Irving Fisher Committee on Central Bank Statistics

IFC Bulletin

No 41

Combining micro and macro statistical data for financial stability analysis

Proceedings of the IFC Warsaw Workshop, 14-15 December 2015

May 2016

BANK FOR INTERNATIONAL SETTLEMENTS

Contributions in this volume were prepared for the Satellite meeting organised by the IFC in Warsaw, Poland, on 14-15 December 2015. The views expressed are those of the authors and do not necessarily reflect the views of the IFC, its members, the BIS and the institutions represented at the meeting.

This publication is available on the BIS website (www.bis.org).

ISSN 1991-7511 (online)

ISBN 978-92-9197-479-5 (online)

Proceedings of the IFC Workshop on
"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"
Warsaw, Poland, 14–15 December 2015

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Combining micro and macro data for financial stability analysis

Overview of the IFC Workshop, Warsaw, 14–15 December 2015[1]

Kaushik Jayaram[2] and Bruno Tissot[3]

Introduction

Dealing with the Great Financial Crisis (GFC) of 2007–09 and its aftermath, policymakers have increasingly focused on the need to strengthen macroprudential frameworks to ensure the stability of the financial system, both nationally and globally (Borio (2015) and Caruana (2014)). However, this does not imply that the traditional, microprudential approach to the supervision of individual financial institutions is no longer necessary[4]. Rather, it argues for the development of a more integrated approach in which both micro and macro dimensions complement each other (Bank for International Settlements (2014)).

To be sure, this requirement for a combined approach is not new and was identified long before the onset of the crisis. Over the past two decades, financial standard-setters have progressively realised the need to focus less on a purely institution-level supervisory approach and more on a broader macroprudential perspective. This shift was seen as a key building block in strengthening the resilience and stability of the financial system (Crockett (2000)).

The prerequisite for any effective policy approach is a statistical framework that allows for an effective analysis and monitoring of the micro and macro dimensions (Borio (2013)). Indeed, a key policy response after the GFC was to launch an international Data Gaps Initiative (DGI) to explore information gaps revealed by the crisis and provide appropriate proposals for strengthening data collection (International Monetary Fund and Financial Stability Board (2009)). That initiative was considered as an essential step for the support of financial stability analysis and monitoring as it would deal with both micro- and macroprudential dimensions. The first phase of the Initiative (DGI-I), launched in 2009, was followed in 2016 by a second phase (DGI-II) to implement "*the regular collection and dissemination of comparable, timely, integrated, high-quality, and standardized statistics*" with a view to helping "*straddle the divide between micro and macro analysis*" (IMF and FSB (2015)).

While significant progress is being made in terms of data collection, a key point is to make sense of the accumulated information and assess its value for policy purposes – especially in mitigating possible systemic risks. What are the issues and

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[4] The financial standard setters lay great emphasis on the ongoing progress of microprudential reforms by regular monitoring of Basel III standards (BCBS (2016)).

challenges arising from the combination of micro and macro data for financial stability analysis? What are the potential benefits for policy use? To what extent can specific country experiences benefit the global community? Looking ahead, what are the opportunities and challenges related to new financial stability policy initiatives in the area of statistics?

To explore these issues of key interest to the central banking community, the Irving Fisher Committee on Central Bank Statistics (IFC) co-organised with the Narodowy Bank Polski (Poland) (NBP) in Warsaw on 13–14 December 2015 a workshop on combining micro and macro statistical data for financial stability purposes.

As highlighted by Marek Belka, the NBP's President, in his opening remarks, this IFC initiative was a welcome opportunity to review how systemic risks in the financial system could be better assessed and managed. The analysis of fragilities should take place both at the macro level, by looking at the means of the distributions, but also at the micro level, to assess tail risks. Having well designed and well structured statistical information systems was essential to support such financial stability analyses.

In introducing the discussions, Turalay Kenç, the IFC's Chair, underlined the shortcomings of traditional financial stability frameworks that had relied primarily on institution-level supervision. He emphasised the need to combine micro and macro information. The reason is that, in the highly interconnected and complex structure of today's financial system, risks that arise at the institutional level can have system-wide dimensions. As such risks cannot necessarily be identified through aggregated data, more granular information is needed. However, combining macro and micro data is not just a matter of aggregation. What is key is a proper statistical framework that allows these two dimensions to be looked at in ways that are parallel, harmonised and complementary.

More than 25 papers were presented at the workshop, allowing for an in-depth exploration of six main themes. Session 1 took stock of the different ways of analysing financial stability that result from having a macro or a micro perspective. Session 2 described the challenges of integrating micro and macro data into an encompassing statistical framework, while Session 3 described how the micro data can be harmonised and used to close gaps in financial stability analysis. Session 4 showed, in particular, how entity-level data can help to better understand systemic risks. Session 5 focused more specifically on emerging market economies, which have gained considerable experience in this area, reflecting their specific challenges. Session 6 reviewed various ongoing international initiatives that can be instrumental in advancing much-needed new statistical frameworks. The IFC Chair, Deputy Governor of the Central Bank of the Republic of Turkey (CBRT), concluded the workshop by highlighting the key statistical priorities in the agenda of the G20, which was chaired by Turkey in 2015.

Session 1: Micro and macro views on financial stability: different perspectives of the risks affecting the financial system

The first session, chaired by Gülbin Sahinbeyoglu (CBRT), looked at different ways of analysing financial stability and the related data implications. The various presentations included a review of the new approaches to analyse financial stability

(BIS) and illustrations from various angles, eg banking resolution (Manchester University), bank profitability (NBP), and supervisory monitoring (ECB).

The BIS paper provided a bird-eye view on macroprudential policy frameworks, instruments and indicators and reviewed the associated recent literature. A key lesson from the GFC is that comprehensive frameworks of this kind can help to better monitor financial stability risks. In particular, they allow for a clearer understanding of financial cycles, as distinct from "traditional" business cycles. They can also be a useful tool for measuring the two key dimensions of systemic risk, its cross-sectional dimension (ie to how financial risk is distributed within the system at a given point in time) and its time dimension (ie how financial fragilities progressively build up over time). Lastly, they help to design, calibrate and implement adequate macroprudential tools based on the combination of micro and macro level data. Indeed, a number of ambitious macroprudential frameworks have been implemented since the GFC with the aim of (i) strengthening the resilience of the financial system and (ii) controlling financial booms and thereby the subsequent busts (see FSB (2011a)). But, while a wide array of macroprudential tools is available, their deployment involves costs and benefits. Interactions between macroprudential policy and monetary and fiscal policies as well as the overall global financial environment complicate the impact of these policies and the measurement of their effectiveness (see BIS (2015)).

The paper from the University of Manchester presented a theoretical model for examining the scope of a central bank's financial stability policy, including in particular its lender of last resort function and its regulatory function. Various courses of action are open to the central bank (eg closure of an individual bank, intervention in the interbank market, provision of liquidity assistance) depending on its financial stability objectives. How these micro-level actions impact the financial system at the macro level depends on factors such as the scale of interbank activity, general risk-taking behaviour in the banking system and the risk of system-wide distress. Therefore, central bank policy actions must take into consideration both micro level data on institutions under stress and more general macro conditions, underscoring the importance of combining these two perspectives.

The paper from the NBP examined the impact of market structure and business cycles on bank profitability. Using panel data consisting of micro- and macro-statistical data sets, the paper analysed the performance of the Polish banking system over a 15-year period spanning the GFC. Not surprisingly, a key finding was the confirmation that there was a strong correlation between micro level performance and the macro situation. For instance, the profitability of individual banks was significantly influenced by general business cycle developments; in turn, the strong performance of individual institutions played a key role in withstanding shocks to the Polish financial system during the GFC.

The session's final paper, from the ECB, discussed the conceptual and operational issues in building a comprehensive and high-quality data set building on micro supervisory sources. A key post-GFC priority for the European System of Central Banks (ESCB) has been to strengthen its macroprudential framework and, within this framework, to generate more detailed and timely information on the banking system. The related Consolidated Banking Data (CBD) has become an important data source for macroprudential analysis. It includes granular information on balance sheet data including profitability, asset quality and solvency, distributed by size classes of banks and covering nearly all of the EU's banking system. The data are consolidated on a cross-border as well as cross-sector basis. The main conceptual and operational challenges relate to deriving aggregate statistics from these micro-supervisory data, which were not designed initially for statistical reporting and were collected on a national, non-harmonised basis.

To conclude, the session's main theme was that financial stability assessments may differ significantly depending on the micro and/or macro focus of the analysis, and that it would be useful to combine these perspectives. This was emphasised by Martin Arrowsmith in his discussion remarks, drawing on recent experience at the Bank of England in combining macro and micro sources for financial stability analyses.

Session 2: New statistical frameworks for financial stability analysis: experiences and challenges for micro and macro data integration

The second session, chaired by Robert Kirchner (Deutsche Bundesbank), focused on the main challenges faced in integrating micro- and macro-level data for financial stability, both for analysing systemic risk and for designing macroprudential policy tools. The key issue is how best to capture the build-up of vulnerabilities that have a system-wide importance but arise in specific sectors of the financial system or even at the level of individual entities. Looking only at macro aggregates thus raises the risk of missing pockets of vulnerabilities in the system; moreover, a more granular analysis is often required even when vulnerabilities are detected at the macro level, not least to calibrate macroprudential tools. The session provided a good illustration of these issues, with presentations describing the challenges faced when marrying micro and macro data, in particular to diagnose household vulnerabilities (ECB/Statistics Finland), especially those related to mortgage lending (Ireland), or to implement monetary or macroprudential policy actions (ECB, NBP).

The first paper, jointly from the ECB and Statistics Finland, presented a way to assess household indebtedness by linking micro and macro balance sheet data. As observed during the GFC, assessing household balance sheets (eg debt, wealth) is of particular policy interest, due to the implications not only for the macro economy through the effects of household financial position on consumption and saving, but also from a financial stability perspective (see IFC (2015a)). Despite methodological and data limitations, the paper was able to mobilise a mixture of national accounts and survey sources to build a data set of household wealth and debt in a reliable and timely manner and at quarterly frequency. Using three measures of indebtedness – debt-to-income ratio, financial leverage ratio and leverage ratio – the paper showed how the impact of the financial crisis varied both across euro area countries and, within each country, across household groups depending on their incomes. This promising approach suggests that efforts to better integrate national accounts and survey data would yield information that could usefully illuminate the distributional impact of policy actions.

The purpose of the paper from the Bank of Ireland was also to integrate macro and micro data to better analyse the state of domestic household mortgage lending, in a post-GFC context marked by a sharp increase in delinquency and repayment arrears. To this end, aggregate quarterly data on mortgage balances published by the Bank of Ireland were combined with micro level loan data. This allowed a granular analysis of loan and borrower characteristics, since the micro data sets contained more comprehensive coverage of origination, geographic distribution, loan-to-value ratios and interest rate types. The study confirmed that the value of this type of micro-macro combination exercise lies in enabling an analysis of the underlying factors affecting mortgage arrears, thus providing a better understanding of the build-up of risks in the financial system.

The next paper, from the ECB, also emphasised the challenges faced by the "new statistical framework" when integrating macro and micro data, namely by describing the setup of a collection of regular statistics on balance sheet items and interest rates from individual monetary financial institutions (MFI) in Europe. Combined with macro monetary aggregates, these data have helped to better evaluate the effectiveness of monetary policy and its transmission mechanisms. They also support financial stability analysis. One example highlighted in the aftermath of the GFC is that assessing the situation in interbank markets or of "macro" liquidity conditions is facilitated by taking into account the heterogeneity among individual banks.

But using micro level data such as household surveys to draw inferences about macroeconomic patterns can be a methodological challenge, not least due to data limitations as well as quality issues. Yet there are a growing number of statistical techniques that can be used to address these difficulties. One example was provided by the paper from the NBP, which studied economic patterns among a sample of Polish households based on micro household budget survey data. This allowed the identification of specific household groups with similar characteristics (in terms of propensity to consume, for example), and in turn provided insights into the state of household balance sheets (eg savings, debt) at a more macro level. While the study pointed to the methodological and data challenges of such (complex) approaches, it also showed that there is a potentially quite large area to be explored looking ahead.

Certainly, the challenges in integrating micro and macro data can in turn limit the effectiveness of policy. In particular, micro household information has proved to be a key building block in developing macroprudential tools in several countries, in particular for instruments such as debt service-to-income (DSTI) and debt-to-income (DTI) limits. The last paper of the session, from the NBP, used household wealth survey data to evaluate the effectiveness of DSTI as a policy tool for restricting credit growth. It concluded that DSTI could be a blunt policy instrument that could impose costs on relatively healthy segments of the financial sector, thereby adversely affecting market conditions. The study emphasised the need for a proper statistical apparatus to ensure that the policy tool is correctly calibrated to target over-indebted or financially distressed households.

The necessity of verifying the usefulness of the micro data mobilised in the new statistical frameworks was also emphasised by Bruno Tissot (BIS) in his discussion remarks. The rising demand for more granular information, reflecting a structural shift as well as new, concrete policy needs, creates the need for an adequate framework for the integration of this information to facilitate economic analysis. To meet this requirement, the "tool kit" of micro data users should clearly identify the data foundations and provide for a comprehensive and consistent aggregation process to produce sound macro analyses. This in turn will open up new knowledge opportunities, based on more meaningful information. Using micro data within this framework can help users to think differently and to reframe policy questions.

Session 3: Closing data gaps for financial stability analysis: the importance of micro level data sources and harmonisation

The session, chaired by Pietro Franchini of the Financial Stability Board (FSB), focused on the benefits of using micro level data for financial stability analysis and closing the gaps identified by the international community after the GFC. Using different country and sector-level databases, the various papers in this session emphasised the importance of data harmonisation, in particular for internal purposes (Bank of Portugal), external users (Bundesbank) and cross-country comparisons (ECB, Netherlands Bank).

The Bank of Portugal's paper argued that closing data gaps for financial stability analysis could be achieved by a better integration of the micro databases already available either in central banks or in other public agencies. Portugal has been leading progress in this area, with the creation of an integrated statistical system among authorities, across several dimensions and policy uses. Examples of the micro databases included in this framework are the Central Credit Register (CCR), the Central Balance Sheet Database (CBSD) and the Securities Statistics Integrated Systems (SSIS), allowing for a fully integrated granular data set with credit, borrowing, balance sheets and security information.

The paper from the Deutsche Bundesbank explained how its Research Data and Service Centre allows internal and external researchers to make use of harmonised data on the domestic financial system. The Bundesbank has one of the largest repositories of micro-level data in Germany, covering banks, securities, enterprises and households. The system allows external users to access a wide range of granular statistics while preserving the confidentiality of institution-level information.

The paper from the ECB presented the Centralised Securities Database (CSDB), a key harmonised reference data set for European securities. This database integrates a variety of micro sources on a daily basis and provides useful information for analyses related to financial and monetary stability (eg the analysis of the refinancing needs of deposit-taking institutions and of their funding structures), particularly from a cross-country perspective. However some challenges remain. First, the use of the CSDB data has not yet reached its full potential for policy purposes and could be further extended. Second, there is a need to develop tools that are more user-friendly to access the large volume of micro data and generate meaningful aggregated information.

Continuing on the same theme, the paper from the Netherlands Bank used the ESCB's Securities Holding Database to analyse investor heterogeneity across countries and sectors, again underscoring the importance of harmonisation for these data. This study provides important insights into the degree, and evolution, of home bias in asset allocation and the related implications for financial stability assessments.

In his discussion remarks, Jacek Kocerka (NBP) emphasised that, in addition to the importance of collecting and harmonising micro data, attention should focus on dissemination methods. One has to shift away from the "traditional" presentation of aggregated tables and graphs and find new ways of extracting useful information from the "ocean" of micro data. This is the key challenge for statisticians and policymakers alike.

Session 4: Transforming entity-level credit information into knowledge about macro stability threats

The fourth session, chaired by Aurel Schubert (ECB), discussed how entity-level credit information can be utilised to analyse the potential development of system-wide risks. Many countries have set up CCRs under the auspices of their central banks or financial supervision offices and use them mainly for micro-level supervision, especially for credit and counterparty risk analysis. But it is also possible to use CCRs as a source of more "macro" information drawing connections between financial institutions to support the analysis of contagion across sectors and jurisdictions. The five papers presented in the session described a variety of country experiences in using entity-level data to inform a macro-level analysis of credit risks, with specific attention to vulnerabilities relating to banks (Portugal), non-banks (Poland), OTC derivatives (Ireland) and mutual funds (Japan).

The first paper, from the Bank of Portugal, described the structure and uses of the CCR maintained by the Bank's Statistics Department. In Portugal, this database supports many of the central bank's functions including monetary policy analysis, financial stability and banking supervision. The study shows that a CCR can be a powerful, multipurpose source of credit information covering all banks and other credit institutions. One example is the key inputs provided by the CCR in designing early warning indicators (EWIs) that are used to shape timely macroprudential policy interventions.

Two papers from the NBP focused on the situation of non-bank entities. The first presentation showed how the credit risks of non-bank financial companies can be assessed in Poland, drawing on multiple data sources: balance sheet and income statement databases, prudential reports of credit information, and insolvency data from a national register. This information can for, instance, be mobilised to estimate a PD (probability of default) model and to develop credit scores for non-financial corporations with the aim of gauging the sources of potential distress. The second NBP presentation looked at the determinant of banks' lending standards and the terms of loans granted to corporates and households, in particular to assess the relative importance of supply and demand factors.

Credit information is also an important element to be considered when monitoring the derivatives market, and particularly the credit default swap (CDS) market, as evidenced during the GFC. The American International Group (AIG) case shows how uncertainty about the scale of counterparty credit risk exposures and potential contagion effects can generate acute financial stress in these markets, with system-wide implications. International regulation has since tried to enhance transparency in derivatives. Of particular importance was the G20 decision on the reporting of over-the-counter (OTC) contracts to trade repositories (TRs). The paper from the Central Bank of Ireland used TR data on CDS and network analysis to identify interconnectedness among financial entities and possible contagion paths resulting from counterparty credit risk. The study highlighted the importance of accessing micro-level data to better assess the risks arising from the shadow banking sector.

An interesting aspect of credit information relates to the cross-border implications of financial stability risks. The Bank of Japan paper covered this topic by analysing the cross-border portfolio investment flows of Japan's mutual funds. Search for yield had resulted in a significant build-up of the funds' exposure to European banks, with potentially destabilising effects, although the scale of such investments is not yet systemically important. The paper emphasised the usefulness of collecting micro, fund-level level data to enhance policymakers' understanding of how investors may react to changing market conditions (particularly sharp variations in exchange rates), to assess the possible magnitude of associated "fire sales", and to spot potential sources of financial instability.

Discussing these papers, Maciej Piechocki (BearingPoint) stressed the challenges posed to the financial industry by the growing reporting requirements from public authorities since the GFC. As policymakers and supervisors seek a more timely risk assessment on an entity-by-entity basis as well as at systemic level, a move away from "traditional" template-based aggregated reporting structures will be required. The use of new standards for automatic data reporting (eg XBRL, SDMX)[5], as well as new approaches such as disaggregated cube-based data reporting will be needed. The potential benefits will include limiting the reporting burden for the industry while improving the transparency of the data collected.

Session 5: The experience of emerging market statistical institutions in combining micro- and macro-level data: different approaches, a common goal

The fifth session focused on practices and challenges encountered by emerging market countries in combining micro and macro data, with a specific focus on the experiences of Chile, Indonesia, Malaysia, Poland and Turkey. As highlighted in the opening remarks of the Chair, Masahiro Higo (Bank of Japan), such experiences were particularly enlightening with regard to (i) the type of granular data (information on debtors, lenders, market segments, regulations) that are essential for analysing financial stability, (ii) how micro databases (eg CCRs) can contribute to the improvement of these statistics and (iii) what was required in terms of statistical cooperation.

The Central Bank of Chile presented a model for assessing mortgage default risk. It relies on the combination of aggregated macro data on loans and prices with micro data from the Chilean Survey of Household Finance. The study found that both system-wide (macro) features and idiosyncratic (micro) factors provide value when assessing the possibility of defaults, and that this value is even greater when one takes into consideration the interaction between these two types of information. This suggests that financial regulators could play an important role in communicating general financial and market conditions that could influence individual lending and borrowing decisions.

The paper from the NBP described the dynamics of the Polish housing market with a focus on demand, supply and prices. In a relatively small economy, housing market conditions can have a large influence on the macro economy; for instance, small changes in interest rates can affect the dynamics of housing supply and demand and potentially cause large shocks in the real economy. The paper showed that micro and macro data could be usefully combined to estimate a forecasting model and help

[5] For issues related to standards such as XBRL (eXtensible Business Reporting Language) and SDMX (Statistical Data and Metadata eXchange), see IFC (2016).

the central bank to anticipate potential developments in the real estate market and their possible financial stability consequences.

The paper from the CBRT used firm-level data to assess the risks posed by the forex liabilities of non-financial Turkish firms. The study analysed the factors driving firms' decisions to issue FX denominated debt (eg exchange rate prospects) and the associated risks in the absence of hedging. One conclusion was that non-exporting firms may be vulnerable to significant losses due to unexpected exchange rate movements, but this would have a limited financial stability impact unless the aggregate size of such debts grows substantially.

The next two papers in the session, from the Bank of Indonesia and the Bank of Malaysia, focused on the development of internal statistical systems that combine micro and macro data. The Indonesian Financial System Statistics (SSKI) comprises firm-level data covering the full range of the financial system, including the banking sector and other financial corporations as well as money markets. This information is combined with various macro aggregates, eg on household finances, government debt, real estate and non-financial corporations. In addition, the SSKI also includes payment and settlement statistics as well as financial inclusion indicators, making it a comprehensive system for supporting the various aspects of financial stability analyses. At the Central Bank of Malaysia, for which macro financial surveillance is a key mandate, granular credit information on financial and non-financial firms as well as households is used to support macroprudential analyses and policies. The related challenges include the management of data gaps, timeliness and quality. The Bank is therefore moving towards an integrated solution to support effective and timely data collection, storage and dissemination.

Discussing the presentations, Laura Vajanne (Bank of Finland) recalled that, for proper macroprudential policymaking, aggregate data were not enough: what was needed was micro-level data and their linkages within a macro framework. She stressed the importance of emerging market countries' long experience in using macroprudential tools. One key lesson was the need to devote attention to specific pockets of risk, such as real estate markets, foreign currency loans etc. Another was that data are often of insufficient quality, as they are gathered for non-statistical purposes, from a large number of sources, and with a wide range of techniques and formats. Last, she emphasised the need for coordination, both within central banks and with other authorities, to be able to get the best out of the existing micro databases. That puts a premium on addressing existing restrictions on data-sharing between competent organisations (IFC (2015b)).

Session 6: Intensifying cooperation between national and international institutions: from a national perspective to the global financial system

The workshop's final session, chaired by Eugeniusz Gatnar (NBP), covered the broader role of international cooperation in closing financial stability data gaps, both for specific areas such as debt securities (Spain), shadow bank and derivatives (ECB), and more generally to make the most of available micro data (BIS).

First, international cooperation can help the integration of domestic and foreign data. An interesting exercise, presented by the Bank of Spain, was the matching of firm-level characteristics with information derived from international issuance in bond markets. The aim was to assess the underlying credit risk of international issuers –

including when they issue though their non-resident affiliates – by constructing a database containing both international debt issuance information (derived from the international debt securities collected by the BIS) and firm-level data from commercial sources.

Second, there is a need to access granular information covering cross-border activities. The shadow banking sector is a case in point from this perspective, as discussed in the first ECB presentation, which highlighted key related measurement issues. Shadow banking activities cannot easily be captured either through the usual prudential reporting framework or the traditional System of National Accounts – the subsector "non-monetary financial intermediaries" can provide only a very rough estimate of the broad trends in the credit intermediation performed outside the regular banking system. Moreover, there are severe limitations in capturing the cross-border dimension of shadow banking, which can obscure the risks emanating from these entities. The way forward, as already envisaged by the international statistical community, particularly in the context of the DGI, was to integrate aggregate "SNA-type" information with more granular data, with the aim of more accurately capturing the scale of shadow banks and their activities. Cross-border issues are also particularly important with regard to the reporting of derivatives transactions by TRs, as analysed in the second ECB presentation. It is challenging for regulators to analyse these data, which are often heterogeneous and collected in a non-standardised framework. Certainly, clear and detailed reporting guidelines and appropriate data quality checks are being introduced in the European Union, but further international cooperation is needed to develop meaningful global data aggregation frameworks. Lastly, the daily reporting of these transactions is posing enormous challenges given the size and complexity of the information collected.[6]

Third, ongoing initiatives by the international community to close the data gaps exposed by the GFC at the global level are proving a key opportunity to make progress on the better integration of micro information into financial stability frameworks. Indeed, many of the G20-endorsed DGI recommendations have a significant micro data dimension. The BIS paper highlighted five key achievements that could be expected from these international efforts: (i) the comprehensive collection of "pure" micro information that is macro-relevant (eg for systemic banks); (ii) the better assessment of the distribution – the "fourth data dimension" – of macro aggregates (eg identification of fat tails); (iii) the improvement of the quality of macro statistics brought about by a better use of micro information (eg production of integrated sectoral financial accounts); (iv) the greater reliance on evidence-based (micro) information when designing, assessing and reviewing public policies (eg Quantitative Impact Studies supporting financial regulation); and (v) the new frontier for economic thinking that is opened up by access to granular data (eg ongoing BIS work to complement (SNA-type) residency-based statistics with nationality-based information to better capture the activities of global corporations).[7]

Wrapping up the session, Pietro Franchini (FSB) recalled the key FSB-led initiatives to intensify statistical cooperation between national and international institutions. Moving on from a national to a global perspective, the main data needs are to assess the structure and interconnections in the global financial system; analyse

[6] On the general issue of big data and central banks' activities in this area, see IFC (2015c).

[7] See Inter-Agency Group on Economic and Financial Statistics (2015).

risk concentrations and funding dependencies; identify spillovers and externalities; and better understand financial innovation and market complexities (FSB (2011b)). To this end, it was essential to develop an integrated framework of micro and macro financial data that are standardised, transparent and globally consistent.

Concluding remarks

In his concluding remarks, Turalay Kenç commended the workshop in presenting ways to combine micro and macro information and integrate them into a comprehensive financial stability framework. He acknowledged that this posed a number of challenges, as highlighted in the various papers presented. But the valuable lessons of these country examples – particularly those from emerging market economies with significant experience in macroprudential policies – suggested that these issues could be addressed effectively.

Another lesson from the workshop was the importance of international cooperation and the progress made in addressing the lacunae in statistical systems and processes. The IFC Chair highlighted the work done under the G20 DGI. He recalled that the implementation of most of the initial recommendations set in 2009 had now been completed. The focus of the second phase developed under Turkey's G20 presidency in 2015 was now to compile and disseminate comparable, accurate, timely and increasingly consistent data. The range of recommendations is broadly comparable with the first phase of the DGI and is expected to be completed on a five-year horizon. The Inter-Agency Group on Economic and Financial Statistics (IAG) has been tasked with coordinating and monitoring the implementation of these recommendations. As the IAG includes the BIS and the ECB, this will mean that the central banking community will be closely involved in this endeavour.

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IFC Workshop on "Combining micro and macro statistical data for financial stability analysis"
Warsaw, 14–15 December 2015

Opening remarks by Turalay Kenç, IFC Chair and Deputy Governor, Central Bank of the Republic of Turkey

Micro and macro views on financial stability

Good morning, ladies and gentlemen

Welcome to the IFC Workshop on "Combining micro and macro statistical data for financial stability analysis". On behalf of the Irving Fisher Committee on Central Bank Statistics (IFC), I would like to thank the Narodowy Bank Polski (Poland) for organising and hosting this event. There are almost 100 participants with us today from all over the world, and I would like to extend my appreciation to all of those – IFC Executives and members, distinguished guests, speakers and participants – who are contributing to this important workshop.

About the recent financial crisis

The Great Financial Crisis of 2007–09 revealed the insufficiency of a financial stability policy based solely on the combination of microprudential bank regulation and the limitation of the central bank's role to price stability. Hence the first lesson of the crisis was the importance of a system-wide approach when thinking about regulation and supervision. This systemic orientation should focus on interconnectedness and spillovers, at any given point in time, and over time, because of the procyclicality of the financial system. In other words, the systemic focus of policymakers should be on the cross-sectional as well as the time dimension of the build-up of financial fragilities in the system.

Second lesson: the old-fashioned assumption that there are specific sectors specialised in lending to distinct borrowing sectors is not relevant anymore. Most financial institutions now act as both lenders and borrowers, and today's financial architecture consists of a complex network of financial exposures and liabilities. This differs from the "classical banking system" traditionally based on the originate-to-hold model: in the current system it is the originate-to-distribute model, in which banks can resell loans via securitisation.

Third lesson: this new banking model has also spurred the growth of financial intermediation outside the banking system itself, with the larger role being played by the unregulated "shadow banking" system. This unregulated area has led to an increasingly opaque network of interconnected financial relationships across a wide range of institutions, markets and instruments. At the micro level, the new developments may well be seen as innovations that facilitate the functioning of the financial system. But on a more macro level, they create new financial stability risks due to the lack of adequate regulation and increasing maturity and liquidity transformation.

Financial contagion, regulation and systemic risk: micro and macro aspects are intertwined

The complex and highly interconnected structure of our new financial system means that financial stability risk can materialise at both a micro and a macro level. At the micro level, there is now a broad recognition of the need to properly monitor those "too big to fail" actors like major financial institutions that take too much risk for themselves which can spill over to the rest of the system. There is still a role to play for the prudential regulation developed over the past few decades for "traditional" banking systems. This micro approach can be a useful tool to prevent the "idiosyncratic risk" of failure of individual institutions, especially those that are deemed as being of systemic importance.

However, the importance of the role of interconnectedness and of counterparty credit risk in channelling stress into the entire financial system means that the authorities should also take a macro approach in regulation and supervision. Here the focus should be more on preventing "systemic risk" from building up. This macro view means focusing more on system-wide concerns on top of the sole protection of depositors in banks.

How should we balance the need for prudential supervision at the level of individual institutions and the new macro focus on financial risks? Obviously we must develop adequate analytical frameworks that take into account the entire financial system. We must also set up new macroprudential regulations and policy tools to increase the resilience of the financial system.

I welcome the opportunity today to reflect on these new and more comprehensive datasets and indicators, which are needed to deal with these issues.

New statistical frameworks for financial stability analysis

The need for more comprehensive datasets

The recent financial crisis showed us that conducting financial stability policy is more an art than a rule-driven exercise. This means that authorities must have the flexibility to adapt to emerging, unexpected issues as events unfold.

This flexibility is also required on the data front. More comprehensive datasets and indicators are needed for the systemic understanding of the financial system. While traditional, microfinancial approaches were based on granular, individual information at a point in time, we need to look deeper to assess fragilities. To capture "fat tails" and be prepared for "black swan" events, we must look at a wide range of macroeconomic, monetary and financial statistics. This is the only way to understand complex, unexpected spillover effects across the financial system. And we need to conduct this assessment over time, to spot the progressive build-up of vulnerabilities that can at the beginning go unnoticed. To this end, national authorities – and here central banks have a key role to play – are developing adequate frameworks to integrate granular data into a macro perspective.

The experience of Turkey in combining micro- and macro-level data

What is the Turkish experience in this area? A key initiative we took was designing a macroprudential policies dataset on aggregate leverage and maturity mismatches. As a first step, we decided initially to monitor the speed of loan growth, which has become a key reference for macro policy objectives. At a later stage, though, it became clear to us that financial intermediation was shifting away to a certain degree from the domestic banking sector to global financial markets. This required the monitoring of non-financial corporations' cross-border exposures as a result. The foreign exchange risk of those non-financial corporations was tasked to the Central Bank of the Republic of Turkey, which set up a comprehensive micro and macro data integrated statistical framework. The macro layer comprises foreign exchange assets and liabilities of Turkish companies based on national aggregates. The micro layer is based on the central bank's Company Accounts publication and the database of the Risk Center at the Banks Association of Turkey, in which one can integrate micro-level evidence on the degree of liability dollarisation and company specifics, and thereby of the currency risk embedded in the Turkish corporate sector.

This integrated framework has proved to be instrumental in understanding the transmission of institution-level fragilities to macrofinancial stability risks. Non-financial companies in Turkey have, on aggregate, a significant amount of foreign currency-denominated debt, with a substantial short position in foreign currency which is often perceived as a source of currency risk or vulnerability by market participants. The firm-level dataset helped us to dig deeper into the numbers. Long story short, our work helped us to identify better the currency risk of non-financial companies through a firm-level analysis. In particular, we observe that the currency risk of non-financial firms in Turkey might be lower than what macro aggregates have implied.

Looking ahead, we are investing in a high-quality micro-macro framework to capture household finances. Our plan is to generate a nationally representative micro-level panel dataset including information on families' balance sheets, pensions, income and demographic characteristics. The information from these two datasets will strengthen our analysis capacity and deepen our understanding of macroprudential policy transmission mechanisms.

The importance of international cooperation – the G20 Data Gaps Initiative

However, we should not forget that the financial system is global. The last financial crisis showed the importance of cross-border linkages in today's closely integrated economies. The need for monitoring and managing the build-up of financial stability risks underscores the importance of having available and comparable information across countries. It also puts a premium on international cooperation, which is indeed improving markedly. Our presence here today, in a workshop involving central banks from all over the world, is evidence of this progress.

Let me finish my opening remarks by highlighting the sheer importance of the G20 Data Gaps Initiative in this context. The starting point was the realisation that, while the crisis was not due to the lack of statistical information, there were important data gaps that needed to be addressed to prevent or at least mitigate the next financial crisis. Taking the lessons of the crisis to enhance our statistical apparatus is not a new idea. This was exactly what our predecessors did in the 1930s, as they developed GDP measures and national income accounts in order to better analyse economic upturns and downturns including events like the Great Depression. Likewise, the data gaps initiative is calling for new statistical requirements, mostly, but not only, focusing on the financial sector. G20 economies and international organisations are working in close cooperation to close these data gaps, which will help us to have a more comprehensive and accurate picture of the global economic and financial system. And this enhanced statistical information framework will be based on better integration between the micro and the macro perspectives.

Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Macroprudential policy frameworks, instruments and indicators: a review[1]

Blaise Gadanecz and Kaushik Jayaram,
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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 or the central banks and other institutions represented at the meeting.

Macroprudential policy frameworks, instruments and indicators: a review[1]

Blaise Gadanecz[2] and Kaushik Jayaram[3]

Abstract

This paper reviews the recent literature on various aspects of macroprudential policymaking, covering: the use of indicators to guide such policies; policy tools and implementation; assessment of the effectiveness of the policies. In the light of the Great Financial Crisis, four key lessons emerge. Firstly, there is a clear need to put in place macroprudential frameworks. Secondly, measuring financial instability conditions requires a better understanding of financial cycle dynamics. More work is needed to model the empirical properties of the financial cycle. Capturing the interactions between systemic risk, market dynamics and policy choices, as well as spillovers is an area of policy where theoretical and empirical analysis can be developed further. These features also need to be considered when assessing the costs and benefits of macroprudential measures. Thirdly, macroprudential tools are too focused on banks. Changing patterns of financial intermediation call for greater attention to the actions of nonbank players. Lastly, quantitative models combining micro- and macro-level data are required to analyse and calibrate macroprudential tools deployed, and to gauge their effectiveness.

Keywords: macroprudential policy, financial cycles, measuring systemic risk, micro and macro data

JEL classification: G15, G18, G21, G23, G28

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1. Introduction

A key lesson from the Great Financial Crisis is the need to put in place macroprudential frameworks, a view that the Bank for International Settlements had been advocating for many years (Clement (2010)). Macroprudential policies are a key component of the post-crisis framework for financial stability (Borio (2014a)). The aim of this paper is to review the more recent literature on this subject, particularly the work done at the BIS.

The macroprudential policy framework comprises a broad range of policy instruments supported by appropriate institutional arrangements governing their implementation (IMF (2011)). Macroprudential policies focus on the system as a whole rather than its individual components (Crockett (2000), Borio (2003)). Crucially, the effectiveness of macroprudential policies depends on an ongoing assessment of financial conditions, particularly of the build-up of system-wide risks.

While there is no clear consensus on what is precisely meant by macroprudential policy or how it differs from other prudential polices, it is commonly recognised that its principal purpose is to limit systemic or system-wide financial risk (CGFS (2010, 2012); McDonald (2015)). More specifically, macroprudential policies have two main objectives: to strengthen the resilience of the financial system, and to actively limit the build-up of systemic financial risks. Macroprudential policies focus on the interaction between the financial institutions, markets, infrastructure and the wider economy. For example, one objective of these policies would be to encourage the build-up of countercyclical capital buffers in boom times with a view to strengthen bank's defences against the build-up of system vulnerabilities. These buffers would be used to limit losses incurred by banks or other financial system participants in downturns. Another goal of macroprudential policymaking would be to ensure that large, systemically important institutions are subject to more stringent prudential requirements and supervision than smaller players as the potential failure of such institutions would have serious consequences to the financial system and the economy as a whole.

While macroprudential policies are distinct from day-to-day risk management, many macroprudential tools are in effect microprudential instruments deployed with a systemic perspective in mind (BIS (2010)). Depending on the type of vulnerabilities that need addressing, policy tools can be targeted at banks' capital requirements (countercyclical buffers, dynamic provisions, sectoral capital requirements), their liquidity (countercyclical requirements), or the asset side of their balance sheet (loan-to-value and debt-to-income ratios). Some liquidity-based instruments, such as haircuts and margins, can also be applied to specific markets.

Being preventative in origin, macroprudential policies need to be distinguished from crisis management and resolution policies (IMF (2013)). They are also distinct from capital flow management policies, even though many emerging market economies have resorted to them in the past decade for macroprudential purposes.[4]

[4] The idea is to avoid the build-up of vulnerabilities arising from large capital inflows: see Bruno, Shim and Shin (2015).

A key difference from other policies (monetary or prudential) is that macroprudential policy is aimed at specific sectors or practices[5] whereas other policies are typically applied uniformly across the system (Shin (2015)).

This paper takes stock of the recent literature on various aspects of macroprudential policymaking, covering: the use of indicators to guide such policies; policy tools and implementation; assessment of the effectiveness of the policies. The paper is structured as follows. Section 2 discusses the concept of financial cycles and their role in the measurement of systemic risk. Section 3 reviews the types of indicators that can be useful for guiding macroprudential policy intervention, and the desirable properties of such indicators. Section 4 focuses on the choice of macroprudential instruments, based on specific vulnerabilities and policy objectives while section 5 examines the options for the setting and timing of macroprudential policy interventions. Section 6 discusses how macroprudential policy relates to monetary policy. Section 7 offers ways to assess the effectiveness of policy interventions. Section 8 discusses the need for marrying micro- and macro-level data for macroprudential analysis and policymaking. Section 9 concludes.

2. Financial cycles and financial stability

The measurement of financial (in)stability is "fuzzy" at best of times, more so when attempting to measure the build-up of financial risks ex-ante. Nevertheless, this is a key challenge in attempting to model financial instability conditions. Recent studies particularly in the BIS suggest that understanding the characteristics of financial cycles is key to measure the build-up of instability conditions in the financial system While analytical perspectives differ on whether the conditions are driven by fundamentals or are endogenous to the financial cycles (with added impetus through exogenous shock amplifications), two common approaches can be discerned.[6] The first one analyses how aggregate risk is endogenous with respect to the collective behaviour of economic agents. The second one dwells on the amplification of risks due to a number of reasons, eg information asymmetry, herding behaviour, leverage, cross-border exposures. More broadly, this approach puts emphasis on the distinction between individual (rational) actions versus collectively desirable (welfare enhancing) actions. Irrespective of the source of conditions that generate instability, policy analysts generally agree on a need for an operational framework that strengthens the robustness of the financial system to shocks. Since such a framework must necessarily be systemic in orientation, identification and monitoring of systemic risks in the financial system is key.

Underlying these perspectives is the growing recognition that a pure business cycle approach to individual economies and the global economy cannot fully account for the interaction of financial variables and output. Financial cycles are seen as a more promising line of enquiry to assessing the interactions and joint fluctuations of

[5] In some cases, instruments such as LTVs may be used to limit credit surges in property markets. The policy to encourage the build-up of countercyclical capital buffers in systemically important banks would be another example.

[6] The discussions in this section is mainly based on the work done at the BIS (eg Borio and Drehmann (2009), Drehmann et al (2012), BIS Annual Report (2014)).

a wide set of financial variables including quantities and prices. Credit aggregates encapsulating leverage and asset prices (including importantly property prices) play a significant role in this regard. Mutually reinforcing interaction between financing constraints and perception of value and risks are at source of conditions leading to financial distress.

Research at the BIS suggests four broad features that characterise financial cycles.[7] First, financial cycles are much longer than business cycles. Therefore a longer-term view is required. Second, peaks in financial cycles coincide with banking crises or serious financial distress. Financial booms with mutually reinforcing rapid credit growth, surging asset prices often coupled with accommodative monetary and financial conditions leave the system vulnerable so that relatively modest shocks to particular sectors are often amplified into system wide shocks. Third, financial cycles are synchronised across economies. Mobile external capital and liquidity conditions tend to amplify movements in credit aggregates within an economy, but monetary conditions also have a strong cross-border spillover effect. Fourth, financial cycles are more useful to detect risks of financial distress with a good lead time. It is possible to measure the build-up of systemic financial risks in real time with a reasonable level of accuracy8.

Graph 1 shows the length of the US financial cycle and its coincidence with episodes of distress.[9] A key point to note is that the length and duration of financial cycles have increased over time and in amplitude.

Financial cycles change with the macroeconomic environment and policy frameworks. They have grown in length and amplitude in the past few decades, reflecting liberalised financial systems and a relatively prolonged period of stable macroeconomic environment and monetary policy framework. The regulatory changes and macroprudential policy frameworks emerging in the period after the financial crisis could similarly affect the dynamics of the financial cycles in the future. A key inference from the analysis is that policy interventions that focus on business cycles may result in potentially serious financial dislocation over the medium term, as the build-up of financial imbalances continues unchecked while policy corrections attempt to address short-term macroeconomic conditions. Complacency about the financial system is further underscored by the so-called "paradox of financial stability", that the financial conditions appear most benign just before the onset of a major crisis.

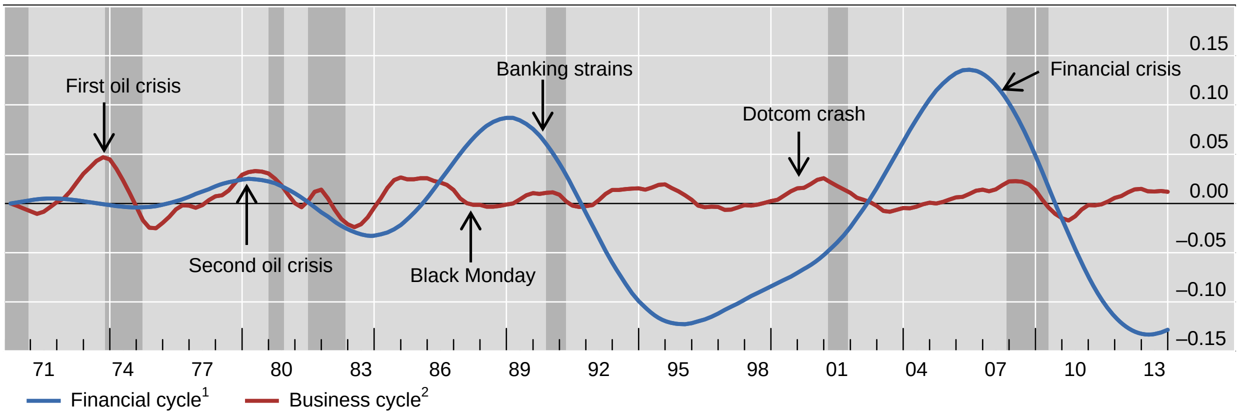
7 Two main approaches exist to measure financial cycles BIS ((2014)). The first one, based on inflection point analysis, assigns peaks and troughs in the cycle to moments when the growth rate of several variables changes direction. Economic production, consumption and unemployment are commonly used variables to identify economic cycles based on this methodology. Turnarounds in real credit growth, credit-to-GDP, and real house prices have been identified as correctly depicting turns in the financial cycle. The second approach relies on statistical filtering of economic or financial series, at the appropriate frequency.

8 See Borio (2012) for an extensive discussion of financial cycles and macroeconomics.

9 Similar results were obtained for a large range of countries (see 84th BIS Annual Report (2014), pp 65-67).

The financial and business cycles in the United States

Graph 1



[1] The financial cycle as measured by frequency-based (bandpass) filters capturing medium-term cycles in real credit, the credit-to-GDP ratio and real house prices. [2] The business cycle as measured by a frequency-based (bandpass) filter capturing fluctuations in real GDP over a period from one to eight years.

Source: M Drehmann, C Borio and K Tsatsaronis (2012) and 84th BIS Annual Report (2014).

In view of the foregoing, it is more important for policy makers to focus on the medium-term financial cycles whose peaks tend to coincide with the financial crisis or severe financial and macroeconomic disruptions (Drehmann, Borio, Tsatsaronis (2012), Hakkarainen (2015)). One could complement this with traditional output gap estimates enhanced with proxies for the financial cycle (Borio, Disyatat and Juselius (2014)).

Developing an effective macroprudential policy framework therefore requires identifying and monitoring the sources of system-wide financial risks in terms of their locus on the financial cycle and the amplitude of the cycle. The indicators that capture the financial cycle as well as their limitations are discussed in the next section.

3. Measuring systemic risk

Prudential regulations, the so called "microprudential approach", tend to target individual institutions or components of the system on a standalone basis, regardless of the institution's impact on the financial system as a whole. Moreover, they tend to apply the standards uniformly across all institutions in the financial system irrespective of the conditions prevailing at any given point in time. In effect, the microprudential approach assumes that the sources of risk are exogenous and independent of the collective impact of the interactions between individual institutions. Moreover, prudential guidelines often apply to regulated entities and do not cover a large number of financial entities in the systems. By contrast, macroprudential policy aims to address the drawbacks of the microprudential approach by focusing on the system as a whole. In other words, a macroprudential policy framework would simultaneously look at the "cross-sectional" as well as the "time-dimension" aspects of systemic risks in the financial system.

In order to do so, two broad categories of indicators need to be distinguished: "time dimension" indicators, which measure how systemic risk builds up over time in a financial cycle, and "cross-section" indicators, which measure the concentration of risks in the financial system and in the systemically important institutions (Borio and Drehmann (2009)).

Capturing various dimensions of systemic risk

In the literature of financial stability analysis, a number of indicators have been developed, ranging from traditional balance sheet variables, market-based indicators, broad macro aggregates as well as qualitative information available to supervisory and regulatory authorities. Some of these indicators gauge the resilience of individual players of the financial system, others are focused on system vulnerabilities. A classification and examples are provided in Table 1.

Capturing the financial cycle: some useful indicators

Table 1

Macroeconomic indicators	Broad credit aggregates Measures of debt sustainability (debt to income, debt service ratio)
Banking sector indicators	Stress tests, bank risk metrics Leverage ratios Maturity and currency mismatch Indicators of funding vulnerabilities Profits and losses
Market-based indicators	Asset valuations in equity and property markets Corporate bond and CDS spreads and risk premia Margins and haircuts Lending spreads
Qualitative information	Underwriting standards Asset quality Credit conditions

Source: CGFS Papers No 48 (2012)

Measures of the resilience of banks or other financial sector intermediaries would include capital and liquidity positions, asset quality, profitability, and resilience in response to stress tests. Most of the so-called "Financial Soundness Indicators" listed by the IMF fall in this category of balance sheet indicators. Asset prices, spreads or market liquidity measures (bid-ask spreads or turnover) can give a sense of market resilience. Measures of common exposures (reflected in asset prices or credit developments) can help identify system-wide vulnerabilities and risks that can arise even when even individual institutions are sound on their own. Systemic vulnerabilities can also be detected by using macro stress tests.[10]

Clearly these measures can be used as input to a richer analysis of vulnerabilities. Yet most of them have drawbacks. In the first instance they are contemporaneous measures which do not necessarily reflect the nature of the financial cycle dynamics.

10 For the limitations of macro stress tests (in particular with respect to capturing non-linearities, the assumptions regarding the initial state and the size of the shock), see Borio et al (2012) and Borio (2015).

Second, they are often aggregates of individual institutional information that do not necessarily indicate the common exposures that are embedded in the system. Market-based indicators which include volatilities and spreads are proxies to indicators of financial distress. However, evidence suggests that the lead time of these variables tend to be too short for effective policy interventions.

Desirable properties of indicators

In addition to correctly capturing institution-, market-specific or systemic vulnerabilities, indicators need to have some additional properties that can help to determine the application or withdrawal of macroprudential tools. Good vulnerability indicators should identify a high proportion of crises that occur, while producing a limited amount of "false alarms". There is a vast literature on early warning indicators for predicting banking crises over short horizons (eg Hutchinson and McDill (1999), Kaminski et al (1999), Bell and Pain (2000), Demirgüç-Kunt and Detriagache (2005), Davis and Karim (2008), Dell'Ariccia et al (2008) and Von Hagen and Ho (2007)), as well as currency crises (Kaminsky and Reinhart (1999)). Over medium- and long-term horizons, credit quantities, debt service ratios and asset prices have been identified as good predictors of financial distress, ((Borio and Drehmann (2009), Gerdesmeier et al (2009), Alessi and Detken (2009), Fornari and Lemke (2009), Borgy et al (2009), Drehmann and Juselius (2013)).

These studies suggest that although early warning indicators are useful statistically rigorous measures that are explicitly forward-looking, not all are equally good predictors of financial distress. Among these, the credit-to-GDP gap, defined as the difference between the credit-to-GDP ratio and its long-term trend is seen as more effective than many others in identifying signs of banking distress. This measure was elaborated by Borio and Lowe (2002) and has been subsequently confirmed for a broad range of countries over a long time span (Drehmann and Tsatsaronis (2014)). Other variables such as credit spreads, risk premia and default rates provide complementary information on the levels of stress and risks in the system.

However, a major difficulty is that while several indicators do consistently move in the same directions as the build-up of financial distress they do not reach their peak levels when the crisis hits. In other words there are leads and lags such that effective monitoring of the risks of financial distress may not occur in real time to guide the deployment of macroprudential tools. While the credit-to-GDP gap is a very useful leading indicator it continues to rise for some quarters even after the onset of a crisis. Likewise, the price-to-rent gap or residential property price gap tend to peak four to eight quarters prior to the crisis CGFS (2012)). Policy makers have to make judgement calls in interpreting the signs. Some reading of tea leaves may be required.

A further complication pertains to the identification of crisis periods, depending on when the analysis starts and finishes. A challenge, faced especially by emerging market economies, is that financial innovation, which results in fast-growing financial sectors or activities (such as securitisation, mortgage lending or consumer credit) comes with incomplete default histories.

Aggregation of data is another major issue. The quality and definition of data relating to specific sectors or time periods can differ. Therefore the indicator thresholds signalling the activation of macroprudential tools should be chosen with care in a cross-country context. Moreover, aggregating several indicators into a single composite measure of financial stability is a difficult task given the complex nature of the financial system and the existence of complex links between various sectors (Gadanecz and Jayaram (2009)).

Lastly, there are data gaps in the measurement of financial vulnerabilities at domestic and international levels. The Financial Stability Board, jointly with the G20 and the BIS, is currently working on improving data availability and reporting in areas where data gaps have been identified (FSB (2015)): maturity/liquidity mismatches and leverage for both the banking and shadow banking systems; banks' common exposures to and funding received from key markets, sectors and instruments, the principal bilateral exposures and funding patterns of large systematically important banks; sectoral balance sheets; credit default swaps, over the counter derivatives and structured complex products. Work is also underway to develop a unique system of legal entity identifiers at an international level, in order to improve risk management in firms, better assess of micro and macroprudential risks, facilitate orderly resolution, contain market abuse and curb financial fraud, and enable higher quality and accuracy of financial data overall.

4. Choice of macroprudential policy tools

The choice of macroprudential tools depends on the type of imbalances and shocks. That puts a premium on an appropriate set of indicators to guide the deployment and release of macroprudential measures as discussed above.

Some tools can be used to remedy financial imbalances that are domestic in nature. Counter-cyclical provisions, capital and liquidity buffers, and balance sheet instruments (eg leverage ratios, limits on debt service and loan-to-value ratios) applied to banks would fall into this category. They are intended to address threats to financial stability arising from excessive credit expansion and asset price booms, and limit amplification mechanisms of risks through leverage. Margining and haircut requirements are meant to achieve similar outcomes on financial markets. Table 2 provides an overview of such domestic instruments and the associated indicators.[11]

Other policy tools can help mitigate vulnerabilities arising from the influence of global factors on domestic economy. A number of commodity exporting countries experienced nominal currency appreciation pressures between 2008 and 2013 due to rising commodity prices. Turner (2015) notes that such appreciation pressures can stimulate the credit supply through a number of channels in the economies affected. First, domestic bank lending can be boosted due to a rise in real income, lower credit risk and lower values of debt denominated in foreign currency. Second, the country's risk premium can decline and the higher real value of expected future exports can serve as additional collateral to attract more foreign lending into the country. Third, if the central bank resists currency appreciation by purchasing foreign exchange as capital inflows increase, domestic bank reserves will usually rise unless the central

[11] For a survey of individual countries' choice and use of macroprudential tools, see IMF (2011).

bank fully sterilises the purchases by selling bonds.[12] Lastly, real currency appreciation in a commodities boom context may increase gross fixed capital formation and reinforce the impact of credit expansion.

Policy instruments and potential indicators

Table 2

Policy instrument	Potential indicators
Capital-based instruments	
Countercyclical capital buffers[1]	Measures of the aggregate credit cycle
Dynamic provisions[1]	Bank-specific credit growth and specific provisions (current and historical average)
Sectoral capital requirements	Measures of the price and quantity of different credit aggregates (stock and new loans) on a sectoral basis: interbank credit, OFIs, non-financial corporate sector and households
	Measures of sectoral concentrations
	Distribution of borrowing within and across sectors
	Real estate prices (commercial and residential, old and newly developed properties)
	Price-to-rent ratios
Liquidity-based instruments	
Countercyclical liquidity requirements	LCR and NSFR
	Liquid assets to total assets or short-term liabilities
	Loans and other long-term assets to long-term funding
	Loan-to-deposit ratios
	Libor-OIS spreads
	Lending spreads
Margins and haircuts in markets	Margins and haircuts
	Bid-ask spreads
	Liquidity premia
	Shadow banking leverage and valuation
	Market depth measures
Asset-side instruments	
LTVs and DTIs	Real estate prices (commercial and residential, old and newly developed properties)
	Price-to-rent ratios
	Mortgage credit growth
	Underwriting standards
	Indicators related to household vulnerabilities
	Indicators of cash-out refinancing

[1] To steer the application of countercyclical capital buffers and dynamic provisions, a range of indicators is useful. However, the table only shows the indicators which have been officially proposed or implemented (for countercyclical capital buffers, see Basel Committee (2010b); for dynamic provisions, see Saurina (2009)).

