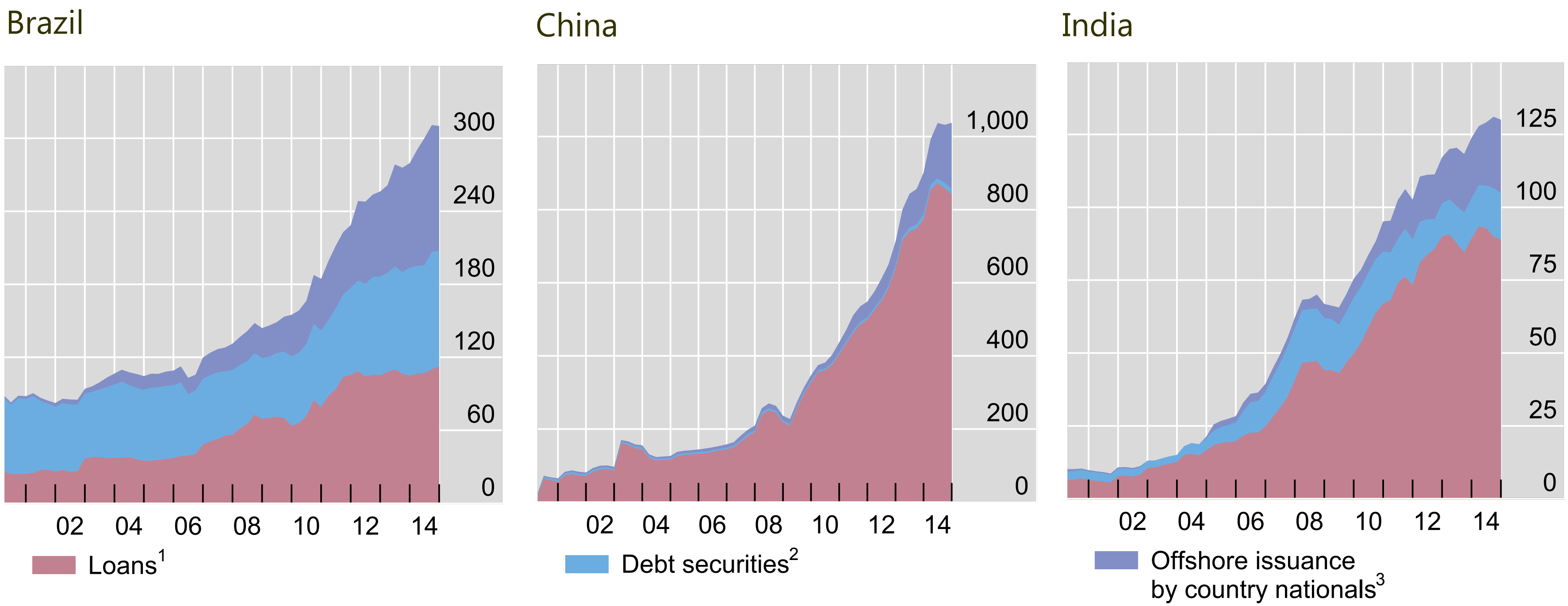
Currency denomination does not follow the national income boundary: case of non-banks

Traditional balance of payments boundary may understate "external" dollar credit



US dollar credit to non-bank borrowers including offshore issuance

In billions of US dollars



[1] US dollar-denominated loans to non-bank residents of the country listed in the panel titles. For China, locally extended US dollar loans are estimated from national data on total foreign currency loans, assuming 80% are dollar-denominated. [2] Outstanding US dollar debt securities issued by non-financial residents of the country listed in the panel title. [3] Outstanding US dollar-denominated bonds issued offshore (ie outside the country listed in the panel title) by non-financials with the nationality listed in the panel title.

Sources: BIS locational banking statistics by residency; BIS International Debt Securities Statistics; national sources; authors' calculations.

Challenges for models of international finance

- General equilibrium models are about GDP components
  - Consumption, investment, …
- But balance sheets do not always follow the GDP boundary
  - Can be messy to have two overlapping partitions of all decision makers in the world

- Some progress can be made if concern is with *global variables*
  - Global factors determining economic conditions
  - “Global liquidity”
  - Risk-taking channel