Source: CGFS Papers No 48 (2012)

[12] The effects on the banking system balance sheet and bank lending may be non-trivial even in case of full sterilisation; see Gadanecz, Mehrotra and Mohanty (2014).

Monetary authorities have tried to mitigate the expansionary effects of commodity cycles and capital inflows by resorting to macroprudential measures. For instance, Bruno and Shin (2013) argue that in Korea macroprudential measures targeted to non-core deposits have reduced the sensitivity of capital inflows to global factors, relative to a group of comparator countries. As noted in Turner (2012), Indian authorities have used restrictions on non-resident flows into their domestic long-term securities markets for similar reasons.

At the domestic or international level, spillovers and systemic risks stemming from the systemic relevance and interconnectedness of banks and other financial institutions may be addressed through capital surcharges (additional loss absorbing capacity) for larger institutions. Size-dependent leverage limits or asset risk weights, limits on single exposures, as well as a monitoring of market concentration and common exposures can also be deployed. Lastly, the Financial Stability Board (FSB) is coordinating work on a specific resolution framework for SIFIs.

Measures to enhance the robustness of market infrastructures (settlement of OTC derivatives, central counterparties, Legal Identity Identifier project) are key complements to the instruments discussed.

Should policymakers rely on a single tool or on multiple instruments? Should macroprudential policies relate to specific sectors, institutions or instruments, or should they be applied across the board, for instance to all banking activities? As argued in Turner (2012), the use of a suite instruments as opposed to a single tool may be less distortionary, more precise and more effective. That being said, a greater number of instruments could make calibration harder (particularly if there is lack of historical data between instruments). In addition, deploying a large number of instruments may inadvertently result in overregulation.

5. Policy interventions: settings and timing

How should policymakers apply macroprudential instruments? Should the application be rules-based or discretionary? Should the settings be fixed or adjustable according to developments in systemic risk?

A rules-based approach has the benefit of being transparent and easy to communicate.[13] However, it can be difficult to calibrate, and suffer from the Lucas critique (meaning that the structural set-up can change as a result of the policy being in place, invalidating previous model calibrations). That would argue for a more discretionary approach (CGFS (2012)). For instance, when decisions were made in Sweden and Australia as to whether or not macroprudential measures should be deployed, signals given by standard housing market indicators such as house price indices or price-to-rent gaps have been overruled by regulatory judgment or market specificities (such as controlled rents).

While a number of countries have used fixed (absolute) limits on risk-taking during boom phases, in the form of loan-to-value ratios, limits on debt service ratios or currency mismatches, these fixed measures may have the disadvantage that they

[13] On the risks of setting and communicating overly ambitious objectives, see Borio (2015).

exert their effects differently during various phases of the cycle. Thus, the use of adjustable instruments, such as procyclical capital requirements for trading books, and margin requirements based on through-the-cycle valuations of collateral assets, has gained traction internationally (BIS (2010)).

It is important to get the timing of policy actions correct, as the costs mis-timed policy action (or policy inaction) can be significant.[14] The costs of a mis-timed activation of macroprudential tools are asymmetric. Delayed action is generally more costly than premature intervention (CGFS (2012)). Delayed activation can mean less effective or ineffective intervention (as measures take time to gain traction). It can even initiate a disorderly unwinding of imbalances. On the other hand, implementing measures too early means unnecessary regulatory costs, and it may weaken the impact of the instrument. Withdrawing too late may amplify procyclical effects. Deactivating too early may give market participants the wrong signal (and thus create moral hazard).

Just like the choice of instruments, the timing of their activation and withdrawal may rest on domestic as well as international considerations, based on the financial and real linkages of the domestic economy with the rest of the world. The case of Switzerland, for instance, where one major bank required government support during the global financial crisis, illustrates the importance of international factors from this perspective. Although domestic indicators accurately identified no domestic vulnerabilities for the bank, its vulnerabilities stemmed from its cross-border exposures (CGFS (2012)).

For all intents and purposes, policymakers can rely on forecasting models and indicators to determine the timing for the application and deactivation of macroprudential measures. In that exercise it is important to capture the interactions between systemic risk, market dynamics and policy choices, taking account of spillovers and second-round effects. This is also an area of policy where theoretical and empirical models can still be developed further.

6. Macroprudential policy and monetary policy

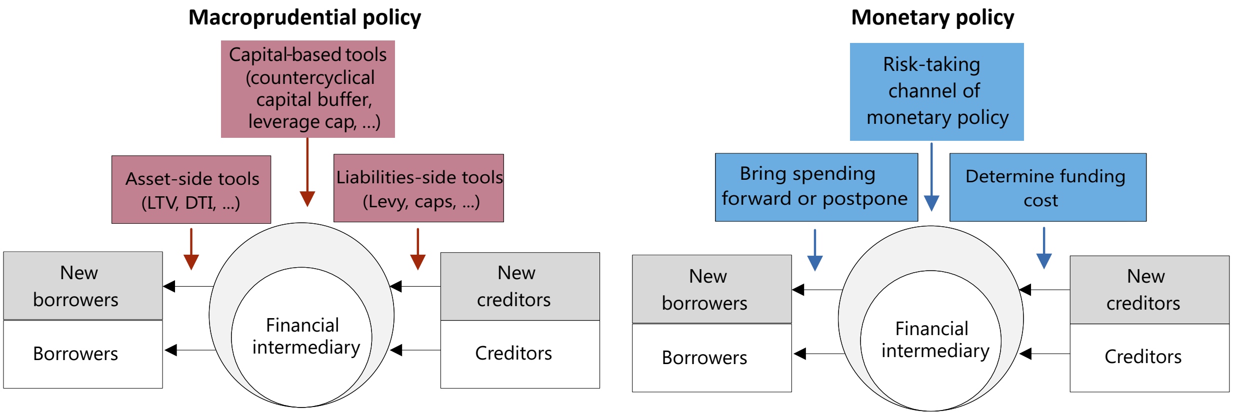
How do macroprudential instruments relate to traditional monetary policy tools? One view is that macroprudential policy might completely substitute for policy interest rate moves in stabilising the economy, insofar as the transmission channels are similar (Cecchetti and Kohler (2012)).[15] Indeed, as noted by Shin (2015) and in BIS (2015), both sets of policies affect the demand for credit (by influencing the timing of consumers' spending decisions) and the financing supply (by impacting banks' funding choices and leverage situation). Another view is that macroprudential tools cannot replace policy rate adjustments (Stein (2013)), because interest rates are the universal price of leverage which apply to all agents in the economy and present virtually no scope for regulatory arbitrage.

[14] In practical terms, this may require a correct identification of the phase of the financial cycle: see discussion in Section 2.

[15] Changes in policy rates or in capital requirements both alter banks' cost of doing business.

The recent literature has come to consider macroprudential and monetary policies as complementary (see Graph 2), for two reasons. First, the policy interest rate alone may be too blunt a tool to address financial stability risks, which often have a sectoral dimension. While interest rates apply uniformly to all parts of the economy and the financial system, macroprudential policies can be tailored to specific sectors, regions, institutions, products or practices. Targeted macroprudential measures can thus usefully complement monetary policy. Second, financial booms may simply be too powerful to be addressed with one type of policy: considering macroprudential and monetary policies as complementary can make it easier to jointly pursue the objectives of price stability, output stability and financial stability (Borio (2014b), Shin (2013)). For instance, macroprudential tools can be deployed to balance the effects of an overly loose monetary policy, although tensions and contradicting incentives may be created when the two sets of policies are pulling in opposite directions (Shin (2015)).

Macroprudential tools and monetary policy are inter-related Graph 2



LTV = loan-to-value; DTI = debt-to-income.

Source: Shin (2015) and 85th BIS Annual Report (2015).

7. Macroprudential instruments: measuring effectiveness in the short- and medium term

In order to gauge the effectiveness and efficiency of macroprudential measures, the following questions can be asked, as outlined in CGFS (2012): (i) Is there a robust link between changes in the instrument and the stated policy objective? For instance, do the measures impact banks' total credit stock, or only their new lending? Do the effects of the measures increase in a linear fashion as the intensity of the measures increases? (ii) What is the effect on expectations? For example, to what extent and how do players adapt their expectations in response to macroprudential measures by enhancing risk management practices or cutting their exposures to certain risks? (iii) What is the scope for regulatory arbitrage, whereby certain risky activities targeted by the measures are still pursued, but outside the scope of the regulatory umbrella? (iv) How quickly can the measures be implemented from a legal, operational and practical perspective? (v) What are the costs of the measures, especially in terms of loss of output and foregone credit expansion?

In practical terms, an assessment must compare two outcomes:

- on the one hand (scenario where no macroprudential measures are taken), the economic and financial fallout on the macroeconomy from the occurrence of a crisis, weighted by the probability of a crisis occurring;
- on the other hand (in case measures are taken), the certain up-front costs of the measures plus the costs of the crisis attenuated by the measures, weighted by the probability of occurrence of the crisis. The question arises whether the probability or timing of a crisis can be known with certainty or whether it has changed compared the previous scenario under the hypothesis that macroprudential measures have been applied.

A number of studies by Basel-based groups make an attempt at quantifying the effects in terms of lower crisis probabilities versus output costs (BCBS LEI (2010a), MAG (2010)). In 2011 the FSB has issued a progress report on the implementation of macroprudential policy tools in G20 and other countries, focusing on the identification of systemic financial risk, the designation and calibration of macroprudential instruments, and the relevant institutional and governance arrangements at national and regional levels.

In addition, a number of recent research papers have assessed macroprudential policy outcomes. Kuttner and Shim (2013) study the effects of macroprudential policies on housing credit and house prices, looking at a large cross-country sample for the period 1980-2011. They show that certain types of targeted credit or tax policies may be used to enhance financial and macroeconomic stability. Debt service to income and loan to value ratios as well as exposure limits and housing taxes appear to influence housing credit extension in the desired direction. Instruments affecting the supply of credit by increasing the cost of providing housing loans (risk weights, liquidity requirements) or restricting their quantities (credit limits) have little or no effect on the housing market. Loan to value and debt service ratios are also found to affect the demand for housing loans in the desired way.

Borio (2015) notes that macroprudential policies are often more successful in strengthening resilience than in constraining booms, and that the effectiveness varies among tools. Capital requirements are often less effective than loan-to-value or debt-to-income ratios, or restrictions on wholesale funding. But all macroprudential tools can be subject to regulatory arbitrage. Another question is whether the effects of macroprudential measures differ according to where one finds oneself in the economic and financial cycle when they are applied. And, are the effects of macroprudential tightening and loosening asymmetric? In a study of the housing market for the period 1990–2013 for 17 economies, McDonald (2015) finds that tightening measures are more effective in restraining booms when credit is expanding rapidly compared to other points in the cycle, and that tightening measures have a stronger impact than loosening ones. These results, though, would need to be qualified by whether fixed or adjustable macroprudential measures have been deployed (see discussion in previous section).

Macroprudential tools are mostly focused on banks. Given the size and scope of non-banking activities, it is well known that leveraged players and activities (eg shadow banking) create systemic risk. Moreover, the asset management industry (eg hedge funds) can and do amplify market disruptions. The ability of macroprudential policy tools in addressing these risks is insufficiently understood (Borio (2015)).

While the policy instruments were largely designed to deal with private sector excesses, the public sector can be a source of risk. Sovereign risks are especially hard to address because of political economy aspects involved and the fundamental macroeconomic nexus that is involved For instance, it may be politically hard to justify macroprudential measures that lean against the wind in a boom phase, given the certain short-term costs and uncertain medium to long-term benefits. That puts a premium on governance arrangements (covering autonomy, competency and know-how) between the central bank, the government and various micro- or macroprudential authorities. Macroprudential policies also need support from other (eg fiscal[16] and structural) policies.

Regarding the international aspects of macroprudential policymaking, Borio (2015) points out that the international co-ordination of policies is an area where further work is required, given the scope for international arbitrage, the nature of international financial conglomerates spanning multiple jurisdictions and the prevalence of financial intermediaries' cross-border funding and other exposures.

There exists a rich literature assessing the effectiveness of capital flow management measures for macroprudential purposes. Such measures have been resorted to in the past decade to attenuate the impact of global financial conditions on emerging market economies. Some studies find that this approach has been effective. In a comparative assessment of the effectiveness of macroprudential policies in 12 Asia-Pacific economies for the period 2004-2013, Bruno and Shin (2013) find that capital flow management measures applied to banking and bond markets have been effective in slowing down banking and bond inflows, respectively.

The evidence reported in other studies on the effectiveness of capital flow management measures for macroprudential purposes is more mixed. Habermeyer et al (2011) find that macroprudential measures introduced in 13 EMEs succeeded in mitigating the impact of capital inflows[17] in some cases, reduced credit growth in others, but failed to restrain asset price inflation. Such measures also do little to remedy maturity and currency mismatches on the liability side of balance sheets. Kuttner and Shim (2013) report that certain types of targeted credit and tax policies can affect the housing market, and could potentially be used as tools to promote financial and macroeconomic stability. However, not all policies are able to achieve this outcome. In particular, policies designed to affect either the supply of or the demand for credit do not have a discernible impact on house prices, and the authors also caution that their findings are sensitive to the choice of econometric approach.

[16] The rise in sovereign risk as a result of bank bailouts in the aftermath of the Great Financial crisis is one illustration of the burden placed on public finances in this context (Borio (2015)).

[17] The objectives of capital flow management noted by the authors include stemming currency appreciation, reducing the volume of capital inflows, changing their composition, providing greater room for monetary policy maneuver, slowing credit growth, and dampening asset price inflation.

8. Combining micro- and macro-level data for macroprudential analysis and policymaking

Macroprudential analysis and policymaking relies on a combination of micro- and macro-level data. That is because gauging vulnerabilities in the system as a whole also involves getting a bird's eye view of individual market players (at least the systemically most important ones) and their interlinkages (Dombret (2012)). For instance, macro stress tests are only comprehensive if, in addition to system-wide metrics, they also incorporate firm-specific balance sheet data, in order to get a sense of interconnections and the potential contagion of shocks. Bank-specific data on capital adequacy, funding and asset quality is often needed to draw a systemic risk map, in order to detect vulnerabilities at systemic institutions that might propagate through the system (Constâncio (2012)).

More generally, the analysis of financial cycles and in particular credit booms shows that these can often be a prelude to financial crisis. The objective of macroprudential policy is then precisely to obtain a systemic perspective of the boom conditions with a view to moderating the credit cycles. On the one hand, macro aggregates are necessary to analyse the systematic patterns in the expansionary phase of booms, such as rising asset prices, economic expansion, widening external deficits, exchange rate volatilities or other conditions of macro fragility. On the other hand, micro data are able to show a strong association between credit booms and firm-level measures of leverage, its external financing conditions, firm value and indicators of banking fragility (Mendoza and Torres (2008)).

Integrating macro and micro data would help in designing quantitative models that can further our understanding of how conditions affecting individual borrowers (demand for credit) could produce strong financial amplification. Moreover, the analysis would also help gauge how effective prudential polices might be in in influencing private borrowing incentives in a desirable manner (Bianchi and Mendoza (2015)).

9. Conclusion

Macroprudential measures serve two main purposes: enhance system resilience and attenuate cycles. They are distinct from day-to-day risk management, crisis management, crisis resolution, and capital flow management measures. They are complementary to monetary policy. This paper has reviewed the appropriate set of indicators that policymakers can rely on when deploying macroprudential tools, depending on the type of vulnerability and the desired policy objective. Work is currently being done to close some data gaps that may limit the availability of a comprehensive set of indicators to guide policymaking.

Rules-based and discretionary approaches for activating and deactivating macroprudential policy tools both have advantages and drawbacks. As timing errors relating to both the activation and deactivation can entail significant costs, identifying the stage and amplitude of the financial cycle is important. More work is required to model the characteristics of the financial cycle to get a better understanding of its empirical properties. Capturing the interactions between systemic risk, market dynamics and policy choices, as well as spillovers and second-round effects, is an area of policy where theoretical and empirical models can still be developed further.

The literature on assessing the costs and benefits of macroprudential measures is young, but growing. Gauging the efficacy of macroprudential policy measures is a multidimensional exercise, taking into account the link between policy outcomes and objectives, effects on expectations, scope for arbitrage and costs. In the main, one has to make a comparison of the costs of two scenarios, weighted by their respective probabilities: occurrence of a crisis under no policy action, versus economic and financial outcomes under policy action.

Yet another issue relates to the diverse nature of macroprudential objectives and instruments. There is no one-size-fits-all approach and which tools to use, how to calibrate them and when to deploy them depends on how the policymaker views the build-up of vulnerabilities. The interaction with fiscal and monetary policy should be better understood while attempting a broader operational framework for financial stability (Borio (2014a), Borio (2014b), Caruana (2014)).

When it comes the use of the indicators, this paper has reviewed the various sets of indicators: balance sheet indicators as well as market-based ones. Many studies have emphasised the need for leading or forward-looking indicators rather than measures that reflect the contemporaneous situation. While both the "cross-section" and "time" dimensions of risks need equal attention, post-crisis policy has to some extent addressed both. These distinct dimensions call for more precise calibration of tools based on the analysis of vulnerabilities, which in turn require more precise indicators. However, of the two, the time dimension presents additional challenges, as macroprudential intersects with macroeconomic policy.

Lastly, the integration of macro aggregates with micro data on firm and household behaviour as well banking sector indicators could help to better calibrate the macroprudential tools as well as to understand their effectiveness.

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Systemic Risk, Interbank Market Contagion, and the Lender of Last Resort Function[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 or the central banks and other institutions represented at the meeting.

Systemic Risk, Interbank Market Contagion, and the Lender of Last Resort Function

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Abstract

We develop a theoretical model examining the financial stability policy of a central bank serving as both the lender of last resort and the regulator of the financial system. Our model accommodates the possibility of financial contagion through interbank market linkages, and adverse feedback from the financial system to the real economy. We identify the volume of activity in the interbank money market, the relative riskiness of the agents in the financial system, and the probability of systemic distress as the key factors influencing the design of financial stability policy. Furthermore, results of simulating the model indicate that there is a substitution effect between reducing the expected scope of a central bank's assistance to an institution in distress and increasing bank capital requirements.

Keywords: Financial Stability, Central Bank Policy, Lender of Last Resort, Banking Crisis, Bank Regulation, Interbank Market.

JEL classification: E58, G01, G21, G28.

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Contents

Introduction

The shortcomings of a financial stability policy based upon microprudential bank regulation and the provision of liquidity to solvent but illiquid institutions in the context of an increasingly complex and interconnected financial system were revealed by the 2007 - 2009 financial crisis. The severity of this crisis initiated a fundamental re-evaluation of the role that central banks and bank capital regulation play in promoting the resilience of the financial system. However, the question of precisely identifying the targets and objectives of a new stability framework remains the subject of an ongoing academic and policy debate.

We believe this is the first study to develop an analytical framework investigating the combined impact of bank regulatory capital requirements and a central bank's commitment to act as the lender of last resort on the operation of an economic system in which financial sector dependencies are mediated through an interbank market. We consider different regulatory policies with varying scopes of the policymaker's intervention. Specifically, the stylised economic system consists of a central bank serving as both the lender of last resort and the regulator of the financial system, two commercial banks interacting through an interbank market, and a non-financial, economic sector producing real output. Our approach involves identifying the appropriate design for central bank regulatory policy and market intervention whose objective is to maximise the difference between expected economic output in the system and a range of potential costs associated with financial distress. In this context, we offer a holistic view of financial stability.

The key factors influencing the design of the optimal central bank financial stability policy are identified to be the volume of interbank lending, the relative riskiness of financial institutions in the system, and the probability of any crisis becoming systemic. Our results also establish the existence of a substitution effect between central bank policies designed to moderate the expectations of financial institutions relating to receiving assistance, and regulations increasing bank capital requirements. Finally, the model also emphasises the importance of a central bank's commitment to fostering the stable functioning of the interbank money market in times of economic stress.

Related Literature

The various literatures analysing a central bank's lender of last resort function, financial contagion, and prudential bank regulation have been evolving largely independently until recently. Our paper contributes to this ongoing research agenda by attempting to develop a more general, unified theory connecting financial stability and regulatory policy.

The original objectives of a lender of last resort are clarified in Thornton (1802) and Bagehot (1873), and suggest that “very large loans at very high interest rates are the best remedy for the worst malady of the money market [...] Any notion that money is not to be had, or that it may not be had at any price, only raises alarm to panic, and enhances panic to madness” (Bagehot, 1873: pp. 56 - 57). This claim finds support in Diamond and Dybvig's (1983) formulation, which shows that the efficient functioning of the banking system requires either a formal deposit insurance scheme or a central bank's commitment to lend to solvent but illiquid institutions. Such guarantees eliminate the possibility of self-fulfilling prophecies of bank runs destabilising the system.

Providing such assistance, however, enables financial institutions to escape market discipline and promotes forbearance (Freixas and Parigi, 2014). Indeed, the empirical evidence in Dam and Koetter (2012) indicates that default probabilities in the financial system increase significantly following a policymaker's intervention. This trade-off between preventing financial contagion and creating moral hazard is formalised in Goodhart and Huang's (2005) seminal lender of last resort model. The existence of a lender of last resort also affects financial institutions' financing decisions, as they come to expect the central bank's collateral quality policy may be loosened under crisis conditions (Wagner, 2007, Ratnovski, 2009, Koulischer and Struyven, 2014).

To address this problem, Goodhart and Huang (2005) propose an intervention strategy based around the notion of constructive ambiguity, the doctrine of not precisely specifying in advance the precise goals and targets of financial stability policy and the mechanism of any central bank intervention. They demonstrate that this encourages financial institutions to behave as if they are not protected, although the central bank may actually stand ready to intervene in a crisis. Nijskens (2014) highlights the fact that the credibility of such an approach is largely determined by the central bank's reputation for strictness. The recent financial crisis, however, has put the efficacy of constructive ambiguity in doubt. Commentators argue that the lack of a clear understanding of how central banks were going to respond to the crisis led to sudden significant changes in assistance expectations, with devastating consequences for financial system stability (Vinogradov, 2012).

Consequently, our model departs from the traditional analysis of constructive ambiguity. We examine a system in which the central bank's policy is common knowledge, thereby allowing it to manage financial institutions' assistance expectations. This approach is akin to forward guidance on future interest rates, in which the central bank communicates the details of its monetary policy in order to correct faulty private expectations, thus reducing misallocation of economic resources such expectations may induce[2] (Blinder, *et al.*, 2008).

Gorton and Huang (2004) point out that while the central bank should be committed to assisting solvent but illiquid institutions, bailouts of insolvent banks provide an additional source of emergency liquidity. Moreover, during crisis periods illiquidity and insolvency often become indistinguishable. One consequence of this identification problem is that central banks may abandon the traditional principles associated with the lender of last resort function by extending loans or engaging in large-scale open-market purchases of the non-performing assets of those non-depository institutions deemed to be systemically important (Buiter, 2008, Aglietta and Mojon, 2014). Freixas and Parigi (2014) conclude that the traditional view, namely that a central bank should only assist solvent but illiquid institutions often

[2] This reflects the spirit of Friedman's (1962) analysis, who argues that following a well-publicised policy has favourable effects on people's attitudes and expectations, which in turn leads to better outcomes than if the same policy actions are implemented on a discretionary basis.

leads to a simplistic analysis of financial stability, and to an artificial separation between lending of last resort and bank bail-out interventions.

Many commentators focus on the interbank money market as the most prominent channel of financial contagion in a banking system. It interconnects banks' balance sheets, and acts to rapidly propagate one agent's distress throughout the financial system (Rochet and Tirole, 1996, Allen and Gale, 2000, Freixas, *et al.*, 2000, Kiyotaki and Moore, 2002).[3] Hence, by intervention in the interbank market the lender of last resort seeks to contain a crisis before it is transmitted any further (Goodhart and Huang, 2005). Further, interbank interest rates transmit the effects of a change in the central bank's policy rate into the real economy, and are now commonly used as benchmark rates in pricing a variety of derivatives used by non-financial firms (International Monetary Fund, 2008, Brunnermeier, 2009). Thus, as a result of the consequent impact on the real sector of the economy, the costs of a sudden evaporation of confidence in this market can be substantial, and severely impede a central bank's ability to achieve its policy objectives (Nagel, 2013). Domanski, *et al.* (2014) argue that the growing importance of the interbank market calls for development of new operating frameworks that would allow for greater flexibility during times when banking sector liquidity is compromised. As our model explicitly accounts for the effects of financial contagion arising out of liquidity channel linkages intermediated through the interbank market, it contributes to identifying how a central bank may achieve this objective.

Existing theories of microprudential regulation are comprehensively surveyed in Dewatripont and Tirole (1994) and VanHoose (2007). This regulatory approach focuses on limiting financial distress in individual institutions by ensuring that they are well-capitalised and managed prudently (Borio, 2003). The regulatory paradigm shift towards macroprudential regulation seeks to limit the risk of system-wide financial distress resulting in a significant loss of real output (Borio, 2003). Galati and Moessner (2010) and Claessens (2014) provide an overview of macroprudential policy tools, detailing the distinctions between the two classes of regulatory regime. Repullo and Suarez (2013) argue that macroprudential regulations are less procyclical and result in an increased accumulation of capital reserves in economic expansions, thereby increasing the resilience of the financial system.

Recent regulatory changes, however, have been initiated without any solid theoretical foundations lending support to their efficacy. Examinations of their effectiveness primarily undertake qualitative assessments, or provide early estimates of the economic costs and resulting impact of the current transition towards macroprudentiality (e.g., Slovik and Cournède, 2011, or Angelini, *et al.*, 2014). Arnold, *et al.* (2012) discuss the practical problems in accurately identifying systemic risk, a core concept around which the new framework is built. Giese, *et al.* (2013) survey the literature to identify the possible transmission channels of macroprudential policy and its effects on credit supply. They conclude that it is impossible to identify with certainty any effects it is going to have *ex ante*. Mészáros

[3] Notwithstanding the fact that Acemoglu, *et al.* (2015) show that shocks of sufficiently small magnitude are more efficiently absorbed by a more densely interconnected financial network.

(2013) emphasises the fact that the new framework suffers from a number of internal and technical difficulties, arguing that it may require an unprecedented level of intervention in order to achieve its new objectives. The theory of systemic risk outlined by Acharya (2009) suggests that any system relying on the use of risk-weighted assets is fundamentally unsuitable in a systemic context, and thus ought to be replaced by a framework based on correlations between banks' asset returns. Van den Heuvel's (2008) model shows that bank capital requirements reduce banks' ability to create liquidity in the economy, creating a welfare cost equal to a 1\% permanent reduction in consumption. While our model accommodates this adverse relation between bank capital requirements, credit supply and economic output, another contribution is that its formulation enables us to examine the joint effects of central bank regulation and lending of last resort on the efficient design of financial stability policy.

Finally, we contribute to the literature investigating the appropriate institutional allocation of the roles of lender of last resort and regulator of the banking system. Goodhart and Schoenmaker (1995) find no empirical evidence in support of either combining or separating these functions. At the same time, Kahn and Santos (2005) suggest that while centralising these roles may lead to excessive forbearance, a multi-institutional arrangement may instead create substantial costs arising from coordination failures. In contrast, our results show that combining the functions of the lender of last resort and the regulator of the banking system may improve the effectiveness of financial stability policy.

The Model

The model economy consists of a central bank, two commercial banks connected through an interbank market, and firms operating in the real economy. The banks use long-term liabilities and equity capital to provide loans to non-financial firms who invest in positive net present value projects. The central bank's policy objective is to appropriately deploy its mandate as lender of last resort and banking system regulator in order to maximise the difference between real economic output generated in the system and the potential costs of economic distress. In this section we first detail the nature of the agents' behaviour in the model. We then proceed to discuss the structure of the interaction between them.

The Commercial Banks

Initially, at $t = 0$ the two commercial banks are of the same size, but have different exogenously-determined risk profiles. Both banks finance their operations through long-term liabilities and equity capital, and maintain a certain level of central bank mandated capital reserves dependent upon the amount of risky assets they hold. The time to maturity of the liabilities is sufficiently distant to make them irrelevant for decision-making within the time frames considered in the model. Thus, the levels of both long-term liabilities and equity capital are assumed to be fixed.

The interbank money market is the conduit through which the banks interact to reallocate their initial endowment of risky assets. The lending bank is characterised as the prudent bank because it diversifies its portfolio of assets, while the second, risky bank borrows in the interbank market in order to leverage its investment position, thereby taking on more risk. Table 1 depicts the balance sheet structures of the two banks. Panel A captures their initial balance sheet position, Panels B and C show the post-transaction changes.

Balance sheet structures of the two commercial banks

Panel A: Initial balance sheet structure — Table 1

Assets	Liabilities
Risky Assets: a_t	Long-term Liabilities: l
Reserves: k_t	Equity Capital: c

Panel B: Post-transaction balance sheet of the risky bank

Assets	Liabilities
Risky Assets + Interbank Loan: $a_t + \frac{1}{1+\kappa} i_t$	Interbank Loan: i_t
Reserves: $k_{u,t}$	Long-term Liabilities: l
	Equity Capital: c

Panel C: Post-transaction balance sheet of the prudent bank

Assets	Liabilities
Risky Assets - Interbank Loan: $a_t - i_t$	Long-term Liabilities: l
Interbank Loan: i_t	Equity Capital: c
Reserves: $k_{s,t}$	

The interbank loan pays a gross interest rate of ρ, which is proportional to the additional leverage the interbank loan generates, thereby accounting for the increased risk that the risky bank is going to default. Specifically,

$$\rho = 1 + \rho_0 \times \frac{i_t}{a_t} \tag{3.1}$$

where ρ_0 is a scaling factor.

The level of capital reserves that the central bank requires the commercial banks to maintain corresponds to a certain proportion of the value of risky assets that they hold, and is stipulated in the form a total regulatory capital ratio, κ.

Issuing an interbank loan is equivalent to reallocating endowment capital from risky assets to the interbank market, without changing the overall size of the prudent bank's balance sheet. Borrowing in that market increases the size of the risky bank's balance sheet. As a result, the levels of capital reserves held by the two banks after the transaction will differ, as shown in equations (3.2) and (3.3) for the prudent and the risky bank respectively.

$$k_{s,t} = \kappa \times [(a_t - i_t) + i_t] = \kappa a_t \tag{3.2}$$

$$k_{u,t} = \kappa \times (a_t + \frac{1}{1+\kappa} i_t) \tag{3.3}$$

The investment payoffs to the banks differ and realise consecutively. The payoff to the risky bank realises first at $t = 1$, while that to the prudent one realises immediately afterwards at $t = 2$.

The payoffs of the risky bank $\widetilde{R_H}$, and the prudent bank $\widetilde{R_L}$ are given by:

$$\widetilde{R_H} = \begin{cases} R_H \; with\; probability\; p(S_H) \\ 0 \; with\; probability\; 1 - p(S_H) \end{cases} \tag{3.4}$$

$$\widetilde{R_L} = \begin{cases} R_L \; with\; probability\; p(R_L|R_H) = 1 \\ R_L \; with\; probability\; p(R_L|0) = p(S_L) \\ 0 \; with\; probability\; 1 - p(S_L) \end{cases} \tag{3.5}$$

where R_H and R_L are the gross rates of return on the investments of the risky bank and the prudent bank respectively, $R_H > R_L$, $p(S_H)$ is the unconditional probability of the risky bank's investment project being a success, and $p(S_L)$ is the probability of the prudent bank's project success being conditional on the risky bank's project failing.

This structure leads to three possible states of the economy, according to the three combinations of the unconditional and conditional probabilities of the banks' investment projects being successful. (1) A good state, in which the investments of both banks are successful (unconditional probability of $p(S_H)$); (2) a neutral state, in which the investment of the risky bank fails but that of the prudent one is successful (unconditional probability of $[1 - p(S_H)] \times p(S_L)$); and (3) an adverse state, in which both investments fail (unconditional probability of $[1 - p(S_H)] \times [1 - p(S_L)]$).

Notice that the information revealed at $t = 1$ provides only partial knowledge about the exact state of the economy if $\widetilde{R_H} = 0$. This in turn affects the central bank's policy.

We model the unconditional probability of a good state, $p(S_H)$, explicitly as a logistic function:

$$p(S_H) = \frac{1}{1 + e^{\alpha + \beta a_t}} \tag{3.6}$$

The initial equal size of the two banks is normalised to 1. Hence, a_t can be expressed in terms of κ as $a_t = \frac{1}{1+\kappa}$,[4] and equation (3.6) is equivalent to:

$$p(S_H) = \frac{1}{1 + e^{\alpha + \beta\left(\frac{1}{1+\kappa}\right)}} \tag{3.7}$$

where α is an independent factor which determines the probability that the economy will be in a good state, and β is a factor capturing the systemic sensitivity of that probability to changes in the level of investment in the risky asset or capital reserves.

The function $p(S_H)$ is concave and decreasing in a_t, or, equivalently, increasing in κ. This reflects an important element of prudential regulation, namely that the higher the levels of capital reserves held by financial institutions, the greater the stability and resilience of the financial system.

[4] Initially, a bank's asset-side of the balance sheet comprises only risky assets and capital reserves, therefore $a_t + \kappa \times a_t = 1$ or $a_t = \frac{1}{1+\kappa}$.

The terminal values of the two banks can be expressed as follows. For the risky bank:

$$V_{u,T} = max\big(\big[R_H(a_t + i_t) - \rho i_t + k_{u,t}\big], 0\big) \tag{3.8}$$

which takes a value of 0 with unconditional probability $1 - p(S_H)$. For the prudent bank:

$$V_{s,T} = max\big(\big[R_L(a_t - i_t) + \rho i_t + k_{s,t}\big], 0\big) \tag{3.9}$$

which takes a value of 0 with unconditional probability $[1 - p(S_H)] \times [1 - p(S_L)]$.

Non-financial Firms

The primary role of non-financial firms in the model is to generate real economic output outside the financial system by appropriately investing funds they obtain from the banks in positive net present value investment projects. The non-financial sector is a perfectly competitive environment consisting of two types of firms, higher and lesser creditworthy corporations. Higher (lower) creditworthy firms invest in less (more) risky projects as defined by their unconditional probability of success. These projects generate an average rate of return, r. The two banks invest in risky assets by channeling loans to the non-financial firms. A firm's creditworthiness is determined by the bank they borrow from, so the prudent bank channels funds to more creditworthy firms, and *vice versa*. Accordingly, the probabilities that the investments of the differing credit classes of firms are successful are identical to the banks from which they borrow.

The Central Bank

The central bank's objective is to maximise the difference between the volume of economic output generated in the system and the expected costs of economic distress. The value function of the central bank incorporates the economic output generated by the financial system and the non-financial firms, the additional costs generated by stress in the interbank market, the opportunity cost of requiring banks to hold capital reserves, output losses resulting from bank failures, the direct costs of assisting a bank in distress, and the expected repayment of any emergency funding it may provide.

Real Economic Activity

Economic output is generated by the non-financial firms by utilising the funds intermediated by the banks to pursue investments in value-generating projects. The activities of the banks also add value to the economy, hence the net payoffs they earn are also accounted for in the economic output function. The total economic output, Ω, is given by:

$$\Omega = (R_H - 1) \times (a_t + i_t) + (R_L - 1) \times (a_t - i_t) + 2ra_t,^5 \tag{3.10}$$

[5] This is a reduced form of the basic function of economic output specified as $\Omega = (R_H - 1) \times (a_t + i_t) - (\rho - 1)i_t + (R_L - 1) \times (a_t - i_t) + (\rho - 1)i_t + r(a_t + i_t) + r(a_t - i_t)$.

A default on a bank's interbank obligations would result in a significant impairment of the functioning of the interbank money market. Given its importance for an efficient transmission of monetary policy, as well as its close relation with the interest rates derivatives market, this will lead to additional costs, s, that the central bank has to bear if it does not intervene. In October 2008, during the financial crisis, the LIBOR-OIS spread, often considered to be a gauge of the health and efficient functioning of the interbank market, rose from its pre-crisis average of approximately 10 basis points to more than 350 basis points. Furthermore, the TED spread, measuring the perceived credit risk in the entire economy, increased from approximately 30 basis points to almost 460 basis points during the same period. The magnitude of these changes indicates how substantial the economic costs of a sudden evaporation of confidence in the interbank market can be. Indeed, Brunnermeier and Pedersen (2009) report that while the losses sustained between 2007 - 2008 by U.S. financial institutions alone were in the order of several hundred billion dollars, they were subsequently amplified to more than 8 trillion dollars in the overall stock market. While a central bank's intervention can mitigate these costs, we assume it involves guaranteeing the principal of interbank loan's amount extended, forcing banks to forego any interest they expect to earn on their funding position.

Requiring commercial banks to maintain a certain level of reserves diminishes the amount of capital available for lending to the non-financial firms, thus lowering total economic output, and creating a deadweight loss for the economy. This opportunity cost, denoted by Φ, is modelled as the value of additional output of non-financial firms that is lost every period.

$$\Phi = r \times \left(k_{s,t} + k_{u,t}\right) = r \times \left(2a_t + \frac{1}{1+\kappa} i_t\right) \kappa \tag{3.11}$$

The effects of a bank failure are similar in this respect, as they result in a sharp decline in credit supply. We assume that a bank that has been resolved is not replaced in the system. This loss of output, Γ, is modelled as a perpetuity paying $a_t \times r$ every period, that is, the return the non-financial firms could have generated had total credit supply not decreased. Using the average rate of return, r, generated by the non-financial firms as a discount factor, the present value of such a perpetuity is simply $\Gamma = a_t$.

Finally, any central bank assistance to a bank in distress involves restoring that bank's balance sheet to its initial position. That is, the central bank provides the troubled bank with funds equal to the value of its long-term liabilities and equity capital net of the capital reserves it is required to hold, denoted by Λ. Since such funds are not a subsidy, the central bank's value function also accounts for the expected value of their repayment, $\Psi = \delta \times \Lambda$, where $\delta$is a discount factor. Additionally, the central bank may also charge a penalty interest rate, r_p, on the assistance it provides. As a result, the value function that the central bank maximises is given by:

$$\mathrm{V_{CB}} = E[\Omega] - \Phi - E[s] - E[\Gamma] - E[\Lambda] + E[\Psi] \tag{3.12}$$

corresponding to the difference between the aforementioned economic gains and costs.

Central Bank's Strategic Policy Objectives

In order to achieve its policy objective the central bank chooses one of the following three strategies when responding to a crisis in the banking system. First, it may allow a bank in distress to be resolved. Second, it may intervene in the interbank market and guarantee the repayment of any interbank loans in order to prevent stress and contagion, while still allowing the bank in distress to be resolved. Finally, it may attempt to avert a crisis altogether by immediately assisting the bank in distress through an injection of liquidity.

An important assumption is that the extent of the central bank's assistance capacity is restricted to just one bank in the system. This reflects the notion that accepting essentially worthless collateral in return for the support funds it provides leads to a significant deterioration of the overall quality of the assets held on the central bank's balance sheet (Buiter, 2008).

Importantly, in order to fulfil its mandate the central bank always has an incentive to save at least one bank. A failure of both banks leads to a collapse of the entire financial system, and results in an infinitely large economic loss.

Structure and Evolution of the Game

At $t = 0$ the central bank selects one of the three potential strategies outlined above. This decision is based on maximising the expected value of its value function for each strategy. This decision is then publicised and becomes common knowledge. The commercial banks determine the size of the interbank loan that maximise their expected terminal value given the central bank's policy. The gross interest rate ρ is specified, the transaction in the interbank market takes place, and the two banks make their investments.

Between $t = 0$ and $t = 1$ a shock determining the state of the economy occurs, and R_H realises at $t = 1$. If $R_H = R_H$, then $R_L = R_L$ in the subsequent period. In that case, both banks earn their expected returns, the risky bank repays the interbank loan together with the interest that it owes, and the central bank does not have to intervene, nor incurs any losses.

If the realisation of R_H at $t = 1$ is $R_H = 0$, the value of the risky bank's assets reduces to 0, and the path along which the subsequent events in the game evolve depends upon the strategy that the central bank has adopted. If the central bank decides not to respond to the failure of the risky bank's investment and allows the bank to be resolved, it incurs the cost associated with the loss of future output, together with the costs associated with the ensuing stress in the interbank market, so that:

$$\mathrm{L}_{\mathrm{CB,t=1}} = \Gamma + s \tag{3.13}$$

The latter cost can be mitigated if the central bank restricts its intervention to guaranteeing the interbank loan. Such a decision, however, implies that it incurs an additional cost equal to the value of the principal amount of the interbank loan, that is:

$$\mathrm{L}_{\mathrm{CB,t=1}} = \Gamma + i_t \tag{3.14}$$

Finally, the central bank can avoid incurring the cost of future output loss altogether by assisting the risky bank and providing it with enough capital to restore its balance sheet to its initial position while still guaranteeing its interbank obligations. The cost of such intervention is equal to the value of the bank's long-term liabilities and equity capital, net of the reserves it holds, so that:

$$\mathrm{L}_{\mathrm{CB,t=1}} = l + c + i_t - k_{u,t} \tag{3.15}$$

Using the balance sheet identity equation[6], and substituting $k_{u,t}$[7] the above cost becomes:

$$\mathrm{L}_{\mathrm{CB,t=1}} = a_t + \frac{1}{1+\kappa} i_t \tag{3.16}$$

The events at $t = 2$ depend on both the realisation of R_L, and the actions of the central bank at $t = 1$. If the prudent bank earns the expected return on its investment but the central bank does not take any action at $t = 1$, it is forced to write off its interbank position. If size of the interbank loan is large enough, writing it off will put the prudent bank in distress. The sufficient condition for distress to occur is for the value of the interbank loan to be greater than the net return the bank earns on its risky assets, namely:[8] [9]

$$\frac{\mathrm{R}_{\mathrm{L}} - 1}{R_L} a_t < i_t \tag{3.17}$$

If equation (3.17) holds, the central bank must provide the prudent bank with a capital injection equal to the value of the interbank loan less the net return the prudent bank earns, so that:

$$\mathrm{L}_{\mathrm{CB,t=2}} = i_t - (R_L - 1) \times (a_t - i_t) \tag{3.18}$$

In the adverse state of the economy, when $R_L = 0$, the central bank provides the prudent bank with enough capital to restore its balance sheet to its initial position, that is:

$$\mathrm{L}_{\mathrm{CB,t=2}} = l + c - k_{s,t} \tag{3.19}$$

or:

$$\mathrm{L}_{\mathrm{CB,t=2}} = a_t \tag{3.20}$$

The central bank's decision to guarantee the risky bank's obligations in the interbank market means that a part of the emergency capital injection the prudent bank requires in a bad state of the economy has already been provided at $t = 1$, changing the cost of assistance to:

[6] Based on the initial balance sheet, $l + c = a_t + \kappa a_t$.

[7] $k_{u,t} = \kappa \times \left(a_t + \frac{1}{1+\kappa} i_t\right)$.

[8] This is a reduced form of the inequality $(R_L - 1) \times (a_t - i_t) < i_t$.

[9] If this inequality does not hold, the prudent bank will be able to write off the interbank loan, and is not going to require any assistance from the central bank.

$$L_{CB,t=2} = a_t - i_t \tag{3.21}$$

Finally, the prudent bank is resolved in a bad state of the economy if the central bank decides to fully assist the risky bank at $t = 1$. This situation arises as the central bank has insufficient funds left to assist the prudent bank. Figure 1 depicts all the possible sequences of events, together with the costs that the central bank incurs in each state of the economy, as well as the payoffs to the two banks.

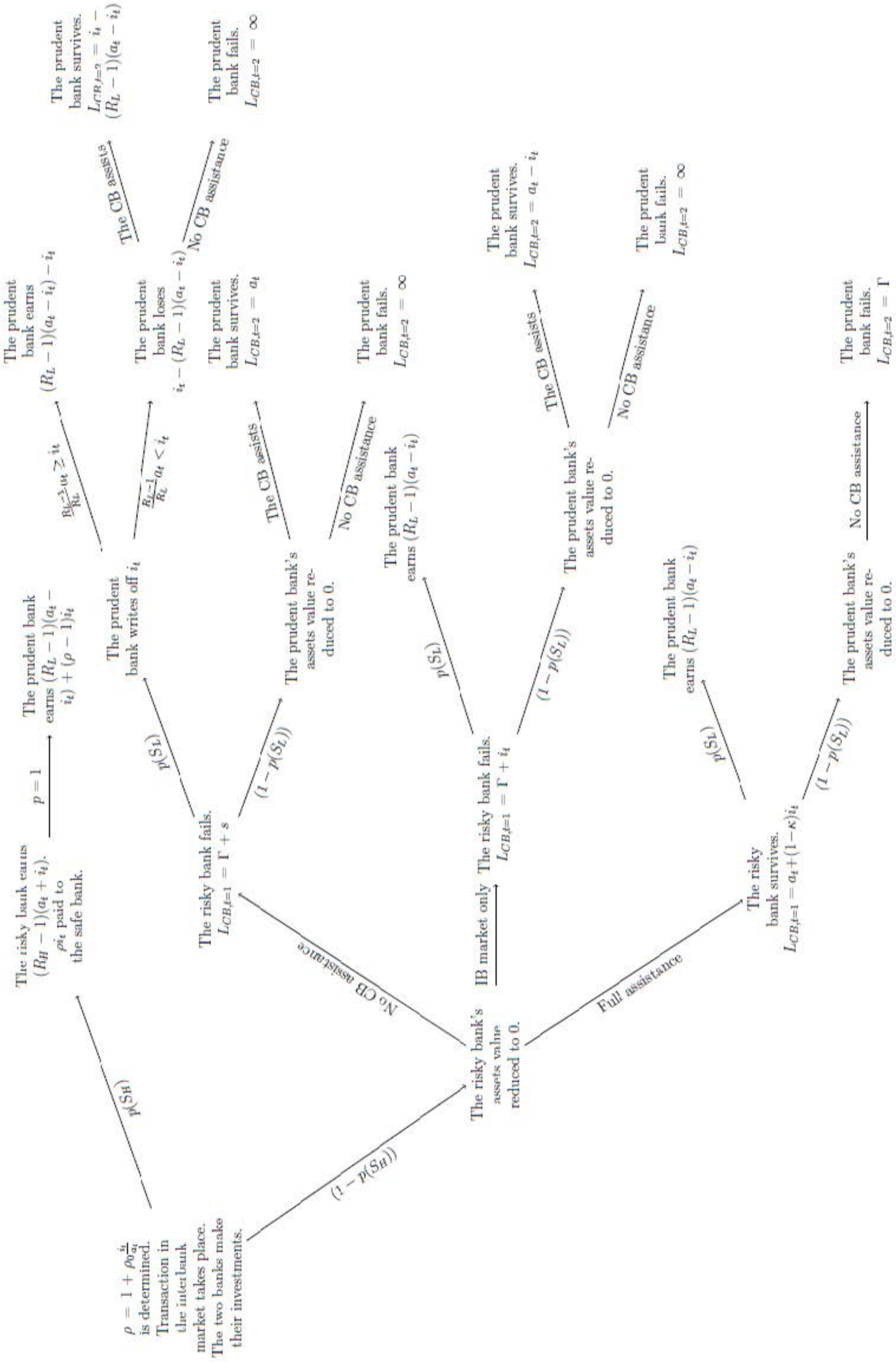


Figure 1: Event Tree

Solving the Model

To derive the optimal central bank policy we simulate the interactions in the model for plausible values of the specified parameters which we justify below. This approach also allows us to identify key decision-relevant factors for the central bank. Given the central bank's crisis response strategy chosen and publicised at $t = 0$, it is possible to identify the size of the interbank loan that maximises the terminal values of the two banks. We first derive the expected terminal values of the two banks for each of the three strategies, and then take first derivatives with respect to the size of the interbank loan.[10]

The results for the risky bank show that the optimal size of the interbank loan is constant regardless of the strategy selected by the central bank, and is given by:

$$i_{u,t} = \frac{R_H + \kappa}{2\rho_0(1+\kappa)^2} \tag{3.22}$$

The optimal size of the interbank loan for the risky bank depends positively on the level of returns it expects to earn, R_H, and is negatively related to the cost of borrowing in the interbank market, ρ_0, and the level of capital reserves, κ, the bank is required to maintain.

In the case of the prudent bank, the optimal size of the interbank loan it extends depends upon the strategy selected by the central bank. If the central bank decides on a non-intervention strategy at $t = 1$, this has different consequences for the prudent bank, depending on the relation between the size of the interbank loan and the prudent bank's net earnings.

When the size of the interbank loan exceeds the net earnings of the prudent bank, $\frac{R_L-1}{R_L}a_t < i_t$, the terminal value-maximising loan size function is given by:

$$i_{s,t} = \frac{R_L - 1}{2\rho_0(1+\kappa)} \tag{3.23}$$

For $\frac{R_L-1}{R_L}a_t \geq i_t$, the loan size function is given by:

$$i_{s,t} = \frac{R_L[p(S_H) + p(S_L) - p(S_H)p(S_L)] + [p(S_L) - p(S_H) - p(S_H)p(S_L)]}{2p(S_H)\rho_0(1+\kappa)} \tag{3.24}$$

In the adverse state of the economy, the terminal outcome for the prudent bank depends upon which of the remaining two strategies the central bank selects. However, as the repayment of the principal amount of the loan is guaranteed under either strategy, the loan size maximising the prudent bank's terminal value is the same in both cases, and is given by:

$$i_{s,t} = \frac{(R_L - 1)[p(S_H) + p(S_L) - p(S_H)p(S_L)]}{2p(S_H)\rho_0(1+\kappa)} \tag{3.25}$$

The prudent bank's decision depends not only on the factors that also drive the decision of the risky bank, but are additionally impacted by the probabilities that

[10] For details see Appendix A.

determine the state of the economy. Irrespective of which crisis response strategy the central bank selects, the optimal size of the interbank loan for the prudent bank is related to the level of expected return on its investment, R_L, the cost of borrowing in the interbank market, ρ_0, and the level of capital reserves, κ, in an identical fashion as the size of the interbank loan for the risky bank. However, in case of the strategies in which the repayment of the interbank loan is guaranteed by the central bank, the size of the interbank loan for the prudent bank also depends negatively on the unconditional probability that the economy will be in a good state, $p(S_H)$, and positively on the difference between the sum and the product of the two probabilities in the model.

An important constraint is that the risky bank cannot borrow more than the prudent bank is willing to lend, and *vice versa*. Thus, the actual size of the interbank loan is given by the minimum of the two optimal individual size functions:

$$i_t = min(i_{s,t}, i_{u,t}) \tag{3.26}$$

This mechanism also ensures that the expected terminal value of at least one of the two banks is maximised. The intersection of the two loan size functions corresponds to a simultaneous maximisation of their expected terminal values.

Simulation Experiments

The value of the functions described in the preceding section depend upon a number of fixed parameters together with the total capital ratio, κ, which can take any value between 0 and 1. In all the simulations below, the total capital ratio is treated as the independent variable.[11]

Baseline Simulation

Table 2 lists the selected parameter values for the baseline simulations. These values are chosen to constitute a reasonable reflection of those encountered in developed economies. Specifically, performance-related information available via Bloomberg Database and the FRED Database indicates that more risky banks have been generating return on equity in excess of 25%, while the safer ones of approximately 10%. We believe our assumed parameter values for R_H and R_L are, therefore, quite conservative. As reported by Damodaran (2015), the average annual rate of return of S&P 500 listed firms between 1928 and 2014 is approximately 10%, justifying our choice of the value for r. The choice of parameters α and β results in a probability of a successful investment by the risky bank of between 62.5% - 67.5%, reflecting the average cumulative five-year survival probability of a B-rated corporation (Hamilton and Cantor, 2006). Given the assumption about R_L, the likelihood of the prudent bank's success conditional on the risky one's failure, $p(S_L)$, reflects its greater financial soundness and resilience. This difference in the banks' risk profiles is further reflected in the values assigned to their respective discount factors, δ_s and

[11] All the simulations presented in this paper were undertaken using MatLab.

δ_u, which mirror the cost of equity capital reported by real banks. Finally, the choice of the value for s pertains to Brunnermeier and Pedersen's (2009) analysis of the 2007 - 2008 liquidity crunch, in which the initial losses of the financial sector were reported to be approximately 5% of stock market capitalisation. Our assumption of $s = 0.1$ thus corresponds to 5% of the total initial value of the commercial banking system in the model.

Fixed parameter values for the baseline simulations

Table 2

Parameter	Assumed value
R_H	1.2
R_L	1.05
r	0.1
ρ_0	0.5
α	-1
β	0.5
$p(S_L)$	0.7
δ_s	0.75
δ_u	0.2
s	0.1
r_p	0

The Interbank Loan Market

If the value of the interbank loan is lower than the net earnings of the prudent bank, $\frac{R_L-1}{R_L}a_t \geq i_t$, the prudent bank is able to absorb the losses suffered in the interbank market when the risky bank defaults on its loan obligations.

Figure 2 depicts the simulated optimal loan size, defined as that which maximises a bank's expected terminal value for a given level of capital reserve requirements and the loan size limit implied by the inequality in (3.17).

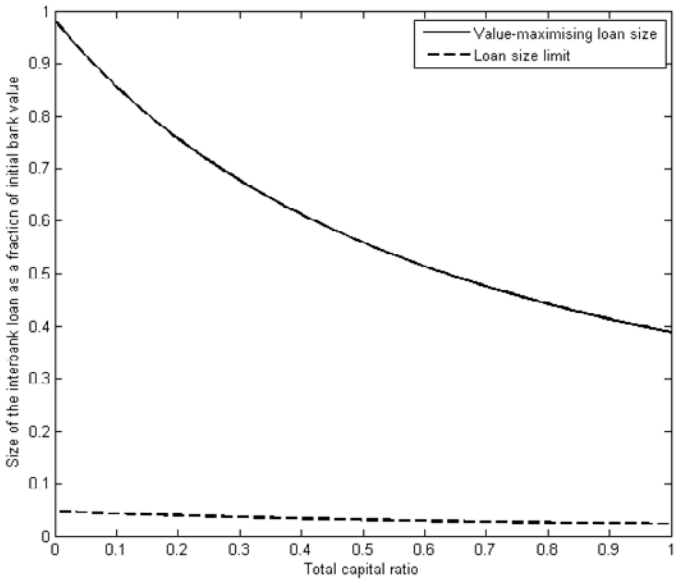


Figure 2: Optimal loan size for the prudent bank, subject to $\frac{R_L-1}{R_L}a_t \geq i_t$

The baseline results show that the prudent bank's optimal loan size exceeds the limit implied by its net earnings, and indeed that the difference between the two is substantial. We find that ρ_0, interpreted as the sensitivity of the net interest rate on the interbank loan to the amount of additional leverage the loan creates, must increase from its baseline value of 0.5 to almost 10, *ceteris paribus*, for $\frac{R_L-1}{R_L}a_t \geq i_t$ to hold. This implies that the net interest rate on a loan which increases the leverage of the risky bank by 1 percentage point should be 10%. Such degree of sensitivity, however, makes borrowing in the interbank market prohibitively expensive.

The results for the case of $\frac{R_L-1}{R_L}a_t < i_t$ are shown in Figure 3. Here the inequality holds, as the optimal loan size is above the limit implied by the prudent bank's net earnings. The conclusions for the situation where $\frac{R_L-1}{R_L}a_t \geq i_t$ also apply in this case, as increasing ρ_0 reduces the optimal loan size.

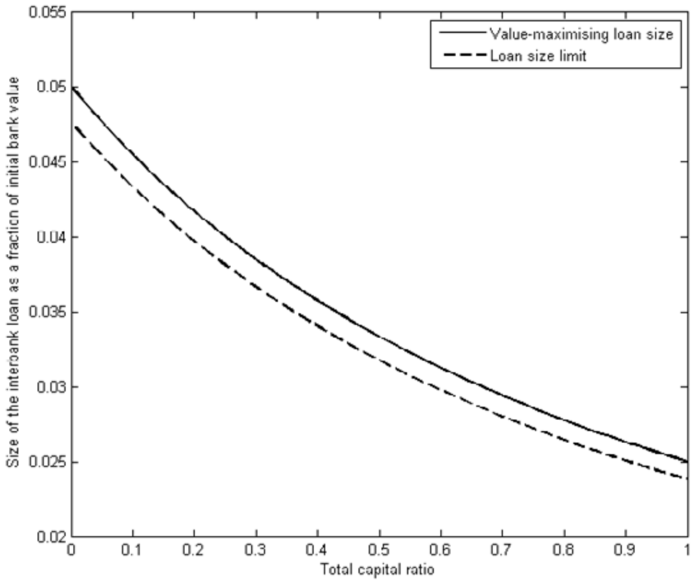


Figure 3: Optimal loan size for the prudent bank, subject to $\frac{R_L-1}{R_L}a_t < i_t$

Collectively, the two results illustrated in Figures 2 and 3 indicate that the prudent bank is able to absorb any losses in the interbank market only if the volume of lending in this market is small. Hence, we conclude that in a majority of cases, if the central bank does not act at $t = 1$, the prudent bank will always require its assistance at $t = 2$. This implies that its optimal loan size in this case is given by equation (3.23), and by equation (3.25) if the central bank decides to act.

We determine the volume of interbank market transaction, $i_t = min(i_{s,t}, i_{u,t})$, by comparing the prudent bank's optimal loan size functions with the amount the risky bank wishes to borrow. These are depicted in Figure 4.

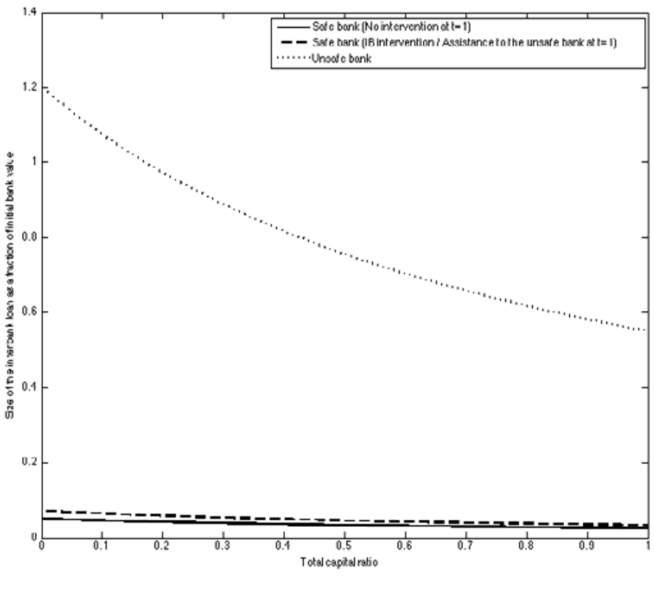


Figure 4: The optimal loan size functions of the prudent and the risky bank

Figure 4 confirms that for a plausible range of parameters, the size of the loan issued in the interbank market is always equal to that which maximises the expected terminal value of the prudent bank, $i_t = min(i_{s,t}, i_{u,t}) = i_{s,t}$. Indeed, we find that the two banks maximise their expected terminal values simultaneously only when R_H is reduced to a level very close to R_L, and ρ_0 is also substantially decreased.

The Central Bank's Value Function

We present the baseline results for the central bank's value function for the three defined strategies in Figure 5.

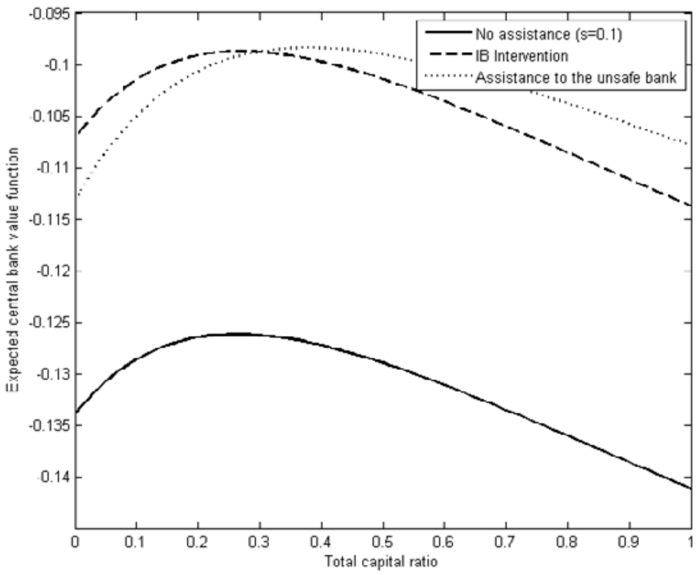
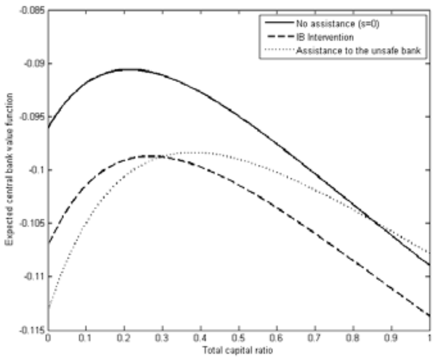


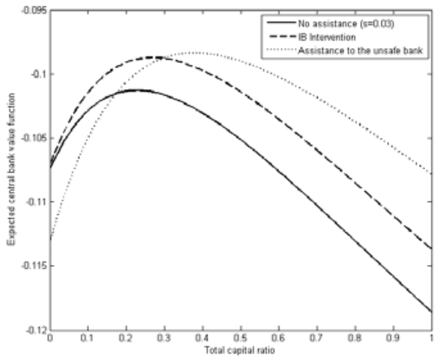
Figure 5: Baseline results for the central bank's strategies

The central bank's expected value function for all three strategies is convex, implying there exists an optimal level of capital requirements which maximises its objective function in all cases. Each function is also asymmetric, with marginal benefits accruing from increasing capital requirements towards their optimal level greater than the marginal costs of increasing them beyond it. Moving towards that optimal level, however, yields diminishing marginal benefits in each case.

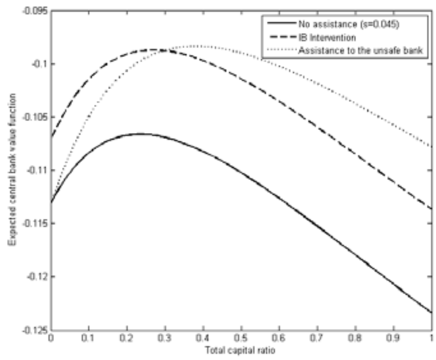
Figure 5 suggests that a strategy of no intervention at $t = 1$ generates the worst policy outcome for the central bank. Note that this result is sensitive to the assumption that the economy incurs additional costs arising from stress in the interbank market which may impair the efficiency of the monetary transmission mechanism. We find that if this cost is minimal ($s = 0$) this strategy actually becomes the most preferable option for the central bank, a result illustrated in Figure 6a. Furthermore, as shown in Figures 6b and 6c, we identify $s = 0.03$ and $s = 0.045$ as critical levels of that cost, changing the central bank's preference for one strategy over the remaining two. These results indicate that the introduction of an alternative mechanism supporting the efficient functioning of the interbank market in crisis conditions, other than an explicit guarantee of interbank loan repayments, would affect the central bank's strategic policy preferences. The regulatory liquidity standards introduced in the Third Basel Accord, requiring financial institutions to hold enough highly-liquid assets to meet their short-term financing needs in stressed market conditions, are one example of a mechanism which could help to reduce the costs generated by an impairment of the interbank market's functioning during a crisis.



(a) $s = 0$



(b) $s = 0.03$



(c) $s = 0.045$

Figure 6: Expected central bank's value function for different level of s

Figure 6c demonstrates that the additional cost of $s = 0.045$ is sufficient to make the outcome of the strategy of no assistance at $t = 1$ worse than those in which the central bank guarantees the repayment of the interbank loan. For that reason, we consider this strategy is likely to be inferior to the remaining two.

We compare the baseline results for central bank intervention in the interbank market at $t = 1$ to guarantee the interbank loans, with further assisting the risky bank by restoring its balance sheet in Figure 7.

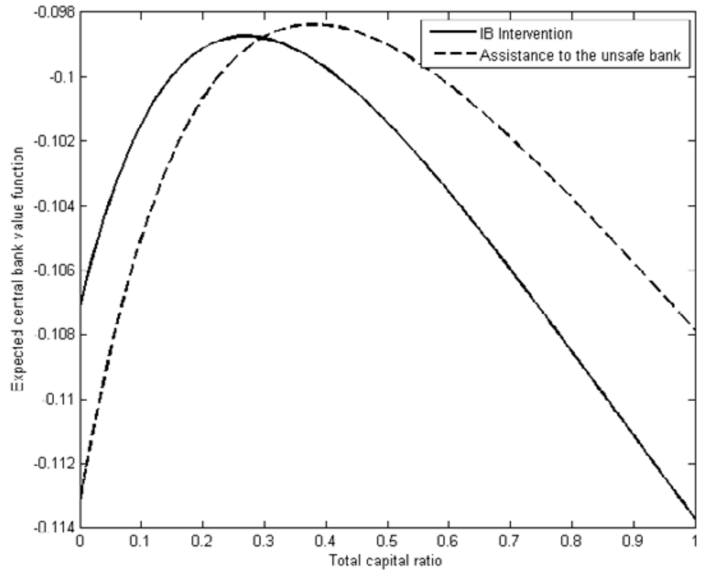


Figure 7: Effects of loan guarantee intervention in the interbank market, compared with providing full assistance to the risky bank at $t = 1$

Restoring the balance sheet of the risky bank at $t = 1$ leads to a superior outcome for the central bank, as its expected value function is maximised at a higher level. This, however, is achieved for a level of capital requirements that is approximately 15 percentage points higher than in the situation where central bank intervention is restricted to guaranteeing loans in the interbank market. In effect, the capital reserves of the risky bank must be sufficiently high, thereby serving to at least partially counterbalance its riskiness in order for the central bank to find it optimal to provide balance sheet assistance.

This preference for assisting the risky bank arises for two reasons. First, even though the central bank guarantees the repayment of the principal amount of the interbank loan in both strategies, it expects the risky bank to eventually repay any assistance it receives.[12] If, however, the central bank only intervenes in the interbank market to guarantee loans, that amount of assistance becomes a pure loss. Second, the schedule of costs incurred by the central bank in each of the two strategies is different. The costs of assisting the risky bank which are incurred at $t = 1$ are lower than those of intervening in the interbank market.[13] Although interbank market intervention results in a smaller loss at $t = 2$, this loss is only incurred in the adverse state of the economy. Consequently, the degree to which the $t = 2$ loss affects the central bank's expected value function and its strategic preferences depends on the unconditional probability of the occurrence of an adverse state.

Modifying the assumptions about the parameter values determining the size of the interbank loan (ρ_0), and the unconditional probability of the adverse state of the economy ($p(S_L)$) has implications for the central bank's preference for one strategy

[12] The discount factors applied to the repayment of emergency funding provided to a commercial bank reflect both the probability of repayment and the time a bank will require to return the funds.

[13] Intervention in the interbank market: $L_{CB,t=1} = a_t + i_t$ at $t = 1$, and $L_{CB,t=2} = a_t - i_t$at $t = 2$; Assisting the risky bank: $L_{CB,t=1} = a_t + (1 - \kappa)i_t$ at $t = 1$, and $L_{CB,t=2} = a_t$ at $t = 2$.

over the other. Figures 8 and 9 depict the effects of reducing the size of the interbank loan, and of increasing the unconditional probability of the adverse state, respectively. Both modifications make intervening in the interbank market to guarantee the loan repayments the strategy which results in the best outcome for the central bank. A lower volume of interbank lending reduces the costs of assisting the bank in distress, as well as the pure loss the central bank incurs if it guarantees the loan repayment, thereby increasing the maximum value of the expected central bank value function and reducing the optimal level of capital requirements.

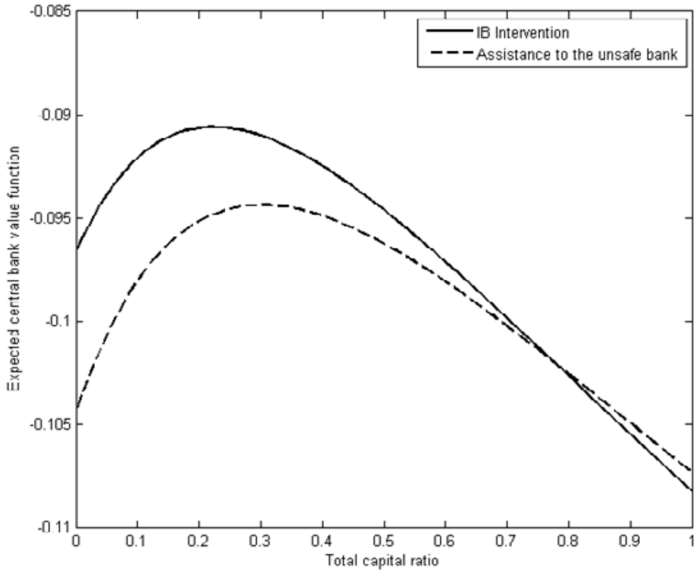


Figure 8: Expected central bank value function based on a smaller interbank loan (ρ_0 ↑)

Conversely, a higher probability of an adverse state of the economy increases the costs the central bank expects to incur. This leads to a higher optimal level of capital requirements. However, the maximum value of the expected central bank value function decreases by less if it confines its intervention to the interbank market, as the $t = 2$ loss associated with this strategy is lower than that resulting from assisting the risky bank instead.

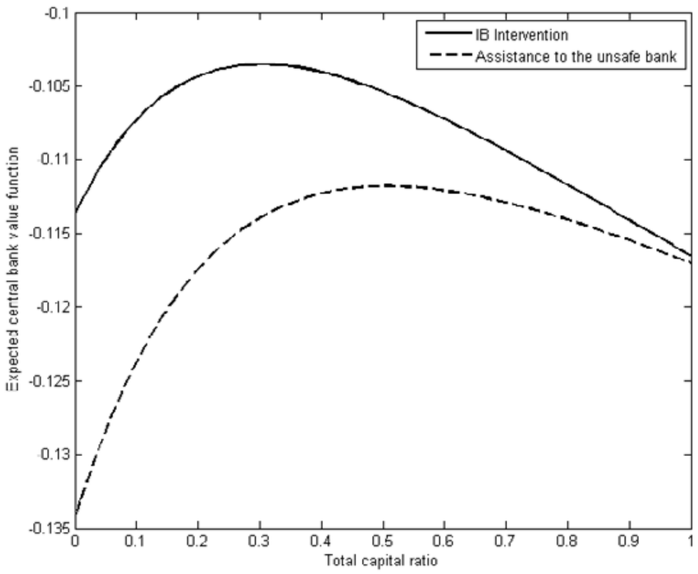


Figure 9: Expected central bank value function based on a higher unconditional probability of a bad state of the economy ($p(S_L)\downarrow$)

We also identify the central bank's perception of bank riskiness to be an important factor in determining its preferred strategy. The discount factor applied to the repayment of the emergency funding reflects both the time necessary to return the funds provided by the central bank, as well as the default risk of the assisted institution. If the central bank perceives the risky bank to be even riskier than it is in the baseline simulation, the discount factor (discount rate) applied to it will be lower (higher).

We find that changing the discount factor's value from $\delta_u = 0.2$ to $\delta_u = 0.15$ is sufficient for the intervention in the interbank market to become the strictly dominant strategy, a result we illustrate in Figure 10. This implies that the central bank will opt for the safer alternative of intervening in the interbank market and assisting the prudent bank if it believes that the risky bank is likely to default in the future despite receiving emergency funding, or that it will require a very long time to return the funds provided.

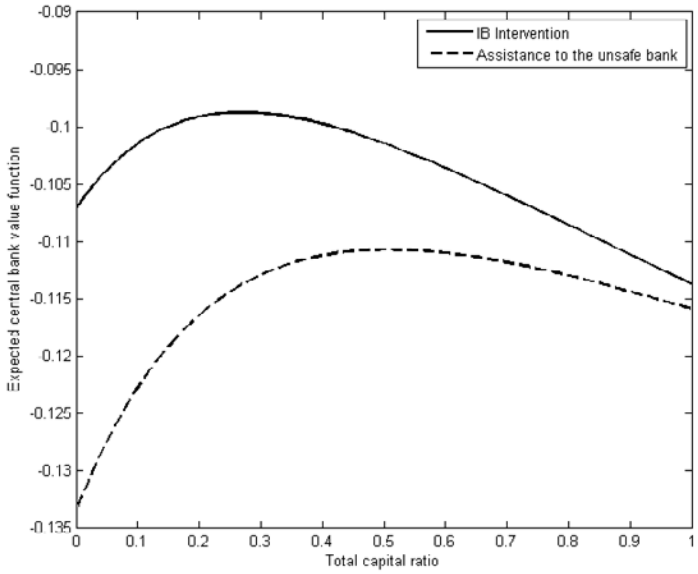


Figure 10: Expected central bank value function based on a lower risky bank's discount factor ($\delta_u \downarrow$)

Finally, the central bank may also consider charging a penalty rate, corresponding to additional interest the assisted institution has to pay on the funds provided. This is illustrated in Figure 11.

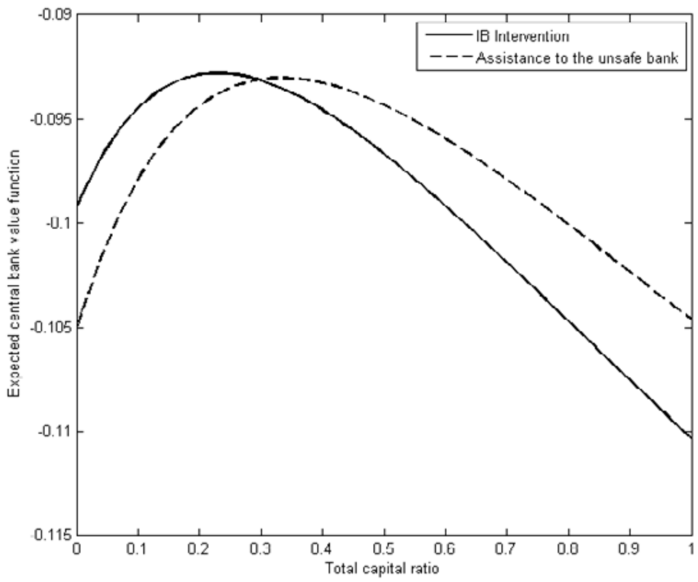


Figure 11: Expected central bank value function with an additional penalty rate on liquidity assistance

The simulation results show that introducing a penalty rate on emergency liquidity assistance increases the maximum values of the central bank's objective function, and lowers the optimal level of capital requirements. Moreover, it also serves to make intervention in the interbank market more likely to be the preferable strategy for the central bank. Effectively, the additional funds the central bank expects to receive compensate it for the losses it incurs guaranteeing the principal of the interbank loan, and thus impacts upon the ordering of its preferences.

Comparative Statics

Table 3 below produces comparative statics showing how the nature of the central bank's expected value function, and the optimal level of the capital requirements change when the assumptions concerning the levels of the fixed parameters are increased.

Comparative statics

Table 3

Change in value assumption	$E[V_{CB}]$	κ maximising V_{CB}
$R_H \uparrow$	$\uparrow$	$\downarrow$
$R_L \uparrow$	$\uparrow$	$\downarrow$
$r \uparrow$	$\uparrow$	$\downarrow$
$\rho_0 \uparrow$	$\uparrow$	$\downarrow$
$\alpha \uparrow$	$\uparrow$	$\downarrow$
$\beta \uparrow$	$\downarrow$	$\uparrow$
$p(S_L) \uparrow$	$\uparrow$	$\downarrow$
$\delta \uparrow$	$\uparrow$	$\downarrow$
$s \uparrow$	$\downarrow$	$\uparrow$
$r_p \uparrow$	$\uparrow$	$\downarrow$

The effects of modifying parameters ρ_0, δ, s, or r_p are discussed in detail in the preceding subsection. Increasing R_H, R_L, or r all influence the central bank's value function in the same way. They all lead to a higher expected economic output without changing the central bank's expected losses. These expected gains and losses, however, also depend on the probabilities determining the state of economy. Increasing α and $p(S_L)$ raises the unconditional probabilities of the economy being in a good or a neutral state, in which the investments of the banks are successful. If the probability that the economy is in a good state is more sensitive (higher β) to the amount of reserves held by banks, then the optimal level of capital requirements is also going to be higher. However, this results in a larger opportunity cost of regulation, thus reducing the maximum value of the central bank's objective function.

Discussion

We believe the predictions arising from the model we outline have a number of important implications for a central bank's financial stability policy design. Crucially, our results emphasise the importance of a central bank's proactiveness in achieving the objectives of a macroprudential financial policy. Positioned at an intersection of financial markets and the real economy, central banks can identify adverse changes in the condition of the financial system, here reflected in interbank market conditions, faster than other market participants or policymakers, and gauge their impact on the real economy more accurately. As reflected by the policy implications discussed below, this superior information plays a key role in determining the appropriate design of a central bank's policy.

First, our results imply there is a trade-off between the nature and scope of a central bank's response to a banking crisis, and the level of capital reserves financial institutions are required to hold. A bank's risk appetite is affected both by its assistance expectations, and by the capital requirements with which it has to comply. The absence of an implicit guarantee that the central bank will help in a crisis enhances market discipline, while high capital requirements make riskier investment more costly.

We find that the optimal level of capital requirements increases with the scope of the central bank's commitment to intervene at $t = 1$. The baseline results show that the central bank's expected value function is maximised at a lower level of capital reserves when it only intervenes in the interbank market than if it assists the risky bank by restoring its balance sheet. This suggests that financial stability policy should be based on active management of assistance expectations, and setting capital requirements accordingly. Our model shows that a strict commitment to limiting the scope of the central bank's intervention in response to a crisis and requiring financial institutions to hold high capital reserves may be economically wasteful.

Further, as shown in Figure 7, when comparing the effects of interbank loan guarantee intervention and of providing full assistance to the risky bank at $t = 1$, there exists a level of regulatory capital requirements at which the value functions associated with the two strategies intersect. At the switch level of capital reserves, the central bank considers the two alternative strategies to be equally effective in achieving its objective. Importantly, this has further consequences for the central bank's policy decision if the regulatory bank capital reserves ratio is set at a different level to that which maximises its value function. Should the specified level of capital reserves be sufficiently greater (lower) than the one for which the two value functions intersect, the central bank can increase the expected value of its policy pre-commitment by a prior commitment to an alternative intervention policy instead. For example, the central bank can achieve a better outcome by announcing a commitment to providing full assistance to the risky bank rather than by limiting its intervention to interbank loan guarantee if the regulatory capital reserves the commercial banks need to hold exceed the level for which it is indifferent between the two strategies, and *vice versa*. Since the individual sizes of the interbank loans that maximise the expected terminal values of the two commercial banks are the same for each of the two strategies, such decision would not affect their investment policy but would result in a better expected outcome for the entire economic system. While an accurate identification of the preference switch level of regulatory capital may be difficult in practice due to the uncertainty in measuring or estimating variables determining the expected central bank value function, as long as the levels of reserve requirements that maximise the two expected value functions are of a similar order of magnitude, the potential welfare loss stemming from a commitment to a suboptimal intervention policy is not substantial. This uncertainty also implies that the central bank's preference for one strategy over the other may be affected by the reputation it wishes to uphold.

Second, the results support the use of countercyclical capital buffers. The optimal level of capital requirements is an indicator of the relative importance of bank reserves given the set of conditions assumed in the simulation. Our results show that the significance of capital buffers in enhancing the central bank's value function increases with the unconditional probability of a bad state of the economy, irrespective of how the central bank responds to a crisis. Since banks have no access to external financing, the higher capital requirements in the bad state can only be met through a fire sale of assets. A fire sale, however, leads to further depreciation of the value of a bank's remaining assets. This problem can be potentially addressed by the adoption of countercyclical capital buffers.

We identify three key factors a central bank should consider in deciding whether to confine its intervention activity to the interbank market only, or to step in early and assist the risky bank. These factors are: the volume of activity in the interbank market, the unconditional probability that the economy will find itself in an adverse state, and an accurate assessment of the level of insecurity of the risky bank.

Our baseline results suggest that assisting the risky bank is the preferable strategy for the central bank. The optimal level of capital reserves in that scenario may be so high, however, that it is possible this would impair the banks' ability to perform their core function of liquidity creation and credit provision. This finding reflects Diamond and Dybvig's (1986) argument that financial stability policy motivated solely by macroeconomic concerns may undermine the primary reason for the existence of banks. We find that an introduction of penalty rates charged by the central bank on liquidity assistance gives some way to alleviating this problem.

Finally, our paper emphasises the importance of a central bank's commitment to averting system-wide financial contagion through the interbank market. The widespread use of interest rate derivatives by non-financial firms has created a new channel linking the stability of the financial system to that of the entire economy. As of the end of 2014, interest rate contracts account for more than 80% of OTC derivatives traded globally, with a notional amount outstanding of more than $500,000 billion (Bank for International Settlements, 2015).

Furthermore, a well-functioning interbank market is crucial for efficient transmission of monetary policy or of emergency liquidity injections. Severe stress in that market will impair a central bank's ability to achieve its policy objectives. Our simulations suggest that an additional cost created by stress in the interbank market equivalent to just 4.5% of the initial value of banking system assets is sufficient for the policy of no assistance to become the least preferable strategy for the central bank, reflecting the spirit of the discussion above.

Conclusions

Following the financial crisis of 2007 - 2009 defining the objectives of a central bank's financial stability policy has become less clear-cut, and continues to be a subject of an ongoing academic and policy debate.

An increasingly complex and interconnected economic system places a central bank at an intersection of monetary and fiscal policies, as a lender of last resort, a supervisor, and regulator of the banking sector, with additional responsibilities for monitoring the interbank money market (Freixas and Parigi, 2014).

Our model identifies the volume of interbank lending, the relative riskiness of the banks in the financial system, and the probability of the crisis becoming systemic as the key factors relevant for a central bank's financial stability policy design. Furthermore, the model highlights the importance of upholding the stability of the interbank money market for the security of the entire economic system.

Finally, our results establish the existence of a substitution effect between the scope of a central bank's assistance to an institution in distress, and the level of capital requirements. We find that active management of banks' assistance expectations yields similar results to changing capital requirements. An ill-designed financial stability policy that does not strike the right balance between the two, however, may result in significant economic costs.

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Appendix A: Derivation of the Interbank Loan Size Functions

The Risky Bank

a) No Central Bank Assistance

If the central bank provides no assistance to the risky bank at $t = 1$ it earns its expected returns with probability $p(S_H)$, and 0 otherwise. As a result, its expected terminal value is given by

$$E[V_{u,T}] = p(S_H) \times \left[R_H \left(a_t + \frac{1}{1+\kappa} i_t\right) - \rho i_t + k_{u,t}\right] \tag{A.1}$$

b) Central Bank Assistance:

Should the central bank decide to assist the risky bank at $t = 1$ and provide sufficient funding to restore the bank's balance sheet to its initial position, the bank's terminal value is equal to $a_t + \kappa a_t$. Consequently, its expected terminal value of the risky bank is given by

$$\begin{aligned} E[V_{u,T}] = p(S_H) \times &\left[R_H \left(a_t + \frac{1}{1+\kappa} i_t\right) - \rho i_t + k_{u,t}\right] \\ &+ [1 - p(S_H)](a_t + \kappa a_t) \end{aligned} \tag{A.2}$$

As the additional term in equation (A.2) is independent of i_t, both (A.1) and (A.2) provide the same value for the size of the interbank loan which maximises the expected terminal values of the risky bank.

Therefore:

$$E[V_{u,T}] = p(S_H) \times \left[R_H \left(a_t + \frac{1}{1+\kappa} i_t\right) - \rho i_t + k_{u,t}\right] \tag{A.3}$$

Since $\rho = 1 + \rho_0 \frac{i_t}{a_t}$,

$$\begin{aligned} E[V_{u,T}] = p(S_H) \times &\left[R_H \left(a_t + \frac{1}{1+\kappa} i_t\right) - \left(1 + \rho_0 \frac{i_t}{a_t}\right) i_t \right. \\ &\left. + \kappa \left(a_t + \frac{1}{1+\kappa} i_t\right)\right] \end{aligned} \tag{A.4}$$

Taking the first derivative with respect to i_t:

$$\frac{\partial E[V_{u,T}]}{\partial i_t} = p(S_H) \times \left[R_H \frac{1}{1+\kappa} - 2\rho_0 \frac{i_t}{a_t} + \frac{\kappa}{1+\kappa}\right] \tag{A.5}$$

Setting the first derivative equal to zero:

$$0 = p(S_H) \times \left[R_H \frac{1}{1+\kappa} - 2\rho_0 \frac{i_t}{a_t} + \frac{\kappa}{1+\kappa}\right] \tag{A.6}$$

$$i_t = \frac{(R_H + \kappa) a_t}{2\rho_0 (1+\kappa)} \tag{A.7}$$

Since $a_t = \frac{1}{1+\kappa}$,

$$i_t = \frac{R_H + \kappa}{2\rho_0 (1+\kappa)^2} \tag{A.8}$$

This indicates the size of the interbank loan that maximises the expected terminal value of the risky bank regardless of which strategy the central bank selects.

The Prudent Bank

a) No Central Bank Assistance:

If the central bank decides not to intervene at $t = 1$ the effects on the prudent bank's terminal value depend on whether the inequality $\frac{R_L - 1}{R_L} a_t < i_t$ holds. Two cases are relevant.

For $\frac{R_L - 1}{R_L} a_t \geq i_t$, the net earnings of the prudent bank exceed the value of the interbank loan to be written off, resulting in the following expected terminal value:

$$\begin{aligned} E\left[V_{s,T}\right] = {} & p(S_H) \times \left[R_L(a_t - i_t) + \rho i_t + k_{s,t}\right] \\ & + [1 - p(S_H)]p(S_L)\left[R_L(a_t - i_t) - i_t + k_{s,t}\right] \\ & + [1 - p(S_H)][1 - p(S_L)][a_t + \kappa a_t] \end{aligned} \tag{A.9}$$

As last term in equation (A.10) is independent of i_t, the size of the interbank loan which maximises the expected terminal value of the risky bank can be computed as:

$$\begin{aligned} E\left[V_{s,T}\right] = {} & p(S_H) \times \left[R_L(a_t - i_t) + \rho i_t + k_{s,t}\right] \\ & + [1 - p(S_H)]p(S_L)\left[R_L(a_t - i_t) - i_t + k_{s,t}\right] \end{aligned} \tag{A.10}$$

which is equivalent to:

$$\begin{aligned} E\left[V_{s,T}\right] = p(S_H) \times \Bigg[& R_L a_t - R_L i_t + i_t + \rho_0 \frac{i_t^2}{a_t} + \kappa a_t \\ & - p(S_L)[R_L a_t - R_L i_t - i_t + \kappa a_t] \Bigg] \\ & + p(S_L)[R_L a_t - R_L i_t - i_t + \kappa a_t] \end{aligned} \tag{A.11}$$

It follows, by taking the first derivative with respect to i_t and setting it equal to zero:

$$\begin{aligned} \frac{\partial E\left[V_{s,T}\right]}{\partial i_t} = {} & R_L[p(S_H)p(S_L) - p(S_H) - p(S_L)] \\ & + [p(S_H)p(S_L) + p(S_H) - p(S_L)] + 2p(S_H)\rho_0 \frac{i_t}{a_t} \end{aligned} \tag{A.12}$$

$$\begin{aligned} 0 = {} & R_L[p(S_H)p(S_L) - p(S_H) - p(S_L)] + [p(S_H)p(S_L) + p(S_H) - p(S_L)] \\ & + 2p(S_H)\rho_0 \frac{i_t}{a_t} \end{aligned} \tag{A.13}$$

$$i_t = \frac{\left[R_L[p(S_H) + p(S_L) - p(S_H)p(S_L)] + [p(S_L) - p(S_H) - p(S_H)p(S_L)]\right]a_t}{2p(S_H)\rho_0} \tag{A.14}$$

Since $a_t = \frac{1}{1+\kappa}$,

$$i_t = \frac{R_L[p(S_H) + p(S_L) - p(S_H)p(S_L)] + [p(S_L) - p(S_H) - p(S_H)p(S_L)]}{2p(S_H)\rho_0(1 + \kappa)} \tag{A.15}$$

Equation (A.16) denotes the size of the interbank loan that maximises the expected terminal value of the prudent bank if the central bank decides not to intervene at $t = 1$, and the prudent bank's net earnings are sufficient to enable it to write off the interbank loan.

For $\frac{R_L-1}{R_L} a_t < i_t$, the prudent bank's net earnings are not sufficient to absorb the loss associated with writing off the interbank loan. It therefore requires the central bank's assistance in both the neutral and the bad state of the economy. Consequently, its terminal value function is given by the following expression:

$$E[V_{s,T}] = p(S_H) \times [R_L(a_t - i_t) + \rho i_t + k_{s,t}] + [1 - p(S_H)](a_t + \kappa a_t) \qquad \text{(A.16)}$$

Taking the first derivative with respect to i_t and setting it equal to zero:

$$\frac{\partial E[V_{s,T}]}{\partial i_t} = p(S_H)\left[-R_L + 1 + 2\rho_0 \frac{i_t}{a_t}\right] \qquad \text{(A.17)}$$

$$0 = p(S_H)\left[-R_L + 1 + 2\rho_0 \frac{i_t}{a_t}\right] \qquad \text{(A.18)}$$

$$i_t = \frac{(R_L - 1)a_t}{2\rho_0} \qquad \text{(A.19)}$$

Since $a_t = \frac{1}{1+\kappa}$,

$$i_t = \frac{R_L - 1}{2\rho_0(1 + \kappa)} \qquad \text{(A.20)}$$

Equation (A.21) gives the size of the interbank loan that maximises the expected terminal value of the prudent bank if the central bank decides not to intervene at $t = 1$, and the prudent bank's net earnings are insufficient to enable it to write off the interbank loan.

b) Central Bank Intervenes in the Interbank Market:

If the central bank decides to intervene in the interbank market it provides the prudent bank with the principal amount of the interbank loan in the neutral state, and assists it in the bad state, resulting in the following expected terminal value function:

$$\begin{aligned} E[V_{s,T}] &= p(S_H) \times [R_L(a_t - i_t) + \rho i_t + k_{s,t}] \\ &\quad + [1 - p(S_H)]p(S_L)[R_L(a_t - i_t) + i_t + k_{s,t}] \\ &\quad + [1 - p(S_H)][1 - p(S_L)](a_t + \kappa a_t) \end{aligned} \qquad \text{(A.21)}$$

Taking the first derivative with respect to i_t and setting it equal to zero:

$$\frac{\partial E[V_{s,T}]}{\partial i_t} = [p(S_H) + p(S_L) - p(S_H)p(S_L)](-R_L + 1) + 2p(S_H)\rho_0 \frac{i_t}{a_t} \qquad \text{(A.22)}$$

$$0 = [p(S_H) + p(S_L) - p(S_H)p(S_L)](-R_L + 1) + 2p(S_H)\rho_0 \frac{i_t}{a_t} \qquad \text{(A.23)}$$

$$i_t = \frac{[p(S_H) + p(S_L) - p(S_H)p(S_L)](R_L - 1)a_t}{2p(S_H)\rho_0} \qquad \text{(A.24)}$$

Since $a_t = \frac{1}{1+\kappa}$,

$$i_t = \frac{(R_L - 1)[p(S_H) + p(S_L) - p(S_H)p(S_L)]}{2p(S_H)\rho_0(1 + \kappa)} \qquad \text{(A.25)}$$

Equation (A.26) depicts the size of the interbank loan that maximises the expected terminal value of the prudent bank if the central bank decides to intervene in the interbank market at $t = 1$.

c) Central Bank Assists Risky Bank at $t = 1$:

Finally, if the central bank assists the risky bank at $t = 1$, the prudent bank will to receive the principal amount of the interbank loan in the neutral state, and will be resolved in the bad state, as the central bank only assists one commercial bank. Consequently, its expected terminal value is given by the following function:

$$\begin{aligned} E\left[V_{s,T}\right] = p(S_H) \times \left[R_L(a_t - i_t) + \rho i_t + k_{s,t}\right] \\ + [1 - p(S_H)]p(S_L)\left[R_L(a_t - i_t) + i_t + k_{s,t}\right] \end{aligned} \tag{A.26}$$

This function's first derivative with respect to i_t is equivalent to (A.23). As a result, the optimal size of the loan if the central bank assists the risky bank at $t = 1$ is given by equation (A.26).

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The impact of market structure and the business cycle on bank profitability: does the SCP paradigm work?

A case study in Poland prior to and during the financial crisis[1]

Małgorzata Pawłowska, Narodowy Bank Polski (Poland)

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 or the central banks and other institutions represented at the meeting.

The impact of market structure and the business cycle on bank profitability: does the SCP paradigm work? A case study in Poland prior to and during the financial crisis

Małgorzata Pawłowska[1]

Abstract

The aim of this study is to examine the impact of banking-sector structure and macroeconomic changes on bank profitability in the Polish banking sector over the past fifteen years (i.e., prior to and during the global financial crisis of 2008). The model developed in this paper incorporates the Structure-Conduct-Performance (SCP) hypothesis, as well as the Relative Market Power Hypothesis (RMP) created by Smirlock (1985). Furthermore, this paper also examines the overall effect of financial structure and macroeconomic conditions to determine whether financial development and business cycles affect the profit of Polish banks. Finally, this paper tests the impact of foreign capital on the profitability of Polish banks and attempts to determine if there is a link between the context of the parent banks and the profitability of their affiliates.

Empirical results based on two panel data sets describing both micro-level and the macro-level data are ambiguous, and find evidence of RMP hypothesis, as well as the traditional SCP, in the Polish banking sector. This paper also finds that increased foreign ownership and intermediation (i.e., grater loans in total assets) have a positive effect on bank profitability. Furthermore, this paper finds a positive correlation between the context of parent banks and the profitability of their affiliates. As in other countries, the profitability of commercial banks in Poland are contingent upon the business cycle.

JEL: F36; G2; G21; G34; L1.

Keywords: bank profitability, concentration, market power, market structure, Lerner index, Polish banks, business cycle, foreign banks.

[1] Warsaw School of Economics, National Bank of Poland. The views expressed in this paper are the views of the author and do not necessarily reflect those of the National Bank of Poland.

Contents

Introduction

The profitability of banks is a subject of great interest in bank management, financial markets, bank supervisions, and academics. This interest is driven by increasing consolidation within the banking sector, changes in production technology and macroprudential policy. Identifying the determinants of bank performance is an important predictor of unstable economic conditions. Profitable banking systems are likely to absorb negative shocks, thus maintaining the stability of the financial system.

The aim of this study is to estimate the impact of market structure on the performance of banks in the Polish sector throughout the past fifteen years (i.e., prior to and during the financial crisis of 2008). In order to test the traditional Structure-Conduct-Performance (SCP) hypothesis, this paper empirically investigates the effect of market structure as it relates to profitability with a particular focus on whether banks that are operating in concentrated markets generate more profit or not. This paper, besides the traditional SCP hypothesis, tests the Relative Market Power (RMP) hypothesis created by Smirlock (1985). He posited that there is no relationship between concentration and profitability but rather between a bank's market share and its profitability. This paper also examines whether financial development and business cycles affect the profit of Polish banks. Furthermore, due to that fact that the consolidation processes are correlated with the changing ownership structure in the Polish banking sector, this paper also tests the impact of foreign capital on the profitability of Polish banks. Finally, this paper attempts to determine if there was a link between the context of parent banks and the profitability of their affiliates.

In order to carry out a quantitative assessment this study is divided into two investigations that were conducted on two different panels - panels A and B. Both panel data sets combine micro- and macro-statistical data sets for Polish commercial banks as well as macroeconomic data covering cyclical factors and macroeconomic environment. Panel A consists of yearly data combining a statistical data set for Polish commercial banks as well as information about the macroeconomic environment for the period 1997–2012. Panel B consists of quarterly data combining a data for Polish commercial banks and their parent banks as well as information about the macroeconomic environment for the period 2007Q1–2013Q2. Micro - level data for Polish commercial banks was received from the National Bank of Poland (balance sheets and profit and loss accounts) and micro - level data for their parent banks was received from the Bankscope database[2]. For two of the panel data sets - panels A and B respectively, macroeconomic data was received from Polish Central Statistical Office (CSO) and

[2] The Bankscope database was created by Bureau van Dijk-Electronic Publishing.

Eurostat. The degree of competition within the Polish banking sector was estimated using the Lerner indices for yearly data, and the change of concentration within the Polish banking industry was analysed using the Herfindahl-Hirschman indices (HHI). Profitability in the Polish banking sector was analysed using the return on assets ratios (ROA).

This study consists of two parts and a summary. The first part is a broad literature review concerning the relationship between bank profit, market structure, and the degree of competition. The second part consists of three parts: the first part describes the structural and technological changes within the Polish banking sector that lead to changes in profitability. The second part presents the results of the analysis of panel A data and the third part presents the results of the analysis of panel B data. The summary provides an overview of the empirical results and the conclusions that were drawn.

1. Relationship between Bank Profitability, Market Structure and Degree of Competition

In recent years there have been ongoing debates concerning the economic role of market structure and competition within the banking industry. Accordingly, the competition between banks and profitability of the banking sector is of interest not just at the individual bank level; rather, it is crucial at a broader macroeconomic level. The SCP model developed by Bain (1951) describing the relationship between the market structure, company conduct and performance. The SCP model assumed that in a more concentrated system leads to less competition and hence to higher profitability (cf. Berger (1995). Smirlock (1985) tested an alternative explanation for these results, and he posited that there is no relationship between concentration and profitability, but rather between bank market share and bank profitability and created the relative market power hypothesis (RMP). The other one theory is the Efficiency Structure Hypothesis (ESH) that was developed by Demsetz (1973). The ESH theory states that if banks enjoy a higher degree of efficiency than their competitors, they can increase shareholder value or gain market share by reducing their prices. According to the ESH, concentrated markets are those where highly effective firms (banks) operate. Higher bank profitability with high market shares do not result from their power (size) but from higher X-efficiency, which creates their power. In SCP paradigm and a theory based on ESH, concentration ratios (i.e., Herfindahl-Hirschman (HHI)) indices[3]) are used to explain competitive performance in the banking industry. However, subsequent results of analyses based on the SCP paradigm have shown that the relationship between the structure of the market and conduct is even more complex.

[3] The HHI is calculated as the sum of the squared market shares of each firm in a market in terms of assets. It ranges from 0 to 1.

The Industrial Organization Approach to Banking (IOAB)) is a theory concerned with the issue of measuring competition in the banking sector and defines the following measures of competition: the Lerner index,[4] the H-statistic,[5] and the Boone-indicator[6] (cf., Degryse et al., 2009, Van Hoose D. (2010), Bikker and Leuvensteijn, 2014). The Lerner index was used in this paper for evaluating competition within the Polish banking sector.

A large number of studies have already dealt with the determinants of bank profitability on the banking structure level and broader macroeconomic level. The analyses focus primarily on microeconomic or bank-specific drivers of profitability, based on mainly variables like size and cost management (efficiency). Number of studies examined the influence of the market structure based on SCP paradigm. A positive relationship between concentration and profitability was reported i.a. by Demirguc-Kunt and Huizinga (2000), Molyneux and Thornton (1992), Goddard et al. (2004), which confirm the traditional SCP hypothesis. However, Mirzaei et al. (2011) and Maudos and Guevara, (2004) confirmed the relative market-power hypotheses (RMP). ESH hypothesis by contrast, was confirm by i.a. Claeys and Vander Vennet, (2008).

Most of the studies focusing on macroeconomic influences on profitability of banks find that the business cycle has a positive influence on the development of bank profitability and also find a positive correlation between bank profitability and inflation (i. a. Albertazzi and Gambacorta, 2009; Bikker and Hu, 2002; Demirgüç-Kunt and Huizinga, 2000, Rumler and Waschiczek 2010). However, there is not a lot of work taking into account the relationship between the profitability of the parent banks and situation of their affiliates, and this paper fills this gap.

2. Banking Structure, Business Cycle and Profitability of Banks – panel data analysis

2.1. Structural and Technological Changes in the Polish Banking Sector

The profitability of commercial banks in Poland in the fifteen years (prior to and during the financial crisis) was influenced by a large number of internal and external factors: consolidation, technological processes, Poland's accession to the European Union and the real economy. The consolidation in the Polish banking sector led to changes in concentration measured with the HHI ratios (see figure 1 in the Appendix 1). After a significant decreased in the profitability of commercial

[4] The Lerner Index measures the so-called monopoly mark-up. According to the Lerner index, the market power of a monopoly depends on the price elasticity of market demand. The increasing value of the Lerner Index indicates a decrease in competition.

[5] Panzar and Rosse defined the measure of competition, known in the literature as the H-statistic. The increasing value of the H-statistic indicates an increase in competition.

[6] The Boone method is based on the so-called efficient structure (i.e., hypothesis ESH) (cf., Pawłowska (2011).

banks between 2001 and 2003 (related to the economic slowdown), there was a clear improvement in profitability. The improvement in banks' profitability ratios return on assets (ROA) and return on equity (ROE) was facilitated by, among others, a decrease in the share of non-performing loans[7]. The slight decrease in profitability indicators within the period of 2008–2009 was caused by the global financial crisis. The period of 2010-2012 was the sovereign debt crisis in the Eurozone. However, in this period profitability of Polish commercial banks improved again (see figure 4 in the Appendix 1). Furthermore, in comparison to the other EU countries Polish banks performed very well.

When analyzing the processes that took place in the Polish banking sector over the past 15 years it should be noted that privatization led to an increase in the share of foreign capital in the Polish banking sector. As of the end of 2012, the share of banks with predominantly foreign capital was approximately 65% whereas at the end of 1997 it was approximately 15%. However the share of foreign capital between 2008-2014 decreased slightly. The fact that some of banks being on the list of G-SIFIs[8], are parent-banks of banks operating in Poland is of significance for profitability of Polish banking sector (e.g., Unicredit Group and Crédit Agricole Group).

Currently, the Polish banking sector is relatively small in comparison to the other EU worth 85% of the country's GDP[9] and has relatively simple traditional business models.

2.2 Empirical Results

In order to test the traditional SCP hypothesis and RMP hypothesis, and impact of the macroeconomic changes on Profitability of Banks in Poland, this study consists of two investigations.

The first investigation is based on yearly data from 1997 to 2012 (panel A) and the second investigation is based on quarterly data (panel B) covering the period of the financial crises and debt crisis 1997Q4–2013Q2. This data was obtained for all commercial banks operating in Poland (i.e., Polish banks, subsidiaries of foreign institutions, and branches of foreign banking institutions). Both of the panel data sets combine micro-level data for Polish commercial banks and macro-level statistical data covering cyclical factors. This study uses a variety of microeconomic indicators stemming from the bank data to capture changes in the economic framework, including balance sheet and income statement figures from the National Bank of Poland balance sheet statistics[10]. Additionally, panel B data consists of quarterly data from the Bankscope database, which is a source of valuable information

[7] Since Poland's accession to the EU the classification of non-performing loans changed to a less restrictive classification, for instance for sub-standard receivables from 1 to 3 months into from 3 to 6 months, for doubtful receivables from 3 to 6 months into from 6 to 12 months, for lost receivables from above 6 months to above 12 months. See NBP (2004).

[8] List of G-SIFIs is updated each year in November by the Financial Stability Board.

[9] Polish Financial Supervision Authority, 2013.

[10] Panel data sets take into account mergers and acquisitions in the Polish banking sector. The numbers of banks are presented after accounting for mergers and acquisitions, with the acquiring institution treated as a new entity.

about foreign parent institutions of the Polish affiliates. The micro-level data from Bankscope was merged with data on the Polish banking institutions.

Macroeconomic data on the growth of GDP and inflation in Poland come from the Polish Central Statistical Office (CSO). Panel B also includes macro-level data from Eurostat concerning GDP growth in the parent banks' country.

In order to test the traditional SCP hypothesis and RMP hypothesis, model estimation was performed separately to avoid any alignment of variables in both panels A and B.

2.2.1 Panel A (yearly data set, prior to and during the financial crisis) - the baseline model

In order to carry out a quantitative assessment of the impact of market structure on the banking profitability in the Polish banking sector, GMM[11] estimator was used based panel A. In the model, as profit indicator return on assets was used (ROA). Also the model distinguish between market structure and relative market power.

The following regression with ROA as the dependent variable was calculated as follows:

$$ROA_{it}=\alpha_1+(1+CRI)(a_1 market\ structure_{it}+a_2 market\ power_{it})+a_3 business\ cycle_t+\sum_{j=1}^{N} b_j oth_{it}+\varepsilon_{it} \quad (1)$$

where ROA_{it} denotes the return on assets ratio for each bank *i* for each year *t*.

Market structure measures are determined by taking the competition measure from the Lerner index average *(LAv_t)* for each year *t* and the variable indicating concentration ratio, the Herfindahl-Hirschman index for assets (HHI_t) for each year *t*. Additionally, as a proxy of market structure the regression also estimated the variable indicating the share of banks with majority of foreign equity *(FC_t)* for each year *t*. *Market power* measures were calculated as:

- the share of bank assets in the total assets *(MP_{it})* for each banks *i* for each year *t,*
- the Lerner Index (LI_{it})[12] for each banks *i* for each year *t*.

The model also tests the impact of the size on the banking sector profitability, as the relative market power measure:

- the size is calculated as the log of the total assets (LA_{it}) for each banks *i* for each year *t*.

Also, model control the impact of financial crisis on relation between profitability and market structure and market power, therefore in regression was used control dummy variable (*CRI)* that takes the values of 1 if t>2007 and zero elsewhere.

The model also tests the impact of *business cycle* on banks profitability define as:

- CPI index (CPI_t) and GDP growth yoy (GDP_t) and for each year *t*.

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[11] Dynamic panel data model, based on the first difference.

[12] See: Pawłowska (2014).

In regression were used control variables (oth_{it}) such as:

- the ratio of total deposit to total assets (DTA_{it}), for each banks *i* for each year *t*,
- the ratio of total loans to total assets, as a measures of the magnitude of disintermediation tendencies (LTA_{it}), for each banks *i* for each year *t*,
- the variable indicating efficiency of banks define as interest cost divided by total interest income (CTI_{it}) for each banks *i* for each year *t*.

The variable α is a constant term, ε_{it} denotes the error, and a_1, a_2, a_3 and b_j are the regression coefficients.

In table 3 in the Appendix 2, for the whole analysing period, the positive coefficients (a_1 and a_2) are find in regressions 2-4. It means that traditional SCP paradigm may exists. However, based on Panel A, this paper find that during the crisis, the size and relative market power have greater impact of profitability of Polish commercial banks then market structure. Prior to and during the crisis, in regression 1 and 4 coefficients a_1 for HHI as a measure of market structure is insignificant.

This paper find positive impact of the share of foreign capital on profitability of Polish banks, also during the crisis (estimation 5). What is important, that in each estimation based on Panel A, this paper find, negative and significant impact on cost to income ratio on profitability. It means that better cost management load to better profitability of banks, which may also support efficiency structure hypothesis. Also, based on Panel A, this paper find, positive and significant impact on the ratio of total loans to total assets on profitability (estimations 4 and 5). This means intermediation (i.e., grater loans in total assets) have a positive effect on bank profitability.

Generally crisis had negative impact of bank profitability, but during the crises the most important factor was the relative market power. It should be noted that, for the whole analysing period this paper find that profitability of banks is procyclical. This paper find the positive coefficients (a_3) between GDP growth and inflation in regressions 1-5.

2.2.2 Panel B (quarterly data set, during the financial crisis)

In order to carry out a quantitative assessment of the impact of banking sector structure on the banking profitability in the Polish banking sector during the crisis, the quarterly data set was used, based on panel B, and also GMM estimator.

The following baseline model with ROA as the dependent variable was calculated as follows:

$$ROA_{it} = \alpha + a_1 market\ structure_{it} + a_2 market\ power_{it} + a_3 business\ cycle_{t} + \sum_{j=1}^{N} b_j\, oth_{it} + \varepsilon_{it} \quad (2)$$

where ROA_{it} denotes the return on assets ratio for each bank *i* for each quarter *t*[13].

Market structure measure was defined as:

- the concentration ratio such as Herfindahl-Hirschman index for assets (HHI_t) for each quarter *t*.

Also in this model was defined the size of the banking sector: as the log of total assets of the whole banks ($Size_t$) for each quarter *t*.

Market power, the relative market power measure, was defined as:

- the share of bank assets in the total assets (MP_{it}), for each bank *i* for each quarter *t*.
- the share of bank loans in the total loans (ML_{it}). for each bank *i* for each quarter *t*.

Also, as the relative market power measure, the model also tests the impact of the size on the banks on profitability, which was defined as: the log of total assets (LA_{it}) for each bank *i* for each quarter *t*.

In the model was also estimated the dummy variables indicating the foreign ownership:

- the dummy (*FO*) that takes the values of 1 if banks is foreign-owned and zero elsewhere, for each bank *i* for each quarter *t*.

The model also tests the impact of business cycle on banks profitability during the crisis. The variable *business cycle* was define as: GDP_t growth (yoy) and inflation growth (CPI_t) for each quarter *t*.

In regressions were also used control variables (oth_{it}):

- the ratio of total deposit to total assets (DTA_{it}), for each bank *i* for each quarter *t,*
- the ratio of total loans to total assets, as a measure of the magnitude of disintermediation tendencies (LTA_{it}), for each bank *i* for each quarter *t,*
- the core capital ratio (CAR_{it}) ratio, as an indicator of bank's risk behavior (the higher the capital ratio, the greater the risk aversion), for each bank *i* for each quarter *t,*
- and the share of housing foreign currency loans to the household sector in total loans ($FXHL_{it}$) as an indicator of banking sector development, for each bank *i* for each quarter *t*.

In table 4 in the Appendix 2, positive coefficient (a_1) are find only in regressions 3. However, positive and significant coefficients (a_1) was find for variable *Size*. Also, positive and significant coefficients (a_2) was find for relative size (*LA*) in regression 2-4.

However, relative market power – measured in terms of the individual institution's share in total domestic lending (*MPL*) and measured in terms of the individual institution's share in total assets (*MP*) – had no significant influence on the profitability indicators in analyzed in this study. Also based on Panel B this paper find positive impact of foreign capital on profitability, the results indicate a significant correlation between the profit, and the dummy variables for, majority foreign owned banks (estimations 4 and 5).

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[13] To determine the robustness, additional estimations were calculated with the return on equity *(ROE)* for each banking sector *i* for each year *t*, as a dependent variable. The results were very similar.

Of the microeconomic control variables, the ratio of core capital to risk weighted assets was found to have a significant and negative influence on bank profitability. Bank size – measured in terms foreign currency lending negative and significant influence on profitability. The findings indicate that foreign currency loans did not positively contribute to banks' profitability. Similar to results based on panel A, results based on Panel B indicate the positive correlation between intermediation (i.e., grater loans in total assets) and banks profitability. However surprisingly, also similar to panel A, results indicate the negative coefficient between the ratio of total deposit to total assets and profitability.

Generally, for the whole analysing period this paper find positive correlation between, GDP growth and inflation (*CPI*), and profitability of banks. It means that profitability of banks is procyclical.

Impact of situation in parent banks on profitability of their affiliates

Furthermore, the paper also test impact of condition of parent banks on profitability of their affiliates. In this case was estimated additional regressions based on data from Panel B with using GMM estimator. ROA of banks with majority of foreign capital was the dependent variable in this model, where $ROAf_{it}$ denotes the return on assets ratio for each bank with majority of foreign equity i for each quarter t.

The model tests the impact of business cycle in parent country on foreign banks profitability during the crisis. The variable *business cycle* was define as GDP growth in parent country, and was taken from Eurostat *(parent_GDP)*. In regressions were also used the following control quarterly variables (oth_{it}) from Bankscope database institutions of the Polish affiliates for each bank with majority of foreign equity i for each quarter t: *parent_Total_Capital_Ratio* - the capital ratio of foreign parent institutions of the Polish affiliates, *parent_Net_Loas_to_Assets* – net loans to assets ratio of foreign parent institutions of the Polish affiliates, *parent_ROA* – ROA ratio of foreign parent institutions of the Polish affiliates.

In table 5 in the Appendix 2, the positive coefficient (a_1) is find. It means that GDP growth in the parent country of the bank operating in Poland has a significant and positive impact on their profitability in Poland. Also ratio of net loans to assets of foreign parent institutions of the Polish affiliates (*parent_Net_Loas_to_Assets*) has positive influence of the profitability of bank operating in Poland. It means that generally disintermediation tendencies in European banks has negative impact of profitability of their affiliates. Negative impact of parent total capital ratio (*parent_Total_Capital_Ratio*) it may means that a higher capital ratio on average did not prevent higher profitability. This result is also relevant for the current economic policy debate about future regulatory requirements for the banking sector. However, ROA ratio of foreign parent institutions of the Polish affiliates *(parent_ROA)* is insignificant in the model.

Conclusions

In order to test the traditional SCP hypothesis and the RMP hypothesis prior to and during the Global Financial Crisis, this paper empirically investigated the effects of market structure and market share on the profitability of Polish banks based on two panel data sets for the two time periods (i.e., prior to and during the crisis - panel A and panel B only during the crisis). This paper also empirically investigated the impact of other bank-specific characteristics and the macroeconomic environment on the profitability of Polish banks, particularly the impact of foreign capital.

All empirical results based on two panel data sets, for the most part, are confirmed the RMP hypothesis but when verifying the traditional SCP hypothesis, the empirical results are ambiguous. On the one hand, this paper demonstrate a positive or insignificant correlation between profitability and market structure indicating by HHI ratio, and for the most estimations the positive and significant correlation between profitability and market power as well as between profitability and the size of the bank, prior to and during the crisis (based on panel A data). This result was supported in more detail with the quarterly information during the crisis, based on panel B. What is important, based on panel A, that in each estimation we find a negative and significant impact between the cost to income ratio and profitability. This means that better cost management leads to better profitability in banks.

Of the microeconomic control variables based on other bank-level specific characteristics from panel B, the core capital ratio was found to have a significant negative influence on bank profitability. Furthermore, the findings indicate that foreign currency loans, did not positively contribute to banks' profitability. This paper found a positive correlation between intermediation (i.e., grater loans in total assets) and bank profitability in both panel data sets. However, this paper found a negative coefficient between the ratio of total deposits to total assets and profitability.

The regression results, based on panel A, showed that banks have generally benefited from a change of ownership structure during the past fifteen years. Also, the detained quarterly data found in panel B shows that foreign capital was a stabilizing mechanism during the crisis. This paper finds a positive correlation between the context of parent banks and the profitability of their affiliates. Those results support the fact that geographical diversity with parent institutions and different characteristics of their Polish affiliates help the local financial system to remain relatively vigorous throughout the global financial crisis (Pawłowska, Serwa, & Zajączkowski, 2015).

Finally, bank profitability are strongly influenced by cyclical developments, and this paper found a positive correlation between GDP growth and bank profit for both panel data sets - the same effect was found for CPI indices. Also, based on the Bankscope database, this paper found a positive correlation between GDP growth and bank profits in the parent country.

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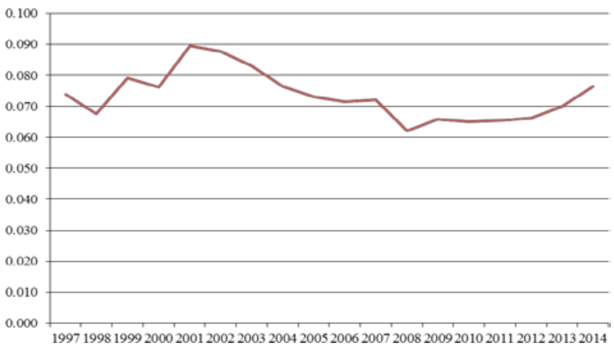
Appendix 1

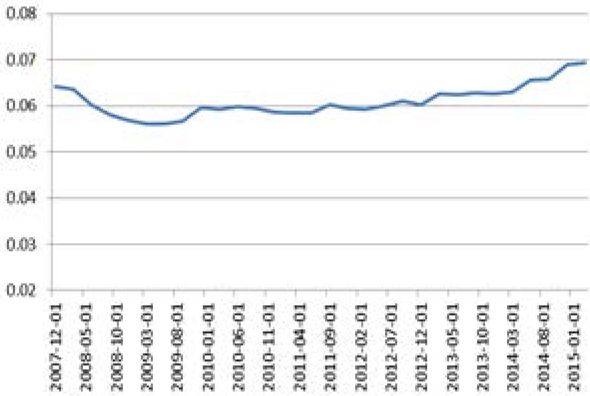
Figure 1: Concentrations in the Polish banking sector

HHI



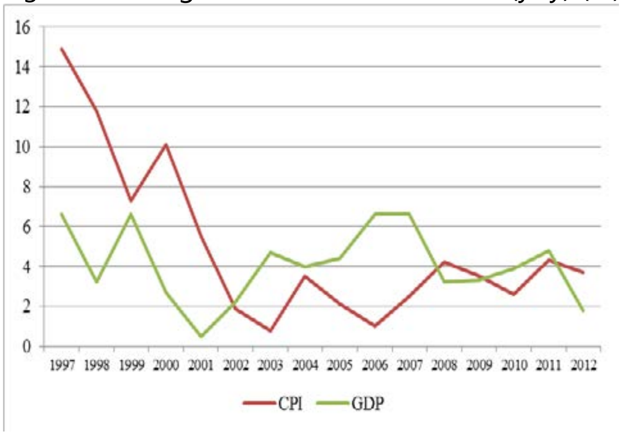
Source: PFS and own calculations.

HHI (quarterly)



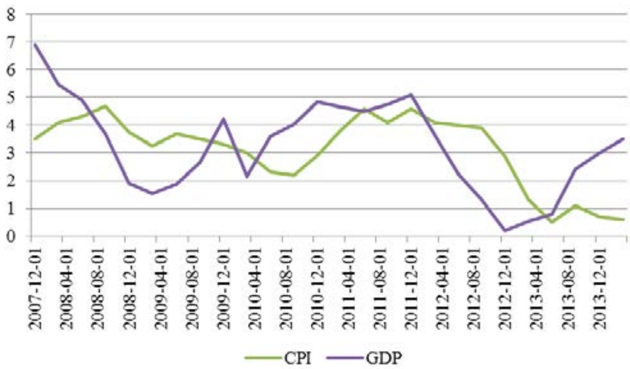
Source: NBP and own calculations. HHI index was seasonal adjusted.

Figure 2: GDP growth and Inflation rate (yoy) (%)



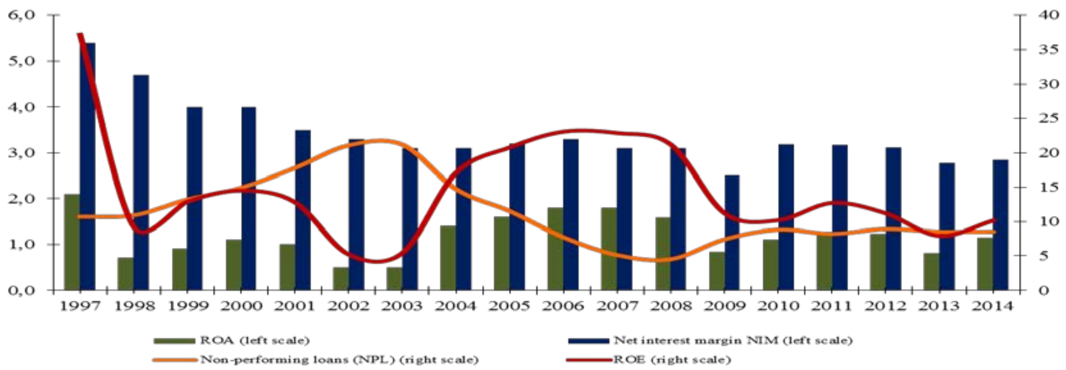
Source: CSO.

Figure 3: GDP growth and Inflation rate (yoy quarterly) (%)



Source: CSO.

Figure 4: Commercial Banking Sector's Profitability Indicators in Poland



Source: NBP and own calculation.

Appendix 2

Table 1: Panel A Summary Statistics on the Characteristics of Polish banking sector structure and balance sheet data

This table provides summary statistics (mean, min, max and standard deviation (SD)) for all variables in the model. Data are observed yearly 1997-2012 for each Polish commercial banks.

	All Banks			
	Mean	SD	Min	Max
Observations	1978			
Dependent Variable				
Balance sheet data (for each bank *i* and year *t*)				
ROA Ratio (%)	-0.004372	0.1183983	-1.345672	1.148604
Independent Variables:				
Market Structure				
Balance sheet data for each year *t*				
HHI	0.0734929	0.0078982	0.0620602	0.0894186
Lerener Av[1]	0.2251663	0.0602216	0.116554	0.3069982
Share of Forign Capital (%)	58.28561	19.25915	15.3	72.3
Market Power				
Balance sheet data (for each bank *i* and year *t*)				
MP Ratio (%)	0.0145719	0.0294166	1.94e-06	0.197598
Log Assets (size)	14.37138	2.101532	6.864837	19.07505
Lerener Index	0.1938524	0.2280034	0.0125002	3.912896
Bank-Specific Variables				
Balance sheet data (for each bank *i* and year *t*)				
Total Loans/Assets (%)	15.23042	3.212855	6.864837	25.34692
Total Deposit/Assets (%)	0.4173208	0.4128244	0	6.4821
Interest Cost/Interest Income (%)	0.7750329	3.14585	0	75.73241
Macroeconomics				
Data for each year *t*				
GDP	4.0505	1.81972	0.5	6.6
CPI	5.4792	4.166438	0.8	14.9

Source: own calculations on the basis of NBP and CSO data. [1]Average of the Lerner index for each year was normalized (see Pawłowska 2014).

Table 2: Summary Statistics on Bank Characteristics for Panel B (quarterly data)

This table provides summary statistics (mean and standard deviation for bank balance sheets data and macroeconomics data). Data are observed quarterly 2007Q4–2013Q2.

1. Data for All sample

	All Banks				Banks with majority of Foreign capital			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Observations	1634				1407			
Dependent Variables:								
Balance sheet data (for each bank *i* and quarter *t*)								
ROA Ratio(%)	-0.02455	0.20185	-2.86388	0.81991	-0.0279	0.2178	-2.8639	0.8199
ROE Ratio(%)	0.020114	0.20185	-4.731094	0.48876	0.01802	0.21173	-4.73109	0.4047
Independent Variables:								
Balance sheet data for each quarter *t*								
Market Structure								
Balance sheet data for each quarter *t*								
HHI	0.059575	0.002153	0.05599	0.06412	0.05957	0.00215	0.05599	0.06413
Log Size of Banking Sector	27.68921	0.158017	27.3304	27.8992	27.6892	0.15798	27.3305	27.8992
Market Power								
Balance sheet data (for each bank *i* and quarter *t*)								
MP Ratio (%)	0.014539	0.027114	1.42e-1	0.16214	0.01236	0.022408	1.42e-1	0.16213
ML Ratio (%)	0.014539	0.027267	0	0.17197	0.01230	0.021413	0	0.15757
Log Assets (size)	21.69478	2.438546	12.0695	26.0074	21.4947	2.492519	12.0694	25.7244
Bank-Specific Variables								
Balance sheet data (for each bank *i* and quarter *t*)								
Tier1 Ratio (%)	0.182737	0.1653909	0.0054	3.14585	0.17869	0.161253	0.00538	3.14584
Total Loans/Assets (%)	0.777339	0.2256738	0	1.47161	0.79578	0.227887	0	1.47160
Total Deposit/Assets (%)	0.346451	0.3381435	0	2.52977	0.3411	0.330231	0	2.52977
FXHousingLoans/Assets (%)	0.085851	0.1521338	0	0.65490	0.08676	0.1559	0	0.65490
Macroeconomics								
Data for each quarter *t*								
GDP	3.278261	1.75493	0.2	6.9	3.27721	1.75502	0.2	6.9
CPI	3.408696	1.02258	0.5	4.7	3.40863	1.02233	0.5	4.7

Source: own calculations on the basis of NBP and CSO data.

2. Data for Parent Banks

	Mean	SD	Min	Max
Observations	1257			
Independent Variables:				
parent Net Loans/Assets (%)	52.27033	23.10678	0.005	99.251
parent_Total_Capital_Ratio (%)	14.16492	5.224161	7	56.6
parent_ROA (%)	0.477185	0.866871	-6.36	8.958
parent_ROE (%)	6.934040	9.598102	-129.584	42.196
parent_loan_loss_ratio (%)	2.734991	1.982544	0.021	12.44
parent_GDP	0.1164969	2.770955	-9.2	7.9

Source: own calculation on the basis of Bankscope and Eurostat.

Table 3. Results for the Panel A

This table provides empirical results for data are observed yearly 1997-2012.

Variables	Estimate (1)	Estimate (2)	Estimate (3)	Estimate (4)	Estimate (5)
L1.ROA	0.1291524***	0.1848878***	0.1397995***	0.1828694***	0.2213944***
Market structure					
HHI_t	0.004034	0.0183837*	-	-	-
LAv_t	-		0.1567493**	-	-
FC_t	-		-	0.0006266**	0.1567493
Market power					
MP_{it}	-	1.057503*		1.020856**	-
LI_{it}	-			-	0.155171***
LA_{it}	0.0272884***	-	0.023718***	-	-
Macroeconomics					
GDP	-	0.012952***	0.0090024***	-	-
CPI	0.0069283***	-	-	0.0075206***	0.0020774**
Bank-Specific Variables					
CTI_{it}	-0.0040247**	-0.004425**	-0.0039121**	-0.004188***	-0.009632***
LTA_{it}	-	-	-	0.0087123**	0.0097125***
DTA_{it}	-0.000698	-0.000392	0.0005646	-	-
			Impact of the crysis:		
Market structure					
*HHI_t*CRI*	-0.0014337	0.0642391	-	-	-
*Lm_t*CRI*	-			-	-
*FC_t*CRI*	-	-	0.2813902	0.0000411	0.0066043***
Market power					
*MP_{it}*CRI*	-	0.4018004		0.4831009	-
*LI_{it}*CRI*	-	-		-	-0.1312851**
*LA_{it}*CRI*	0.0136843**	-	0.0151119***	-	-
Binary variable					
CRI	-0.2350996*		-0.3315409**	-0.0329648*	-0.4615208***
const	-1.138948**	1.183***	-1.307023***	-0.833817***	1.183***
Sargan test	0.2625	0.3081	0.2524	0.2700	0.0592
Time Period			1997-2012		
Number of observations	963	963	896	963	963
Number of groups	117	117	111	117	117

Source: author's calculations. ***/**/* indicate significance at the 1/5/10% level respectively.

Table 4. Results for the Panel B

This table provides empirical results for data are observed quarterly 2007Q4–2013Q2.

Variables	Estimate (1)	Estimate (2)	Estimate (3)	Estimate (4)	Estimate (5)
L1.ROA	0.734351***	0.7206154***	0.877926***	0.6548425***	0.6526878***
Market structure					
HHI	-4.567491	0.4545575	0.617823***	1.767206	3.145156
Size	0.200488**	-	-	-	-
Market power					
MP	-	0.556646	-	-	-
ML	1.017407	-	-0.0946574	-	-
LA	-	-	-	0.058173***	0.0581294***
Foreign ownership					
FO	-0.0475637	-0.016291	-	0.2766389**	0.3084672***
Macroeconomics					
GDP	-	0.0023232	-	-	0.0028546**
CPI	-0.0016897	-	0.0009523**	0.0496***	-
Bank-Specific Variables					
LTA	-	0.1969856***	-	0.0497474**	-
DTA	-0.0371561***	-	-0.017174***	-	-0.080709**
CAR	-	-	-0.013356***	-	-
FXHL	-	-0.0246905	-	-0.780618**	-0.752328**
const	-5.254702	-0.1833865	-0.0270513	-0.0270513	-1.62991
Sargan test	0.1698	0.1465	0.0408	0.2524	0.0097
Time Period			2007Q4-2013Q2		
Number of observations	1231	1231	1231	1231	1231
Number of groups	86	86	86	86	86

Source: author's calculations. ***/**/* indicate significance at the 1/5/10% level respectively. All variables were seasonal adjusted.

Table 5. Impact of Situation in Parent Banks on Profitability of Foreign Banks in Poland: results based on the Panel B

Variables	Estimate
L1.ROAf	0.8000654***
Macroeconomics - *business cycle in parent country*	
parent_GDP	0.0045741***
Bank-Specific Variables *in parent country*	
parent_Total_Capital_Ratio	-0.0061702*
parent_Net_Loas_to_Assets	0.0025147***
parent_ROA	0.0067614
const	-0.091345
sargan test	0.0021
Time Period	2007Q4-2013Q2
Number of observations	710
Number of groups	51

Source: author's calculations. ***/**/* indicate significance at the 1/5/10% level respectively. Macroeconomic variable was seasonal adjusted.

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Aggregate macroprudential statistics from micro supervisory data – conceptual and operational issues[1]

Gaia Barbic, Stefano Borgioli and Jan Klacso,
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 or the central banks and other institutions represented at the meeting.

Aggregate Macro-Prudential Statistics from Micro Supervisory Data. Conceptual and Operational Issues

Gaia Barbic, Stefano Borgioli, Jan Klacso[1]

Abstract

In this paper we describe the conceptual and operational issues associated with building comprehensive and high-quality aggregate data set as an aggregation of micro supervisory returns based on the example of Consolidated Banking Data (CBD), a key component of the ECB statistical toolbox for financial stability analysis.

These data contain aggregated information on the EU banking system, with detailed information on the profitability, balance sheets, assets quality, solvency ratios and liquidity position of banks in the EU28 countries. In other words, the CBD describe all the relevant features of national banking systems, displayed also for several sub-components of the whole banking population, with the connected (systemic) risk profiles. CBD are at the cross-road between micro and aggregate (macro) statistics as they are based, conceptually and operationally, on the EBA Implementing Technical Standards on supervisory reporting (ITS) and in line with the new CRD IV/CRR regulation. With the entry into force in 2014 of the new set of ITS the whole CBD statistical framework had to be conceptually reshaped and implemented. In August 2015 the first data were released for the revised CBD.

Transposing firm-level supervisory returns into comprehensive aggregate statistics is a complicated exercise, as even if the majority of supervisory reporting has been harmonized for most of the credit institutions, there still exist several national reporting regimes and accounting standards applied across EU jurisdictions (the application of ITS varies across reporting areas in terms of coverage). A sound methodology is required and operational challenges arise. In this paper we describe how these issues were dealt with.

Keywords: Macro-Prudential Analysis, Consolidated Banking Data, Banking Indicators

JEL classification: C82, G21

[1] The authors are grateful for the useful comments of Meri Rimmanen, Patrick Sandars, Jean-Marc Israël, Samo Boh, Bogdan Chiriacescu.

Opinions expressed herein are those of the authors only. They do not necessarily reflect the views of the European Central Bank.

Contents

Introduction and background

As a response to the financial crisis, the strengthening of the framework for macro-prudential analyses and policies globally and within Europe has been a key priority. Within this framework, the banking sector has always been in the focus of the systemic risk analysis of the E(S)CB such that detailed, frequent and timely information on the EU banking system is necessary. The Consolidated Banking Data (CBD) is the key data set for the macro-prudential analysis conducted at the ECB/ESCB and it is a prominent input into the statistical support to the European Systemic Risk Board (ESRB). The CBD collection started in 2002 and the data model in force until last year was implemented in 2009 by all EU countries. The main data sources for those CBD were the supervisory information collected according to Financial Reporting (FINREP) and Common Reporting (COREP) guidelines, as originally developed by the Committee of European Banking Supervisors (CEBS).

CBD include detailed information on bank profitability, balance sheets, asset quality and solvency broken down by size classes of banks and covers almost 100% of the EU banking system. Already from the start data were fully consolidated on a cross-border and cross-sector basis[2]; cross-border means that data on branches and subsidiaries located outside the domestic market are included in the data reported by the parent institution and cross-sector means that branches and subsidiaries of banks that can be classified as financial institutions other than banks are also included (insurance corporations are not included). CBD included also data for foreign controlled branches and subsidiaries reported separately, as a distinct analysis of these firms is often needed given their large share of the domestic banking sector in some EU countries. CBD were reported at national level for three size classes (small, medium-sized and large banks), which are determined as a percentage of the total assets of the whole EU banking system. This breakdown by size allows the analysis of different national banking systems, as concentration in these markets varies substantially among countries. CBD were first collected on annual basis and from 2010 on a semi-annual basis.

CBD are intensively used for banking and systemic risk analyses, for internal briefings and for external publications. The ECB report on Banking Structures[3] provides an example of the use of these data for banking analysis. CBD are also one of the key inputs to the statistical support provided by the ECB to the ESRB. These CBD were described in Borgioli, Gouveia, and Labanca (2013).

With the entry into force of the European Banking Authority's (EBA) Implementing Technical Standards on Supervisory Reporting (ITS)[4], the availability and extent of harmonisation of supervisory data across EU substantially increased. Following the implementation of the ITS, the ESCB Statistics Committee/Working Group on Monetary and Financial Statistics (WG MFS), the Financial Stability Committee/Macro-prudential Analysis Group (MPAG) and the EBA Standing Committee on Oversight and Practices (SCOP) mandated a Joint Task Force on Consolidated Banking Data ("the TF CBD") to design and implement a revised

[2] Data are fully consolidated in terms of prudential scope, as it is only financial institutions covered except insurances companies. The consolidation in this case is therefore "full" from the supervisory perspective.

[3] http://www.ecb.europa.eu/pub/pdf/other/bankingstructuresreport201410.en.pdf?9a8e28568a0a90cfaa8dbe7c951c4dea

[4] Implementing Technical Standards Amending Commission Implementing Regulation (EU) No 680/2014 on Supervisory Reporting of institutions

reporting scheme for the CBD. The main focus of the mandate was to enhance the data quality as well as the data availability of the CBD and, at the same time, to ensure continuity with the previous framework to the extent possible.

The revised CBD reporting scheme is now organised in twelve main parts, each of them including several templates. Main parts are profitability and efficiency, balance sheet, liquidity and funding, asset quality and capital adequacy. The previous CBD already provided a comprehensive set of data covering the financial statements (balance sheet, income statement), asset quality and capital adequacy. These items were mapped against the ITS and a few series which cannot be mapped against the ITS were discontinued after assessing their analytical value. For the provision of data on asset quality, the existing section of the CBD was largely replaced by new reporting based on a harmonised definition of non-performing loans as well as a few key items on forbearance. In order to cover new requirements, data on concentration risk (sectorial, geographic, NACE activity and funding concentration), and Liquidity and Funding risk including asset encumbrance have been added to the templates. Also the frequency was increased from semi-annual to quarterly reporting.

The new CBD were implemented in the course of summer 2015 and marks a relevant improvement in terms of quantity and quality of data availability.

This paper describes some of the main issues of the conceptually and operationally challenging endeavour of deriving meaningful aggregates starting from firm-level supervisory returns that are based on different accounting systems. The paper also deals with how to preserve (some) continuity in time series constructed by the connection of data points reported according to successive and different data models.

In the next paragraph, we provide a description of the conceptual guidelines underlying the establishment of the new reporting framework for CBD. The following paragraph provides an overview of the main issues faced in the implementation of this new framework. Some examples are then put forward and the last paragraph concludes.

1. Creating the new CBD reporting framework - Guiding principles

As mentioned, The TF CBD was mandated by the parent Committees to design and implement a revised reporting scheme for the Consolidated Banking Data (CBD) based on the EBA ITS. The ITS, based on the new Capital requirements regulation and directive (CRR/CRD IV[5]), aim at implementing uniform reporting requirements for credit institutions and investment firms. The ITS cover the reporting of financial information (by introducing the new FINREP templates for both the IFRS and n-GAAP reporting institutions) as well as the reporting of own funds and capital requirements (by introducing the new COREP templates for all institutions). The ITS

[5] Directive 2013/36/EU on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms (CRD IV) and Regulation (EU) No 575/2013 on prudential requirements for credit institutions and investment firms (CRR)

are complemented by other specific reporting templates introduced by the CRR (asset encumbrance, forbearance, liquidity, leverage ratio, large exposures and non-performing exposures) that are also used for the compilation of CBD.

An important objective of the CBD revision was continuing to provide a complete dataset for the entire EU banking system, including sufficient coverage of national banking system. However, it has to be kept in mind that while the ITS are extended to the entire banking system, it is not to all banks in respect of all templates – especially not for the financial statements (FINREP). Having this in mind some guiding principles in the work on the enhancement of the CBD were laid down:

- As a general rule the previous CBD framework and data points were retained to ensure some continuity in terms of time series, at least for key series. This is particularly important for published indicators. Exceptions were made where the ITS introduced clear benefits e.g. in terms of harmonization and data availability.
- The revised CBD framework was based on the reporting of ITS data points and templates covering (IFRS an n-GAAP) FINREP and COREP; reporting cells for relevant data from non-FINREP banks (and Full sample) were inserted in the reporting scheme, as it was already the case in the previous reporting scheme. It was however recognized that in respect of non-FINREP reporters, estimates or proxies may be needed even from other sources than supervisory returns.
- The reporting framework was based on those ITS templates that ensure coverage of the entire (or the greatest part of) the EU banking system. Hence, COREP templates were, in general and when relevant, prioritized over FINREP as the former has full coverage of banks. Mixing unnecessarily the compilation of CBD series from both COREP and FINREP in a given block of series was also avoided, as the perimeters and definitions can be quite different.
- A balanced approach was kept between additional user needs ascertained by the TF CBD and for the need to minimize the costs of data compilation.
- Undue overlapping and redundancies with already existing data collection were avoided. For instance, while drafting the section of geographical concentration of exposures, attention was paid to avoid possible overlapping with the BIS data on international banking activity.

1.1 Bridging (to the extent possible) the previous CBD information

The CBD framework in place since 2009 already provided a comprehensive set of data with rather long time series. In order not to scatter this information, consistency of at least the key items had to be ensured. Accordingly, the first step in the construction of the new CBD scheme was to produce a detailed mapping of the previous CBD data points against the ITS. As a consequence of this exercise some series from the previous CBD were removed, due to quality and availability issues, low users' value or because they were impossible to be mapped to the ITS.

The **financial statements** section of the previous CBD was rather straightforward to map to the ITS and for all the main series time series continuity was ensured. Only a few granular breakdowns were dropped and some redefinition was needed.

Referring to the **Capital Adequacy** section, the new CBD framework is hinged on the capital requirements introduced by the CRR/CRD IV. The CRR caused major revisions in the definition of own funds, capital ratios and capital requirements and consequently many items in the Capital Adequacy section of the new CBD (own funds in particular) underwent breaks in series or had to be discontinued. Basically only series for Tier 1, Tier 2 and Total Own Funds could be bridged. The old CBD included a detailed section on capital requirements, while the ITS require the reporting of risk exposure amounts. The TF CBD agreed that risk exposure amounts should be included in the reporting scheme with current time series converted into risk exposure amounts. Some further details on exposure classes (e.g. SMEs) were also included, as well as the new requirements on Credit Value Adjustments and Large Exposures in the trading book

The **asset quality** section of the template was very arduous to map. In the previous CBD framework this section suffered from limitations due to reliance on (not harmonised) national definitions, lack of comparability and uneven coverage. On the other hand asset quality is a key part for macro-prudential analysis and the assessment of systemic risk and it is at the core of users' needs. A clear trade-off was there between moving towards new harmonised definitions and keeping the continuity of existing time series. Moreover, the drawback of limited data availability in jurisdictions where a relevant part of the banking system is not (yet) covered by FINREP had to be taken into account as well.

In the end, weighting pros and cons it was decided to move towards new harmonised definitions. A new asset quality section, based on the new harmonised EBA definition of non-performing loans, was introduced in the template to replace the existing one. This allowed comparability across EU countries, even at the price of breaking with historical time series. However, few items of the previous reporting scheme were retained, even if changes in definitions lead anyway to breaks in series.

Finally, few basic items on **Forbearance** were included in the new CBD based on the relevant FINREP template (F 19.00). In this case it was deemed that the analytical value added provided by this information (missing in the old CBD) outweighs the issue that data are not available for most non-FINREP banks.

1.2 New user requirements and making choice between COREP and FINREP

The mapping of the old CBD into the ITS gave the initial core set of data points for the new template. This set was then supplemented with further data points that were made available by the entry into force of the ITS ands were deemed useful to meet relevant users' needs, after having weighted them against the cost to compilers. The previous CBD scheme lacks in fact information in areas key for the assessment of systemic risk, like concentration risk, liquidity and funding or asset encumbrance.

In assessing possible new user statistical needs, COREP templates were given priority over FINREP ones whenever possible. In fact, while COREP templates have to be applied by **all** the EU banks and banking groups uniformly, FINREP templates are differentiated between IFRS banks and banks applying national accounting standards (GAAP-FINREP) and do not have to be reported by all of the institutions (e.g. non-consolidating credit institutions are not reporting based on FINREP).

This is particularly relevant for the profit and loss, balance sheet and asset quality templates (financial information templates). These templates are treated below. However also other part of the CBD framework provide interesting cases.

For instance, the template drawn for the data points used then to build **liquidity indicators** is another example of the preference of COREP template vis-à-vis FINREP ones. Six liquidity indicators were in the end selected by the TF CBD to be inserted in the new CBD (liquidity analysis was a weak area of the 'old' CBD). Two of them came directly from the mapping exercise and they are built starting from FINREP templates and were kept also in the new CBD to ensure continuity. Another four liquidity indicators were then added following a survey conducted to explore users' needs; all of them are calculated starting from COREP templates in order to have them harmonised and available for the whole reporting population.

Conversely the CBD template for data on **concentration risk** is a case in which, notwithstanding the preference given to COREP templates, data filtered from FINREP had to be used in order to cover some areas, with the following need to make micro data from different accounting systems coexist in the aggregate. FINREP data were necessary for instance to gauge domestic and non-domestic activities with the geographical breakdown of assets, liabilities and profit or loss by location of the activity.

The new **geographical concentration** template shows also a good example of aggregation problems passing from the micro to the macro level. The final template is not broken down by exposures classes, given the difficulties in mapping Standardised approach (SA) and IRB exposure classes and hence only total exposures are reported. In fact the definitions are not exactly the same in SA and IRB but at the same time exposures classes provide valuable information even at the highest level of aggregation. Another key issue was the coverage of the foreign exposure information provided by the COREP templates; in fact only banks with more than 10% foreign exposures of total exposures report geographical breakdown according to the ITS. Evaluating competing options to bridge this gap, it was in the end decided to report all "domestic banks" for which the breakdown is not available in the reporting country (as towards domestic counterparties).

The information for **sector counterparty** concentration is also based on the FINREP breakdown of loans and advances by six sectors of counterparty (F 05.00), with a small breakdown by NACE codes of loans and advances to non-financial corporations (F 06.00); breakdown on debt securities by five sectors of counterparty (F 04.01 – F 04.09); and breakdown on equity instruments by three sectors of counterparty (F 04.01 – F 04.03 and F04.06 – F 04.08). A template for **funding concentration** had to be derived as well from FINREP (F 08.01). In case of the sector counterparty concentration, data collected based on FINREP are adjusted by a smaller amount of information collected from non-FINREP banks and also from the full sample of banks containing only simplified information about the breakdown on loans and advances (loans and advances to general governments, central banks and credit institutions are collected separately, to other financial corporations, non-financial corporations and households are grouped under category "other"). The template for funding concentration is amended by a small amount of information on retail funding and wholesale funding derived from COREP templates (C 68.00).

1.3 Integrating NON-FINREP reporters in the framework

A distinctive and key value added of CBD has always been the coverage of entire EU banking system with coverage of the EU national banking systems. In fact also the previous CBD framework, which was built starting from the CEBS FINREP and COREP, was supplemented with information coming on a best effort basis from other supervisory or statistical reports (or from annual accounts), in order to accommodate the whole banking system.

In the conceptual design of the new CBD, the same problem of reconciling, at macro level, different (in terms of accounting) micro supervisory returns had to be tackled.

While the ITS foresee that all banks within the EU must report the full COREP templates, there are still gaps in the coverage of FINREP data, as some banks do not have to report FINREP (e.g. banks not consolidating) and there is also a differentiation between banks applying IFRS (IFRS-FINREP) and banks applying national accounting standards (GAAP-FINREP). In fact FINREP must only be reported by banks compiling consolidated accounts according to IFRS or which are required to do so by NCAs. Also remittance frequency for n-GAAP reporting banks is not the same in all cases as in FINREP and tends to be lower.

Looking ahead, even in the steady-state[6], n-GAAP reporting banks and/or non-consolidating banks will represent a non-trifling part of few national banking systems. The extent to which this is the case varies across EU countries; FINREP reporting is extended to the entire banking sector in a majority of jurisdictions, but in a few jurisdictions the share of total assets of non-consolidating banks and/or reported according to n-GAAP is (and will be) not negligible.

Keeping this in mind, the new CBD framework was drawn in a way to use COREP templates to the maximum extent possible (see above). However this was of course not possible for some sections of the reporting scheme.

In order to have full coverage of the EU banking system and of national ones, non-FINREP reporting intermediaries had to be integrated within the CBD overall reporting framework. This integration must be accomplished in a transparent way and must be such that overall aggregates can be compiled and key financial information items can be reconciled across different class of reporters.

The enhanced CBD framework was then constructed starting from the ITS requirements and complementing them with specific data items for non-FINREP reporters to be compiled from national reporting or annual accounts or other data sources. This integrated set of requirements allows full aggregation of the main items (like interest income, total deposits, etc.) of the sub-components of the different banking systems. Aggregation would include "of which" items to provide transparency and decomposition between ITS (FINREP) and non-ITS (non-FINREP) data.

This reconciliation issue is further complicated by the different reporting regimes granted to different class of firms under FINRPEP rules [full FINREP,

[6] SSM banks will be required to compile data according to FINREP at least using a simplified format by 2017. Non-SSM NCAs that still have banks reporting according to n-GAAP currently do not have firm plans to extend FINREP (full or partial) to other institutions.

reduced FINREP ....]. All things considered, in the enhanced CBD reporting scheme three separate templates were drawn for different categories of reporters:

FINREP reporting banks (IFRS reporters)

n-GAAP consolidated banking Groups that are asked to compile a simplified FINREP (GAAP-FINREP reporters)

Solo banks, for which FINRPEP reporting is not envisaged (non-FINREP reporters)

The table below summarise all the possible CBD treatment of different class of firms.

Table 1Treatment of different classes of financial intermediaries in the CBD

CBD reporting schemes	**CBD Reporting sources**	
	Transitional period	**Steady state**
Consolidated or Sub-consolidated IFRS banking groups	Harmonised FINREP Harmonised COREP	
Consolidated or Sub-consolidated n-GAAP banking groups	National GAAP FINREP and/or national GAAP templates (proxy series) Harmonised COREP	SSM countries: Full FINREP or Simplified FINREP or simplified FINREP or Data Points FINREP (1)
		Other countries : National GAAP FINREP and/or national GAAP templates (proxy series)
		All countries: Harmonised COREP
Solo banks	National templates (proxy series) (2) Harmonised COREP	SSM countries: Full FINREP or simplified FINREP or over simplified FINREP or Data Points FINREP (3)
		Other countries: National IFRS/GAAP and/or Non-FINREP templates (proxy series)
		All countries: Harmonised COREP

Notes:
(1) and (3): For more details, refer to the draft Regulation of the ECB on reporting of supervisory financial information, October 2014, first table, page 10: https://www.bankingsupervision.europa.eu/legalframework/publiccons/pdf/reporting/draft-ssm-reporting-regulation201410.en.pdf;

(2): Some countries might have implemented FINREP-like reporting for solo institutions

The definition of the templates for the first two categories of reporters (IFRS-FINREP and GAAP-FINREP reporters) was rather straightforward, being based on FINREP templates that were harmonised across countries. It was basically enough to select the FINREP templates that were needed to meet user needs, ensure to the possible extent the continuity with the previous CBD, trying at the same time to limit the impact on compilers.

More challenging was the **derivation of a template for non-FINREP reporters** that could accommodate data availability and frequency, uneven across relevant jurisdictions, and at the same time detailed enough to contain information relevant for banking and stability analysis (also because the items contained in the scheme for non-FINREP reporters would be the only ones for which the compilation of "global aggregates" would be available).

In the end a **step by step approach** was used to assemble the template for non-FINREP reporters (and foreign controlled branches; see paragraph below). As a first step a survey on data availability was carried out among jurisdictions where the activity of non-FINREP reporters is not irrelevant. The main outcome of the survey was that these countries shared very close data availability for the main items of the profit and loss, balance sheet and asset quality templates. These 'common' items were used as the basis and then complemented by a) the non-FINREP items that were mandatory in the previous CBD template (need to ensure a certain continuity of the series) and b) further items that emerged as particularly relevant to meet important users' needs (for instance for the statistical support that the ECB has to provide to the ESRB, but not only) to be reported on a best effort basis. At the end of this step-by-step process, the template for the mandatory items to be reported for non-FINREP reporters was ready and it is the one that has been implemented.

The final template so emerged from crossing the results of the survey on data availability with what was prescribed for the old CBD reporting and the consideration of users' needs. The template for non-FINREP reporters allows in turn calculating, at least for the most relevant items, aggregates and indicators for the whole banking system(s). This streamlined template is used also to report data for foreign-controlled branches.

The 12 sections that make up the final template are presented in Appendix 3.

1.4 Reporting scheme for foreign-controlled branches

In the previous CBD framework, foreign-controlled branches had to report exactly the same items as domestic firms and foreign-controlled subsidiaries. However, data availability is rather reduced for foreign-controlled branches. This was evident already from the analysis of data points reported for these intermediaries for the previous CBD and was further confirmed by an ad-hoc survey conducted by the TF CBD among all EU countries, as both exercises pointed towards limited data availability. Some data points were reported by just a few countries, possibly generating misleading information for the EA and EU aggregates. Furthermore, even under the new reporting framework there is no harmonised supervisory reporting for branches, as all the FINREP and COREP reporting is related only to credit institutions and their subsidiaries.

It was hence decided to draft streamlined reporting scheme in order to get better coverage and higher quality data (by reducing the effort to try to get proxies for data not reported uniformly by branches). Moreover it emerged from the outcome of the ad-hoc survey and from the data reported in the old CBD that the data points available for foreign-controlled branches highly overlaps with those available for non-FINREP reporters. For this reason it was decided to have for foreign-controlled branches the same reporting scheme that was drafted for non-FINRPEP reporters (see paragraph above).

2. Implementation

The implementation of the new CBD framework as well as the preparation of all the necessary documentation needed for the communication with the users and compilers from NCBs and national authorities started immediately after the TF CBD rolled out the revised reporting scheme. The main steps of the implementation included the creation of the new structure for the CBD, the implementation of the quality checks, the definition of the indicators and aggregates calculated based on the reported elementary data points and the link between the new data and the old data.

To design the new dataset, the first fundamental step was the introduction of a new Data Structure Definition (DSD) for the CBD. The DSD is a set of dimensions that provides a unique description of each data item in the dataset.

Considered the large amount of additional information available under the revised CBD framework, the DSD already in place for the previous CBD dataset did not allow a sufficiently detailed description of the newly defined data items. New dimensions needed to be coded and while the old CBD series key consist of 11 dimensions; the new series keys have 16 dimensions (Appendix 1). A detailed description of the series keys and the single dimensions according to the new CBD framework is given in Appendix 2.

2.1 Implementation of validation rules and data quality checks

In order to ensure a good quality of the data collected and published, several validation rules and checks are applied to the raw data received from the NCBs to assess their quality.

Within a data collection, data are revised several times until a sufficient quality is guaranteed. This is done throught an iterative approach which requires an intense discussion between the ECB and NCBs. Not just raw data are checked, but also aggregated figures and indicators calculated by the ECB are subject to the revision process, in order to ensure an accurate description of the respective banking sectors.

Data quality assessment is carried out along different dimensions:

Completeness. It is verified that all the expected data have been reported to the ECB.

Consistency / Stability. Reported data should be consistent with historical values. Large changes and discrepancies are analysed and NBCs are asked to provide valuable explainations in these cases. As an example, countries are asked to confirm any changes in the reporting population. Also, the dynamics of the total assets for each reporting sector (domestic large, medium seized and small banks, foreign EU and non-EU controlled branches and subsidiaries, etc.) is assessed. NCBs are asked to double-check the reported values in case the variation between the last two periods exceeds 15%.

Correctness. According to the EBA ITS, several items are expected to be reported with negative sign (e.g. interest expenses) or positive sign (e.g. interest income), and some other have to be reported as percentage values. During the data quality assessment, it is checked whether data have been transmitted according to the EBA ITS guidelines or corrections are needed. The CBD framework differs from the EBA ITS regarding the reporting of data related to accumulated impairment or allowances. According to the CBD framework, all these items should be reported as positive (in case they decrease the gross value of the exposure) while they are reported differently in several FINREP templates (e.g. in F04.03 accumulated impairment is reported as a negative value).

Accuracy / Horizontal and vertical comparability. According to the CBD templates, data are reported within the same table or in different tables both on an aggregate level and with different breakdowns. For instance, data can be broken down by reporting sector, meaning that Full sample data and IFRS-FINREP, GAAP-FINREP as well as Non-FINREP data are reported; other examples include counterparty breakdowns, as in the case of total loans. In these cases it is checked whether the sum of the breakdown is equal to the aggregate figures. However, in several cases the equality does not hold due to methodological differences between different FINREP or COREP templates (e.g., loans and advance reported in F01.01, that are used in the CBD Balance sheet templates, do not include cash and cash balances at central banks while loans and advances reported in F05.00, that are used in the CBD Balance sheet – break templates include these items as well).

2.2 Definition of the aggregates and indicators

The CBD dataset has been considerably enhanced and a whole new set of information has become available. To make the use of the CBD more efficient and straightforward, several aggregates and indicators are derived from the raw data received from NCBs. These aggregates and indicators are defined to meet the users' needs and are among the basic items used in different kinds of financial analysis.

Aggregates

Three types of aggregates are calculated: aggregates across reporting frameworks, aggregates within reporting frameworks and aggregates across countries. The aim of the aggregation of reporting frameworks is to make available the data as much as possible for the most important frameworks (from the analytical point of view). In several cases data are reported by IFRS-FINREP, GAAP-FINREP (or, alternatively, directly by FINREP) and Non-FINREP banks, but the information is missing for the Full sample. In this case, the aggregate figure for the Full sample is calculated from the reported data as sum of FINREP (IFRS + GAAP if the FINREP figure is not directly available) and Non-FINREP contributions (e.g. Interest income). Also, some items are available for IFRS-FINREP and GAAP-FINREP reporters but are not directly reported for the FINREP aggregate (e.g. Dividend income), which is then calculated. The aggregation of different reporting sectors poses a problem of harmonisation of the data. In fact, the Full Sample aggregate includes data from FINREP reporters and Non-FINREP reporters, and thus methodological discrepancies have to be taken into account. However, this represents a real issue only in a very few countries and as data are made available for all reporting framework, it can be easily overcome.

Data aggregation within reporting frameworks covers the calculation of aggregate figures from the available breakdowns. According to the CBD template, in some cases only breakdowns are reported, while the total figures are not part of the reporting templates. An example is the item Net interest income. This information is available for Non-FINREP reporters and for the Full Sample, but is not reported directly for IFRS-FINREP, GAAP-FINREP and FINREP reporters. Therefore, item Net interest income is calculated from the items interest income and interest expense reported directly for IFRS- and GAAP-FINREP and caclulated for FINREP reporters.

Finally, a cross country aggregation is performed. As data are available for all EU countries, it is possible to calculate EU and EA aggregates. In both cases, the aggregate figure takes into account the changing composition. This information was available also under the previous CBD framework; however, in case the whole banking sector was taken into account, the overlap caused by the double counting of subsidiaries and branches was neglected. The problem is the following: if a banking group has it's headquarter in country X (EA country) and has a subsidiary in country Y (also EA county), then the data relating to the subsidiary are reported by country X (under the consolidated data of the banking group) and also by country Y (the data of the subsidiary). Thus a simple sum of values for country X and Y includes the figures for the subsidiary twice. To overcome this issue, two new aggregates are calculated, the "clean EU" and "clean EA" aggregates. Clean EU represents "All domestic banking groups and stand-alone banks, foreign (non-EU) controlled subsidiaries and foreign (non-EU) controlled branches" and clean EA represents "All domestic banking groups and stand-alone banks, foreign (non-EA) controlled subsidiaries and foreign (non-EA) controlled branches". It was estimated that the overestimation due to the use of aggregate 67 (that is, the simple EA or EU aggregates) is around 10% both for the EU and EA figures.

Indicators

There are four areas of indicators calculated: profitability and efficiency indicators (e.g. Return on Equity, Return on Assets), Asset quality indicators (e.g. NPL ratio), Balance sheet and liquidity indicators (e.g. Leverage ratio) and Capital adequacy indicators (e.g. Solvency ratio). By the introduction of the new regulatory framework and the new EBA ITS, it was possible to derive new indicators or to enhance the definition of indicators already in use. In some cases, the definition of the indicator had to be changed due to the change in the definition of the underlying items.

New indicators were calculated mainly in the area of asset quality, liquidity and capital adequacy. New asset quality indicators include for example indicator Net Non-performing debt instruments per Gross Non-performing exposures. This indicator is calculated for FINREP reporters and it is also available for the breakdown for non-financial corporates and households – within the new framework it is not just total provisions available but also provisions on non-performing exposures, therefore the coverage ratio can be calculated. The list of Balance sheet and liquidity indicators have been enhanced thanks to the more precise data on the amount of liquid assets and short term liabilities available under the revised CBD framework, and now includes for example indicators such as Liquid assets to Short-term Liabilities. The available indicators on capital adequacy have been revised as well. Due to the new regulation, the definition of capital changed and this affected the definition of solvency ratio. Moreover, new and important measures of solvency need to be reported, such as the CET1 ratio (Common Equity Tier 1 ratio), and are now included in the list of CBD indicators.

2.3 Joining the old and new CBD in order to make time series available under the new framework

In this section we discuss the technical issues related to the creation of time series that also include historical CBD data reported under the old framework. As previously described, a mapping between the old and the new CBD items was made whenever possible, in order to ensure the continuity of the series. However, this mapping was not always straightforward, due to methodological changes in the framework. The main changes concerned the reporting framework and the regulatory framework. Under the old framework, all data points were reported for the full sample of the banks[7], while selected data points were reported for non-IFRS and non-portfolio reporting IFRS banks. In the new framework there are 5 categories of different aggregate reporters (IFRS-FINREP, GAAP-FINREP, Non-FINREP, FINREP, Full Sample). Where possible, the "old framework" full sample data were mapped into the "new framework" full sample data (e.g. total assets, **Figure 1**). In case of items available only for FINREP reportersunder the "old framework" that are reported under the "new framework" by both IFRS-FINREP and GAAP-FINREP banks (or directly by the aggregate of FINREP banks), the history is attached to the FINREP aggregate (e.g. net interest income, **Figure 2**). Selected items are mapped between the "old framework" non-IFRS and non-portfolio reporting IFRS banks and the "new framework" non-FINREP banks (e.g. net interest income. In this case, the sum of net interest income for FINREP banks and non-FINREP banks is then attached to the full sample). In some cases the history is attached only to IFRS-FINREP banks, as some of the items are reported only by these banks (e.g., the available for sale portfolio is defined only for IFRS banks and is required to be reported only by IFRS-FINREP banks, **Figure 3**).

Regarding the changes in the regulatory framework, there are some items available in both the old and the new framework, but for which the definition may have changed significantly[8]. This is the case e.g., of the definition of non-performing exposures. When a change of definition occured, the old series are considered as discontinued at the level of raw data, but, where possible, a mapping was preserved at the indicators level. As an example, the calculated indicator "Gross non-performing debt instruments [% of total gross debt instruments]" exists both under the old and the new framework (although the name is slightly different), and historical values are available under the new indicator. However, historical observations of the underlying series, i.e. provisions (accumulated impairment) and

[7] However, not all the data were necessarily reported by the full sample of banks, e.g. AFS portfolio is defined only for IFRS banks.

[8] This change is in most of the cases related to the implementation of the new Basel III framework

non-performing exposures, were not made available under the new series,because of potentially large differences in the definition of these items.

Figure 1 Mapping the history – "Full sample" data attached to "Full sample"

In thousands EUR	Total assets - Austria, All domestic banks, Full sample	
	"Old CBD" data	"New CBD" data
2008	830,294,460	830,294,460
2009	867,842,605	867,842,605
2010	856,667,295	856,667,295
2011	873,509,134	873,509,134
2012	847,589,865	847,589,865
2013	788,427,096	788,427,096
2014		750,818,312

The history is attached, where it is possible, also in case of the calculated indicators. There are two basic ways how to attach the history in case of these indicators. The first is to calculate the indicator for the full period available using the latest version of the underlying items, as the history should be already matched for those items. The second is to calculate the indicator based on the new framework only for the period when the data are available based on this framework and to attach the history of the indicator calculated based on the old framework. At the beginning it was the first option used, but several errors or shortcomings of this option came out. In the new framework, the indicators are calculated for several reporting frameworks, but when it is calculated for a particular framework (e.g. Full sample), only items reported under this framework are used. However, in some cases the history of the data is not attached for all the underlying series under that particular framework (e.g., all Full sample items have history except one, when it is the FINREP the history is attached to), or, when there are just a few series entering the calculation, it can happen that the whole numerator or denominator is lacking the history. In such cases, the calculated history is not matching the "real" historical data, or even can't be calculated for that particular framework. As mixing up of items using different reporting framework should be avoided, finally it was the second option used. As an example, indicator "Staff expenses [% of total assets]" is calculated for the Full sample. The indicator is calculated as Staff expenses over total assets. However, while for the item total assets the history is attached also to the Full sample, for item Staff expenses the history is attached only to the FINREP reporters. It means that using the first option, the calculation would fail.

Figure 2 Mapping the history – 2 items under the old framework attached to one FINREP item under the new framework, all domestic banks

In thousands EUR	"Old CBD" data - Germany, all domestic banks		"New CBD" data - germany, all domestic banks, FINREP reporters
	Interest income	Interest expenses	Net interest income
2008	281,361,359	-238,521,996	42,839,363
2009	184,710,315	-144,185,831	40,524,484
2010	156,129,662	-118,862,714	37,266,948
2011	170,248,763	-132,933,671	37,315,092
2012	143,976,389	-110,414,744	33,561,645
2013	108,689,279	-76,369,304	32,319,975
2014			32,808,176

Figure 3 Mapping the history – "Full sample" data attached to "IFRS-FINREP"

In thousands EUR	Available for sale financial assets, Belgium, All banks	
	"Old CBD" data, Ful sample	"New CBD" data, IFRS-FINREP
2007	216,613,334	216,613,334
2008	221,996,776	221,996,776
2009	176,644,447	176,644,447
2010	159,658,775	159,658,775
2011	150,167,313	150,167,313
2012	120,134,863	120,134,863
2013	113,560,245	113,560,245
2014		132,198,167

3. Examples and applications

The significantly enlarged dataset described so far, together with the considerable amount of new CBD based indicators, offers potential starting points for new and more in-depth analysis of the EU28 banking system.

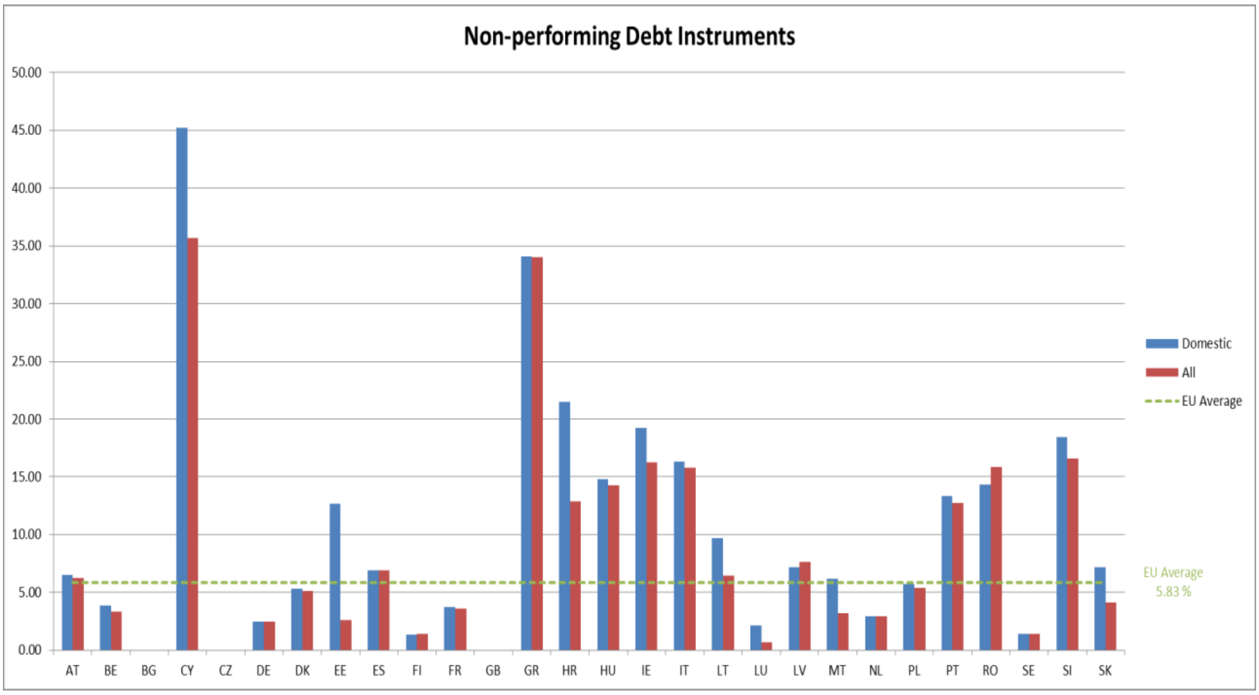
In this section we present an analysis of a sub-group of indicators selected from the whole set of indicators that are built and published on the basis of the CBD elementary data points collected. The aim of this selection is to provide a thorough overview of the EU banking sector and to demonstrate the value added of the CBD series for macro-prudential analysis.

As already described, while one of the main focus of the review of the framework was to ensure the continuity of the analytically relevant time series as much as possible, in some cases the new harmonised definitions represent such a value added that the items under the previous framework were discontinued. In other cases, the templates were enlarged by a large set of new items available. The first case is related mostly to asset quality items (such as non-performing exposures) or the definition of capital, the other case is related to, e.g., asset encumbrance items, forborne exposures or liquidity items (e.g. items requiring stable funding or liquid assets).

The following examples include charts on indicators affected by the above mentioned changes, i.e. based on newly collected data (such as forborne exposures, asset encumbrance and data on liquidity) or on items subject to a new definition according to the new CRR/CRD IV regulation (Non-performing debt instruments ratio, Tier 1 ratio, CET 1 ratio, etc.).

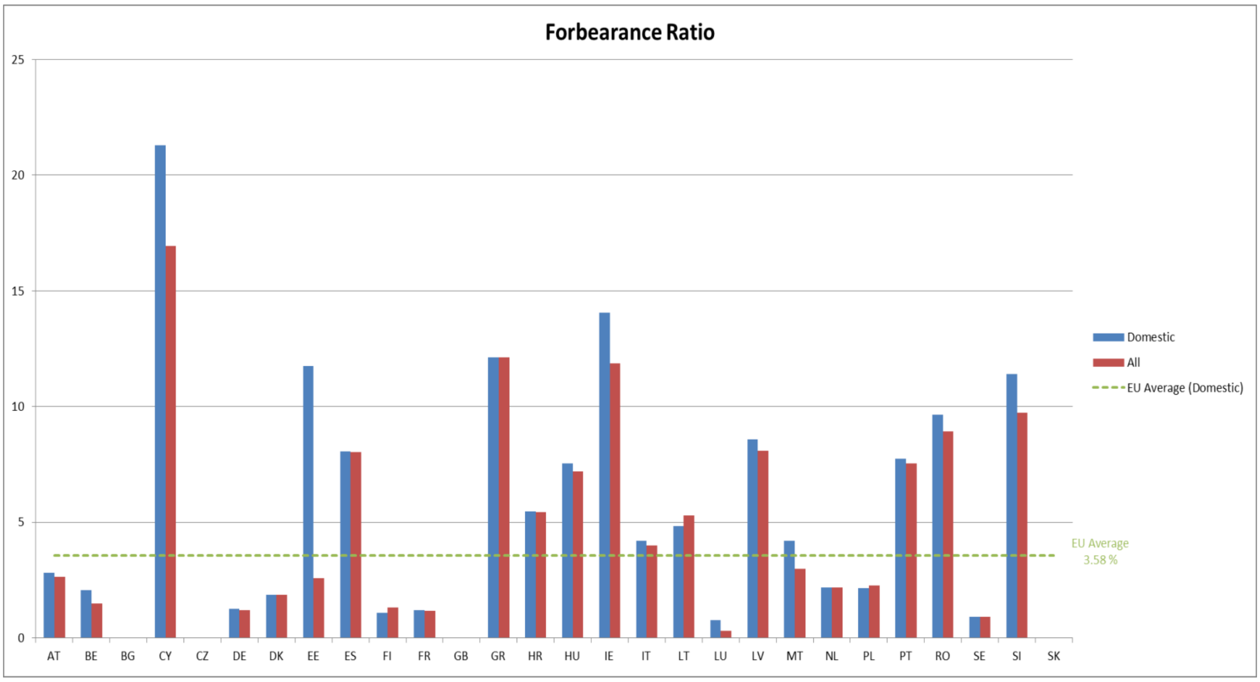
As from end-2014 the reporting framework changed to a large extent for the banks, while the dataset is enlarged, it is still subject to certain data quality constraints as well as some confidentiality issues. Therefore, as it is clear also from the below examples, in some cases the indicators can’t be published for all countries. However, while confidentiality issues are expected to affect data availability also in the future, data quality issues should gradually diminish.

Figure 4 Non-performing Debt Instruments per Total Debt Instruments by country (Q4 2014)



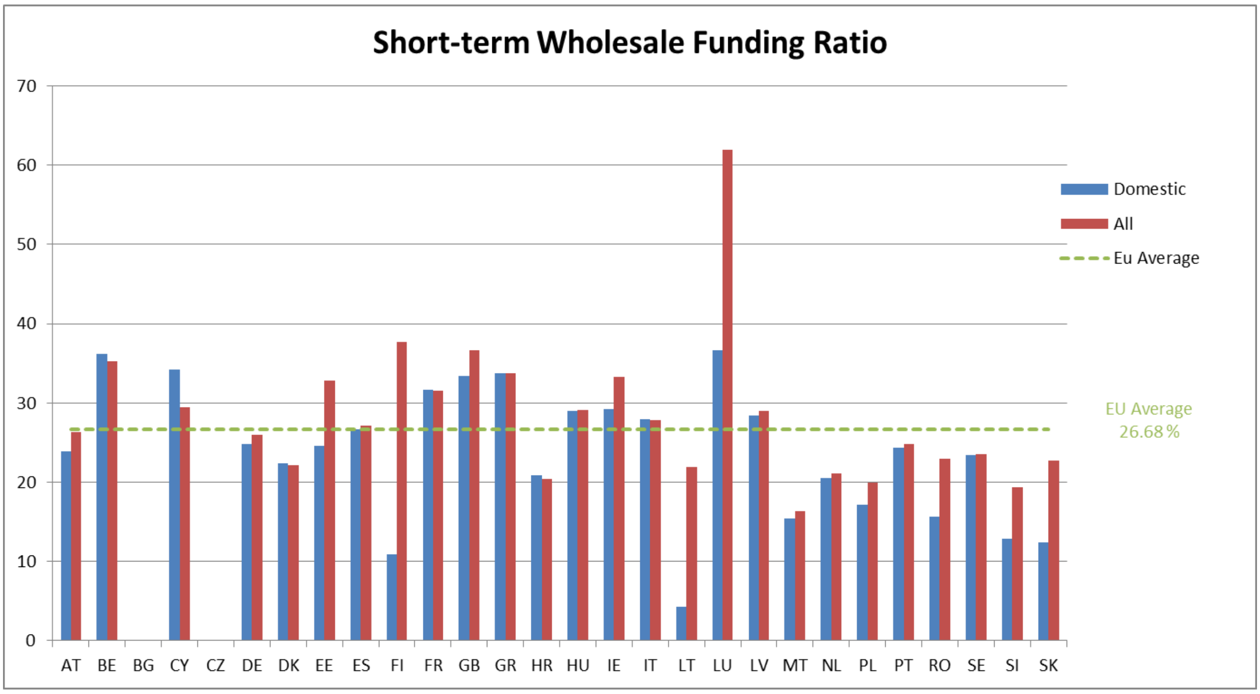
Source: ECB.
Data are displayed in percentages.
Debt instruments are the sum of Loans and advances and Debt securities.

Figure 5 Forbearance ratio for Total Debt Instruments by country (Q4 2014)



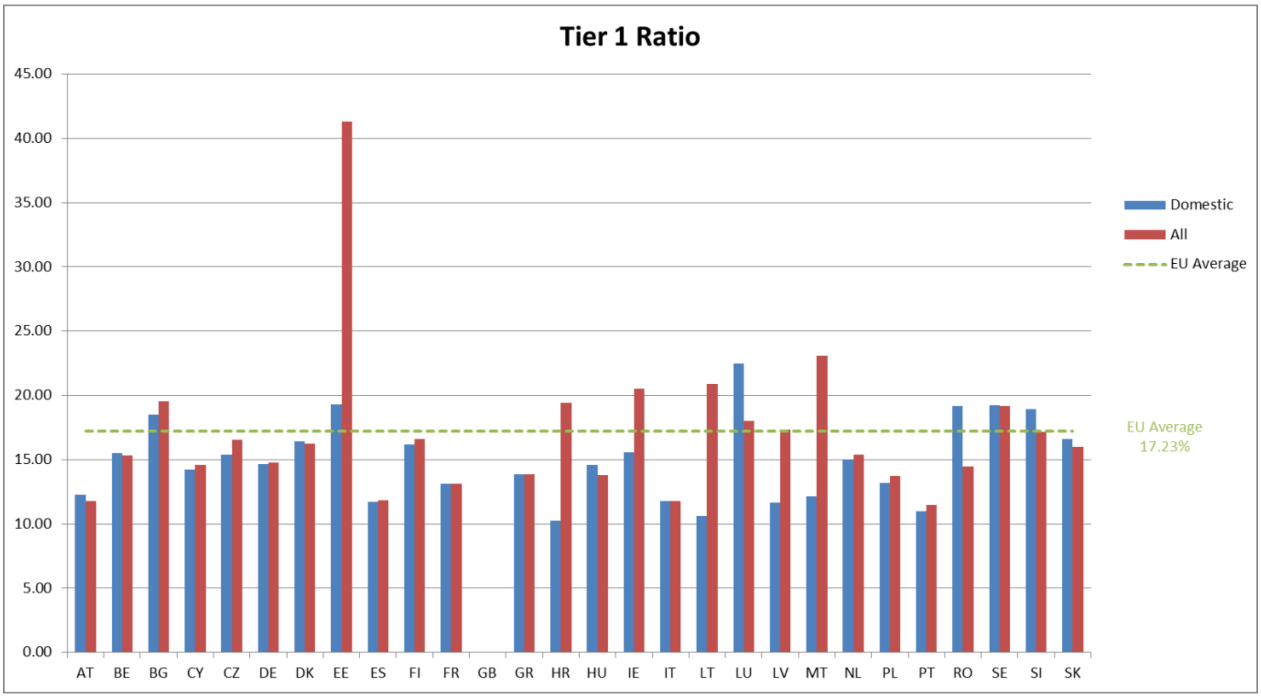
Source: ECB.
Data are displayed in percentages.

Figure 6 Short-term wholesale funding ratio by country (Q4 2014)



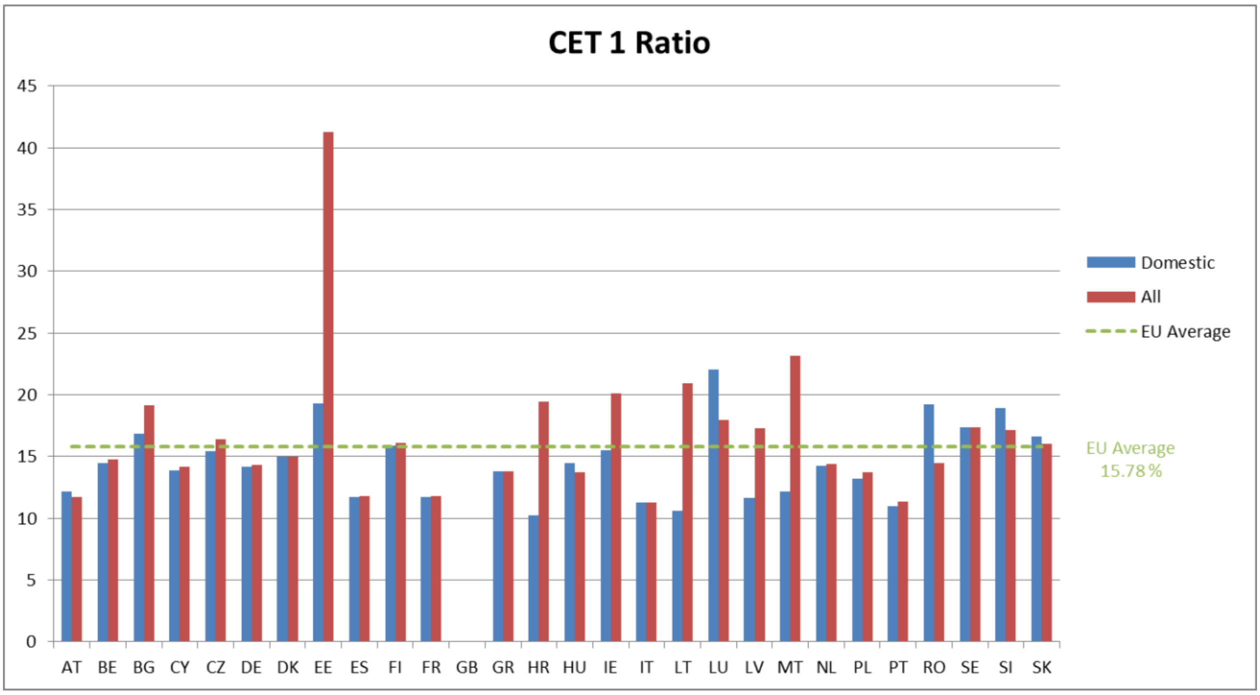
Source ECB.
Data are displayed in percentages.

Figure 7 Tier 1 ratio by country (Q4 2014)



Source ECB.
Data are displayed in percentages.

Figure 8 Common Equity Tier 1 ratio by country (Q4 2014)



Source ECB.

Data are displayed in percentages.

4. Conclusion

Deriving aggregate statistics from micro- (supervisory) data, not designed primarily for statistical needs and sometimes built on different non-harmonised accounting and conceptual basis, presents challenges both at conceptual and operational level.

In this paper, we described on the example of CBD how can be such micro-level data used to build a comprehensive and high enough quality macro-level database. We described a set of steps and issues that should be performed/solved during such a process, like the issue of disharmonised data, the possible aggregation of data collected in order to minimise the reporting burden or the question of time series in case there is a change in the framework.

After the outbreak of the financial crisis there is an increasing need for more granular and detailed data not just on a micro-level for supervisory purposes, but also on a macro-level in order to support macro-prudential decisions or decisions related to financial stability. As such macro-level data can be built-up using already available micro-level data; a positive outcome of this paper is that it is possible to support policymakers with granular data without significantly increasing the reporting burden on financial intermediaries.

Appendix 1: Changes in the dimensions used in the DSD for the “old” and “new” CBD

Position in key	Concept name
1	Frequency
2	Reference area
3	CBD reference sector breakdown
4	CBD reference sector size
5	CBD item
6	Original maturity
7	Data type
8	Counterpart area
9	Balance sheet counterpart sector
10	Currency of transaction
11	Series denomination

Position in key	Concept name
1	Frequency
2	Reference area
3	Counterpart area
4	CBD reference sector breakdown
5	Balance sheet counterpart sector
6	Non-financial corporations activity type
7	CBD reference sector size
8	CBD reporting framework
9	CBD data item
10	CBD accounting portfolio
11	CBD exposure type
12	CBD valuation method
13	Residual maturity
14	Data type
15	Currency of transaction
16	Data item unit

No change in dimension, no change in code list
No change in dimension, new code list
New dimension

Appendix 2: Description of the dimension used in the CBD DSD

Dimension No. 1, Frequency: This dimension indicates the frequency of the reported time series and can take a value "A" for annual or "Q" for quarterly.

Dimension No. 2, Reference area: This dimension represents the country of residence of the reporting institution.

Dimension No. 3, Counterparty area: This dimension represents the area of residence of the counterpart of the data item. For the purpose of the CBD2 key family the dimension value "_Z" (Not applicable) is used in the "Reporters" part and value "W0" (World -all entities, including reference area, including international organisations) is used where the data item to be reported is not allocated to a specific area.

Dimension No. 4, Consolidated Banking Data reference sector breakdown: This dimension indicates the reporting sector (domestic institutions, foreign EU subsidiaries, etc.).

Dimension No. 5, Balance sheet counterpart sector: This dimension indicates the sector of the counterpart, e.g. S11 financial corporations, S1M households, etc. For items within the CBD2 key family where the sector is not specified the dimension value "_Z" is used, referring to the "Not applicable".

Dimension No. 6, Non-financial corporations' activity type: This dimension represents the activity type of the non-financial corporations (Manufacturing, Construction, etc.). For items within the CBD2 key family where the activity type is not specified or where the Balance sheet counterpart sector (dimension No. 5) is not "S11" (non-financial corporations), the dimension value "_Z" is used, referring to the "Not applicable".

Dimension No. 7, Consolidated Banking Data reference sector size: This dimension refers to the size group of the corresponding reporting sector. The following 6 values apply to the CBD: "L" - large institution, "M" - medium-size institution, "S" - small institution, "A" - all institutions, where no size group is specified, "F" – SSM significant banks and "N" – SSM less significant banks.

Dimension No. 8, Consolidated Banking Data reporting framework: This dimension refers to the reporting framework of the corresponding reporting sector. The following 5 values apply to the CBD: "A" – full sample – All banks/groups irrespective of the reporting framework, "F" – FINREP reporting institutions (IFRS + GAAP), "I" – IFRS-FINREP reporting institutions, "G" – GAAP-FINREP reporting institutions and "N" – non-FINREP reporting institutions.

Dimension No. 9, Consolidated Banking Data item: This dimension represents the item of the CBD reporting scheme. The first character of the item codes is always a letter specifying the main domain of the data item following this list: "A" – assets, "D" – distributions, "E" – exposures, "I"- indicators, "L" – liabilities, "LE" – Equity, "LF"

– off-balance sheet items, "O" – own funds, "P" – profit and loss items, "Q"- liquidity, "R" – reporters.

Dimension No. 10, Consolidated Banking Data accounting portfolio: This dimension represents accounting portfolios of the CBD reporting items (Available for Sale, Held to Maturity, etc.). For items within the CBD2 key family which refer to number of institutions where portfolio is not applicable, the dimension value "_Z" is used, referring to the "Not applicable". For other items where the portfolio is not specified, the dimension value "_X" is used, referring to "Not specified".

Dimension No. 11, Consolidated Banking Data exposure type: This dimension represents the exposure type of the CBD reporting items (performing exposures, non-performing exposures, encumbered assets, etc.). For items within the CBD2 key family which refer to the number of, the dimension value "_Z" is used, referring to the "Not applicable". For other items where the exposure type is not specified, the dimension value "_X" is used, referring to "All exposures".

Dimension No. 12, Consolidated Banking Data valuation method: This dimension represents the valuation method for the CBD reporting items (carrying amount, original exposure value, etc.). For items within the CBD2 key family which refer to the number of institutions, the dimension value "_Z" is used, referring to the "Not applicable".

Dimension No. 13, Residual maturity: This dimension represents the residual maturity of the CBD reporting items. For all items, where the residual maturity is not specified, or where it is not applicable, the dimension value "_Z" corresponding to "Not applicable" is used.

Dimension No. 14, Data type: This dimension indicates the type of data to be reported. In the data flow under consideration the three following values are relevant: "LE" - Closing balance sheet/Positions/Stocks, "T" - Transactions, and "_Z"- Not applicable.

Dimension No. 15, Currency of transaction: This dimension describes the currency in which reported items are denominated. For the CBD data flow, two code values are relevant: "_T" - All currencies of denomination and "_Z" - Not applicable.

Dimension No. 16, Data item unit: This dimension specifies in which measure the reported series is expressed. In case of data expressed in the common currency (euro), the code value assigned must be "EUR" - Euro. Countries that do not use the common currency (euro) should convert the data into euro using the foreign exchange rate as of end of the corresponding reporting period. All items reported as percentage should be characterised within this dimension by "PC" - Percent. For other items that are reported as plain numbers, e.g. the number of credit institutions, the code value "PN" – Pure number is used.

Appendix 3: Description of CBD templates

1st part	Reporting population	Information on the number of credit institutions
2nd part	Profitability and efficiency	Income statement and distribution data
3rd part	Profitability and efficiency (Ratios)	Information on the distribution of the ROE
4th part	Consolidated balance sheet	Information on assets, liabilities, equity and off-balance sheet items
5th part	Balance sheet breakdowns	Breakdown of main financial assets and liabilities by counterparty economic sector
6th part	Measures of asset quality	Information on non-performing loans and impaired assets
7th part	Concentration	Geographical, sectorial concentration of assets and funding concentration by sector and instruments
8th part	Liquidity and funding	Information on liquid assets and asset encumbrance
9th part	Capital adequacy – own funds	Information on the own funds
10th part	Capital adequacy – exposures	Information on the type of exposures
11th part	Capital adequacy – other	Information on capital buffers
12th part	Capital adequacy – ratios	Information on distribution of institutions by risk approach, solvency ratio and Tier 1 ratio

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Deriving household indebtedness indicators by linking micro and macro balance sheet data[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 or the central banks and other institutions represented at the meeting.

Deriving Household Indebtedness Indicators by Linking Micro and Macro Balance Sheet Data[1]

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Abstract

Since 2008, when the U.S. subprime mortgage crisis triggered the financial crisis, financial stability analysis has been increasingly interested in the leverage and indebtedness of households along with the vulnerability of different household groups. The reason for this interest is that the household balance sheet and thus, also their risks, are typically analogous with those of financial institutions. This was seen in the subprime crisis and is a source of macro-prudential systemic risk. Moreover, several reports, for example the IMF/FSB report to the G-20 Finance Ministers and Central Bank Governors concerning data gaps[2], emphasise the need for household data which is broken down by different household types. However, none of the reports specify how, in practice, the accounts should be used.

This paper uses the micro-macro linkage of wealth and income accounts and thus creates a set of macroeconomic wealth accounts broken down by household groups, using micro data available at the national level. The paper discusses the methodical and data source limitations of having a full set of accounts. Due to these limitations, it applies a hybrid concept - a mixture of national accounts and survey approaches. The aim of the project is to derive a framework where indebtedness indicators can be optimally estimated in a timely manner and at a quarterly frequency. This paper makes the first attempt to estimate annual time series and highlights problems related to time series estimation and suggests how these estimations could be developed further.

Keywords: wealth distribution, income distribution, wealth survey, national accounts, balance sheets, micro-macro link, indebtedness, household debt, household leverage

JEL classification: E21, E01, D14, D31

[1] The views expressed are those of the authors and do not necessarily reflect the views or policy the European Central Bank (ECB) or Statistics Finland.

The authors wish to thank Andrew Kanutin, Marshall Reindorf, Roberto Rosales and Peter van de Ven for providing helpful comments without implicating them for any remaining errors.

[2] IMF/FSB report to the G-20 Finance Ministers and Central Bank Governors.

Contents

1 Introduction

Since 2008, when the U.S. subprime mortgage crisis triggered the current financial crisis, there has been increasing emphasis on financial stability analysis. The analysis has focused not only on the banking balance sheets but also the balance sheets of other economic sectors (counter-part sectors) and on capturing a risk of insolvency as well as to understand how potential shocks caused by insolvency would be transmitted through balance sheets to the other agents in economy (see for instance: Castrén and Kavonius 2013). The central role of specific household groups in triggering the crisis also increased central banks' interest in distributional issues. One of the several reflections of this is that the European Central Bank President Mr. Mario Draghi emphasised, in his speech held on 14 May 2015 in Washington DC, that monetary policy inaction has clear distributional effects. Additionally, monetary policy always has distributional consequences.

So far, this type of analysis has been limited by data availability. There have been several high-level initiatives like 'the IMF/FSB report to the G-20 Finance Ministers and Central Bank Governors' and 'the Report on the Measurement of Economic Performance and Social Progress' by Stiglitz, Fitoussi and Sen which suggest developing macroeconomic accounts covering household consumption, income and wealth broken by different household types. This would allow timely analysis of the distributional aspects of income, consumption and wealth. Thomas Piketty's (2014) book on Capital in the Twenty-First Century also emphasised the importance of distributional analysis. From this point of view, it can be said that the interests of two rather different worlds: monetary and financial stability as well as social fairness are motivating the analysis of household indebtedness.

These reports have been acted upon by several European and international groups. In order to establish the micro-macro linkage and disparities in national accounts, the OECD and European Commission established an Expert Group on Disparities in National Accounts investigate this linkage and other possible ways to disaggregate national accounts. The first group has now finished its work. Subsequently the OECD has decided to continue its work on income, consumption and saving. However, the expansion of the mandate to wealth was considered to be too extensive. The new group covers two areas of work: (1.) improving the consistency of the estimates, and (2.) trying to develop a methodology to arrive at more timely estimates by extrapolating short term macroeconomic data.

Independent of these international initiatives, there are, and have been in the past, a number of independent initiatives investigating the linkage between micro and macro statistics. The focus has been mostly on income and consumption and the motivation has been to understand the differences between the two sources and thus analyse the reliability of the two statistics or to alternatively, create macroeconomic accounts by household type. From the wealth point of view Henriques and Hsu (2012) have recently written a paper on the linkage between the Survey of Consumer Finances and Flows and of Funds Accounts in the U.S. It discusses the coverage issues of these two statistics and how well they are matching by analysing the time series. Additionally, Antoniewich (2000) has compared the household sector in the U.S. flows of funds statistics and the Survey of Consumer of

Finances. A similar data evaluation is undertaken by Avery, Ellienhausen and Kennickell (1988) in their article. Analyses using European data are considerably rarer as this type of data is relatively new in Europe. Antoniewicz et al. (2005) have investigated the linkage in Cyprus, Canada, Italy and the United States. Also Durier and Lucile (2012) have recently investigated the micro and macro sources for French wealth data.

The purpose of this paper is to develop a framework in which timeliness of national accounts and some of detail of the Household Finance and Consumption Survey (HFCS) is integrated within the same framework. As for central banks, indebtedness and the breakdown of indebtedness is an important tool that can be used to define policy reactions. This paper does so by focusing on the indebtedness measures, i.e. to estimate debt to income, leverage (debt to assets) and financial leverage (debt to financial assets) ratios by household type. These are typical measures that are also used in the analysis of macroprudential policies[3]. The adopted approach is different, for instance, from the one taken by the OECD which develops a complete accounting framework covering time series for consumption and income. In this paper we apply a micro-macro linkage framework which was also presented in Honkkila and Kavonius (2013) and Kavonius and Honkkila (2013) where the linkage between Household Finance and Consumption Survey (HFCS) and Euro Area Accounts (EAA) is analysed.[4] This linkage is used here to derive these indicators at an annual frequency but, in the future, this framework could be used to have quarterly indebtedness indicators. The advantage of the approach is that it would allow the estimation of timely data rather than having to wait for the whole framework broken down by household types. However, as will be discussed later in this paper, both approaches have similar problems such as having stable time series. Therefore, this paper discusses also how these kinds of estimators could be further developed.

This framework is done mostly for the purpose of macroprudential policy analysis and to allow the analysis of indebtedness in different types of households. From the macroprudential and monetary policy point of view, there are two main arguments for this type of data. First, this framework would allow timely distributional data. The nature of the monetary and macroprudential policies is such that timely information on potential risks in different household groups is required. As also shown by the U.S. subprime mortgage crisis, the macroeconomic aggregates often hide risks and potential problems. These data already exist but unfortunately the survey data are typically published with a time lag of a few years. Second, these types of accounts also help to understand different reactions of the household to the macroprudential and monetary policy analysis overall. The risk transmission and the risk of the households depend a lot on the households' income and portfolio and correspondingly, this affects how the households react as a result of different economic stimuli.

[3] See for instance: ECB (2015). Bi-annual Financial Stability Review uses the indebtedness measures in the standard macroprudential analysis.

[4] Ampudia, Pavlickova, Slaclek and Vogel (2014) have used similar kind of framework to update the HFCS data and they applied it in the analysis of household heterogeneity in the euro area during the recession.

The analysis is performed for all euro area countries except Estonia, Ireland, Latvia, Lithuania, Luxembourg and Malta i.e. Austria, Belgium, Germany, Greece, Spain, France, Italy Cyprus, the Netherlands, Portugal, Slovenia, Slovakia and Finland. The reason for excluding these five countries is that they do not yet provide the required data[5].

This paper is organised as follows: the second chapter of the paper discusses the applied methodology. It briefly summarises the framework applied and introduces the wealth concepts and indicators used in this paper. Then, it discusses the applied time series methodology. The third chapter focuses on the results of the practical exercise which has been performed in this paper. The fourth chapter discusses the plausibility of the results and the main estimation problems. Overall, this paper presents a first attempt of estimating these time series and thus, in the penultimate section possible future strategies for further development are discussed. The final chapter summarises the main conclusions.

2 Applied methodology

The largest challenge of this exercise is to reconcile micro and macro data sources and to understand the reasons for the differences. There are several reasons why micro and macro estimates of households' balance sheets may produce different results. These include differences in the definitions of wealth items, methodologies applied and measurement problems in both sources. One should particularly note that micro surveys focus on one individual household which forces the data producer to define the concepts from the household point of view. In the macro data, the concepts are defined at total economy level and are also counter-parted to the other sectors. Potential estimation and measurement problems in the micro data include sampling and reporting bias, while macro data may need to allow some bias in the household sector to satisfy the balancing constraints. Moreover, it should be borne in mind that it is likely that virtually all statistics underestimate household assets. A clear indication of this is – as Zuckman (2013) points out – is that global assets are reported to be smaller than global liabilities. He estimates that about six per cent of household financial wealth is held unrecorded in all the world's tax havens. It is of course almost impossible to say how this underestimation is allocated between countries. A more detailed description of the potential differences especially between the survey and national accounts' data is presented in Honkkila and Kavonius (2013).

Concerning the comparability of the data sets, we also made two adjustments to the financial accounts estimates which are made in Honkkila and Kavonius (2013). First of all, many countries cover also non-profit institutions serving households (NPISH). In case there are household sector accounts without NPISH these are naturally used but in case these are not available, the series without NPISH are estimated.

[5] The Household Finance and Consumption Survey was conducted in Luxembourg and Malta, but all necessary data for Luxembourg and Malta are not available in the Euro Area Accounts. Data for Ireland is missing from the first HFCS wave and Estonia, Latvia and Lithuania were not members of the euro area at the time of the first HFCS wave.

Additionally, there are pure population differences in the figures. This adjustment is also performed in all the numbers presented in this paper.[6]

This paper focuses on household indebtedness using some of the most common indicators in order to analyse their different aspects. The indicators used cover both wealth and income. This approach, where several aspects of wellbeing are covered simultaneously, is emphasised as being conceptually relevant in the current body of welfare analysis, and is one of the key recommendations in the Stiglitz, Sen and Fitoussi (2009) report. Marc Fleurbaey (2009) identifies four approaches of the measurement welfare. The approach applied in this paper is near to *the capability approach* which emphasises the need to look at several aspects of welfare even though the capability approach goes even further by covering material and immaterial aspects of wellbeing.

'Asset-based poverty measures' have been constructed and analysed in several papers recently[7]. The derived indicators presented in this paper combine household-level wealth and income data in order to get a broader picture of sustainability levels and on the sufficiency of financial resources of different households groups. This line of research is similar to the one used in this paper. However, in our paper the emphasis is on household indebtedness indicators which are important for financial stability analysis. Additionally, this paper applies, to the largest extent possible, the national accounts framework in order to produce timely estimates and time series data.

In this paper, we focus the estimation on three different kind indebted measures which are also commonly used at aggregated level in financial stability analysis[8]:

i) Debt to income ratio, i.e. loans divided by gross income.
ii) Financial leverage ratio, i.e. loans divided by financial or liquid assets (equity)
iii) Leverage ratio, i.e. loans divided by total assets (equity).[9]

Household loans cover all short- and long-term loans. The most commonly used income concept is disposable income, but this is unfortunately not available in the HFCS and thus, we use gross income. The gross income concept used in this paper covers wages and salaries, entrepreneurial income (mixed income), property income and transfers before taxes.[10]

Leverage ratio is normally understood as debt-to-equity ratio. Households, however, do not issue any equity and thus, we define leverage ratio as debt divided

[6] A similar adjustment is done for instance by Antoniewichz (2000) where she is building this type of micro-macro linkage by using the U.S. data.

[7] See Brandolini et al. (2010), Barceló and Villanueva (2010), Azpitarte (2012) and Törmälehto et al. (2012)

[8] See for instance: ECB (2015).

[9] In the case of households the leverage ratio could also be defined as assets/net wealth. However, it should be beard in mind that by defining leverage in this way, some households would have negative leverage ratio.

[10] Honkkila and Kavonius (2013) describe the income used in detail. See additionally: ECB 2013.

by assets.[11] We analyse two different concepts of wealth in the denominator of the leverage ratio equation: liquid assets and total assets. The use of these two wealth concepts is common also in the asset-based poverty analyses[12], since different wealth concepts serve different analytical purposes.

The concept of liquid assets used in this paper covers deposits, securities other than shares and derivatives, mutual fund shares, quoted shares and net equity of pension funds and life insurance.[13] In practice, this means that all items from the financial accounts wealth concept are included, except for currency, unquoted shares and other equity, financial derivatives and other accounts payable/receivable[14].

In order to make theoretically solid household group breakdowns and time series analyses the wealth concept used has to consist of items that are comparable across the two sources. This is why these few items have to be excluded from our concept of liquid wealth. Unquoted shares are included in the wealth concept of both HFCS and national accounts. However, the sector delineation of unquoted shares, especially concerning self-employment businesses, is different in the two sources (ECB 2013, p.93) and it is not possibly to combine the survey data on unquoted shares with the national accounts data. Furthermore, one might argue that assets invested in unquoted shares are less liquid than other kinds of financial assets. The share of unquoted shares in financial wealth is less than 10% in the euro area, but this item can be relevant for specific household groups.

Comparing to the concept used in Honkkila and Kavonius (2013), net equity of pension funds and life insurance[15] is included. Several papers suggest that there are conceptual and coverage problems in the comparison of this item in micro and macro statistics (Love, Smith and McNair 2008). Given that pensions and life insurances are an important part of household wealth, we consider the items to be comparable enough so that the breakdowns by household groups can be applied to the national accounts framework.[16]

[11] Castrén and Kavonius (2013) are using the same definition for the household leverage ratio.

[12] Both Törmälehto et al (2012) and Barceló and Villanueva make a distinction between liquid wealth and other, broader wealth concepts.

[13] It could be argued that the net equity of pension fund and life insurance should be excluded from this concept as these are relatively costly and difficult to liquidise.

[14] In the case of households, these are mainly delayed payments. Additionally, this item is used for balancing of accounts, i.e. "the data quality" of this item is not necessarily particularly good.

[15] The technical reserves held by insurance enterprises consist of the actual reserves against outstanding risks in respect of life insurance policies, including reserves for with-profit policies endowments or similar policies, prepayments of premiums and reserves against outstanding claims. Although held by managed by insurance enterprise, the technical reserves are held in trust for the benefit or policyholders, or beneficiaries in the case of reserves against outstanding claims. *The reserves are, therefore, considered to be assets of the policyholders or beneficiaries* and liabilities of the insurance enterprises. *In the financial accounts, the claims of holders of both life and non-life insurance policies over the insurance enterprises and described as the net equity of household on life insurance reserves and on pension fund and prepayments of insurance premiums and reserves for outstanding claims*. See: SNA93, 7.123-7.124. ESA95, Annex 7.1. Pension wealth in the HFCS covers only wealth invested in voluntary pension schemes.

[16] See for instance: Henriques and Hsu 2012, pp 7. Honkkila and Kavonius 2013.

The concept of total assets is also introduced in this paper. In addition to liquid assets, it includes real assets, as well as unquoted shares. As the availability of these data at macro level is not particularly good, this indicator has required more estimation than the other indictors in this paper and thus, the quality of these estimates are likely to be worse than the other estimates presented. However, the data availability of non-financial assets will considerably improve in the near future and the quality of these indicators will therefore improve considerably.

The estimation follows the following principles:

(1.) The levels of income, financial assets and liabilities are taken from macro data (national annual financial accounts). For the original figures population adjustments are performed as described Honkkila and Kavonius (2013) and Kavonius and Honkkila (2013).

(2.) Due to the lack of macro data, the levels of real assets are taken from the micro data (HFCS). These are extrapolated by using existing data, i.e. by using the time series of non-financial assets if these are available. If these are not available, produced assets have been used as a proxy. Belgium, Cyprus, Greece and Spain do not have any produced assets series available and therefore, the real wealth time series are not approximated for them.

(3.) The distribution of income, financial assets and liabilities by household groups are taken from the HFCS data. These distributions are calculated item by item at the most accurate level possible. For example, the financial leverage ratio for household group x (say, bottom income quintile) is:

$$FLR(x) = \frac{{}^{Ls_x}\!/_{Ls} * Lm}{{}^{Ds_x}\!/_{Ds} * Dm + {}^{Bs_x}\!/_{Bs} * Bm + {}^{Qs_x}\!/_{Qs} * Qm + {}^{Ms_x}\!/_{Ms} * Mm + {}^{Ps_x}\!/_{Ps} * Pm}$$

where L, D, B, Q, M and P stand for (the total sum of) liabilities, deposits, bonds, quoted shares, mutual fund shares and private pensions respectively, the suffix x refers to the population group x, s for survey data and m for macro data.

(4.) The time series follow the time series profile of the financial accounts at the level of individual wealth and income items. This is the only option as HFCS data currently exists only for one period. The only exception is Italy which has HFCS data for two years, 2008 and 2010. In this case the data allows a sensitivity analysis to be undertaken in this paper.

3 The results of the estimation

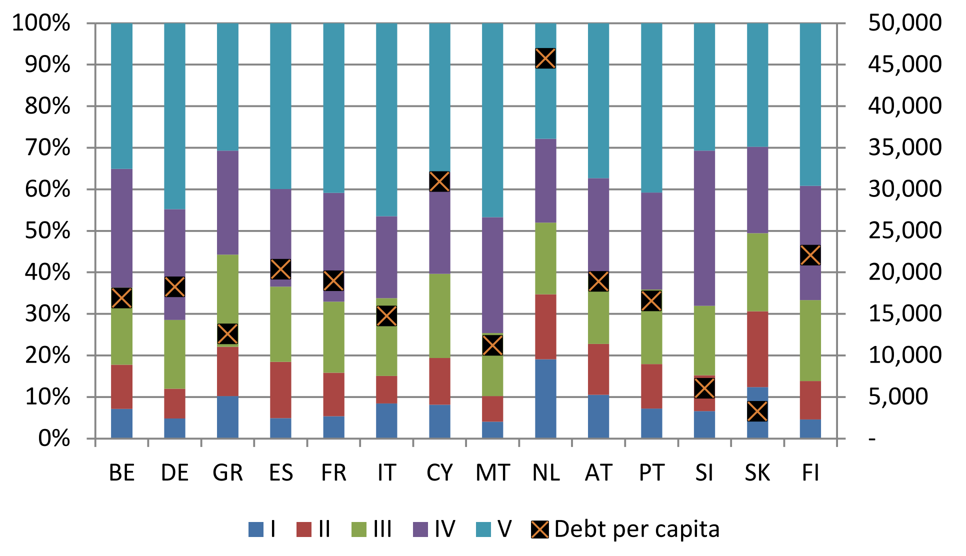
This section briefly summarises the results of the estimations by income quintiles. The estimation could, however, be performed by many other types of breakdowns, i.e. depending on the use and user needs the framework can be estimated by breaking down by age groups, consumption quintiles etc. The cross sectional results of this exercise are reliable but there are several issues in time series estimation which will be further discussed in the section.

Less than half of the households in the euro area (43.7%) participate in debt markets (ECB 2013) and less than one in four households have mortgage debt, i.e. debt collateralised by the household main residence or other properties. Approximately

30% of households have other non-mortgage debt. The average outstanding values of mortgage debt are very high compared to non-mortgage debt, and the outstanding value of mortgage debt accounts for more than 80% of total debt.

Both debt participation and average values of outstanding debt are smaller in households belonging to lower income groups. Consequently, debt stock increases with household income. This is mostly caused by the high significance of mortgage debt. Households with high income are prepared to undertake and are also able to obtain higher mortgages than lower-income households. In all euro area countries, the top income quintile holds the largest share of total debt stock in comparison to other income quintiles.

Figure 3.1 Levels of per capita debt (right axis) and share of total debt by income quintile (left axis) in euro area countries



Source: Euro area accounts (levels of debt, 2010) and HFCS (distribution of debt, survey year 2008-2010)

Figure 3 shows the cross-country differences in the levels of per capita household sector debt and the distribution of debt by income quintiles. Households are most indebted in Cyprus, the Netherlands[17] and Finland. In most countries the share of debt of the bottom two income quintiles is less than 20% of total debt. In the Netherlands this share is 35%, and in Slovakia 31%, making these two countries outliers. Also in Greece and Austria the two bottom income quintiles have more

[17] One reason for the high indebtedness in the Netherlands is specific mortgage contracts typical for the Dutch mortgage markets. Such contracts allow the repayment of the entire debt stock only at the termination of the contract. This means that during the period when a typical mortgage is being amortized, the debt stock remains unchanged, but simultaneously the indebted household is required to build its assets side in the form of mutual funds or other insurance products. This has no impact on the net wealth of the household, but it increases the levels of both households' debt and assets.

The extra financial asset in mortgage escrow account amount to less than 10 per cent of outstanding mortgage balances. If this is netted from the accounts, the debt ratios are still relatively high.

than 20% of total debt. The debt share of the bottom quintile is lowest in Malta and Germany.

In the remaining part of this chapter, the values of debt by income quintiles are analysed from a broader perspective. First, in relation to the income levels, secondly to the holdings of financial assets and finally to total wealth.

Debt to income and financial leverage

Figure 3.2 shows the debt-to-income ratios and financial leverage ratios by country and by income quintile. As can be seen, cross-country differences in the levels of these indicators can be observed. The debt to income ratio of the entire household sector is more than 100% in Cyprus, the Netherlands and Portugal and Spain. Highest financial leverage ratios are observed in Spain, Cyprus and Finland. In Finland the underlying reason is that the pensions are based mostly on social security and therefore, the share of private pensions – which are the ones which are included in the national accounts' pension item – is low. Technically speaking, this implies that the government saves on behalf of the households.

Slovenia and Slovakia are countries with relatively low debt levels in comparison with income levels, while the debt levels of Belgian and Italian households are low compared to their financial wealth stock. In the Netherlands, the debt to income ratio is extremely high, but financial leverage ratios may be assessed as reasonable. This can be partially explained by the specific mortgage contracts in the Netherlands as mentioned earlier which lead to unusually large debt stocks that are offset by financial assets held for the purpose of repaying the entire mortgage after a longer period.

With regard to the differences between income groups, several patterns can be distinguished. First of all, high-income households have relatively low debt-to-income ratios as well as financial leverage ratios in all countries. Somewhat surprisingly, relatively low debt-to-income ratios are observed also for the second lowest income quintile. This seems to be a combination of low debt stock and sufficient income vis-à-vis the poorest income group. In the second income quintile, high debt-to-income ratios are not observed very frequently. Somewhat of an outlier is Spain, where the highest debt to income ratio is observed in the second income quintile, and where the financial leverage ratio is also very high in this group.

Depending on the country, the most vulnerable income groups with regard to high indebtedness in relation to income and financial leverage are the bottom quintile or the third and fourth income quintiles. The bottom income quintiles have highest debt to income ratios in most countries. In Cyprus, Greece and Portugal the debt ratio in the first income quintile is particular high.

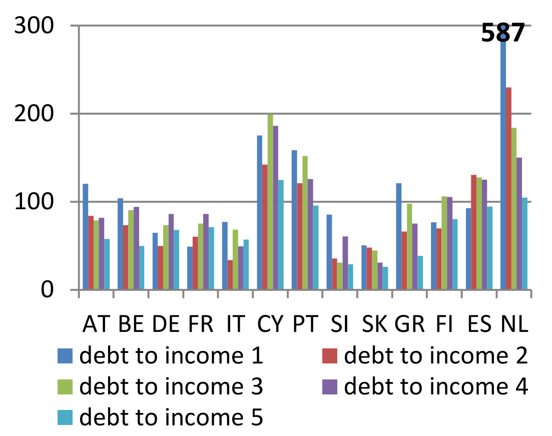
Leverage ratios

The ratio of the debt stock to total assets, including real wealth, varies between nine and 26% in the euro area countries. The causality between income and leverage ratio is not very systematic (see figure 3.2). Overall, the indebtedness in relation to the total assets seems to be highest in the third and fourth quintiles. The reason for this might be that there are several households in the first quintile are not "wealthy enough" to borrow money from bank to get indebted and several households in the fifth quintile are enough wealthy that they do need to borrow money. The exceptions are Austria, Italy and the Netherlands. In Austria and Italy, the first income quintile is particularly indebted in relation to their assets and in the Netherlands all the income quintiles are highly indebted. In the Netherlands, the high share of financial assets which is certain type of counterpart to the non-financial assets. Additionally, the large Dutch financial portfolio is related to the facts that as the pensions based on the social security are not particularly large, private pensions are quite popular. However, overall, i.e. in relation to income as well as in total assets, the Dutch households is the most indebted in the euro area.

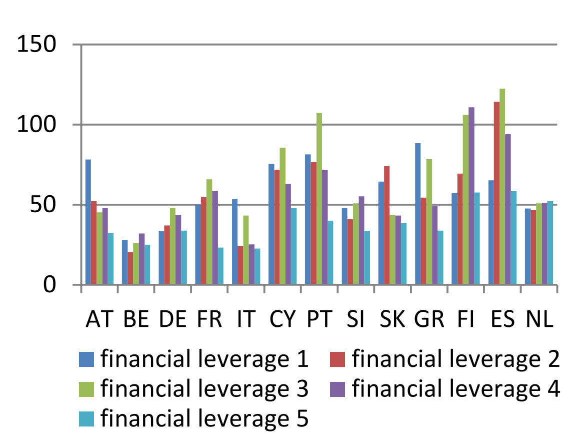
The Cypriot households which have much debt in relation to their income seem also have a considerable amount of non-financial assets, i.e. their properties are relatively valuable. Consequently, their leverage ratio is relatively low in relation to other indebtedness indicators. Dutch, Portuguese and Finnish households are particularly indebted. However, in Finland and Portugal the debt is concentrated on the third and fourth quintiles as in the Netherlands all the quintiles are quite indebted.

Figure 3.2: Different debt ratios by country and income quintile

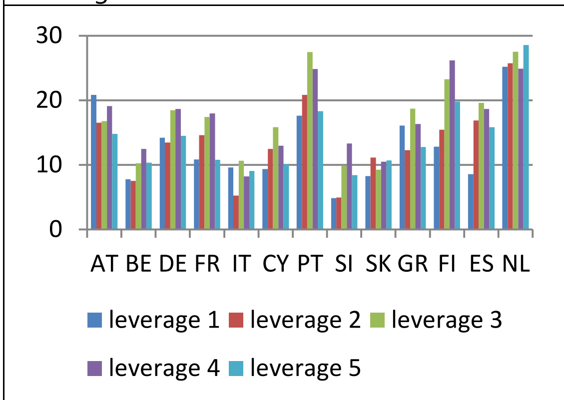
Debt to income ratios



Financial leverage ratios



Leverage ratios

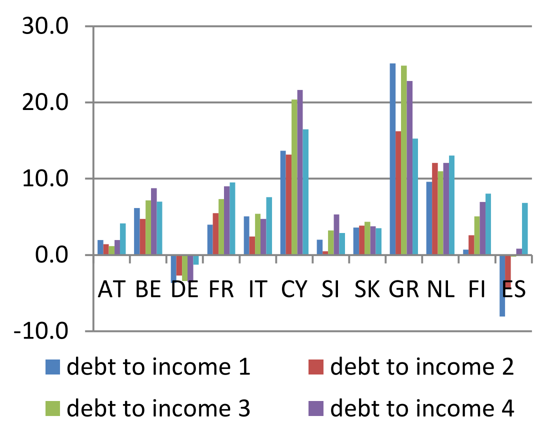


Impact of the crisis

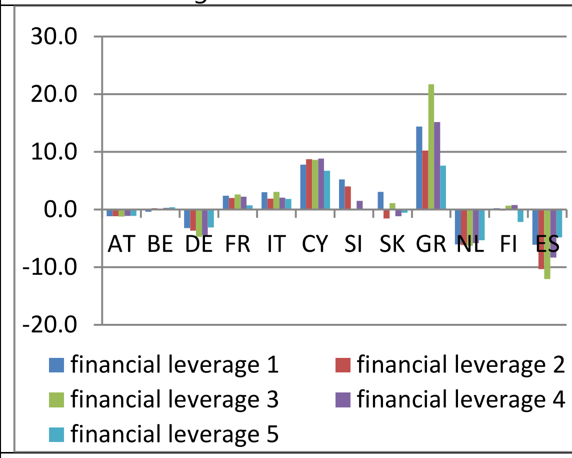
With the methodology described earlier in this paper, we finally estimate the impact of the financial crisis on the vulnerability of households in different income quintiles (see figure 3.3). Between 2008 and 2011 debt-to-income ratios grew in all euro area countries, with the exception of Germany. The increase was most severe for middle-income households in Cyprus and Greece, as well as for the bottom income quintile in Greece. The debt-to-income ratio grew relatively fast also in the Netherlands, and this growth was spread pretty evenly across various income quintiles. Probably the most interesting figures are observed for Spain, where on one hand, the debt-to-income ratio grew significantly only in the top income quintile. On the other hand, households in the two bottom quintiles seemed to be less indebted in 2011 than at the start of the crisis. In general, there is a slight positive relationship between the growth of the debt-to-income ratio and income, particularly in Austria, France, Slovenia and Finland.

Figure 3.3: Changes in different debt ratios by country and income quintile 2008-2010

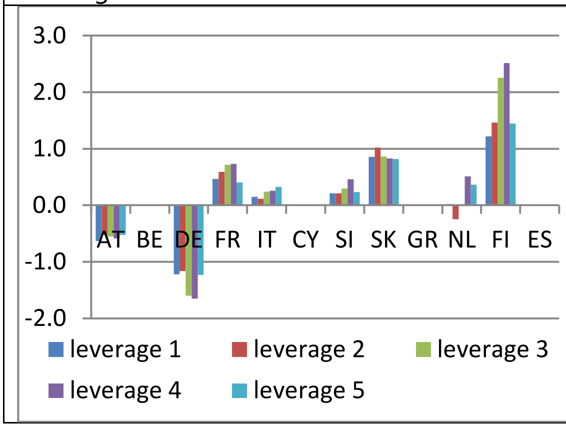
Debt to income ratios



Financial leverage ratios



Leverage ratios



There are significant cross-country differences in the development of the financial leverage ratio: This ratio has decreased for all income quintiles in Austria, Germany, the Netherlands and Spain. The effect was most significant for middle income households in Spain. The ratio grew very quickly in Cyprus and Greece and most severely for middle income households in Greece. There is no clear pattern between the development of the financial leverage ratio and income.

The time series for the leverage ratio was not possible to estimate for all the countries as the lack of data availability for non-financial assets limits this analysis. The countries for which this cannot be estimated are included in Figure 3.3 but no data are shown. The leverage ratio decreased in Austria and Germany. There are two factors which might underlie this development. The first factor is whether the households have increased their debt. As mentioned earlier, in relation to income, household debt has decreased in Germany and increased only slightly in Austria. The second factor is real wealth, particularly the amount and the value of properties. In Germany reported property values have increased exceptionally quickly during this period. This is due to extremely sluggish development in the previous years. During recent years the German property prices have caught up the rest of Europe. A similar price development in Austria is apparent. This has led to the decrease of leverage ratio. At the same time in France, Italy, Slovakia and particularly in Finland, households have increased their debt and this is not supported by a strong development of property prices. Correspondingly, this has led to the increase of leverage ratio.

4 Plausibility of results

There are two aspects that might impinge on the plausibility of the results. First, differences in the underlying statistics which might also have an effect on the quality of indicators presented in this paper. These are typically problems inherited by all the estimations where this linkage has been used. Second, problems related to the estimation of time series, which thus may show up in under- or overestimated time series presented in this paper.

Concerning the first issues, i.e. differences in underlying statistics, the estimations errors are significantly related to the coverage of the statistics used. Results from the first wave of the HFCS indicate that on average the survey produces lower levels of financial wealth compared to the national accounts. The methodological report of the HFCS (ECB 2013, pp. 96-97) shows the difference between HFCS and national account estimates for per capita wealth items. In these figures some adjustments were made to the concept of financial wealth but no adjustments were made for the reference population. Additionally, the national accounts figures included non-profit institutions serving households (NPISH). The main conclusion was that the differences in the estimates between the two sources were relatively small for real assets and liabilities but partially significant for financial assets. In five out of ten countries for which macro data were available for real assets, the survey estimates were higher than the national accounts figures, while in all countries the survey figures for financial assets were clearly lower than the national accounts estimates.

Table 4.1 shows the comparisons of per capita levels of liquid assets per asset type. As stated before, these items are comparable across the two sources. Moreover, additional adjustments, both for the sector and the population, have been made to the national accounts figure in order to make the reference population identical in the two sources. To do this first of all, NPISHs have been excluded from the figures. For those countries for which data for households only was available in the EAA, the figures have been taken as such. Since institutionalised households are generally excluded from the survey samples, these are also excluded from the national accounts data. The estimation procedure of the NPISHs for the countries where these are not separated from the national accounts' estimates as well as exclusion of the institutionalised households are estimated as described in Honkkila and Kavonius (2013) and Kavonius and Honkkila (2013).

Due to these additional adjustments, the differences between the estimates of liquid wealth are somewhat smaller than the differences between financial wealth. It is worth mentioning that in spite of the remaining differences the country rankings of liquid wealth levels are practically identical in both sources.

Table 4.1: Comparison of liquid wealth levels, HFCS / NA %

Country	Deposits	Bonds	Quoted shares	Mutual funds	Private pensions	TOTAL
Belgium	76%	90%	144%	71%	39%	69%
Germany	52%	47%	78%	53%	33%	45%
Greece	19%	7%	9%	23%	43%	19%
Spain	43%	32%	76%	34%	39%	43%
France	45%	35%	124%	33%	39%	45%
Italy	33%	23%	45%	28%	9%	25%
Cyprus	27%	64%	71%	n.a.	131%	44%
Luxembourg	52%	56%	62%	33%	102%	57%
Malta	48%	54%	26%	77%	26%	34%
Netherlands	55%	33%	30%	51%	19%	43%
Austria	43%	8%	91%	25%	12%	31%
Portugal	27%	7%	12%	22%	31%	26%
Slovenia	44%	4%	682%	12%	18%	34%
Slovakia	55%	15%	86%	68%	20%	51%
Finland	76%	90%	144%	71%	39%	69%

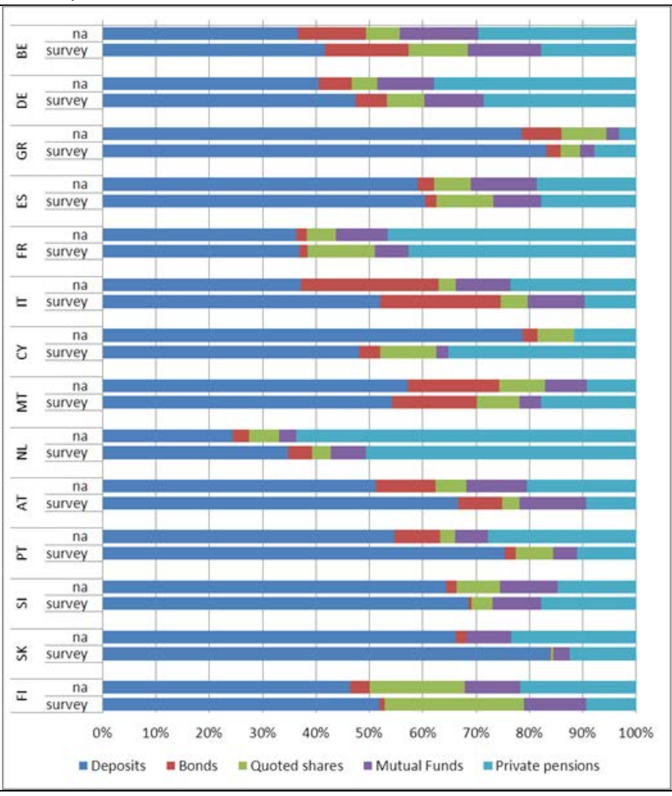
The differences in the financial assets are still large and vary from country to country. This result is not surprising and in line with the conclusions from previous studies (Johansson and Klevmarken 2007, D'Alessio and Ilardi 2012).[18] On the one hand, the reasons for this discrepancy are that household survey data has to deal with sampling errors and reporting bias, and both sources of bias usually tend to produce lower rather than higher figures. On the other hand, national accounts data may need to allow some bias in the household sector to satisfy the balancing constraints. In addition, other types of measurement errors in the national accounts data are possible, especially in cases where several wealth items for the household sector are produced as residuals.

For the type of indicator estimation methods presented in this paper, the large differences between the wealth levels are not problematic as long as such difference do not have any impact on the distribution. One of the main methodological challenges is to quantify the reasons of these differences and to analyse what kind of distributional impact these might have. In the case of the errors in national accounts, it is practically impossible to say whether these are equally distributed. The survey related problems might be a bit easier to analyse. Particularly problems related to sampling errors might have a considerable effect on the distribution as well.

[18] The differences between macro statistics and surveys are normal. For instance Cynamon and Fazzari (2014) document the large gap and mismatch between micro and macro estimates of household income and consumption in the United States. The gap is roughly 50 per cent. However, it should be borne in mind that the wealth surveys typically have even larger gap compared to consumption and income surveys. This is typically related to the fact that wealth is considerably more unequally distributed than income. The surveys have typically problems in covering the very richest households. This has typically a large negative impact on the coverage.

In the wealth statistics considerable part of differences is claimed to be caused by the non-observation bias or measurement error of underrepresenting the wealthiest households in the sample. Several papers for instance Bach et al. (2015) and Vermeulen (2014) indicate the difference would mainly be caused by the fact that the richest tail is missing in these estimations, i.e. the richest households are under-represented in these samples. On the one hand this would have considerable distributional effects. The largest differences would most likely occur in financial instruments. As the financial accounts estimates are larger than survey estimates that would lead to the overestimation of assets of the households in the survey sample. On the other hand, it should also kept in mind that this limitation is already in the survey results and for the financial accounts this is somewhat inherited from the survey results. Another aspect to this issue is that as the ultimate aim is to derive indicators. Consequently, if the differences are systematic and equally distributed then these do not cause any error to the estimates.

Figure 4.2: Comparison of financial wealth structures, HFCS / NA



However, the way of correcting these errors should be investigated and there could be two ways of correcting this type of error. First, either to adjust national accounts totals and to take the view that it is not necessary to cover these asset richest households. Then the idea would be only to focus in these indicators on the critical mass of the households and follow an approach that the richest tail does not matter from the policy point of view. The second option is to estimate this missing households and their distribution by using additional data sources. The latter is probably more advisable but in any case the key for the future work is to understand where these differences come from and how these are distributed.

Concerning the practical differences as was also shown in Andreasch et al. (2013), the structure of liquid wealth is very similar in the micro and macro data. Figure 4.2 shows the structure of liquid wealth by asset type with the population adjusted data. The results are very similar to the ones by Andreasch et al.

In the HFCS data, financial assets account for 17% of households' gross wealth in the EA15. The share of financial assets is less than 10% in Greece, Cyprus, Slovenia and Slovakia, but more than ¼ in Belgium and the Netherlands. The corresponding shares in macro statistics are significantly higher in countries for which macro data on real assets are available. This result is not unexpected for (at least) two reasons: all assets related to self-employment businesses are classified as real assets in the HFCS, while macro statistics include all unquoted shares as financial assets. Furthermore, the distribution of financial wealth is much more skewed than the distribution of real wealth, which may lead to more pronounced sampling bias in the micro data.

If this skewedness is analysed against the method presented in this paper, assuming that the distribution between different instrument types in national accounts is correct, the estimated indicators portfolio breakdown is actually correct. The reason is that this breakdown is derived from the national accounts. However, if the skewedness effects the distribution among households then the estimated indicators are also wrong.

As mentioned earlier in the paper, the time series have been estimated by deriving the distribution of each individual instrument by household type from the HFCS data and time series developments from the financial accounts' instruments. This basically assumes constant household distribution per financial instrument. This also means that if we assume that the distribution of these instruments in the financial accounts stays equal then the ownership share of each household type stay equal as well. The growth rate of individual stocks of instruments is running the development and shares of individual household groups. Mathematically this can described as follows:

$$I_q = \alpha_q * I$$

where I is denoted for an instrument (total) and is financial accounts' data and I_q is each quintiles' share of the instrument. α_q is each quintile share of the instrument in percentage and thus, q can have a value from 1 to 5. Then, equally:

$$\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 = 1$$

And α_q is estimated from the HFCS data:

$$\alpha_q = V_q / \sum V_q$$

where V_q is an absolute value for some instrument for quintile q.

The reason for the assumption for constant household distribution at instrument level is that the HFCS data are currently available only for one year. Only Italy transmits the data for all quarters and thus, Italian data can be used for a sensitivity analysis of this assumption. As these weights presented above are normally applied to the whole time series, the weights for Italy are calculated separately for 2008 and

2010. The missing observation has been estimated by assuming linear development for the missing year.

The results of the sensitivity analysis are summarised in the figures 4.3 which show Italian debt to financial wealth as well as debt to wealth and debt to income by using the method proposed in this paper, i.e. the method which uses only one survey to estimate the time series, and the benchmark method where the survey results for 2008 and 2010 are used.

When the benchmark year is missing, the basic assumption is practically that *the instrument portfolio stays constant and only the relative prices of the portfolio are varying. The other increase (investment) or decrease (amortisation) of the assets is assumed the follow average decrease of the assets*. During the financial crisis, this assumption seemed to be wrong. Two observations concerning these results can be made: (1.) The lower the income quintile, the bigger the estimation error. (2.) In the case of liquid assets and income the different is considerably larger than in the fixed assets. Especially, the lower income quintiles seem to have considerably higher debt ratio than the estimation method used in paper would indicate. Most likely this is partly caused by the faster speed amortising debt but the small amount of financial wealth seems to develop considerably slower than average. This can be caused the fact that low income households are investing less in financial wealth and might even sell that in a crisis situation. In the higher income quintiles the difference is considerably smaller as these households did not have such economic pressure to react to the crisis.

The OECD Expert Group, which is estimating time series on income and consumption, has dedicated much time to the estimations. They have experienced similar kinds of problems as in this exercise, i.e. that typically the lowest income quintiles are considerably over-estimated. In the other income quintiles the estimation errors are typically quite small. This is a logical error as the applied methodology estimates the total development correctly. Therefore, even a small error in the lowest income quintile is relatively large – as the cumulated wealth is relatively small overall. A converse small error appears in the highest income quintiles but this appears again relatively small as these households have cumulated wealth.

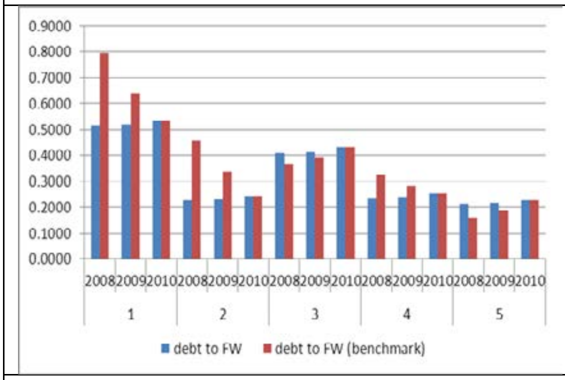
The fundamental question is what to do with this type of problem. In the case of consumption and income measures, the data availability is better than in wealth and therefore, the estimation can be fed by alternative data sources. The OECD Expert Group raised the idea of deriving the estimations for instance by tax data. The data availability and time lag of data differ from country to country. Therefore, it is easiest to do this type of linkage at country level.

Concerning the balance sheet data the situation is more complicated. The problem is that there are limited amount of data sources related to wealth. In some countries in which there are data on wealth available for instance from taxation, the use of that type of data could be investigated. However, a structural solution which could be applied for several countries is unlikely to be possible. From this point view, an establishment of a short term survey which provides a smaller set of the data more frequently than the HFCS would be a solution. The extreme approach would be the one which have been under investigation in the Federal Reserve of Cleveland where a short-term survey with a relative small sample is conducted quarterly. This would not be an indicator based approach and it would have a far richer data set.

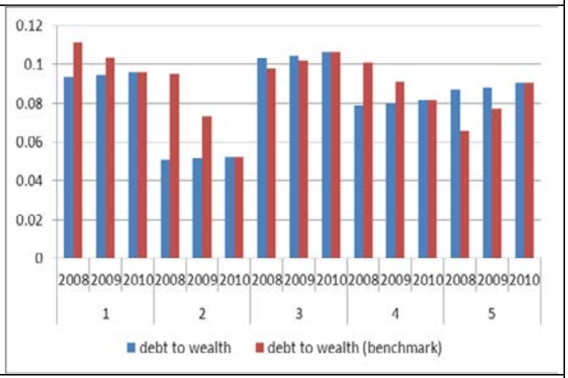
Establishing a separate survey would be expensive compared to this type of derived indicators. Additionally, as even a relatively light full survey – with a small sample – is typically also quite time consuming to compile, this type of indicator would have the benefit of being relatively light to be compiled. One solution could be for instance an annual light survey with a limited number of households which then could be used to correct the weight of the annual indicators.

Figure 4.3: Sensitivity analyses with the Italian data by using one reference year and calculated by using two reference years (benchmark)

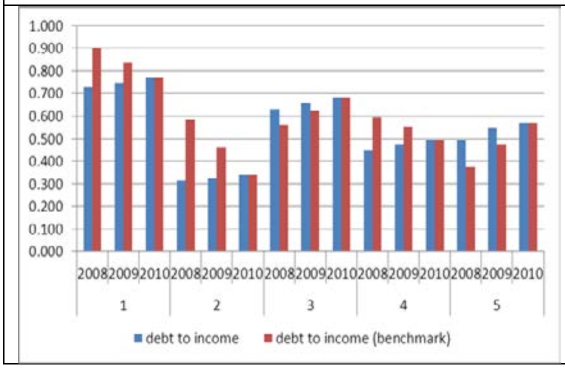
Debt to financial wealth



Debt to wealth



Debt to income



An alternative or even supplementary method could be to consider whether some income items based on income surveys could be used to improve these estimates. This would practically only apply to interest carrying instruments, i.e. debt securities and loans. Thus, for the other instruments some other methods should be investigated.

The only conclusion which can be drawn from these results is that the lack of the reference (HFCS) data is causing large problem to the actual estimations. However, it should be noted that this exercise was done for Italy in the middle of the deepest years of financial crisis. As at the time the Italian economy was under stress, the estimation error was also likely to be most extreme. In less turbulent years this estimation method causes more plausible results. Additionally, it is important to notice that the largest estimation error can be observed in the debt to financial wealth ratio. This is in the line with the assumption that household in the financial stress try first to finance their debt from income and financial wealth. The last resource of financing is real wealth.

It can be concluded that the Italian data in this particularly turbulent period provided an excellent stress test for these estimations. It can be assumed that in the case of another country and at a less turbulent point of time the estimation method could have produced better results. However, this also shows that the stability of results need to be further investigated and it is also the second essential aspect in the future work.

5 Conclusions

The discussion on the micro-macro linkage is mature and so far, the discussion has mostly focused on the theoretical micro-macro linkage rather than on practical applications. In this paper, we have made an attempt to create a practical application of a micro-macro linkage and estimated debt-to income, financial leverage and leverage ratios by income quintiles. From the financial stability point of view, these are important indicators and would be useful in short-term policy analysis of indebtedness.

It is important to develop a timelier framework – optimally a quarterly one – which would provide timely distributional analysis. This attempt shows that this framework can potentially provide interesting results. However, the performed sensitivity analysis showed that more data and additional analysis of this framework is needed.

There are two different errors which need further analysis. First, there are problems which are related to the different coverages of two sets of statistics used. This requires the adjustment of the population of both statistics and making them as comparable as possible. The remaining differences, which cannot be adjusted, then need to be understood and quantified. It is essential to be able to recognise the nature of the differences and what the distributional impact of these differences are in order to properly break down the balance sheet by household types.

Second, for the time series estimation it is essential to investigate how to capture the relative movements of the different balance sheet items between the different groups of households, such as income quintiles. The fundamental challenge of this framework is the assumption that at the instrument level the wealth portfolios of different income quintiles follow the average investment and price development. The sensitivity analysis showed that especially during the crisis in a country which has significant financial problems this assumption is not always correct. In reality, the bottom income quintile households were either amortising debt quicker than expected or their financial assets stock was rather stable comparing to the other quintiles.

Currently, the analysis is restricted by the availability of the data. When additional survey results become available, it will also be important to see whether the balance sheet movements between quintiles are large in less turbulent periods. As also mentioned in the paper, this problem is well recognised and, for instance, the OECD group which focuses on income and consumption is struggling with similar issues. The solution for this could be to investigate alternative supplementary sources for these calculations. One possibility is to explore whether some income items could be used to estimate the development of stocks or alternatively, to investigate whether some “lighter” short-term wealth survey could support the data needs of these calculations. The latter option is clearly limited by financial constraints.

This paper also shows relevant information for cross-cutting years when the financial accounts and survey data are available. When both data sets are available the estimates are also quite accurate. The only estimation issues are related to the coverage of the data sets and the distributional impacts of the coverage issues. This is a clearly an issue which should be investigated further – especially the impact of underrepresentation of wealthy households in the survey. Otherwise the framework can already be applied to the historical data and when more survey data become available, it will also ease the time series estimation process. A timely quarterly or even annual framework remains still as a challenge.

The analysis of this paper shows that debt to income ratio of the household sector is particularly high in Cyprus, the Netherlands, Portugal and Spain. The bottom income quintile is particularly indebted in Cyprus, Greece and Portugal. When the indebtedness is analysed vis-à-vis to financial wealth the same countries seemed to be indebted. Only households in the Netherlands seem to be less indebted in relation to financial wealth as the Dutch mortgages are usually counterpartyed with financial assets. Additionally, in relation to their financial assets, the Finnish households seem to be quite indebted. This is partly due to the fact the pension saving is to a large extent taken care by the public sector in Finland. Also in relation to total wealth these countries are relatively indebted. Similarly, the speed of getting indebted in years 2008-2011 was the most rapid in these countries. Overall, it also can be concluded that the highest income quintiles were relatively less indebted and typically, the middle income quintiles were most indebted.

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Warsaw, Poland, 14-15 December 2015

Understanding long-term mortgage arrears in Ireland: insights from macro and micro data[1]

Jean Cassidy, Central Bank of Ireland

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 or the central banks and other institutions represented at the meeting.

Understanding Long-Term Mortgage Arrears in Ireland: Insights from Macro and Micro Data

Jean Cassidy[1]

Abstract

The financial crisis and a prolonged period of economic downturn in Ireland resulted in a very rapid increase in the number of delinquent mortgage loans. The associated pressure on both household and bank balance sheets raises concerns from a financial stability perspective, particularly in light of the persistent nature of long-term arrears. This paper highlights the importance of both macro- and micro-level data for a thorough analysis of mortgage delinquency in Ireland, and for the formulation of effective resolution policies in this area. The main advantages of macro-level data on mortgage arrears are their frequency, timeliness and comprehensive coverage, providing regular updates on developments in the entire Irish mortgage market. While these data point to an improving situation at an aggregate level, the persistent increase in the number of accounts in very long-term arrears remains a cause for concern. Detailed micro-data facilitate a more rigorous analysis of this cohort, providing an insight into the characteristics of those loans and borrowers in long-term arrears. An analysis of the flows by depth of arrears shows that while the rates of transition towards improved states have increased over time, they remain particularly low for those accounts in very long-term arrears. Loan-level data allow comparisons between the resolution strategies for mortgages that have successfully exited long-term arrears and those that remain in deep arrears. In addition, mortgages in deep arrears can be further split between those that have begun repayment and are showing some improvement in their arrears balance, and those whose situation continues to deteriorate.

Keywords: Banks; Mortgages; Arrears

JEL classification: G21

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Introduction

Maintenance of financial stability depends on detailed, timely and reliable data in order to successfully identify challenges, assess risk, and formulate adequate and effective policy measures. This paper highlights the importance of both macro and micro-level data for addressing a prominent financial stability issue in Ireland over the past five years, namely the level of mortgage arrears. Since the onset of the financial crisis and the broader economic recession in Ireland, mortgage repayment difficulties have become increasingly prevalent. Mortgage arrears rose rapidly during the period from 2009 to 2013, with the value of accounts in arrears over 90 days peaking at 17.3 per cent of total mortgages on principal-dwelling homes (PDH), and despite the recent recovery in the economy and the labour market, the data suggest a degree of persistence among the long-term arrears cases. Understanding the underlying causes and dynamics is critical for the successful resolution of the arrears problem.

The remainder of the paper is structured as follows. Section 2 describes the development of the mortgage arrears crisis in Ireland, as evidenced by the aggregate statistics. It highlights the significant benefits of comprehensive and timely data in providing regular updates on an issue of such importance for Irish households, the financial sector and the wider economy. Section 3 introduces the micro-data on mortgage arrears and describes the detailed information contained in these data that facilitate a more rigorous analysis, particularly of those cases in long-term arrears. The data are used to examine rates of transition into and out of the various states of arrears over time. Building on this analysis of flows, Section 4 addresses the issue of arrears resolution. It focuses on a cohort of accounts that have exited long-term arrears and discusses the resolution strategies that may have contributed to this. Section 5 concludes, and discusses the potential for such data to inform policy-making in the area of arrears resolution.

Section 2: Mortgage Arrears in Ireland

The financial crisis and economic downturn in Ireland resulted in a very rapid increase in mortgage arrears between 2009 and 2013. Unemployment, falling property values and a decline in income levels were the key drivers of mortgage distress over this period (McCarthy 2014). The unemployment rate rose from just 4.6 per cent at the end of 2007 to a peak of 15 per cent in early 2012. Average house prices fell by over 50 per cent from their peak in 2007, leaving a significant proportion of mortgage holders in positions of negative equity. Furthermore, many borrowers who remained in employment suffered a decline in their income levels due to wage cuts and tax increases. These factors, combined with high pre-crisis debt levels, contributed to the very rapid increase in incidences of mortgage delinquency over the period. At end-September 2009, 4.1 per cent of mortgage loans on principal-dwelling homes (PDH) were in arrears of more than 90 days. By end-September 2013 this figure had increased to over 17 per cent.[2]

The Central Bank of Ireland collects aggregated data relating to the number of, and outstanding balance on mortgage accounts in arrears, as well as information relating to restructured accounts and repossessed properties. The data are provided on a quarterly basis by all entities[3] that hold loans secured on properties located in the Republic of Ireland. They are published by the Central Bank of Ireland in its quarterly *Residential Mortgage Arrears and Repossession Statistics,* and provide a comprehensive update on the performance of the entire mortgage market. [4] Specifically, they cover arrears broken down by duration; legal proceedings and repossessions; forbearance arrangements broken down by type; and the performance of restructured mortgage accounts.

The sharp deterioration in the performance of PDH mortgage loans is clearly evident in Figure 1, which shows the value of loans in arrears of more than 90 days from September 2009 (when the data were first collected) to June 2015. The arrears crisis peaked in September 2013, when loans in arrears of more than 90 days accounted for 17.3 per cent all PDH loans, in value terms. The outstanding balance on these non-performing loans was almost €19 billion at that time. The overall arrears situation has improved since then, as the share of loans in arrears of more than 90 days has fallen to 13.4 per cent. However, the collection of more detailed data since September 2012 on the duration of arrears has revealed some important compositional issues. These data highlight the growing proportion of loan accounts in very deep arrears, i.e. more than 720 days past due[5]. Figure 2 shows the quarter-on-quarter change in the value of loans in arrears of more than 90 days, broken down by the various duration categories. At the shorter-term end, the trend has been encouraging for a number of years, insofar as it suggests that the formation of new arrears cases has been declining since late 2012. However, the value of loans in longer-term arrears continued to grow throughout 2013 and 2014. Over this period the average quarter-on-quarter rate of growth in accounts in arrears over 720 days was 7 per cent. As a result, loans in this cohort now account for 60 per cent of loans in arrears over 90 days, having increased from a share of 25 per cent in late 2012 (Figure 3). The outstanding balance on these loans was €8.3 billion at end-June 2015, equivalent to 8 per cent of the total outstanding value of all PDH mortgage loans at that time. The data suggest that these loans in deep distress are showing no signs of improvement and are simply transitioning through to more advanced stages of arrears. The magnitude and the persistent nature of long-term arrears are a cause for concern from both a financial stability perspective and a wider

[2] These figures are in value terms, rather than the number of accounts.

[3] These include banks, building societies, retail credit firms and a small number of unregulated entities.

[4] Data are collected separately for loans on PDH and buy-to-let (BTL) properties. For the purpose of this analysis the focus is solely on PDH loans.

[5] Borrowers with loans in arrears of more than 720 days have not necessarily failed to make a single repayment for a period of 720 days. They do, however, possess an arrears balance equivalent to 720 days past due.

macroeconomic perspective, given their implications for the balance sheets of the lenders and the borrowers.

In light of the rapidly evolving nature of the mortgage arrears crisis over the past six years, the availability of timely and detailed statistics is essential for comprehensive monitoring of developments and formulation of effective resolution policies. These macro-level data have delivered some crucial insights into the developments in arrears and the level of progress towards resolution achieved to date. The data are comprehensive, designed to cover all mortgage loans secured on properties in the Republic of Ireland, including those loans held by non-bank institutions and a small number of unregulated entities. The data are collected and published quarterly and on a consistent basis, providing a common template and set of definitions for all institutions, thus facilitating accurate analysis over time. The *Residential Mortgage Arrears and Repossessions Statistics* are widely recognised as the official source of information on mortgage arrears in Ireland, providing a frequent, timely and definitive understanding of the trends in mortgage arrears over time.

Notwithstanding this significant contribution, these data lack sufficient granularity to provide meaningful insights into the characteristics of the loans or the borrowers, to permit a more thorough analysis of long-term arrears cases. For example, they tell us nothing about when the loans were originated, what type of interest rate applies, or how the loan-to-value ratios have evolved. They provide us with no information on the borrowers, and they do no permit us to track movements into and out of the various states of arrears. In the absence of more granular information, it is difficult to formulate a policy response that adequately targets problem cases with an appropriate solution.

Section 3: Micro-Data on Irish Mortgage Arrears

Loan-level data have been collected by the Central Bank of Ireland from Irish headquartered credit institutions since 2011. The initial collection of data was to satisfy the requirements of the Prudential Capital Assessment Review (PCAR), a stress test of the capital resources of the domestic banks, undertaken in 2011 to calculate the level of recapitalisation required at that time. Since then, the Central Bank has continued to collect loan-level data twice yearly. The data contain over 250 fields describing loan, borrower and collateral characteristics. *Kennedy and McIndoe Calder (2011)* and *McCarthy (2014)* provide a detailed description of the data including the most pertinent fields.

One of the drawbacks of these data, relative to the aggregate statistics described in Section 2, is their coverage of the market. The data are collected from the five largest mortgage providers in Ireland, and according to the figures for June 2015, their coverage of the PDH mortgage market at that time was around 91 per cent by number of accounts, or 88 per cent by outstanding balance. While this obviously suggests a very comprehensive coverage of the overall market, their share of very long-term arrears cases is lower – 75 per cent by count or 73 per cent by balance. The relative importance of non-bank entities in the Irish mortgage market has increased significantly. These include authorised retail credit firms, as well as other entities holding mortgage loans that were previously on the balance sheets of Irish resident banks. At end-2013, non-bank entities held 2.5 per cent of all mortgage loans (in value terms). By June 2015 this share had increased to 6.5 per cent, following sales of mortgage loans by a number of banks during that period. The higher relative share of long-term arrears cases by these non-bank entities indicates that sales by credit institutions have been predominantly concentrated in delinquent loans (Cassidy, 2015). The coverage of around three quarters of long-term arrears cases within these micro-data is, however, considered sufficient for analysis purposes. Nonetheless, it is worth exercising caution when making inferences on the wider population.

On the other hand, the primary advantage of the loan-level data is the granular detail contained within. Information on loan origination, geographic location, loan-to-value (LTV) ratio, interest rate and other important variables for understanding the profiles of mortgage borrowers is available, and allows for deeper analysis of the mortgage arrears crisis, and the identification of the factors that may be driving long-term arrears. Previous research on mortgage arrears in Ireland has shown that distressed borrowers exhibit quite different characteristics to performing borrowers. Loan-level data can uncover some of these important differences.

3.1 Point-in-Time Analysis[6]

Figure 4 shows the distribution of mortgages in arrears of more than 360 days by year of origination of the loan. It shows that loans originated between 2005 and 2008 account for a very large share of those mortgages that are currently in arrears of more than 360 days (approximately 63 per cent). This is unsurprising given that this period was the height of the property boom in Ireland, and overall mortgage approvals peaked around this time. However, the data also indicate that issuances of loans that are now in deep arrears grew at a relatively faster during these years than all other loans. Figure 4 shows the share of loans that are currently in arrears of more than 360 days in the total number of mortgages issued in each year. This share increased significantly from 2005 and peaked in 2007. The figures imply that 7.6 per cent of all loans originated in 2007 are now in arrears of more than 360 days. This compares to an average share of 4.4 per cent in the years from 1995 to 2004.

In terms of interest rates, there are three distinct types in Ireland: fixed rates, standard variable rates (SVR) and other variable rates with a contractual obligation to a fixed margin above a policy rate (tracker). During the 2003-2009 period, tracker mortgages increased in popularity, and the average margin over the ECB main refinancing rate was 110 basis points (Kelly et al, 2015). Tracker mortgages are no longer offered to new borrowers, although their share of outstanding mortgages remains relatively high. Figure 5 indicates that for the sample of mortgage loans in the loan-level data, 37 per cent are currently on tracker rates, while 54 per cent are

[6] The most recent micro-data refer to end-June 2015.

on SVRs. Looking at the cohort of loans in long-term arrears, SVR mortgages are over-represented, accounting for 64 per cent of loans in arrears over 720 days. While interest rates on tracker loans have trended downwards in recent years in line with policy rates, SVR rates have moved in the opposite direction. For these loans, the lender is permitted to unilaterally change the interest rate, independent of any changes to policy rates. Funding pressures on Irish banks in recent years and efforts to improve their interest margins have resulted in an upward trend in SVR rates. Therefore it is not surprising that SVR mortgages are over-represented among the cohort of loans in deep distress. Goggin et al (2012) suggests that costs relating to increased credit risk may be a factor in variable interest rate price-setting, i.e. banks with higher arrears rates exhibit higher variable mortgage rates. Of course such a strategy could be counterproductive in that it may contribute to further upward pressure on arrears.

The loan-level data also permits an analysis of arrears by geographic location. To facilitate this, the Nomenclature of Territorial Units for Statistics (NUTS) geocode is assigned to the borrower location data fields. The NUTS 3 classification splits Ireland into eight separate regions: Border, Midlands, West, Dublin, Mid-East, Mid-West, South-East and South-West. Table 1 ranks these regions by their share of total mortgage loans, showing that Dublin has the highest mortgage population – almost 29 per cent of total loans. Table 1 also shows loans in arrears of more than 360 days as a proportion of total outstanding loans in the respective region. For the country as a whole, 4.5 per cent of all mortgage loans are in arrears of more than 360 days. The Midlands and Border regions have the highest shares of long-term arrears, at 6.1 per cent and 5.7 per cent respectively. The lowest shares of long-term arrears are found in the South-West, Dublin and West regions.

This finding can be explored further using additional data relating to loan-to-value (LTV) ratios. Both the original LTV and current LTV are available in the loan-level data, and the median values of these are presented by NUTS 3 region in Table 2. Firstly, current LTVs are higher among those loans in long-term arrears compared to those of total mortgage loans – this is expected as borrowers in arrears are not obviously reducing their outstanding loan balances as quickly as borrowers of performing loans. Higher LTV ratios can be associated with either higher outstanding loan values or lower house price valuations. Comparing the current LTVs to the original LTVs indicates that among the longer-term arrears cases, housing valuation drops have been significant. For the total cohort of loans in arrears over 720 days, Table 2 shows that the median current LTV is 21 percentage points above the original LTV. The differential is highest among the Mid-East and Border regions, but is considerably lower in Dublin, the West and South-West regions. This is unsurprising, given that these regions include Ireland's three largest cities. As noted above, these three regions also display the lowest shares of long-term arrears, suggesting that developments in house price valuations are an important factor in the transition into longer-term arrears.

3.2 Flows Analysis over Time

Using a time series of the loan-level data, it is possible to observe movements in to and out of the various states of arrears over time. This is a particularly useful feature of the data, as it uncovers some interesting dynamics that are not available through the aggregated statistics. In particular, these details provide meaningful insights that may assist in the formulation of policy measures and the effective targeting of resolution strategies.

Table 3 illustrates such a flows analysis, by examining movements across arrears states between June 2014 and June 2015. The diagonal of this transitions matrix displays the percentage of each arrears category that showed no movement over the year. For example, starting at the top left, of all the accounts that were performing in June 2014, 97.8 per cent of them were still performing in June 2015. At the opposite end, 80.1 per cent of accounts that were in arrears of more than 720 days in June 2014 were still in this category a year later. The useful feature of such a presentation is that anything to the right of the diagonal shows a deterioration in the arrears position over time, while anything to the left indicates movement towards an improved state. So for the cohort of loans that were in arrears of more than 720 days in June 2014, 12.4 per cent of them had cured completely a year later, while almost 20 per cent of them had moved to an improved arrears state. This uncovers a positive development in the arrears situation that is simply not visible in the aggregated statistics. For the same group of reporting institutions, the aggregate statistics indicate an increase of 2 per cent in the number of accounts in arrears over 720 days between June 2014 and June 2015. On the other hand, however, the transitions matrix shows that 35.1 per cent of accounts in arrears of between 361 and 720 days deteriorated further over that period, moving into deeper arrears.

Table 4 focuses on loan accounts there were in long-term arrears in June 2014, by combining the last two categories of arrears duration to consider all those in arrears of more than 360 days. Almost 74 per cent of these accounts were in a similar or worse position one year later. On the other hand, almost 19 per cent of these accounts had exited arrears completely, and were back to zero days past due by June 2015. This raises the question of whether these loans have different characteristics that might shed some light on their divergent path over that period. Understanding what has contributed to "curing" that 19 per cent of long-term arrears cases could provide valuable policy lessons.

It is worth noting that transition rates to improved states of arrears have increased over time. Figure 6 uses transition rates over six month periods to illustrate this point, and it shows the percentage of accounts in each arrears category that had moved to any lower arrears state six months later. For example, 28.1 per cent of accounts in arrears up to 90 days in June 2012 had exited arrears six months later. The share of "improving" accounts was much greater by December 2014 – at this time over 45 per cent of accounts in arrears up to 90 days had exited arrears by June 2015. Figure 6 indicates that progress in transitions to improved states has been slowest among the cohort of loans in very long-term arrears. For loans in arrears over 360 days in December 2014, 18 per cent of them had moved to an improved arrears state six months later. This figure represents just a 6.3 percentage point increase in the share of "improvers" in this category in June 2012.

Section 4: Resolving Mortgage Arrears

Arrears resolution strategies have been concentrated, for the most part, on forbearance arrangements, whereby the terms and conditions of the loan are altered in such a way that makes repayment more manageable for the borrower.[7] Forbearance techniques include a variety of short-term arrangements such as interest-only repayment periods, and other temporary deferral of or reductions in the repayment amount. Extending the term of the mortgage and/or capitalisation of the arrears balance have also been widely used as resolution measures, and in recent years banks have increasingly considered advanced modification options such as split mortgages, which involve warehousing a portion of the loan at a low interest rate, for future repayment.

The micro-data includes information relating to loan modifications, which facilitates an analysis of the types of forbearance that have been applied to accounts in deep arrears. Using the accounts in long-term arrears in June 2014 (i.e. Table 4), it is possible to distinguish between the resolution strategies employed for those accounts that had "cured" by June 2015 and those that remained in long-term arrears. Figure 7 displays the breakdown of modification types for both cohorts. The most notable feature of this analysis is that among the loan accounts that exited long-term arrears and returned to a zero arrears balance by June 2015, 91 per cent of them had undergone some sort of permanent modification. Arrears capitalisation and split mortgages were the most widely used modification types among these "cured" loans. On the other hand, 85 per cent of the loans that remained in long-term arrears over this period had received no permanent modification at all. Even looking beyond the permanent modification types, the data also indicates that the use of temporary restructuring options has been very low among this group. Less than 30 per cent have been granted a temporary arrangement, and for those that have, the vast majority have been interest only arrangements of up to one year, many of which have expired.

It should be noted that these data do not cover all possible resolution strategies put forward by the reporting institutions. Under the Central Bank of Ireland's Mortgage Arrears Resolution Targets (MART) framework, there are other options that may be deemed to be "sustainable solutions" aside from the usual forbearance measures discussed here. The most common of these involves loss of ownership of the property, either voluntarily or through repossession proceedings. It is likely that a number of the persistent long-term arrears cases analysed here have gone down this route.[8] Repossession is considered to be the final resolution option, once other possibilities have been exhausted, as it implies a realisation of losses by the lender. Over half of the cases analysed above in persistent long-term

[7] Home repossession figures are very low in Ireland, by international standards. This has been influenced, in some part, by a legal loophole that made it difficult for lenders to initiate such proceedings. This loophole was closed by the Government in 2013, and it is expected that the number of repossessions will increase over the coming years.

[8] New micro-data covering all types of sustainable solutions under the MART framework will shortly be available.

arrears have a current LTV of over 100 per cent, while 36 per cent of them have a current LTV of over 120 per cent.

The data also contains information on arrears balances. Examining the evolution of these balances over time can reveal whether or not any of the deep arrears cases are showing a reduction in arrears, even if it isn't sufficient to move them out of the long-term arrears cohort. Looking again at the loans that remained in arrears over 360 days over the period from June 2014 to June 2015, only 7 per cent of these accounts recorded a reduction in their outstanding arrears balance. The remaining accounts continued to add to their large accumulated arrears balance over that period. The lack of progress on these cases is clearly a cause for concern from a policy perspective, as they represent over 4 per cent of the entire sample of mortgage loans in this analysis. Extrapolating this to the wider population implies that there is a significant quantity of loans that are in very deep distress and continuing to deteriorate.

Conclusion

This paper highlights the merits of both macro and micro data in deepening our understanding of important financial stability issues. Both types of data have made a significant contribution to the mortgage arrears debate in Ireland, and continue to shape the formulation of policy measures in this area.

Aggregate data have crucial advantages in terms of their frequency, timeliness and broad coverage of the mortgage market. They provide a valuable snap-shot of the current state-of-play, and their harmonised and consistent nature make them highly suitable for publication, meaning that vital updates can be communicated to lenders, borrowers, policy-makers and the general public. The Central Bank of Ireland's *Residential Mortgage Arrears and Repossession Statistics* are widely used by these audiences, and they have served as a reliable source of information on mortgage arrears since 2009.

The aggregated nature of these data facilitates speedy processing and timely availability for users, but it is also the source of their limitations. These data are incapable of addressing the in-depth issues at the heart of the mortgage arrears crisis. The characteristics of the loans themselves, the arrears profiles, and the resolution strategies are delivered only at a high level, and there is no information at all relating to the borrower or the collateral. Such detail requires the collection of micro-data to complement the aggregate statistics and provide crucial insights and answers to the most pertinent questions. Although their coverage is rarely as comprehensive, and the timeliness and frequency considerably less favourable, the wealth of information available in the micro-data makes them an invaluable resource in terms of understanding and addressing financial stability issues.

Using both data sources, this paper has provided some new, meaningful insights into developments in long-term arrears cases, which have become the crux of the mortgage arrears crisis in Ireland. While the aggregate statistics indicate that the overall arrears situation has been improving for two years now, they highlight the persistent growth of long-term arrears. The loan-level data facilitate a more detailed analysis of this cohort, providing valuable information relating to the interest rate type on the loan, the geographic location of the borrower, and the development of the loan-to-value ratio over time. The data also allows us to examine the flows in to and out of long-term arrears over time, which serves two useful purposes. On the one hand, it allows us to identify the successful cases – those accounts that were in deep distress and have now exited arrears. Close examination of this group suggests that permanent modification has played a vital role in these positive outcomes. On the other hand, the data also allow us to delve into cases of persistent long-term arrears and to distinguish further between those that may be making incremental steps towards progress by reducing their arrears balances, and those that continue to deteriorate and appear to be beyond the reach of traditional forbearance measures. Such analysis highlights the heterogeneous nature of the long-term arrears cohort – an observation that is simply not feasible using aggregated data alone.

The micro-data in particular are useful for informing policy, and in this regard there are still some unanswered questions. Further detail is required to assess the extent to which repossession and voluntary loss of ownership is playing a role in arrears resolution. In addition, as outlined in Section 3, the coverage of the loan-level data is currently restricted to a small number of credit institutions. While they account for a very large share of the mortgage market, their coverage of arrears and particularly long-term arrears is lower. Expanding the data to cover other credit institutions as well as non-bank mortgage holders would address the issue of representativeness. In this regard, initiatives such as the Irish Central Credit Register and the European Central Bank's AnaCredit project are to be welcomed.

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Figure 1: Mortgage Accounts in Arrears over 90 Days (by value)

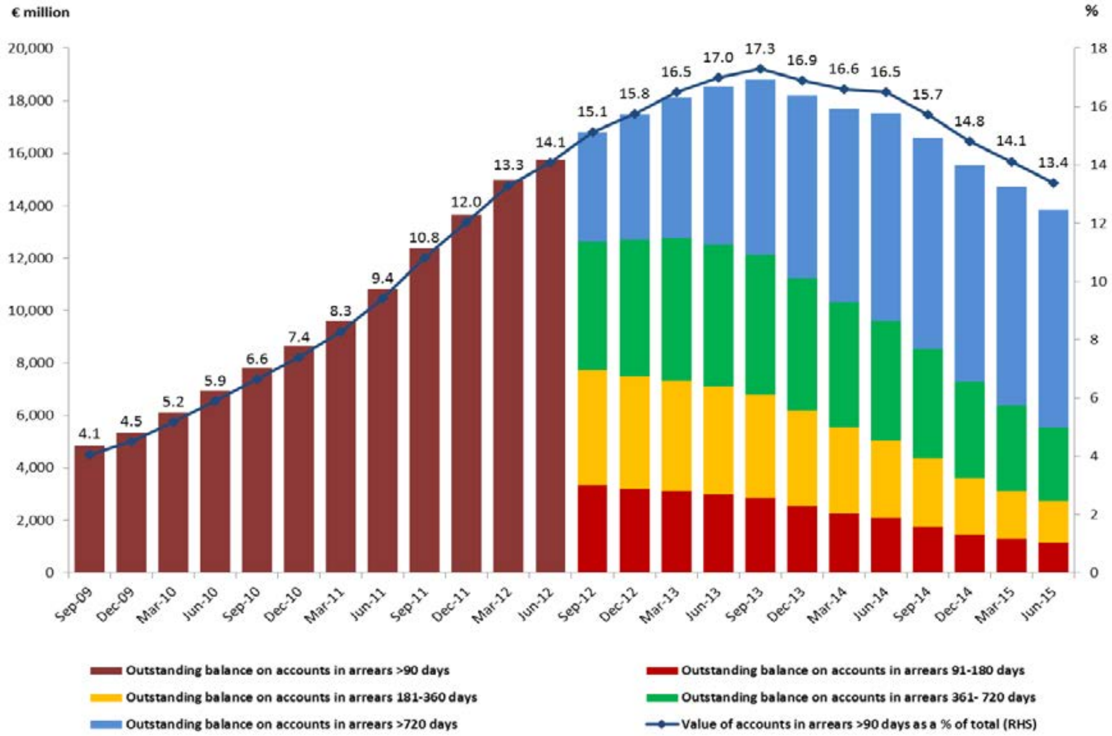

Figure 2: Quarter-on-Quarter % Change in Value of Accounts in Arrears

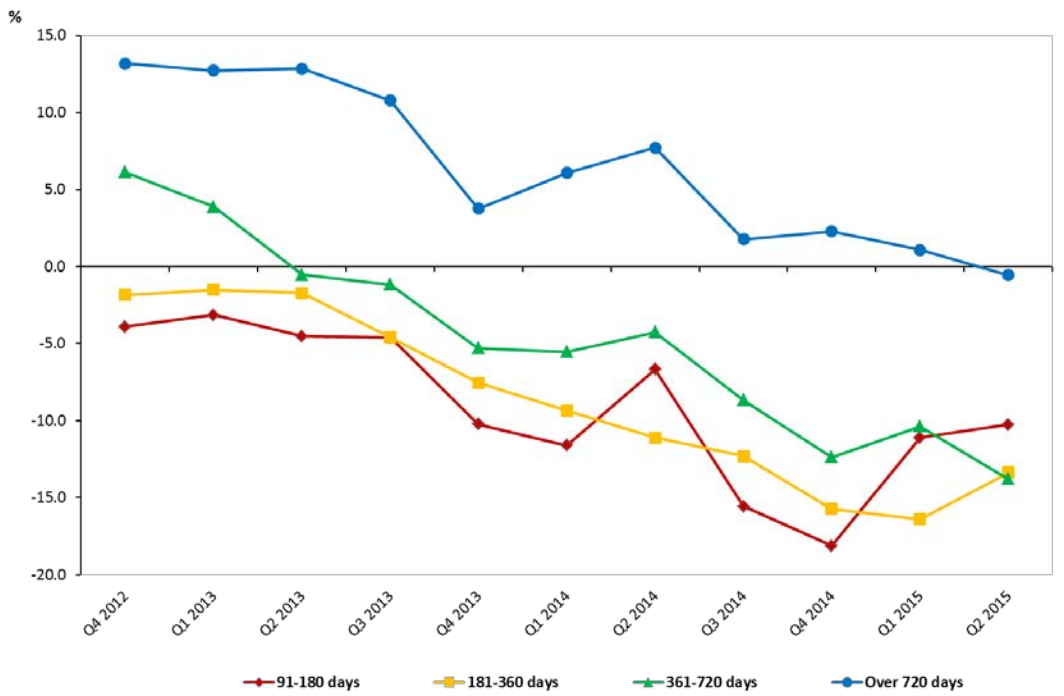

Figure 3: Mortgage Accounts in Arrears over 90 Days

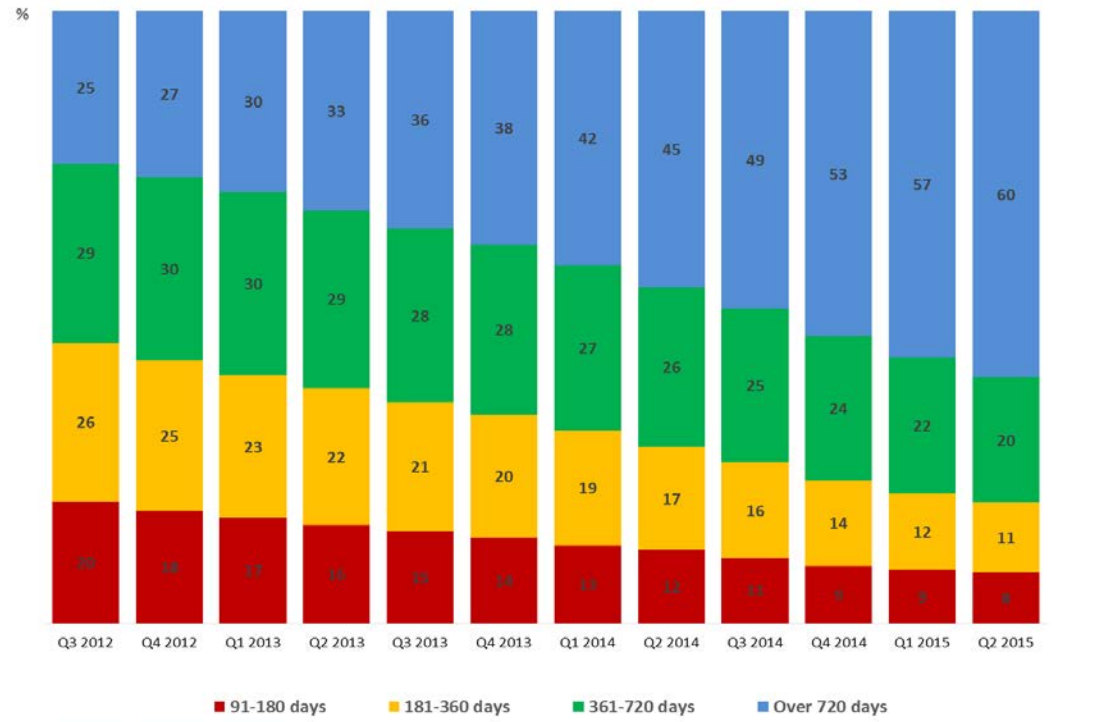

Figure 4: Mortgage Accounts in Long-Term Arrears by Year of Origination

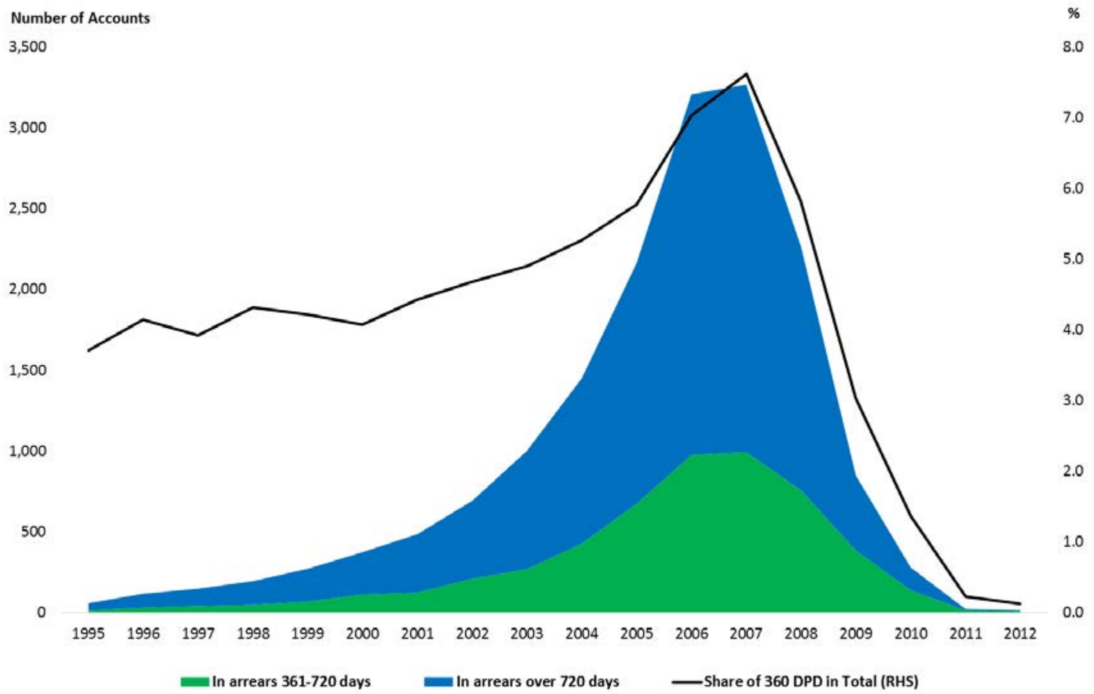

Figure 5: Long-Term Arrears by Interest Rate Type

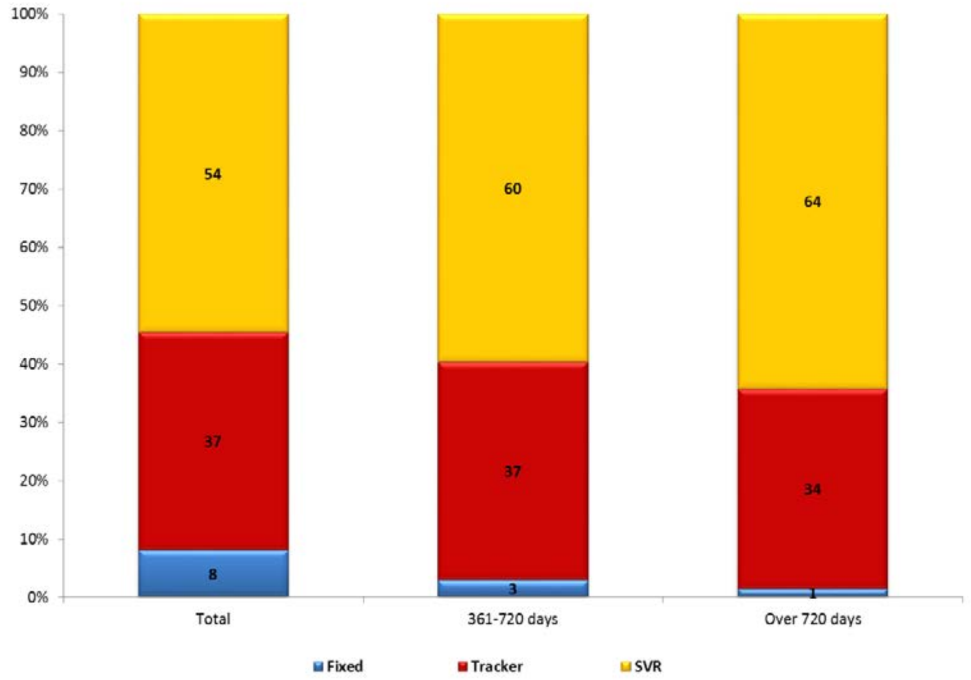

Figure 6: Transition Rates to Improved Arrears States

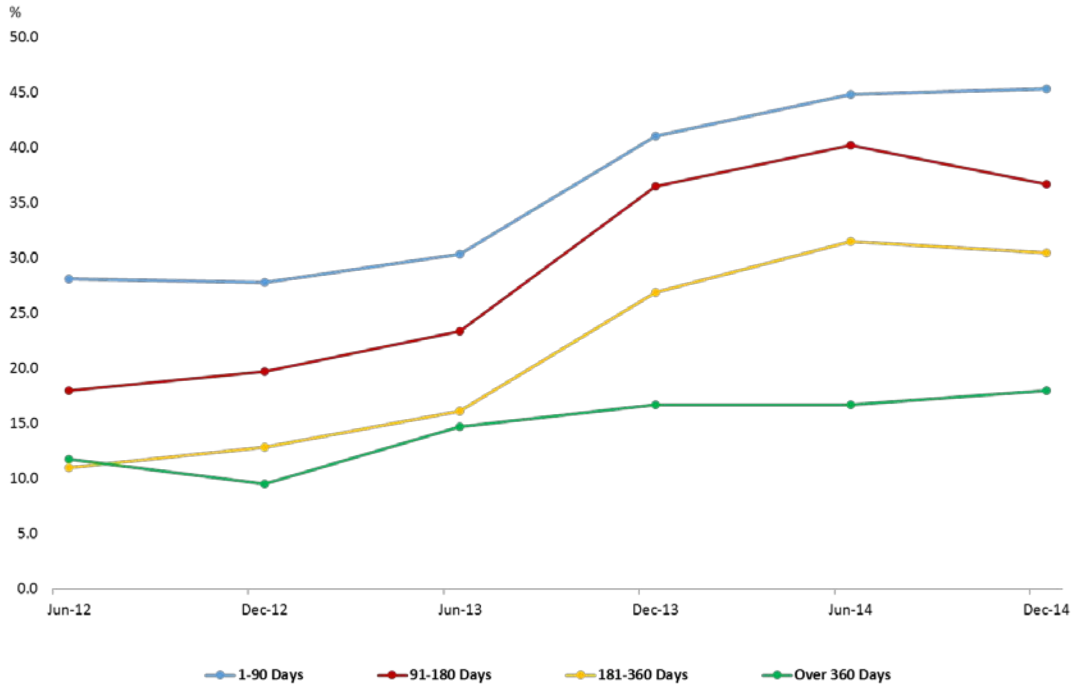

Figure 7: Permanent Modifications for Accounts in Long-Term Arrears in June 2014

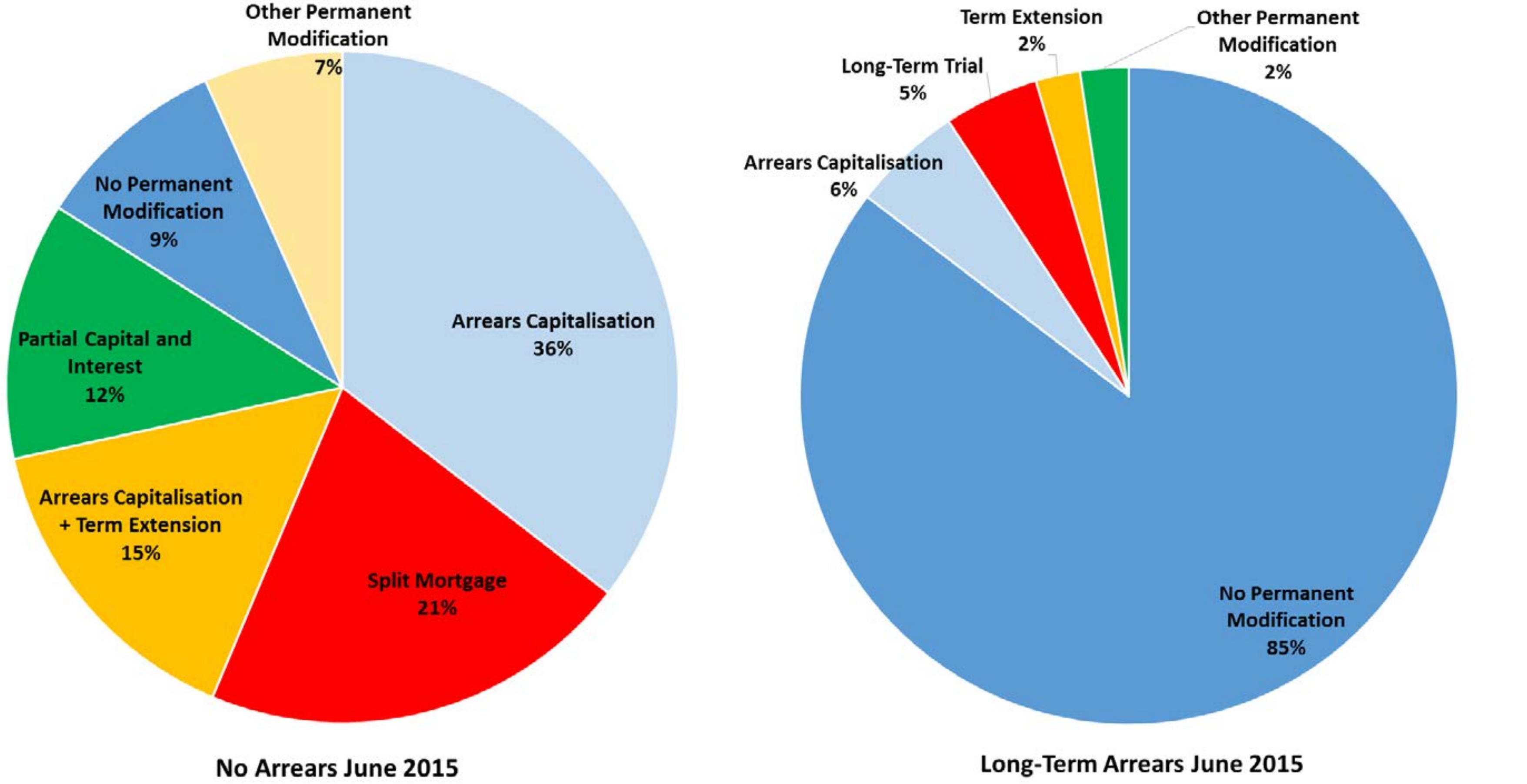

Table 1: Long-Term Arrears by Geographic Location

	% Share of Total Mortgages	>360 Days in Arrears as a % of Total
Dublin	28.9	3.9
SouthWest	15.2	3.6
MidEast	13.2	5.5
MidWest	10.6	4.6
West	9.6	3.9
Border	9.4	5.7
SouthEast	8.0	5.3
Midlands	5.1	6.1
Total	**100.0**	**4.5**

Table 2: Original and Current Loan-to-Value Ratio by Geographic Location

	TOTAL		361-720 days		>720	
	OLTV	CLTV	OLTV	CLTV	OLTV	CLTV
Dublin	80	61	83	86	85	100
South-West	70	57	75	81	78	95
Mid-East	77	66	83	94	83	111
Mid-West	75	61	80	85	83	103
West	70	58	77	84	79	92
Border	71	62	81	93	83	109
South-East	73	62	79	92	82	106
Midlands	77	65	85	100	85	108
Total	**76**	**61**	**80**	**88**	**83**	**104**

Table 3: Transition Rates among Arrears Categories, June 2014 - June 2015

Jun-14	Jun-15						
	0 Arrears	1-30 Days	31-90 Days	91-180 Days	181-360 Days	361-720 Days	Over 720 Days
0 Arrears	97.8	1.1	0.6	0.3	0.2	0.0	0.0
1-30 Days	63.6	18.7	9.4	4.8	2.9	0.6	0.1
31-90 Days	48.3	11.5	17.3	11.1	8.5	3.2	0.1
91-180 Days	42.5	5.9	7.8	13.2	18.7	11.7	0.3
181-360 Days	35.8	5.0	3.7	3.4	17.2	33.2	1.8
361-720 Days	28.1	3.8	2.5	1.7	2.7	26.1	35.1
Over 720 Days	12.4	2.1	1.6	1.0	0.9	1.9	80.1

Table 4: Transition Rates from Long-Term Arrears, June 2014 - June 2015

Jun-14	Jun-15						
	0 Arrears	1-30 Days	31-90 Days	91-180 Days	181-360 Days	361-720 Days	Over 720 Days
Over 360 Days	18.6	2.8	2.0	1.3	1.6	11.5	62.3

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In pursuit of patterns of economic behaviours using cluster and correspondence analysis[1]

Arkadiusz Florczak, Janusz Jabłonowski and Michał Kupc, Narodowy Bank Polski (Poland)

[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 or the central banks and other institutions represented at the meeting.

In pursuit of patterns of economic behaviours using cluster and correspondence analysis

The cluster and correspondence analysis with use of preselected features of the household budget survey with an automated documentation

Arkadiusz Florczak, Janusz Jabłonowski, Michał Kupc[1]

In pursuit for patterns of economic behaviours using cluster & correspondence analysis

Availability of large datasets of (often) sensitive data at the level of Statistics Department imposes the obligation to verify their quality and numerical consistency. However, such circumstances offer a chance to use the low level statistical tools based on purposefully written functions that search for unobservable patterns (clusters) that may not be apparent at higher levels of aggregation in publishable data. The versatile statistical tools created in R environment, relying in principle on e.g. cluster analysis and correspondence analysis, may serve in many fields as a link between micro and macro level analysis, with additional possibility to create the automatic documentation of the R code and results. The working example covers analysis of the saving behaviours based on household budget surveys.

Keywords: cluster analysis, correspondence analysis, household budget survey

JEL classification: C38, D14

[1] Authors are the employees of the Statistics Department in Narodowy Bank Polski.

Foreword

The statistics divisions settled in the domestic or international institutions are unique places of coincidence of special features: when looking from the input side there's nearly unconditional availability of often sensitive data for many sectors, with additional possibility to trigger the surveys, comparing them with the existing data. After a process of data modification and aggregation the output side (externally mainly websites) shows some loss in informative value (entropy), i.e. some units decide to publish mainly only the aggregates, while other disseminate more advanced statistical products. Simple transformation process usually covers verification of internal consistency, missing data, outliers and other comparable issues, then aggregation. Further levels of the data users receive the datasets theoretically free of numerical and logical errors and omissions. However, the pre-aggregated, user-friendly datasets may already trim unknown level of details theoretically interesting for analytics. Additionally, presentation of limited measures of the central tendency (e.g. arithmetic means) may often be misleading in non-normal distributions of the background data. The expansion of research can be promoted in statistical units by creation of statistical and econometric tools that not only verify raw source data for consistency and logical errors, but also searches for eventually hidden patterns in theoretically exploited topics. Since the authors are hired in the Statistics Department, there's a chance to create such toolbox to pre-aggregate and model easily accessible data. The toolbox formation started in early 2015 from, among others, cluster analysis and correspondence analysis, with imposed script formatting in open source R environment with additional aim for prompt automated documentation.

The structure of the paper: after current introduction there's a chapter on the methodology of the cluster and correspondence analysis extended by utility comments. Then the exemplary questions to be answered follow, and attempts of replies, including the box with a piece of automated documentation produced by the statistical tool. Next come the conclusions of the results, followed by the conclusions for the statistical tool and finally a literature review. The views expressed in the paper are not to be associated with those of the National Bank of Poland.

The idea of the cluster and correspondence analysis

The cluster analysis was introduced to the literature in 1939 by R. C. Tryon in "Cluster analysis". Due to large flexibility of application based on free-of-restrictions search for patterns of concentration of diverse features of the data, the clustering method became popular in many branches of science, e.g. biology, medicine, computer science, marketing or social sciences, including economics. In principle, the literature suggests 4 main methods of clustering, as follows:

1. hierarchical,
2. non-hierarchical,
3. graphical presentation,
4. hybrid.

Each method applies comparable stages of preparation, consisting of:

1. selecting objects and features that represent them,
2. transformation of the data,
3. choosing measures of distance,
4. selecting method of clustering,
5. selecting number of clusters,
6. evaluating of results of clustering,
7. interpretation and class profiling.

Strengths: A free of restrictions approach that seeks for the *natural* groups within complex sets of standardized data allows sometimes to find hidden structures and reduced number of explanatory variables, helpful when building e.g. a model that aims to simulate the reality. With longer time series of well-known data some new common features may occur in clusters. Multi-cluster structures can reveal e.g. different regional patterns.

Weaknesses: Firstly, the choice of number of classes can be a pejorative educated guess by a researcher. With large number of variables the choice of only one class may result in very condensed and large cloud of features, which is difficult for interpretation. Secondly, there is a difficulty in interpretation of the clusters even if they exist – since they might form an apparent concentration in terms of statistical structures. The comparison of several linking methods and distance measures shall help anyway. Thirdly, a result is prone to applied type of the distance measure.

The correspondence analysis, which notions dates back to early 20th century, was broadly popularized by Hill in 1974. It can be regarded as a special kind of a canonical correlation analysis between two categories of discrete data (Clausen, 1998). In principle, it's a graphical presentation of the relations between two or more sets of quantitative and qualitative data, usually in the form of (perceptual) maps. The strengths can be repeated after the cluster analysis, however, there are no limitations for the size of dataset that may consist of both variables and objects and the outliers do not affect the position of other objects on the map. The weaknesses may be extended by the suggestions of Greenacre (2009), e.g. time series analysis low frequency points are often situated in outlying positions in the map because of their unusual profiles.

The exemplary questions

Several reports on the Polish households suggest insufficient propensity to save (World Bank, Poland CEM, 2014), which, in line with the expected dropping replacement rates from the public pension system, may result in disappointing streams of income after the retirement. From the one hand, the households' saving motives seem theoretically quite well explained by the economics of consumer choice, but from the other hand, the observed financial savings' rate may suggest lack of strong saving motives for retirement. In pursuit for the savings' motives at the micro level the available household datasets for income and consumption may be handy – especially, if it occurred that some household features repeat more often when savings or excessive consumption are in focus. It could be also nice test of statistical tool i.e. R based cluster and correspondence analysis, which could enrich knowledge at the macro level.

From the available datasets the household budget survey (HBS) was chosen, which is based on the representative method and covers the rotating sample of around 37 thousands households every year. The monthly rotation of households assumes that every month of the year a different group of households participates in the survey, and the ex-post stratification allows to generalize conclusions from samples into population every quarter, within a margin of an error. Each household participating in the survey keeps a special diary for a month, where registers expenditures, quantitative consumption and incomes[2].

The method of monthly rotation of the households' sample complicates the analyses of the time series when searching for patterns of economic behaviours in time. For modelling purposes short vectors of features are preferred or repeated observations the same units in time. The traditional approaches to modelling usually consider e.g. job experience and education, but is there a possibility that the vectors of the household features, which with higher propensity to consume / save, are longer and comprise dozens of features? Or in other words: is there a stable overtime set of HBS features that is common to households with high propensity to save (or consume)? What's the reduction of features for a model-saving household compared with the not-saving household, if any? How does the seasonality savings / excessive spending affect a composition of clusters? Do indebted households share common features and behaviours with those free of mortgage? Does mortgage currency affect clusters?

An attempt to reply

Since the main aim was to verify if there are overtime relatively stable set of features of households that create the highest savings (or excessively consume), the deciles of the annual cash result of employees' households[3] served for a basis for the initial stage grouping. The annual cash result is here calculated as a disposable income minus expenses (according to HBS methodology, the expenses category excludes the accumulation, e.g. real estate purchases, but include consumption of fixed capital, i.e. renovation) repeated in the following years and quarters between 2005 and 2014. Other words, the 1st decile covers the most indebting households, while the 10th comprises the most saving ones. The saving households' group grows with years, however, a number of households in each decile group is quite comparable when considering the generalization of the HBS sample on the entire population with weights.

During a stage of data transformation the quantitative data were transformed into qualitative data that reflected e.g. deciles of income, expenditures and their difference (referred here as voluntary savings) while e.g. the age vector grouped into labelled 5-year cohorts. Such method sacrifices the clarity of the results (large

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2 Source: http://stat.gov.pl/obszary-tematyczne/warunki-zycia/dochody-wydatki-i-warunki-zycia-ludnosci/budzety-gospodarstw-domowych-w-2014-r-,9,9.html.

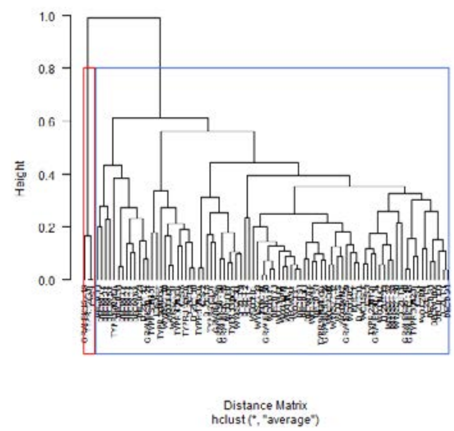
3 Such distinction seems vital from the point of view of households composed of e.g. an employee and an entrepreneur, where incomes would be affected by a turnover from economic activity, and part of private consumption would be deformed by costs of entrepreneurship.

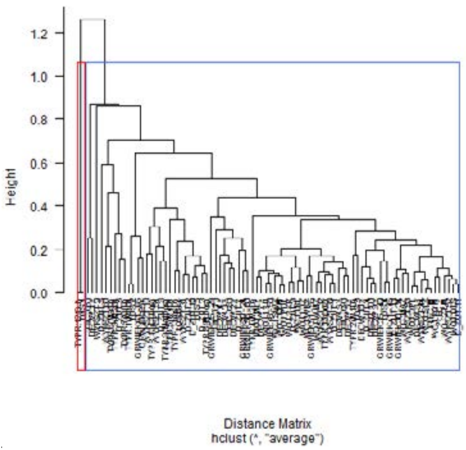
and dense clouds) but should be more profitable in terms of precision. Due lack of acceptable clarity of the results, the cluster analysis was followed by the correspondence analysis, where the data were transformed into artificial data in process of correspondence analysis.

When choosing the distance measures during the cluster analysis, for the binary data the Jaccard measures of dissimilarity, while for the non-binary data (qualitative), the Sneath coefficient, the Gower dissimilarity measure and Sokal & Michener and GDM2 measures were applied. In the following correspondence analysis, due to lack of the literature support for the non-hierarchical methods, only the hierarchical methods were considered with the Euclidean distance measure.

For the optimal choice of the hierarchical method of the cluster analysis followed by the correspondence analysis, the results were evaluated in terms of their deformation after converting distance matrix into cophenetic matrix. The verification relied on the two indicators: the cophenetic correlation coefficient and the sum of square deviations. In the analysed case both indicators suggested the average linkage method as optimal. The visual interpretation of the dendrogram, when evaluating the optimal number of groups, may be tricky, therefore, a further support can be found in 4 relative criteria: silhouette index (SIL), Caliński&Harabasz index (G1), Krzanowski&Lai index (KL) and Davies-Bouldin index (DB). The aim of the profile indices is to evaluate a theoretical appropriateness of selected number of clusters.

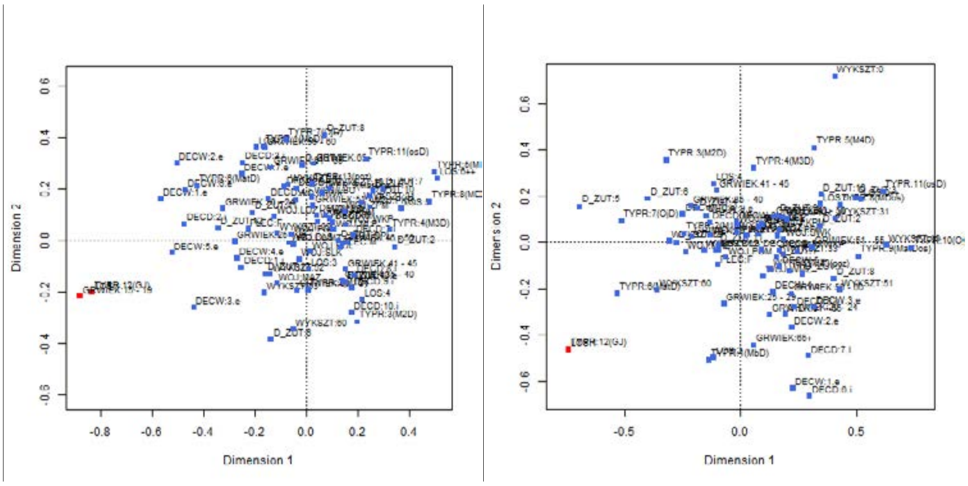
Picture 1 and 2 visualizes the cluster analysis via dendrograms for the employees households' features clustered according to the absolute value of deciles of their annual cash result: 1st (left) and 10th decile (right), with average linkage method for 2014 data.





Pictures 1 and 2, despite being blurred in attached version, share common main interpretation: the blue box covers nearly all 99 analyzed features of the households for 1st and 10th decile of annual cash result in 2014, so any concentration of features for model saving households, based on the HBS, does not occur in this version cluster analysis. The red field in dendrograms covers the outliers, expectedly consisting of youngsters, elders and low income.

Picture 3 and 4 below represent the same features with use of correspondence analysis, presented in a form of the perceptual maps for the same group of employees' households, grouped in deciles of their annual cash result: 1st (left) and 10th decile (right), average linkage method for 2014 data.



The perceptual maps (result of correspondence analysis) confirm a very modest differentiation of features between the most saving and excessively spending employees' households. An alternative combination of available linking methods, types of distances and indices gives comparable results and additionally is not optimum from the point of view of applied indicators.

Clustering for households with mortgages in CHF extended for quarterly data

This part repeats the above described clustering procedure for the narrower part of the HBS, namely, households with mortgage loans in Swiss francs (CHF). A motivation for this particular trimming of input stems from the expectation that features of the indebted household may vary between annual savers and deficit makers due to higher insolvency risk. For instance the CHF indebted households with higher education level of head of family and low decile of disposable income would be rather risk averse and stabilize their budget or create a buffer stock for unpleasant currency shocks, rather than excessively spending and putting their household at risk. After the first round of calculations a question occurred if some more information can be achieved from the trimmed set of quarterly HBS data. A rationale of this additional exercise has risen from the possible effect of the monthly rotation of the households in the HBS sample, which in annual data could create noise in clusters due to e.g. overlapping seasonal effects in income fluctuations and consumption decisions.

Incurring mortgage loans in Swiss francs (CHF) supposed to be popular and broadly available few years back in Poland. Three major shocks in CHF/PLN from 2009, 2011 and 2015 coincide the households' growing insolvency (macro-prudential statistics) revealed that a part of them was not sufficiently prepared for the exchange rate shocks, despite dropping interest rates. Starting from 2012 the HBS covers also the currency for mortgage and loans, therefore, up to 2014 complete 12 sets of quarterly panel data are available. The literature and media repeats generally well known features of the households with mortgages in CHF, i.e. 2+2 composition, living in towns over 500 thousands inhabitants, occupying an apartment below

75m², in a building raised between 1996 and 2006. Interestingly, despite short coverage period (3 years), and modest representation (2,4% of all households), a significant linear decrease in number of households with CHF mortgage can be observed: by 20% between 2012 and 2014, yet hardly explained, while declared mortgage repayment period averaged to 24 years.

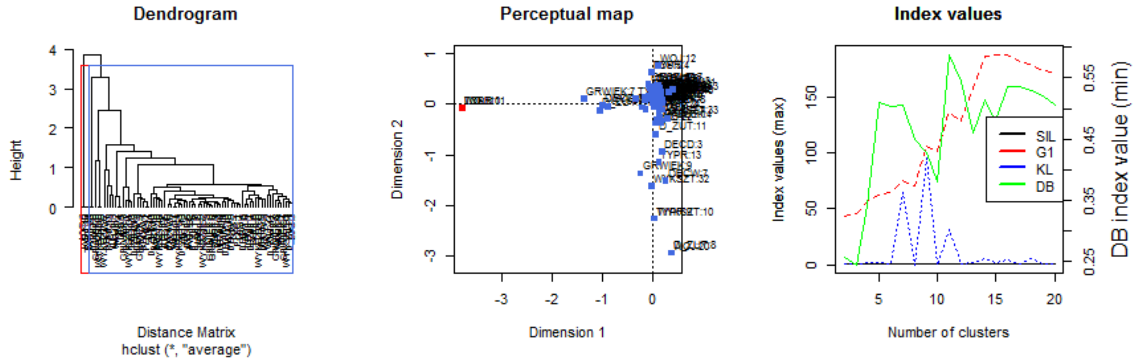
Additionally, an example of automated documentation is inserted in box below, based on Markdown: a lightweight markup language triggered from the level of R compiler, i.e. R Studio that helps to produce fancy and even interactive e.g. HTML, PDF, Word documents and presentations.

The box shows a piece of exemplary automated output in a form of explanatory text, charts and desired piece of R code specified on grey stripes called "chunks":

1

Example of automated documentation in .doc file
[...]
The dendrogram (left) and the perception map (center) profile index (right) with differently colored clusters obtained by average linking method. The chart on the right hand side shows the changing profile indices with growing number of clusters. There are possible profits of playing with the number of clusters, e.g. if for each cluster in HBS analysis different regions or income deciles are falling. Growing number of clusters (limited here to 20) also gives a possibility of the reduction of the explanatory variables in each cluster that can be easier used in econometric modelling, if it seems to make sense, of course.
Sequences of pictures below show the decile for the households with the highest annual deficit in 2014:

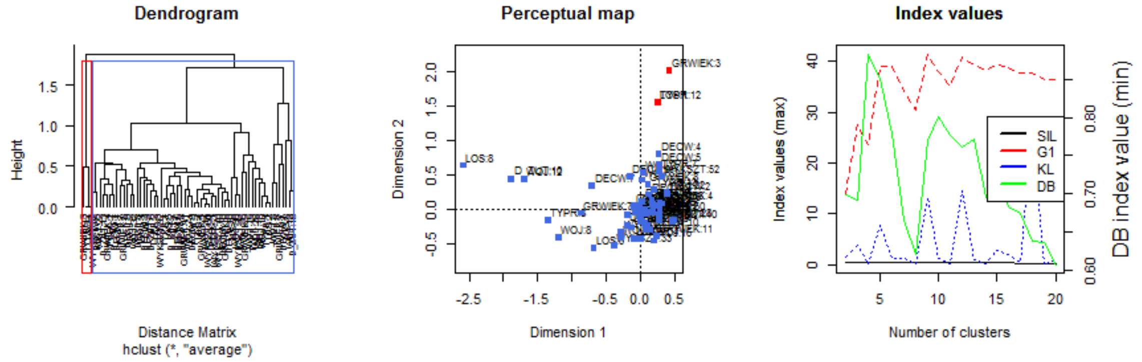
```
a14.1 <- an_kores_skup(dane = dane,rok = "2014", dec = "1", odl="euclidean", metoda_skupien="average",max_nc=20)
```



Below the same set for decile with the highest savings:

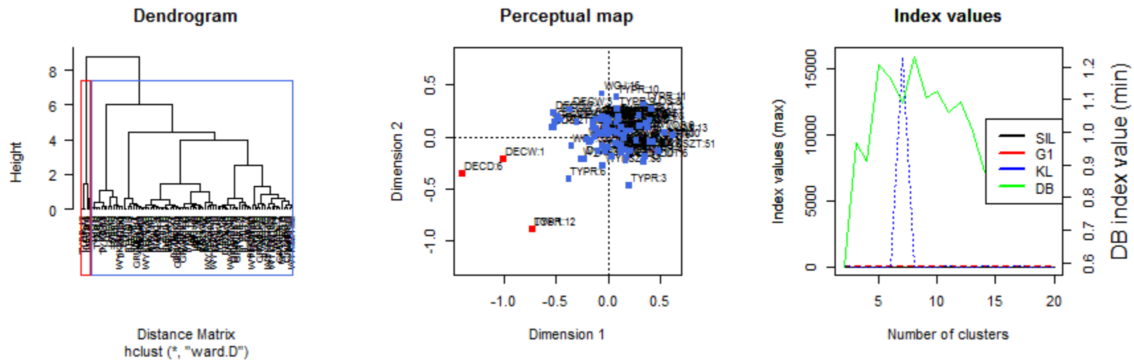
```
a14.10 <- an_kores_skup(dane = dane,rok = "2014", dec = "10", odl="euclidean", metoda_skupien="average",max_nc=20)
```

1

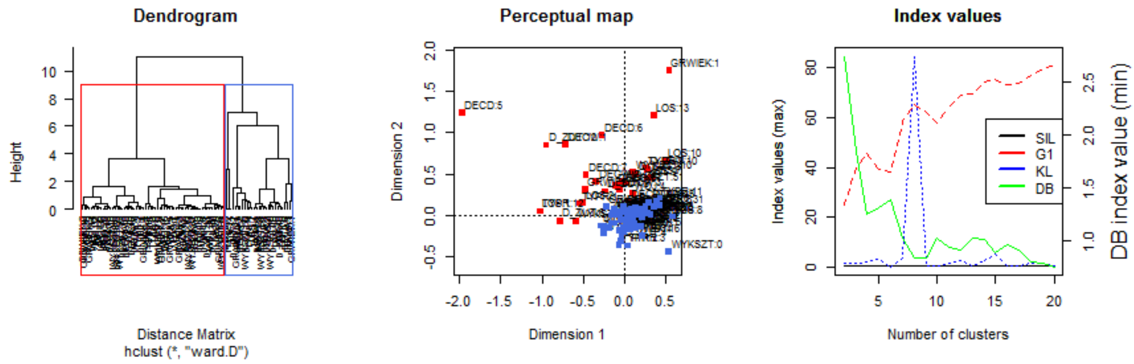


The HBS is stratified in quarterly periods, which allows to reweight the sample for the entire population on quarterly basis too. While the annual data cover all 37 thousands households, so the strong concentrations can be spotted, but at the same time strong seasonal impulses form the income can overlap. There is then a possibility that the cluster and correspondence analysis reflect some seasonal patterns. The following sequence of graphs shows the quarterly sequence of clusters for the most saving households bearing mortgage in 2014 (10th decile of quarterly cash result):

1st quarter:

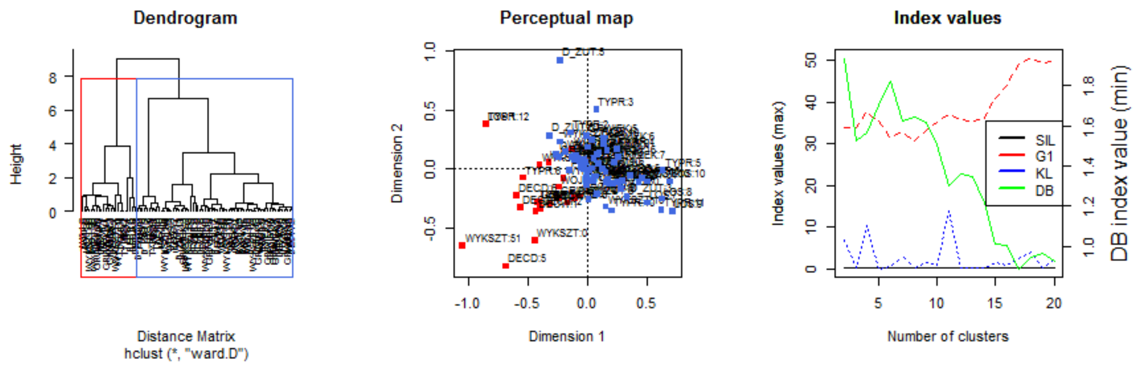


2nd quarter:

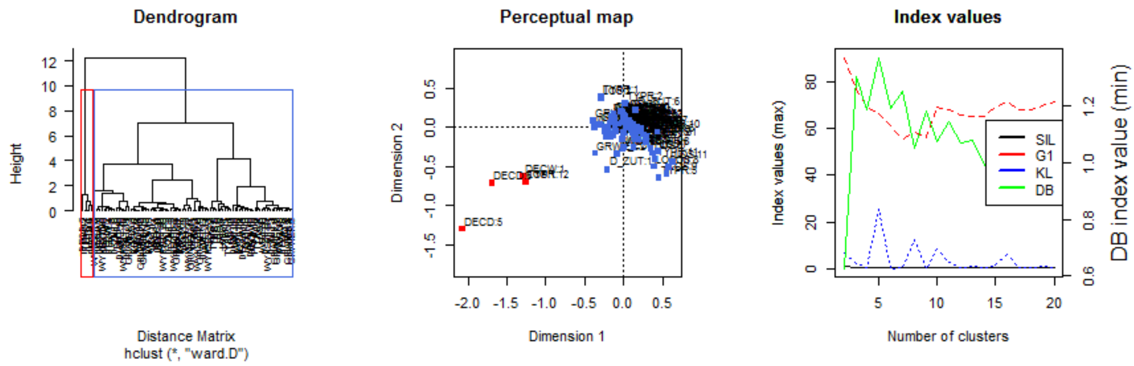


1

3rd quarter:



4th quarter:



Conclusions of the results

The initial aim to find the small sets of (optimally) interpretable features for the most saving and most indebting households was not achieved. The results of the HBS based cluster and correspondence analysis applied on 99 normalized features of employees' households show no difference between two marginal types of households in terms of their annual cash results: in fact single large cluster occurred. Additional analysis for the narrower group of households with mortgage in CHF also shows no significant differences between the most indebting and most saving households. Further trimming of the input dataset into quarters increased the set of dendrograms, perceptual maps, index charts and referred conclusions beyond initially assumed range of this paper. Some seasonal patterns occurred, while the outliers remained in clusters despite further narrowing of the input dataset. The differences in clusters between mortgage indebted and not indebted households finally occurred in quarterly data too, however, not interpretable for authors at this stage of analysis.

In further pursuit for stable behaviour patterns, the results may suggest to extend the number of features rather than searching among the existing ones. If households' consumption reflects somehow a seek for satisfaction of needs, then maybe differentiation in terms of households' subjective evaluation of living conditions (satisfaction of needs in Maslow hierarchy), also reported in the HBS since 2005, covers a quality of inhabited apartment or house. Some interesting initial results, not considered in this paper, occur also for a differentiation of period of a life cycle, i.e. for pensioners' households.

Initial evaluation of applicability of the statistical tool

With regard to the described part of the data mining statistical tool, i.e. cluster and correspondence analysis, their initial preparation from scratch took around 400 hours of literature review, coding in R and ordered documenting of the knowledge and experience database. Further extension of the input can be nearly immediate, however, depends on the nature of analysed feature. The tool suits for different input data, e.g. other surveys, administrative data and matched datasets, however, the process of normalisation, decision tree for choosing distance measures, selecting clustering methods and evaluation of its appropriateness still requires further automation. It was initially tested with the HBS set – the largest and most complex on the household data. The quantitative data generated in clustering procedure may be very helpful in difficult imputations between e.g. administrative and survey datasets, e.g. if obvious common features or distance measures are insufficient. Perhaps, it may serve as a last resort help in reduction of number of potential explanatory variables in modelling, where e.g. number of parameters is close to or exceeds a number of degrees of freedom, or where e.g. various Lasso's fail due to type or size of data.

The function of automated documentation suits many applications at all stages of the computation results. There are very promising examples in initial verification of the raw dataset quality using also very efficient algorithms based on 'Rcpp' package. The Markdown 'shiny' option offers interactive websites, which can be handy especially if the results exceed basic comprehension and can't be further reduced without sacrificing of the essential findings. In this paper the automated Word files allowed for an immediate presentation of uncertain results at 40 pages of charts in trusted order and coherent layout without problems known from copy & paste procedure.

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Setting-up the transmission of individual MFI statistics on balance sheet items and interest rates across the Eurosystem[1]

Piotr Bojaruniec and Graziella Morandi,
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 or the central banks and other institutions represented at the meeting.

Setting-up the transmission of individual MFI statistics on balance sheet items and interest rates across the Eurosystem

Piotr Bojaruniec[1] and Graziella Morandi[2]

Abstract

From its start in mid-1998, the European Central Bank (ECB) has defined the analysis of monetary aggregates and their counterparts as one of the two pillars in its conduct of monetary policy. Hence, the growth of broad money aggregate M3 has steadily been a key policy indicator. As this indicator is produced by the Eurosystem (i.e. the ECB and the national central banks of euro area countries), its high quality, in particular timeliness, integrity, reliability and accuracy, is of utmost importance. Whereas analyses were run for more than a decade based on aggregated data at euro area and national levels, the financial crisis and subsequent policy measures taken by the ECB in response to it, led to the urgent need to drill down to individual banks' data. While national aggregates remain a key component for the compilation of euro area indicators, granular balance sheets and interest rates data have become an important complementary source of information about developments in the money issuing sector. To meet this demand for granular data, statisticians have faced legal and technical issues in various aspects of data compilation and, in response to these challenges, had to establish a new framework amongst the data compilers to allow for the exchange and use of these confidential data. The collection of individual balance sheet items and interest rate statistics gives an example of a "new statistical framework", i.e. a legal and technical structure tailored to address issues such as: data confidentiality protection, increased reporting burden, new approach to managing databases evolving across time to follow the evolution of, e.g., the reporting samples, data quality assessment with expanded databases or data access to final users. This paper intends to describe and explain the issues behind the integration of granular data in macro statistics environments and to explore the set of solutions that have been investigated in the ECB to monitor in parallel both granular and macro-data flows in the particular case of the banks' balance sheet items and interest rates statistics.

Keywords: Monetary policy – MFI – individual data – monetary aggregates – central banking – interest rates

JEL classification: C81, G21

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Contents

Introduction

Micro-data are defined in a formalised way as observation data collected on an individual object - statistical unit. Historically, the European Central Bank (ECB) has always relied in this respect on the concept of Monetary Financial Institution (MFI)[3] to conduct its monetary policy analysis and undertake decisions aiming at fulfilling its mandate to maintain price stability in the Eurozone. However, acting as centralising institution and euro-area-level policy maker within the European System of Central Banks (ESCB) has placed for many years the scope of the statistics collected and compiled at the ECB exclusively on information aggregated at the country level. Until 2012, only aggregate data for euro area countries were transmitted on a regular basis by the national central banks (NCBs) to the ECB. To guarantee cross-country comparison and relevant euro area aggregates, ECB regulations[4] concerning the collection of data on MFI balance sheet items (BSI) and interest rates (MIR) have been issued (together with methodological manuals).

In particular the financial crisis, which started in 2007 and the subsequent deployment of non-standard measures by the ECB, have progressively changed the perspective on data needs to assess the effectiveness of euro area monetary policies, further to the level of inflation in the Eurozone, also for financial stability purposes. In particular, it became clear that evaluating the impairment of the interbank market and analysing the heterogeneity amongst euro area banks regarding their reaction to liquidity shortage and financial ability to face distortions in the money transmission mechanism could only be addressed by looking at the MFI micro picture.

In the first half of 2012, a few months after the announcement by the ECB of additional measures to support bank lending and money market activity, including two longer-term refinancing operations (LTROs with a maturity of 36 months and the option of early repayment after one year[5]), work was jointly initiated by members of the monetary policy and statistics committees of the ECB together with the Eurosystem NCBs to set up an exchange across the Eurosystem of BSI and MIR statistics on an individual basis. In line with the collection of aggregate (macro) BSI and MIR statistics, it was agreed that these data would be collected monthly, thus allowing the timely assessment of ECB non-standard measures' effect.

The individual BSI (IBSI) and MIR (IMIR) datasets were released the first time to the ECB internal users in June 2012 thanks to a strong cooperation within the Eurosystem in order to set up the micro data flow. This paper aims to provide descriptions of the challenges which the ECB statisticians had to face to implement these granular datasets while presenting some of the stakes behind the collection of individual information on the deposit taking and credit granting activity of the euro area MFIs.

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[3] "Monetary financial institutions" (MFIs) are central banks, resident credit institutions as defined in Community law, and other resident financial institutions whose business is to receive deposits and/or close substitutes for deposits from entities other than MFIs and, for their own account (at least in economic terms), to grant credits and/or make investments in securities.

[4] In particular, four regulations have been issue over time regarding BSI statistics, respectively in 1998, 2001, 2008 and 2013, and two regarding MIR statistics, respectively in 2001 and 2013. See references.

[5] These two long-term refinancing operations were announced on the ECB website: https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html

The short story of individual MFI statistics

1. Timeline of proposals and decisions

In 2012, the ECB started to receive on a regular basis from the euro area NCBs individual BSI data. The exchange, which was set up for monetary policy and financial stability purposes, was also supplemented with the one-off transmission of individual BSI and MIR data for historical periods to better support Eurosystem users. These data were intended and still are treated as strictly confidential so that their access is restricted to a limited number of named Eurosystem users. In 2014 the data transmission became permanent and started to also include the regular exchange of individual MIR data.

Another review of the IBSI and IMIR datasets was undertaken mid-2015 in order to address new Eurosystem users' request to expand the sample of MFIs covered in the data exchange and enhance the reporting scheme with higher granularity. The review also included data requirements formulated by the ECB Banking Supervision.

It is worth noting that the short timeline for the implementation of the individual MFI data transmission owes to the fact that the ECB legal framework for collecting national statistics was already in place. It comprises ECB regulations (ECB/2013/33 and ECB/2013/34 at present for BSI and MIR statistics) as well as the ECB Guideline on monetary and financial statistics (referred to as ECB/2014/15 in its last recast). Together, ECB regulations and guideline define qualitatively the scope of the collection of BSI and MIR aggregate data. Statistical regulations are legally binding for all euro area reporting agents; the ECB Guideline imposes obligation on the NCBs to report aggregate data to the ECB. Consequently, none of the data requirements formulated by the ECB stake-holders in setting up the MFI micro-database have ever gone beyond what was already available in the NCBs' databases. While discussing the micro-data transmission it was actually strongly emphasised that reporting agents should not be impacted by the new ECB requirements. Instead, a key issue with the implementation of the individual data transmission was the need to ensure that the regular data flow between NCBs and the ECB remained in line with the strict confidentiality rules applying to individual MFI information. To reach this, the ECB relied on Article 8 of the Council Regulation (EC) No 2533/98 of 23 November 1998 concerning the collection of statistical information by the ECB. Point 2 of Article 8 states that the "transmission from the NCBs to the ECB of confidential statistical information shall take place to the extent and at the level of detail necessary for the exercise of the tasks to be carried out through the ESCB, as described in Article 105 of the Treaty''.

2. Purpose of the data collection

The first transmission of individual statistical information was initiated to strengthen monetary analysis, jointly with the country-wide aggregated MFI balance sheet data that NCBs were already transmitting to the ECB, in the context of the 3-years maturity LTROs launched in December 2011.

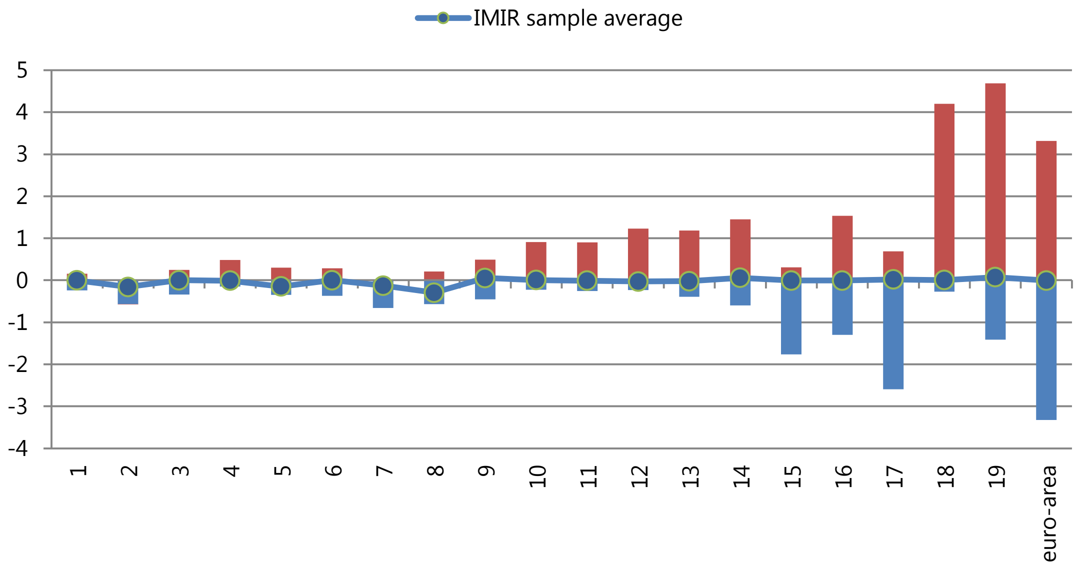
From a monetary policy perspective, data have been required to monitor the effectiveness of the transmission of ECB policy to the real economy. They also allow for a more comprehensive assessment of developments in euro area fragmentation such as heterogeneity in bank funding costs that can only be analysed with information on individual bank interest rates on deposits outstanding. For a given reference period, product category and reference area, IMIR data actually show for instance disparity in the interest rates applied by credit institution reporters. The range between the highest and the lowest rates can be significant. This is illustrated on Figure 1 below.

Two desirable features of the individual MFI data collected by the ECB are their timeliness and their content matching the one of the BSI and MIR aggregates. Data are received with a one month time lag with respect to the date they refer to and only a couple of days after reception of the corresponding aggregates. Content-wise, the last enhancement of the IBSI and IMIR reporting templates constituted a significant improvement with higher granularity in the reported data. IBSI and IMIR reporting templates remain however both subsets of the macro BSI and MIR templates as the scope of the datasets in terms of balance sheet items coverage is bounded by the BSI and MIR regulations seen as the common denominator for the data availability across the Eurosystem at the level of individual reporters. This sheds light on one of the main uses of these micro-data which consists in making possible drilling down from aggregated to individual developments and thus identifying key players in national trends for the set of balance sheet and interest rate indicators used for monetary policy or financial stability purposes. It also allows putting nuances in the national pictures provided by the aggregate data: one can look at the distribution of certain indicators at country level or clustering MFIs according to specific criteria. For instance, economists look at the distribution of lending rates for non-financial corporations (NFCs) splitting euro area countries between vulnerable and less vulnerable economies. More generally speaking micro-data give Eurosystem users more flexibility to apply statistical tools in order to analyse transmission mechanism of monetary policy instruments: micro-data give users a macro-scope for analysing statistical information.

Taking the example of IMIR, the need for more granular information on banks' net interest margins has also arisen in the particular context of prolonged low interest rates, of which the negative rate on the deposit facility. Besides, as the purchase of securities via the expanded Asset Purchase Programme decided by the ECB in January 2015 is expected to influence the financing conditions of euro area households and firms, additional monitoring of banks' risk-taking behaviour has become necessary to assess possible risks for the financial stability of the Eurozone. The current economic circumstances justify the last enhancement of the data collection. From a forward-looking perspective, reviewing and possibly increasing regularly the sample of credit institutions included in MFI micro-data should allow for better calibrating future policy responses taking into account a broader range of business models, in particular and again regarding loans vis-à-vis the non-financial private sector.

Dispersion[1)] of interest rates applied to loans for house purchase denominated in euro, by euro area countries (1-19)

Data with reference September 2015[2) 3)] Figure 1



Source: ECB.

1) Dispersion is calculated based on the September 2015 observation reported for the corresponding MIR aggregate series.

2) Euro area countries have been anonymised and sorted in ascending order according to the difference between the higest and the lowest interest rate applied across all MFIs included in the IMIR sample.

3) The IMIR sample average corresponds to the interest rate average weighted by new business volumes when only IMIR reporters are taken into account. The actual MIR sample (used for aggregate statistics) may be different in some euro area countries leading to a spread between the so-called "IMIR sample average" and the corresponding reported MIR statistics (e.g. country No. 8 on the chart).

3. Content of the individual BSI and MIR datasets

The IBSI statistics encompass information on the balance sheet of MFIs, both on the assets and liabilities side. The asset side indicators include cash, loans to households, NFCs and governments, debt securities, money market fund (MMF) shares/units, equity and non-MMF investment fund shares/units, non-financial assets (including fixed assets) and remaining assets. On the liabilities side, time series are collected for deposits included and not included in the broad money aggregate M3, debt securities issued, capital and reserves and remaining liabilities. The granularity of series allows the analysis by loan purposes for households' loans, e.g. loans for house purchase, and by maturity. Regarding banks deposits, information is collected broken down by type (overnight, with agreed maturity, redeemable at notice, repos), maturity and reference area of depositors (domestic versus other Monetary Union Members) with a focus on deposits placed by NFCs and households – granularity is higher for these two sectors.

NCBs report to the ECB outstanding amounts and, for some of them, the corresponding adjustment series, so called ancillary series, covering on best effort basis information on revaluations for changes in prices and exchanges rates, reclassifications or loan write-offs/write-downs. For loans, additional data on loan transfers, linked for instance to securitisation, are also covered. These loan transfers and adjustment series are collected to derive meaningful transaction measures that reflect actual banking business. As for the aggregate BSI, the information received also allows the compilation of indexes of notional stock from which growth rates are derived.[6]

The individual MFI interest rate data collection, similarly to aggregate MFI interest rates statistics, covers interest rates on euro-denominated deposits as well as loans to households and NFCs. Regulation ECB/2013/34 defines statistical standards for the selected reporting agents and requires from them to report 117 interest rate indicators with the corresponding volumes, of which 91 refer to new business and 26 to outstanding amounts.

Summary of indicators collected for individual MFI Balance Sheet and Interest Rate data

Evolution of the number of indicators since June 2012

Table 1

Number of indicators		June 2012	June 2014	October 2015
Assets	Outstanding amounts	13	15	65
	Adjustment series	12	12	22
	Rates on new loans	24	24	27
	Rates on outstanding loans	-	-	9
	New business volumes of loans	24	22	25
Liabilities	Outstanding amounts	11	15	61
	Adjustment series	11	11	10
	Rates on new deposits	11	11	11
	Rates on outstanding deposits	-	-	4
	New business volumes of deposits	7	7	7

The MFI sample

The main ingredient of individual MFI statistics compared to their corresponding macro-data (aggregate BSI and MIR) is the sample of banks to be selected for the BSI and MIR panels in order to ensure that indicators developed based on the data collected reach a statistically significant coverage of the total population of reporting banks. This section explains the selection criteria that have been used in order to make this selection.

1. Selection of the banks panel

The panel was initially constructed in 2012 so as to cover primarily the largest MFIs in each euro area country plus their significant non-resident branches and

[6] See also "Technical notes" of the ECB Statistics Bulletin: https://sdw.ecb.europa.eu/servlet/desis?node=10000022

subsidiaries across the euro area. Since 2012 the MFI sample has undergone several reviews while being always confined by the ECB regulations applying to the collection of balance sheet items and interest rates. Data on balance sheet items based on solo accounts as a rule were collected on monthly basis until December 2014 in frames of Regulation ECB/2013/33. However, under Article 8, the Regulation allowed NCBs to grant the smaller MFIs - institutions in the tail - derogations in statistical data reporting requirements. Hence individual data for tail reporters cannot be available. Furthermore, some credit institutions might have even participated individually in the monetary operations - one of the sample selection's criteria - but statistical data were reported in aggregated way in line with Section 2 of Annex III in Part 2 of Regulation ECB/2013/33. Furthermore Regulation ECB/2013/34 foresees the collection of MFI interest rates data to be performed either as census or as stratified sampling.

Taking into account these legal limitations, an expert group conducted analysis and discussions regarding the MFI panel which first led to the conclusion that the sample of MFIs to be reported individually should fulfil the following three criteria:

- **Bank size:** the MFI should belong to the 150 "largest banks" stipulated in the Governing Council request. Due to the specific aim of the individual data collection, the first constraint on the "appropriate bank's size" triggered discussions on the way MFIs size could be understood. One criterion was that the requested selection of banks should ensure high coverage ratios for both total assets and lending to private non-financial sector. Amongst various alternatives discussed and taken into consideration such characteristics as total assets, total main assets or volume of lending to non-financial sector were taken into consideration.
- **Active participation in monetary policy operations:** the idea was to ensure the coverage of main participants in different policy measures: 3-years LTRO, deposit facility users as well as users of ECB refinancing.
- **Representativeness:** a national selection of MFIs should ensure the representativeness of the selected panel for monetary policy transmission as well as lending to non-financial private sector. In addition, the membership in the EBA sample could allow evaluating the regulatory impact on the monetary transmission. Furthermore, it was ensured that 131 banks participating in the ECB's Bank Lending Survey are included in the sample as representative main lending institutions for each euro area country.

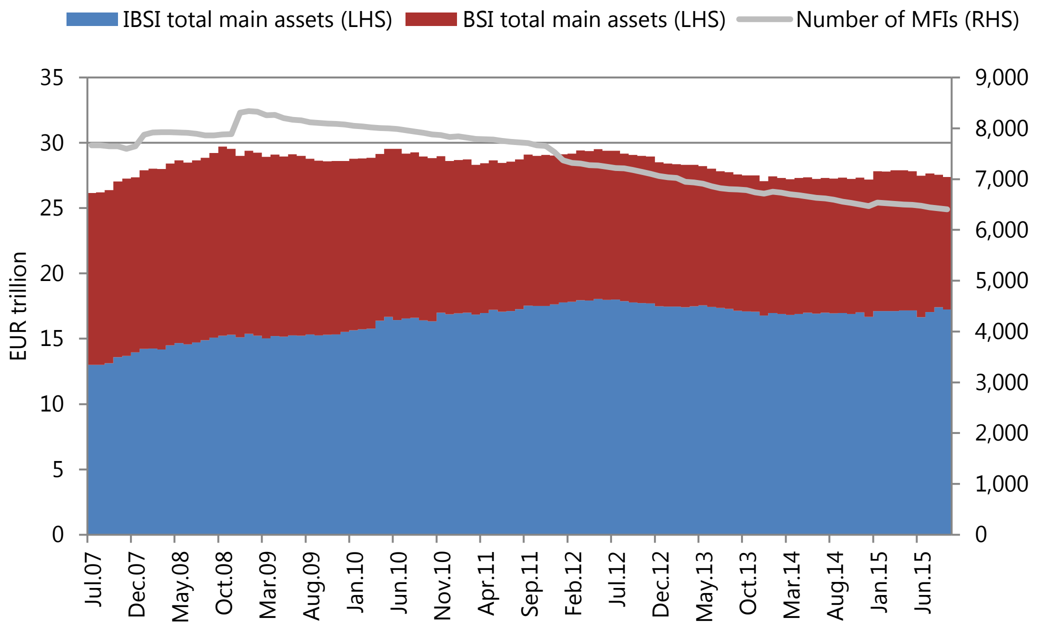
In a second stage initiated in May 2012, an Expert Group made of NCB experts together with experts from the ECB's Directorate Monetary Policy, Directorate General Statistics and Directorate General Research checked the presence in the proposed sample of special institutions having no deposit taking or loans granting activity and for which little analytical value would arise from monthly monitoring. In this respect, the coverage of savings or cooperative banks was examined, as specialised central institutions often channel the liquidity injected by the Eurosystem to small institutions. There was a strong need to identify the use of monetary policy instruments, in particular for the creation of loans to the private non-financial sector. In the relevant countries, special institutions were complemented with a set of associated deposit taking or loans granting credit institutions. Finally, in line with the Governing Council request to report the 150 largest banks, the Expert Group agreed on the selection of 248 credit institutions belonging to around 115 headquarters. The selected reporting agents were informed individually, as mentioned above, via a notice sent by their National Central Bank.

Figure 2 below displays indicatively the number of MFIs resident in the euro area as well as their total assets reported under both aggregate and individual BSI statistics. It shows that a relevant sample of banks for monetary policy analysis requires well-thought selection criteria as both the euro area MFI population and volume of total assets evolve over time. The new extension of the IBSI and IMIR datasets should lead to another approximately 50 credit institutions covered at individual level while the total assets' coverage, based on the aggregate BSI figure, should increase by 10%.

Total main assets[1)] coverage across euro area MFIs

Data with reference July 2007 to September 2015

Figure 2



Source: ECB.

1) Total main assets equals total assets minus remaining assets as defined in Regulation ECB/2013/33.

2. The concept of micro-data group

The scope of the IBSI and IMIR data collections comprises the reporting of accounting positions on a solo basis. However, in some cases, aggregated data have been also reported for group of banks defined at country level. Such aggregates may either result from derogations permitted by the Regulation, and be therefore reported as such to the NCB, or be compiled by the NCB itself based on country-specific criteria. In particular, starting with the 2015 extension, some NCBs opted for the aggregate reporting of savings banks and/or cooperative banks under a single MFI identifier as this is of economic relevance in the case of small institutions following a common and well-defined business model. In light of these fictious entities – these aggregated groups have *a priori* no legal status - the need arose to establish a new concept for aggregated reporting in the particular case of individual MFI statistics, which is referred to as Micro-Data Groups (MDGs) in the ECB technical documentation. Under the IBSI and IMIR frameworks, a micro-data group is defined as a set of banks for which data are reported on aggregated basis but which do not necessarily constitute any legal form. Consequently, the aggregation perimeter does not necessarily match with the one applying to supervisory reporting for instance and it might not be captured by the ESCB Register of Institutions and Affiliates Database (RIAD) which contains the full list of MFIs in the European Union based on information provided regularly by all members of the ESCB.

The idea of *micro-data groups* is to leave space for the NCBs to report aggregated information along different national practises. So far, the following cases were for instance identified:

- Individual data of small MFIs are collected by one MFI which plays the role of the central institution for the group. Aggregated data are directly transmitted to the NCB covering both the central institution and the group members. In such case neither the responsible NCB nor the ECB has access to the underlying individual information on small banks.
- The central reporting institution's data are not combined with the other MFIs' figures on which behalf this central intuition is reporting. In this case, the central reporting institution transmits two full sets of data: one for its own business, based on solo accounts and encoded with its own standard MFI ID, a second one covering the activity of all other institutions. The individual data might be available at the NCB but they are transmitted aggregated to the ECB. In this case, the NCB performs the aggregation by grouping similar institutions within a MDG.
- Data of a small bank is reported both under a MDG on aggregated basis and on solo basis accounts under its original MFI ID. This case is a very similar to the second one when; apart from the aggregated data, the central reporting institution also reports its own individual data. The only difference is that any single MDG member can be reported in addition to the aggregated dataset . Identifying these cases is crucial when it comes to the aggregation of the micro-dataso as to avoid double counting.

As not all full BSI statistics reporters are included in the MIR statistics sample, MDG compositions may sometimes differ for IBSI and IMIR datasets. A bank which is included in the IBSI MDG and is a full BSI reporter does not necessarily provide its MIR data as it might not be a member of the MIR national sample. Besides, banks mergers, acquisition consolidations and restructuring can lead to changes in the micro-data reporting population quite regularly. This implies being able to timely monitor the evolution of the MFI sample. For example, the IBSI/IMIR SDMX data exchange model requires the dimension representing the reporting institution's MFI ID to be listed in the structural definition codes. So here is a need to react on any sample addition or deletion before the actual data exchange takes place. In this context, it was decided to enhance the RIAD system so as to make possible the comprehensive management of MFI lists for micro-data collection purposes. In its data model, RIAD already had a statistical reporting requirements domain (REPT) allowing flagging individual MFI as *BSI full reporter* (EA_BSI_F), *BSI reporter subject to derogation under Article 9 of the regulation* (EA_BSI_NF) or *MIR statistics reporter* (EA_MIR). The list of flags was further developed to also include information on the MFI's IBSI/IMIR samples membership:

- EA_IBSI_EUROSYSTEM: MFI belongs to the IBSI sample.
- EA_IMIR_EUROSYSTEM: MFI belongs to the IMIR sample.
- EA_IBSI_EUROSYSTEM_MDG: MFI is reported within a MDG for the IBSI dataset.
- EA_IMIR_EUROSYSTEM_MDG: MFI is reported within a MDG for the IMIR dataset.

At current stage, 14 MGDs are covered in the data transmission, covering about 2000 small MFIs whereas approximately 300 entities directly report individual data.

3. Coding of MFIs in the data set

From the very beginning, the data structure[7] adopted for the transmission of individual MFI data has used the official RIAD MFI ID for each institution included in the sample. The RIAD list of MFIs is maintained and updated regularly by the ECB in accordance with Regulation ECB/2013/33 and Guideline ECB/2014/15. Each NCB allocates a unique MFI ID to each resident MFI in its geographical area. An MFI code consists of the two digits ISO code corresponding to the resident country followed by any alphanumeric combination of characters, whose number is restricted. In general, MFI identifiers are assigned once only and do not change over time. However, in case of major internal data management reorganisation, central banks are entitled to change these codes. This is seen as a challenge for the maintenance of the individual data reporting system which aims at guaranteeing the univocal identification of reporting agents for users.

In 2014 the reorganisation of internal data management in two NCBs led to important changes in the recording of MFI identifiers: on 3 July 2014 in Belgium and on 17 July 2014 in Italy[8]. This experience resulted in the development of a commonly agreed best practice for managing the transmission and dissemination system environments at the ECB: before new data were received, the ECB team would recode in its databases all data sent with the outdated MFI IDs and remove the series referring to these outdated MFI IDs from the corresponding reception lists in order to prevent the new data from coming with the outdated series keys. At the same time, the involved NCBs are informed that only newly encoded data can be transmitted, even in the case of revisions. The newly encoded series are then disseminated to data users with an explanatory note on the MFI IDs change.

In case of mergers and acquisitions, the recoding of data does not take place. If two in-sample institutions *A* and *B* merge into a newly created institution *C*, the MFI ID of institution *C* is used for the corresponding time series, while historical data are still sorted under the MFI IDs of institutions *A* and *B*.

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[7] SDMX Technical Standards allow the exchange of data (and of metadata closely associated to these data) among statistical institutions based on known data structure definitions. More information about the structure SDMX statistical domains be found in: https://sdmx.org/?page_id=4345

[8] Further details are available under the FAQ section: https://www.ecb.europa.eu/stats/money/mfi/html/index.en.html

Micro-data processing

1. Data transmission

The use of the SDMX data transmission standard was identified as the most appropriate solution to transmit data from the NCBs to the ECB. On the other hand, the restricted Statistical Data Warehouse[9] was chosen for the 'back-flows'. The following three criteria were taken into consideration when opting for the SDMX format:

– confidentiality of individual data transmission

– flexibility in handling the MFI codes

– technical infrastructure on the NCBs that allows generating the GESMES/TS files, and respecting deadlines for data transmission.

During the testing phase, in order to reduce the burden for the preparation of the transmission system, CSV/Excel files were accepted, upon bilateral agreements between each NCB and the ECB. The ECB team was converting the received files into GESMES format with the highest confidentiality flag ("C") to the data.

2. Data quality assessment

The ECB performs data quality checks on each time series received from the NCBs. These checks may be divided into two categories.

– **Formal checks** are based on the data model requirements. They consist in making sure that all required data have been reported for all MFIs, that stocks (IBSI) or new business volumes (IMIR)[10] are reported with positive values, that, wherever in the IMIR template rates are reported, the corresponding business volumes are sent with strictly positive values. Formal checks also include the assessment of relevant changes compared to the previously transmitted data. For instance, IMIR rates or business volumes observations which did not change compared to the previous reference period should be either revised or explained by reporting agents. New missing values are also looked. For IBSI, any new missing value for a given time series must be explained owing to the nature of balance sheet items. By definition, all formal checks must hold. For IMIR, any missing value reported for a time series for which the previous seven observations were not missing must be either revised or explained. The reason behind it is that individual MFIs do not always necessarily grant new loans or take deposits for all breakdowns at each reference date[11].

[9] ECB interface to release and present data. Part of the data released are accessible to the general public, the rest is only accessible to a restricted set of users managed internally,

[10] For further details on the definition of new business volumes, see ECB Regulation EU/2013/34.

[11] The value 0.0000 (rate) indicates an interest rate equal (or very close to) to zero, and the value 0.000 means a very small value of new business (less than 500 €). In IBSI, the value 0 can mean either a small or non-existent volume. NC is used only when the reporting bank does not offer the particular product at all.

- **Linear checks** are internal consistency checks. They look at accounting relations between reported breakdowns and reported totals (for instance, the amount of debt securities pertaining to all maturities must equal the sum of debt securities reported for short-term and long-term maturities). By definition, all these checks must hold with a certain tolerance threshold estimated at country level.
- **Plausibility checks** examine probable relations between reported breakdowns. They are based respectively for IBSI and IMIR on the well-established BSI and MIR aggregate statistics. Via these checks, observations reported for the individual MFIs are basically benchmarked with the corresponding country aggregates. For instance, "individual" new business volumes and outstanding amounts from the credit institution's balance sheet reported respectively under IMIR and IBSI must not exceed the aggregated country of residence's business volumes and outstanding amounts reported under MIR and BSI. The same rule applies to the aggregates compiled exclusively from the IBSI and IMIR samples (sum of all underlying individual reporters). IMIR plausibility checks also look at the difference between the interest rate for a country constructed from the IMIR sample and the rate reported in MIR statistics: such difference is expected to be minimal. When a plausibility check fails, it is very likely that the underlying series have been wrongly reported. However, due to the sampling method applied for compiling MIR statistics and to stratification issues[12], plausibility checks set for interest rates do actually not always hold; in some cases, the direction of change between two consecutive observations might even be different.
- **Graphical checks** only apply to IMIR statistics. Individual series graphs are produced to display the development of rates and new business volumes over time, for each individual data reporter and for each reported indicator. They allow to identify outliers or unusual developments in the series. Country level graphs showing the evolution of each aggregated national series focus on distribution measures such as median, quartiles while marking banks with rates exceeding the country average +/- 3 standard deviations. Moreover, for each breakdown, a Lorenz curve of the new business volumes at the latest data point available is calculated in order to assess business concentration for each breakdown.
- **Top-down analysis** consists in looking at individual MFI preliminary aggregates to identify special developments at a lower level of granularity than the one corresponding to the directly transmitted data. For instance, let us assume that institution *A* reports short-term loans to both domectic and other euro area resident households and for both house purchase and other than house purchase purposes. At first stage, and given a reference date, only the total aggregate "short-term loans to households" is checked, based on a threshold determining as of which level a subcomponent of the aggregate is to be deemed out of the usual range. In this example, the outcome of the top-down analysis could be that only the decrease in loans granted to domestics households for house purchases explains the downward trend observed on total loans to euro area households. Providing that the threshold value is properly set for the given credit institution, such conclusion can be then drawn from looking at a single time series instead of the four series actually transmitted by the

[12] The Guideline ECB/2014/15 in Annex II specifies how the sampling and stratification of the national MFIs should be performed.

reporting agent (two reference areas by two household loans types). This allows optimising the data quality assessment by reducing the amount of observations to be checked while making more straightforward the identification of key players in the trend followed by indicators more broadly used in macro-economic studies (example of the aggregate "total loans to the private sector").

Challenges and way forward

One of the biggest challenges raised by the collection of more granular data by a central institution such as the ECB is the greater exposure to national practices and market specificities than in the case of aggregated statistics. Whereas international organisations may apply global standards for macro statistics granting direct compilers a reasonable amount of flexibility for their implementation at national level, the demand for micro-data make institutions face much more prominently the issue of national practices for compiling regulated statistics. This dramatically changes the perspective on how to collect data: rather than giving priority to users' needs by providing the best indicators summarising the state of play of the economy in a given geographical area –example of the euro area broad money aggregate M3 - the focus of micro-databases implementation must be set on the reconciliation of granular national statistics within a single and consistent data model. In other words, whereas users are given more wiggle room to decide ad hoc on what to do with granular data, compilers must face up to the difficult task of harmonising country-specific data inputs.

As a matter of fact, statistical requirements laid down in the BSI and MIR regulations issued by the ECB are mandatory for reporting agents in euro area countries, not subject to the derogations stated in Article 9 for BSI statistics, and selected by NCBs drawn from the reference reporting population for MIR statistics. While ensuring that data for individual reporting agents are made available in accordance with the BSI and MIR reporting tables, NCBs can however incorporate these requirements in their national reporting forms in order to avoid duplications and to minimise the reporting burden for their reporting agents. This may result in the use of several data sources to compile aggregates; for instance, positions vis-à-vis the NCB may be sourced directly from the NCB's financial statements. NCBs may also provide their reporting agents with a reporting scheme for BSI and MIR statistics showing a higher granularity than the one required by the ECB regulations. Such practises may become problematic if there were initially specifically set up for the compilation of aggregates but not for the production or transmission of the underlying individual data.

Until now, in order to physically transmit the individual BSI and MIR statistics, many NCBs have relied on already existing tools in their statistics department set up for the aggregate data and in some cases this might be suboptimal. Standard SDMX messages which ensure the full confidentiality of statistical data transmission have not necessarily been used at first stage. Database patches also had to be done in some cases in order to combine the different data sources used to compile aggregate data. This may affect the data quality and surely makes the quality assessment on ECB's side more difficult as the NCBs response is likely to take longer when reverting to countries on their specific data issues (failing checks, outliers, special development, etc.). The next challenge is to concentrate efforts on the integrated management of micro-databases. Some work has for instance already been done in Banco de Portugal where statisticians worked on a Business Intelligence Architecture model to be used as reference in IS/IT developments in the statistical area. Their idea is to be able to connect efficiently different data sources via a centralised reference database while providing final users with harmonised outputs independent from the initial data sources.

Cooperation with the NCBs is also a key component when implementing new statistical reporting frameworks. In the specific case of micro-data transmissions, not only NCBs provide the required data to the ECB but they also act as a necessary intermediary between the European institution and the credit institutions in their respective country. Beyond the communication challenge it might represent, the ECB is anyway not empowered to deal with MFIs directly so that only NCBs may revert to credit institutions in the case of questions arising from the data quality assessment. This partly illustrates the philosophy behind the Eurosystem which consists in sharing tasks between the ECB and the NCBs. To this aim and especially in order to achieve a level playing field in processing the data between national compilers and ECB statisticians, efforts have been made to set up appropriate and well defined timelines for each production round despite the data non being published outside the ESCB. NCBs know when to transmit the data, when to expect a feedback from their ECB counterparts and when data are made available to internal final users. The ECB and the NCBs also share folders on a server containing live documents so that any relevant information is channelled as fast as possible between stake-holders.

One enhancing aspect of the statistical reporting framework set up for the collection of individual MFI statistics is the forward-looking approach that was undertaken since the beginning by the project's main contributors. This started with the pilot exercise conceived as a "warm-up transmission" for both compilers and users. Compilers had to design ad hoc quality assessment tools but at the same time they benefitted from relative flexibility to do so. In particular, they were not constrained time-wise by any official publication or press release and from a methodological perspective, they were also not bound by the monetary policy framework applying in the context of "standard measures". The approach was really to investigate the potential of individual MFI statistics to retrieve additional information with respect to the aggregate data in the case of non-standard monetary policy measures. As the pilot exercise finally became a regular production, one may say that the way forward has already started and may be seen as the ongoing way. The last step of the implementation was launched in October 2015 and demonstrates a clear willingness on the ECB side to carry on and further develop the compilation of micro-statistics with the NCBs' support.

In the future, the ECB could ideally receive both the aggregate and individual datasets simultaneously, i.e. on the exact same day, in order to carry out the data quality assessment of both data flows in parallel. This would partly streamline the checking of aggregates by allowing ECB compilers to directly look at underlying series at MFI level when identifying outliers or special developments in the aggregate time series rather than always reverting back to countries.

Progress can also still be made in clustering banks within the MFI reporting sample. Although credit institutions are clearly defined at European level, there remain many differences at country level across banks regarding their size and business models. Being able to better classify credit institutions should allow for a better understanding of the information provided by banking macro data. This becomes particularly relevant in the light of the increasing regulatory requirements for banks. The Supervisory Board Chair Danièle Nouy said in a conference held in October 2015 that the ECB Banking Supervision aims to make banks more comparable and trustworthy and will therefore focus on banks' business models as of 2016. How can statisticians help in this if not by breaking down the broad concept of credit institutions? In this direction, two steps were already achieved with the inclusion, on one hand, of the information on the level of significance of the MFIs amongst the metadata for the IBSI and IMIR samples, and, on the other hand, with the concept of micro-data groups introduced for countries where group of banks may be relatively clearly identified by their business model. However a significant amount of work is still to be done since there is so far no qualitative classification of credit institutions, beyond their ownership and relationship to the parent institution when it exists, available and agreed at European level. Such a classification should be nonetheless established carefully since it should not rely, at least not fully, on "objective figures" such as the banks' total assets for instance or any capital adequacy ratio. In particular, there is always a risk in categorizing qualitatively undertakings. First, in the case of credit institutions, national competent authorities already apply their own scope of consolidation for the financial reporting of entities operating in their country. What if not all of them belong to the same category according to cross-country classifications? Secondly, not all banks may recognise themselves in the categories they would be possibly put into, which they may perceive as a reputational cost. Retroactively this may impact the way they carry out business and lead to a biased interpretation of the MFI level data. Here is the micro-data challenge.

Improving the categorisation of banks within the MFI sample would also imply a further increase of the number of reporters to allow for a reasonable representativeness of each possible category. This is work on-going.

Conclusion

In 2012, at the time when the decision to collect individual MFI statistics was still discussed, NCBs raised the question of the usefulness of such micro-data being made available at the ECB. The project was fairly perceived as a dramatic change in the statistical practices that had been in place for more than a decade for sharing information between the ECB and the other ESCB members. One big concern was that more granular data would create more confusion amongst ECB internal users and blur the euro area picture shown from macro data while increasing the data management burden for compilers.

A few months ago, in 2015 the IBSI and IMIR datasets entered the third phase of their implementation to converge closer to their respective aggregate parent BSI and MIR statistics. This should be first seen as a concrete success in cooperating with the numerous stake-holders involved in this project. It also stresses the relevance of opting for a step-wise approach when integrating micro-data requirements into an already well-established macro-data environment. This allows testing procedures, interacting with users on a more ad-hoc basis and drawing preliminary conclusions on the use of granular information to better monitor the economic situation and assess the impact of monetary policy measures on the financial system before the data flow fully becomes operational and runs in parallel of the transmission of macro information.

The large amount of micro-data received each month by the ECB opens new ways for information to be cross-checked, validated and later on analysed for economic purposes. It places compilers' work in a constant development state reflecting the evolution of the MFI population and banking business in the euro area. This triggers of course challenges; one of them being to try to find synergies between already existing data sources and models. The implementation of the management of BSI and MIR micro-data samples in RIAD system to produce dynamic MFI lists in the IBSI and IMIR data environments offers a good example of progress along these lines.

In his introductory speech to the IFC workshop on Integrated Management of micro-databases held in June 2013, the governor of Banco de Portugal expressed the need "to know how to get the most of available data". The ECB is taking strong initiatives in this direction. The data analysis of macro aggregate balance sheet and interest rate statistics is more and more carried out on the basis of the information provided by the individual data; users are provided with the macro and corresponding micro set of series with a very short time lag. Work is done on the harmonisation of data validation tools used for both data collections. There is a clear focus on integrating the amount of statistical information channelled down from reporting agents up to the ECB in order to better serve its key functions.

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Which households are really financially distressed: How micro data could inform macroprudential policy[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 or the central banks and other institutions represented at the meeting.

Which households are really financially distressed: How MICRO-data could inform the MACRO-prudential policy[1]

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Abstract

We provide a model for calibration of DSTI/DTI limits that allows to account for both the effectiveness and cost of these limits, depending on policy makers preferences regarding type I and type II errors. Based on a seminal wealth survey recently conducted in Poland, the financial position of individual households is assessed. Crucially, the high level of detail in the data allows us to simulate expenditure, income, as well as liquid assets and liabilities. Based on these simulations
and self-assessment of household indebtedness we provide two complementary measures of households' over-indebtedness. By comparing these sets of overindebted households with a set that would arise with commonly used debt-to-income ratios, we assess the desirability of using DSTI and DTI limits in macroprudential policy. We find that that DSTI can be an effective tool in identifying over-indebted households and for a range of plausible preferences regarding type I and type II errors the suggested DSTI limit is in a range of 30%-40%.

Keywords: macroprudential tools, DSTI calibration, households' overindebtedness, financial margin

JEL classification: O50, G21, D12, C81

[1] The views expressed in this paper are solely those of the authors and not necessarily those of the organizations they are affiliated with.

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1. Introduction

Debt-Service-to-Income (DSTI) and Debt-to-Income (DTI) ratios have been one of the most popular policy tools affecting credit dynamics and resilience of the banking sector for many years in both developed and developing countries (Lim et al., 2011). Their popularity will likely increase as macroprudential policy becomes widespread. However, while the effectiveness of the DSTI/DTI limits in affecting credit dynamics is intuitively clear and confirmed in the literature (Claessens et al., 2014), (Kuttner and Shim, 2013), very little is known about the cost of these measures. As a result, calibration of these tools is usually based on heuristic approach, which fails to properly account for both the effectiveness of the measure in identifying the over-indebted households and their cost related to unwarranted elimination of non-over-indebted households from credit market. In this article we provide an approach that allows to calibrate the DSTI/DTI limits taking into account both these effects and the preferences of the decision maker regarding the cost of type II error (failure to identify overindebted household as indeed over-indebted) and type I error (identification of non-over-indebted household as over-indebted one).

In order to calibrate the DSTI limit one needs to have a measure of over-indebtedness that is not directly related to the DSTI. We use two complementary measures. One uses microsimulation model, which is based on the notion of financial margin – the excess of income and liquid financial assets over consumption and debt-servicing costs. The model includes shocks to employment, interest rate, exchange rate and various adjustments in consumption that household could make in response to these shocks. The data come from a new, rich database on household wealth survey in Poland, which includes detailed information about households characteristics, amount and structure of real and financial assets, amount and structure of debt, income, employment and expenditures. As a complementary tool we use a subjective assessment of over-indebtedness by the households themselves, taken from the same survey. Based on the two approaches, two sets of households for each measure are identified: over-indebted and others. Using these results we first assess the effectiveness of the DSTI/DTI as indicators of over-indebtedness by estimating a logistic regression using the binary variable from both microsimulation model and self-assessment with DSTI/DTI as an explanatory variable. We find that DSTI provides a correct identification of households in 70%-80% of cases. Use of DSTI limit will therefore inevitably produce both type I errors error and type II error. Second, we calibrate the DSTI limit for a set of policy makers preferences regarding the importance of these errors, by estimating the optimal DSTI/DTI limit for a range of weights for both of errors. For a plausible set of preferences the DSTI limits we find are in a range of 30%-40%. Our method is easily applicable to other countries and could improve the quality of information used for DSTI/DTI calibration, making both effectiveness and cost of particular limit explicit to the decision maker.

The article is structured as follows. The first part provides an overview of various approaches to overindebtedness measurement found in the literature. Second part provides description of the data used in the study, including the measure of subjective over-indebtedness. In the third part details of the microsimulation model are presented and the resulting over-indebtedness metric. The last section is dedicated to the calibration of DSTI/DTI, followed by conclusions.

2. Literature review on households overindebtedness

There is no agreement on how to define and measure over-indebtedness. As suggested in the European Commission study, conducted to bring together different views on the matter, it is difficult to find common acceptable definition (Davydoff et al., 2008), (Fondeville et al., 2010). The perception of excessive debt varies across countries. However, analyzing different attitudes is valuable to develop some core features that are important in assessing excessive debt and qualifying vulnerable debtors.

Such variety of proposals to define over-indebtedness result in broad set of indicators to measure the level of household indebtedness. There are two key approaches of over-indebtedness measurement, which bases on objective and subjective (self-assessed) indicators of households' debt position (Keese, 2009). Objective measures discussed in the literature refer frequently to household gearing ratios (DSTI, DTI), the number of credit commitments or the length of credit arrears, with suggested limits above which a household is declared insolvent. Subjective measures stem from individual self-assessment under implicit assumption that households know their financial situation well.

2.1 Basic indicators

Over-indebtedness is frequently indicated when the ratio of debt repayments relative to household income exceeds certain limit, commonly set at 30%, 40% or 50% for total debt (Bryan et al., 2010), (Disney et al., 2008), (d'Alessio and Iezzi, 2013), (Persson, 2012), (Betti et al., 2007). It has been relatively well documented that the DSTI/DTI limits indeed do curb credit growth (Claessens et al., 2014), (Kuttner and Shim, 2013). This should not come as a surprise as the DTI limits essentially eliminate some households from the market. To our knowledge very little is known about the cost of these measures – proposed DSTI caps are usually based on heuristics instead of quantitative research and calibration. It has been found that default rate grows with DSTI rate, but is noticeably lower among the most indebted households (Dietsch and Welter-Nicol, 2014). This suggest that the measures are costly, as they fail to correctly identify only truly over-indebted households, yet little is known about the exact nature of these costs.

Another group of commonly used objective indicators refer to the number of credit commitments a household repay or number of months its debt payment is in arrears (Bryan et al., 2010), (Disney et al., 2008), (d'Alessio and Iezzi, 2013). For such measures, over-indebtedness occurs for household with 4 or more credit commitments or 2-3 months being in arrears with debt or/and domestic bill commitments (Disney et al., 2008), (d'Alessio and Iezzi, 2013).

Less frequently used indicators to evaluate over-indebtedness are administrative/legal measures based on credit register information (Haas, 2006), (Persson, 2012), liquidity/illiquidity measures (Disney et al., 2008), debt to assets ratio or consumption to income ratio, which high value may indicate over-indebtedness (Betti et al., 2007) but also a measure to separate households which spending on total borrowing repayments takes them below the poverty line (d'Alessio and Iezzi, 2013). Abovementioned studies suggest, it is impossible to find one statistic to classify households with excessive debt burden, so that there is need to take into account several measures when investigating over-indebtedness (Disney et al., 2008).

2.2 Other measurable indicators

Financial margin is commonly used when assessing households' financial situation, especially its resistance to adverse shocks. Apart from being an excessive debt burden indicator, financial margin, as a multifactorial measure may be used to evaluate households' vulnerability in stress test scenarios considering various type of economic shocks. Indeed, it can include aspects of many basic indicators.

Stress testing is a practical method of evaluating households' vulnerability on micro and macroeconomic shock scenarios and had been used in numerous institutions interested in creditability of borrowers under certain circumstances. Most of researchers consider shocks on unemployment rate and interest rate, but the other possible scenarios are shocks on inflation rate (Hlaváč et al., 2013), real estate price (Froyland and Larsen, 2002), asset prices (Bilston et al., 2015), (Albacete and Fessler, 2010) or exchange rate (Zajaczkowski and, Żochowski , 2007), (Albacete and Fessler, 2010), (Albacete et al., 2014).

Financial margin is usually defined as:

$$FM_i = TI_i - C_i - DS_i + LA_i \tag{1}$$

where TI is i-th household annual net income, C is consumption, DS is debt service and LA are liquid assets.

Financial margin may be defined in various manners, depending on a stress scenario that one aims to examine. For instance (Johansson and Persson, 2006) and (Holló and Papp, 2007) exclude liquid assets and define margin as disposable income reduced by living cost (including debt service cost). However, liquid assets may be an important buffer absorbing a shock, particularly short-lived ones (Vatne, 2006).

An impact of introduced stress factors may vary across countries because of certain credit markets characteristics. In Finland, for instance, interest rate disturbance impacts level of distress significantly more than unemployment rate and exchange rate shocks (Kauko and Herrala, 2007).

2.3 Subjective indicators

Subjective approach assumes that debtors are well-informed about their financial situation. In subjective assessment debtors are categorized as over-indebted when they declare themselves that their borrowing repayments are a 'heavy burden' (d'Alessio and Iezzi, 2013), (Betti et al., 2007), (Haas, 2006), (Disney et al., 2008), (Persson, 2012), (Disney et al., 2008), (Lusardi and Tufano, 2009), (Bryan et al., 2010).

3. Data

We use data from the pilot Study on Household Wealth, which was carried out in 2014 by National Bank of Poland in cooperation with the Central Statistical Office. The study covered representative sample of 3.5 thousand households in Poland. The survey offers ample and detailed information concerning households real and financial assets, level and structure of debt, income, employment and expenditure.

The results of Study on Household Wealth shows that 37% of households in Poland are indebted, including 12.1% holding mortgage loans and 29.4% with non-mortgage (mainly unsecured) debt. Those types of loans accounts for, respectively 81.5% and 18.5% of total household debt in Poland. Polish borrowers hold, on average (median) 2.4 thousand euro of debt, including 25 thousand of mortgage and 1.2 thousand of non-mortgage debt. They spend approximately 10% of their monthly gross income on its service (and 14.1% of their net income).

Based on variables of over-indebtedness suggested in the literature and the limits above which excessive debt is assumed, in Poland there are 8.9% and 4.9% indebted households who allocate more than, respectively, 30% and 40% of their gross income for total debt servicing (16.9% and 10.1% when disposable income is concerned). 22.4% of households declare that their financial margin – the difference between income and liquid financial assets on the one side and expenditures together with debt-servicing costs – is negative. This likely reflects the underreporting of income, documented in various survey around the world (Deaton, 1997), (Bound et al., 2001), (Meyer et al., 2009), (Hurst et al., 2014). We deal with this

issue by running simulations on several models, assuming varying degrees of underreporting.
Approximately 23% of indebted judge their debt as a 'heavy burden'. The distribution of answers is presented in Table 1.

Table 1: **The distribution of answers to the question: "Is household over-indebted?"**

	Definetely disagree	Disagree	Maybe	Agree	Definetely agree
% of indebted households	21.5	38.7	16.8	14.1	8.9

Data on unemployment and resulting transition probabilities in the labour market come from the Polish Labour Force Survey (PLFS). PLFS is a quarterly, representative survey of Polish population carried out by Polish Central Statistical Office. In each round it covers over 100 thousand observations since 2010 (before 2010 it was around 50 thousands). This survey is the main source of information about labour market in Poland. Thanks to the standardized questionnaire, the results of the survey are internationally comparable. It is also important that it allows to use standard definitions of labour market indicators (for example the definitions employment, unemployment and inactivity are consistent with International Labour Organization standard). The PLFS is also designed as so called rotated panel. It has longitudinal structure in which the same persons are asked in two consecutive quarters then there is a two quarters break after which persons are once more asked in two consecutive quarters. This feature of the data can be used to calculate probabilities of losing or finding job between two consecutive quarters.

3.1 Simulation

3.1.1 Labour market transition matrix

The labour market simulations are based on the probabilities of transitions between employment (E), unemployment (U) and inactivity on the labour market (N). Including inactivity is important because of the significant changes in labour supply due to the baby boom generations and pension reforms. The two most important probabilities are the transition from employment to unemployment (probability of job separation) and from unemployment to employment (job finding probability). Probabilities of transitions between different labour market states are estimated using quarterly Labour Force Survey panel data that covers in Poland 100 thousand persons every quarter. However only the half of that number is interviewed in every two consecutive quarters. We use the same procedure mentioned below to calculate job finding and job separation probabilities for the whole population and for six groups of individuals defined by educational level (basic, secondary, tertiary) and age (15-34,35-54, 55+). The probability of finding job by unemployed person can be described as:

$$F_t = \frac{n^{UE}_{t\to t+1}}{n^U_t} \tag{2}$$

where $n^{UE}_{t\to t+1}$ means the number of persons unemployed in time t, who find job until $t+1$ and n^U_t stands for the total number of unemployed in moment t. The probability of separation was calculated as:

$$X_t = \frac{n^{EU}_{t\to t+1}}{n^E_t} \tag{3}$$

The probabilities were estimated quarterly in order to shorten the period before observations and minimise the problem of missed multiple transitions between observations. However, the estimated probabilities need to be seasonally adjusted. Additionally we also use Iterative Proportional Fitting (IPF) procedure in order to correct for panel attrition and have the probabilities consistent with aggregate data published by Polish Central Statistical Office. The negative labour market shocks that increase unemployment results from both: changes in EU and UE probabilities (see Figure 1 and Figure 2). It should be also noticed that volatility of the probability of job separation is mainly a result of the episodes of extremely tight labour market or first quarters of economic slowdown. Beside that short periods, the probability of losing job is relatively stable. However, there are huge differences between age and educational groups (Figure 3). In general probability of job separation is lower for older and better educated persons. It is especially low and immune to economic downturns among persons 35+ with tertiary education. The lower the education, the higher vulnerability for unemployment rate fluctuations.

Figure 1: Unemployment and employment before and after the crisis. *Source: Polish LFS data*

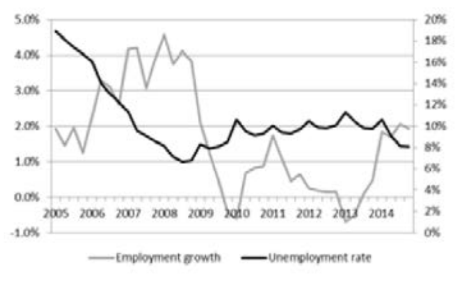


Figure 2: Probabilities of transitions between employment and unemployment. *Source: Polish LFS d*

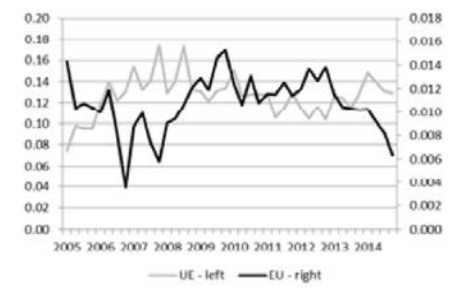
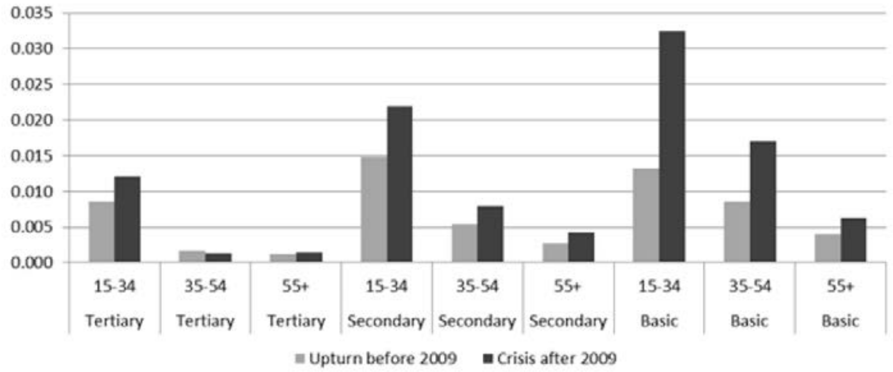


Figure 3: Probabilities of transition E→U (job separation) by education and age groups. *Source: Polish LFS data*



3.1.2 Model description

Stress test of polish households is based on microsimulation model for the financial margin for each individual household (see Equation 1). We allow for shocks in unemployment, credit costs and various responses of the expenditures to these shocks. Given that, negative financial margin is declared by almost one quarter of households even before any shock and this is likely due to underreporting of income. We account for it by identifying over-indebtedness under three different levels of financial margin: lower than zero, lower than -10% of income and lower than -20% of income.

Unemployment, interest rate and exchange rate shocks are all considered in a simultaneous stress test that is based on the highest historical annual growth of stress factors in the last 20 years. In Poland it was 2.7 percentage points for unemployment rate, 3.5 percentage points for interest rate and 17 percentage points for exchange rate.

Unemployment probability had been computed for every individual in the survey with respect to age and education level. Details of the procedure are presented in section describing labour market transitions matrix. Employees are drawn from the sample proportionally to their risk of being unemployed until the increase in unemployment is equal to the one assumed in the shock scenario. To absorb a shock of income fall, unemployment benefits and severance pay have been introduced to the model and they are assigned according to polish employment law. Severance pay in Poland depends on professional experience in one company and varies between 100% of monthly salary for employees with less than 8 years of experience and 300% after 20 years of work. Unemployment benefit depends on overall work experience (amount of benefit) and unemployment rate in a district (number of months a benefit is being paid). As can be seen in Equation 1, employment shock has an influence on households' income and perhaps indirectly on consumption.

$$FM_i = TI_i - C_i - DS_i + LA_i \quad (1)$$

Exchange rate and interest rate shocks, influencing monthly credit commitment, may expose households' vulnerability to particular type of disturbance. Six possible types of credit instalments are considered (various combinations of fixed or variable interest rate, foreign or domestic currency and equal or decreasing instalment) and only one of them is invulnerable to any type of stress scenario (fixed interest rate and domestic currency).

We allow for four responses of consumption to these shocks: unchanged consumption pattern, decrease by 25%, decrease by 50% and finally, reduction to social minimum. Financial margin includes liquid assets, which are assumed shock-invariant. Our simulation implicitly assumes that shocks last for a year. The results of assumed shock scenario are presented in Table 2.

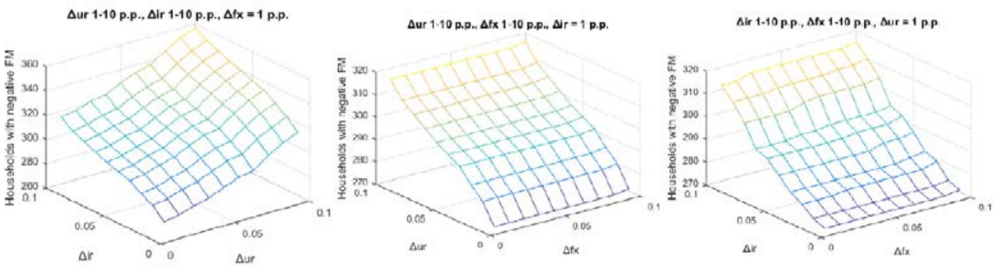
Table 2: **Households with negative financial margin before and after stress scenario with possible consumption adjustments**

	$FM < 0$		$FM < -0.1TI$		$FM < -0.2TI$	
Consumption adjustment	Before	After	Before	After	Before	After
Without reduction	247	289	175	214	121	150
Reduction by 25%		285		207		144
Reduction by 50%		282		205		140
Reduction to social minimum		194		144		103

As a result of introduced shock, number of households with negative uncorrected financial margin grows by 15.4% and comprises 25.8% of indebted households (3.4 percentage points more than before disturbance). What is more, shock absorption by consumption cut seems to be ineffectual. Once a household falls below over-indebtedness line, it usually cannot adjust its lifestyle to be in the black again, what can identify a serious problem for overindebted households. In other words, relatively few households are affected by introduced shocks, but the affected ones usually cannot take an action to deal with the crisis without financial support.

Shock effect is not stronger for financial margin lower than -10% of income and lower than -20% of income (growth by 22.3% and 24% of overindebted households respectively). Consumption adjustments are also ineffectual when margin corrections are considered. The results show that shock and possible reaction in the form of consumption adjustment are almost equal regardless of assumed attitude to financial margin.

Figure 4: Concomitant changes in stress factors (1-10 percentage points).



The charts in Figure 4. present an impact of introduced stress factors on the number of households with negative financial margin. Simultaneous disturbances in 2 out of 3 parameters were introduced (1 to 10 percentage points), with the change of third parameter fixed at the level of 1 percentage point. It is apparent that concomitant changes in unemployment rate and interest rate are the most influential on the number of overindebted families. Assuming 10 percentage points change of both factors and 1 percentage point change of exchange rate, 355 households are said to be overindebted. Exchange rate change seems to have less significant influence on over-indebtedness problem. In conclusion, Polish households are believed to be more vulnerable to disturbances on labour market and interest rates shock.

3.2 DSTI calibration

In the last part, the problem of DSTI limit calibration is discussed. We first use two previously computed measures of over-indebtedness – from microsimulation and self-assessed – to evaluate the effectiveness of the DSTI/DTI ratio in identifying financial stress. Second, we calculate DSTI limits consistent with type I error and type II error trade-offs to present approximate regulations effects. The final choice is the exclusive responsibility of decision makers and depends on one's preferences regarding false positive and false negative ratios importance. Our approach allows to explicitly account for these preferences.

A calibration technique bases on logistic regression model, where a dependent variable is one of over-indebtedness measures and an independent variable is DSTI. Logistic regression estimates for available over-indebtedness measures are presented in Table 3.

As can be seen, 1 percentage point change in DSTI ratio increases odds ratio of being over-indebted in comparison with being solvent by 1.67 to 6.25 percentage points, depending on over-indebtedness indicator assumed.

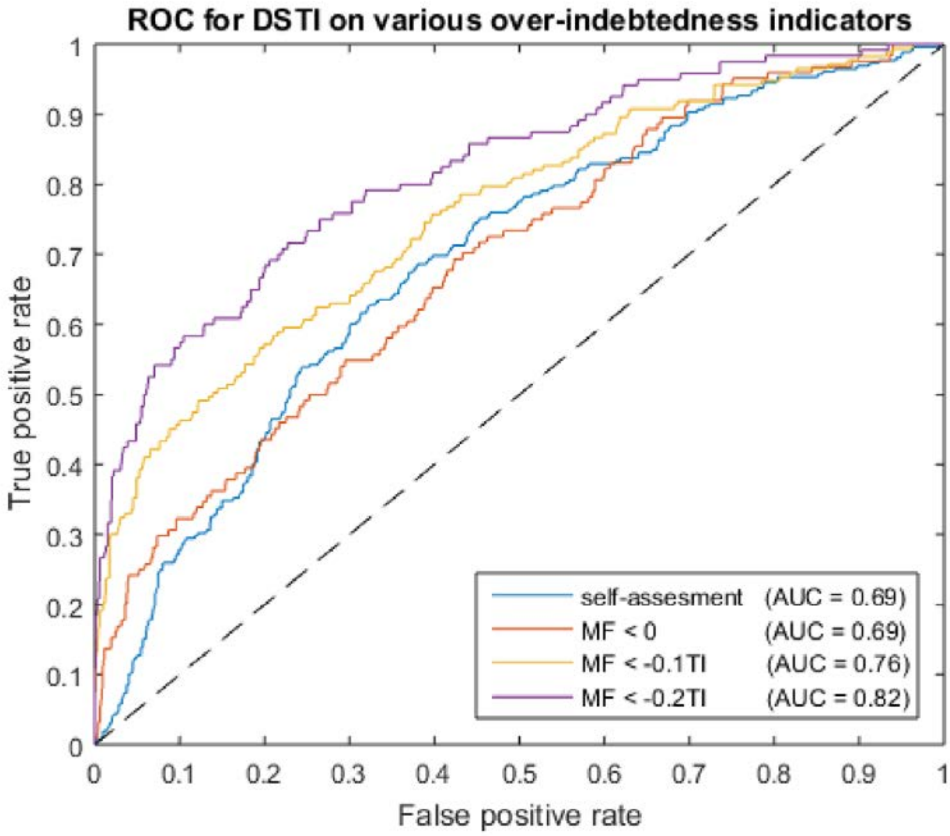
However, margin-based estimates are relatively consistent and there is a significant difference in comparison with self-assessment estimates.

Table 3: DSTI odds ratio estimates in logit models (endogenous variables in the first row). Standard error in parenthesis.

	Self-assesment	$MF < 0$	$MF < -0.1TI$	$MF < -0.2TI$
DSTI odds ratio	1.0167 (.003)	1.0466 (.005)	1.054 (.005)	1.0625 (.005)

Receiver operating characteristic (ROC) curves of estimated models are presented in Figure 5.

Figure 5: ROC curves for estimated logit models



The most significant part of the chart in terms of benefit to cost ratio of imposed caps is the first 10% of false positive rate (higher costs would probably be rejected by policy maker). Financial margin corrections (10% and 20% of total income below 0) seem to be significantly better classified by DSTI ratio than the other indicators, especially when low calibration cost is assumed. Uncorrected financial margin and self-assessment are comparably efficient indicators, but the first one seems to be better in the area of interest. Area under the curve varies between 0.69 and 0.82, what is a satisfying result whereas DSTI is an only regressor.

The results of DSTI calibration based on various over-indebtedness indicators are presented in Table 4. (in the model positive means overindebted). There is not an obvious answer to the question about the best DSTI level and a final decision should be taken by a governing body. However, on the basis of presented results some solutions may be proposed. The core function of the tool is to eliminate as much overindebted as possible (TP - true positive rate). Nonetheless, there is always a side effect, which is rejection of credible debtors (FP - false positive rate). 20% limit causes rejection of a significant fraction of credible households, regardless of over-indebtedness indicator assumed. Application of 30% limit allows to reject a significant share of potentially insolvent debtors, but costs of such decision may also be relatively high (12.2% to 15.5% false positive rate). Limit of 40% DSTI allows to reject from 19.8% to 47.5% of overindebted (depending on assumed over-indebtedness indicator) with relatively low cost (5% to 7.5% false positive rate). However, none of possible DSTI limits can be used as an only tool. Even after imposition of DSTI limit, commercial banks should have an obligation to verify customers' creditability.

Table 4: **DSTI limits. True positive (TP) and false positive(FP) classifications with various over-indebtedness indicators. Type I error and type II error trade-offs for every DSTI cap in parenthesis**

	DSTI = 20%		DSTI = 30%		DSTI = 40%		DSTI = 50%	
	TP	FP	TP	FP	TP	FP	TP	FP
Self-assesment	56.2%	27.6%	32.2%	13.7%	19.8%	7.1%	12%	4.5%
	(1/1.6)		(1/4.9)		(1/11.3)		(1/19.6)	
$FM < 0$	54.8%	31.6%	37.9%	15.5%	29.8%	7.5%	24.2%	4%
	(1/1.4)		(1/4)		(1/9.4)		(1/19)	
$FM < -0.1TI$	63%	29.1%	49.1%	12.2%	37.6%	5%	30%	1.8%
	(1/1.3)		(1/4.2)		(1/12.5)		(1/38.9)	
$FM < -0.2TI$	75.8%	29.4%	60%	12.9%	47.5%	5.5%	39.2%	2.2%
	(1/0.8)		(1/3.1)		(1/9.5)		(1/27.6)	

Notes: True positive rate describes effectiveness in classification of overindebted households. False positive rate equals costs of introduced limits (rejection of credible debtors). Trade-offs in parenthesis represent relation of type I error and type II error (FP/(1-TP)). Relation 1/10 means, that decision-maker considers type I error (unjustified rejection) 10 times more harmfull than type II error.

Table 5. includes various false positive and false negative trade-offs with corresponding DSTI limits. Considering policymakers' preferences and possible weights assigned to false positive and false negative values, it is important to highlight DSTI levels consistent with various trade-offs. Trade-off 1/1 describes symmetric preferences of a decision-maker. In other words, if one treats rejection of credible debtors and acceptance of potentially insolvent ones as equal problems, trade-off 1/1 and 20% DSTI limit should be applied. If, however, costs of credible debtors rejection are considered more harmful than costs of ineffective exclusion, a governing body would choose 1/2, 1/5 (DSTI = 30%) or 1/10 (DSTI = 40%) trade-offs, depending on individual preferences. Trade-off 1/10 means, that cost of unjustified rejection is 10 times more harmful than cost of false negative classification. Commercial banks are obliged to verify debtors credibility and therefore double check whether the households who pass the DSTI test are indeed creditworthy. However, households above the DSTI limit are automatically eliminated from the credit market. This suggests that the cost of type I error is higher than of the type II error as type II error can always be corrected by the commercial bank.

Table 5: DSTI caps for various false positive and false negative (type I error and type II error) trade-offs.

	1/1 DSTI	1/2 DSTI	1/5 DSTI	1/10 DSTI
Self-assesment	16.7%	21.9%	30.4%	37.7%
$FM < 0$	17.5%	22.9%	33.1%	41.2%
$FM < -0.1TI$	18.2%	23.7%	32.4%	37.8%
$FM < -0.2TI$	21.2%	26.4%	34.5%	40.1%

To verify robustness of results, DSTI calibration has also been performed after introduced shock scenario. The results of calibration with possible consumption adjustments are presented in Table 6. As can be seen, DSTI limits for every trade-off increase slightly and the growth is more significant for higher consumption adjustments. However, the results seem to be relatively stable and introduced shock causes increase in optimal level of DSTI limits up to 5 percentage points to 35% for 1/5 trade-off and 45% for 1/10 trade-off.

Table 6: DSTI caps for various false positive and false negative (type I error and type II error) trade-offs calibrated after introduced shock scenario with possible consumption adjusments.

	1/1 DSTI	1/2 DSTI	1/5 DSTI	1/10 DSTI
No consumption adjustment				
$FM < 0$	18.5%	24.5%	34.6%	41.1%
$FM < -0.1TI$	20.1%	27%	35.9%	43.2%
$FM < -0.2TI$	22.5%	29.5%	38.9%	46.1%
Consumption -25%				
$FM < 0$	18.6%	24.6%	34.7%	41.1%
$FM < -0.1TI$	20.3%	27.2%	36.2%	43.2%
$FM < -0.2TI$	22.9%	30%	38.9%	47%
Consumption -50%				
$FM < 0$	18.6%	24.6%	34.9%	41.5%
$FM < -0.1TI$	20.3%	27.2%	36.3%	43.2%
$FM < -0.2TI$	22.9%	30.3%	39%	47.1%
Consumption to social minimum				
$FM < 0$	20.2%	27.2%	36.8%	43.7%
$FM < -0.1TI$	21.9%	30.3%	38.9%	46.5%
$FM < -0.2TI$	26.1%	33.1%	42.3%	49.4%

When it comes to DTI caps, there is also possible to perform separate analysis. However, logit-based calibration allows to handle only one variable in the same time. Therefore, a joint DSTI and DTI caps estimation may be a possible extension of this research. The results of DTI calibration are presented in Table 7.

Table 7: DTI limits. True positive (TP) and false negative(FN) calsifications with various overindebtedness indicators.

	DTI = 150%		DTI = 200%		DTI = 250%		DTI = 300%		DTI = 350%	
	TP	FP	TP	FP	TP	FP	TP	FP	TP	FP
Self-assesment	33%	19%	27.5%	14.8%	22.5%	11.2%	18.2%	8.6%	14.3%	6.7%
$FM < 0$	26.5%	20.7%	24.1%	15.9%	20.8%	11.9%	16.7%	9.2%	14.7%	6.9%
$FM < -0.1TI$	29.5%	20.6%	26.6%	16.1%	24.3%	11.9%	19.1%	9.3%	15.6%	7.2%
$FM < -0.2TI$	34.2%	20.5%	31.7%	16%	28.3%	12.1%	21.7%	9.5%	18.3%	7.3%

At first sight, classification's efficiency is noticeably lower than in case of model for DSTI. The only acceptable limits in terms of false positive rate (DTI = 350% for every over-indebtedness indicator) are ineffective in rejection of overindebted households. On the basis of the results it is not possible to recommend any reasonable DTI limit.

4. Conclusions

In this article we have analysed the usefulness of the DSTI limits as indicators of over-indebtedness. Our model not only provide the information on the effectiveness of the measure, but also on its costs, on which the literature has been largely silent. As a result we allow for explicit calibration of the DSTI limits in a way that takes into account both the desire to limit the access to credit for the over-indebted households and the costs related to the unwarranted penalty imposed on non-over-indebted households. DSTI limits turns out to be relatively good indicators of financial stress and correctly categorizes households in 70-80% of cases, as measured with both objective measures of indebtedness based on microsimulations and subjective measures based on self-assessment. The use of complementary measures of over-indebtedness (objective and self-assessed) increases the robustness of our results. As an indicator DSTI is still far from perfect, its application entails two types of cost – failure to correctly identify truly over-indebted households (false negative, type II error) and identification of non-over-indebted households as over-indebted (false positive, type I error). Based on a logistic regression that have been used to assess the quality of the DSTI limit as an over-indebtedness measure, we can account for decision-makers preferences regarding the importance of these two type of errors. Assuming that both type of errors are of equal importance, the DSTI limit should be set at a level of 20%. In principal however, the type I error is more severe, as it is both, unjustified and final decision that a household will not be granted a loan, whereas type II error can still be corrected by the banks who have the obligation to double-check whether households who do pass the DSTI limit are indeed creditworthy. Assuming that type I error is 5 to 10 times more severe, the resulting DSTI limits are in a range of 30-40%.

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Discussion of session 2 on *"New statistical frameworks for financial stability analysis: experiences and challenges for micro and macro data integration"*[1]

Bruno Tissot, Bank for International Settlements

[1] The views expressed are those of the author and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

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Main focus of the Session

- Usefulness of mobilising micro data and integrating them into a macro framework?
- New trend for the analysis and regulation of financial systems: need to re-engineer current statistical systems?
- Challenges: how to consider multiple risk dimensions?
- Value in sharing experiences?

Five presentations contributing usefully to the debate

- I Kavonius et al (ECB): *"Deriving Household Indebtedness Indicators by Linking Micro and Macro Balance Sheet Data"*
- J Cassidy (CBI): *"Understanding Long-Term Mortgage Arrears in Ireland: Insights from Macro and Micro Data"*
- J Jabłonowski et al (NBP): *"In pursuit for patterns of economic behaviours using cluster analysis and correspondence analysis"*
- G Morandi et al (ECB): *"Setting-up the transmission of individual MFI statistics on balance sheet items and interest rates across the Eurosystem"*
- P Bańbuła et al (NBP): *Which households are really financially distressed: How MICRo-data could inform the MACRO-prudential policy*

Key lessons from the presentations

- Rising demand for more granular information
- Importance of matching micro and macro data
- Integrating micro data poses significant challenges
- A tool kit for micro data users?
- New knowledge opportunities

1. Rising demand for more granular information (a)

- A structural shift towards more micro data information…
  - Social needs: distribution, inequalities (Kavonius)
  - New monetary policy needs: eg fragmentation of interest rates across countries, lenders and borrowers (Morandi)
  - Micro supervision: tail risks
  - Financial stability: micro data to construct macro prudential tools (Bańbuła)

1. Rising demand for more granular information (b)

- … driven by concrete policy needs
  - Impact study / effective policy design / cost benefit analysis (Bańbuła)
  - Complex world leading to complex questions
  - Example 1 (Cassidy) - Irish mortgages: analysis requires granular details on duration, loan characteristics (geography, instrument, borrowers), and transition between various states of arrears – mobilisation of loan data with 250 fields
  - Example 2 (Jabłonowski) - Insufficient saving by Polish households?

2. Importance of matching micro and macro data (a)

- Need for an overall framework to integrate data…
  - Disciplining tool to precise the various data formats
  - Dealing with hybrid concepts (no SNA-type standardisation) (Kavonius)
  - Combining different micro sources (eg banks balance sheets and interest rates (Morandi))
  - Mixing micro-level of information (eg household surveys, real assets) with macro-type data (Kavonius)

2. Importance of matching micro and macro data (b)

- … and in turn to facilitate economic analyses
  - Macro/micro interactions: eg between monetary policy transmission and banks' business models (funding costs, risk-taking appetite (Morandi))
  - Dynamic factors: eg micro analysis of transition from long-term arrears to understand the resolution of the Irish mortgage crisis (eg type of resolution, immediate «cure» versus postponing (Cassidy))
  - Richness of data allows for stress scenarios and calibration of shocks (Bańbuła)

3. Integrating micro data poses significant challenges (a)

- Inherent costs of mobilising and analysing micro data
  - *"Initial preparation from scratch took around 400 hours of literature review, coding and documenting"* (Jabłonowski)
  - Analysis is data constrained (data driven (Kavonius))
  - Data quality issues (eg commercial databases)
  - Confidentiality and requirement for legal changes (eg new ECB role in prudential supervision (Morandi))
  - Communication issues: transforming / synthetizing large datasets (innovative tools, visual interpretation) (Jabłonowski)

3. Integrating micro data poses significant challenges (b)

- Difficulties related to the micro / macro integration itself
  - Timing, sources, frequency (interpolation (Kavonius)), <u>hybrid data concepts</u>…
  - <u>Trade-off</u> when mixing micro-macro layers of information: consistency versus information richness
  - Macro data are usually defined and collected <u>consistently</u>
  - Micro data have a more <u>limited coverage and/or composition bias</u> (eg Irish mortgages (Cassidy))

4. A tool kit for micro data users? (a)

- When setting up the micro-data framework
  - Clarify the data models
  - Optimise the data production processes
  - Conduct reconciliation exercises: accounting relationships, plausibility checks… (Kavonius)
  - Connect different data sources: synergies, cross-checking
  - Conduct judgement-based checks: graphical verification, top down view, peer group comparisons… (Morandi)
  - Set data quality tolerance thresholds

4. A tool kit for micro data users? (b)

- When using the statistical framework for analysis

  - Micro datasets can reveal unexploited patterns (Jabłonowski)

  - The diverse features of the data allows for rich, new ways of analysing: cluster analysis, concentration analysis

  - Test hypothesis (even if not conclusive…)

  - Mobilise techniques popular in other scientific branches

  - Presentation tools eg graphical maps

5. New knowledge opportunities (a)

- More information available
  - Details on the underlying macro dynamics (eg mortgage arrears (Cassidy))
  - Un-mask micro heterogeneity: eg distribution across groups is higher than across countries (Morandi, Kavonius)
  - Influence of time: transition probabilities of moving across groups (Cassidy); distribution changes (Kavonius)

5. New knowledge opportunities (b)

- Micro data can help to think differently

  - Mix different type of information: eg objective financial macro measure / subjective assessment based on surveys (Bańbuła)

  - New analytical tools available to understand and make sense of the data: panel data analysis, micro simulation model, logit model (Bańbuła)

  - Better analysis helps framing policy issues: eg should the resolution of mortgage arrears be based on loss of ownership / forbearance / postponing (Cassidy)? Are Debt Service-To-Income (DSTI) limits useful (Bańbuła)?

A few questions…

- I Kavonius et al (ECB):
  - Value added of a macro framework matched to micro data compared to longitudinal panels, with the identification of the same households over time (and their moving across groups)?
  - Why is interpolation important? Does it bring value? Is it for communication purposes?
- J Cassidy (CBI):
  - How to factor in the difficulties related to composition bias in micro data?
  - Micro data help to assess forbearance strategies. But the crisis showed these strategies were partly a consequence of the macro situation / policies. How to manage this endogeneity?
- J Jabłonowski et al (NBP):
  - Communication challenges posed by methods from other scientific areas eg for policy advise?
  - Trade-off cost of using micro data / risk of inconclusive evidence: is the exercise worth it?
- G Morandi et al (ECB):
  - Issues when matching granular datasets? Importance of a common identifier?
  - How to integrate inter-firms relationships at the micro level (ie the interest rates fixed by a subsidiary may be determined by the balance sheet situation of the group)?
- P Bańbuła et al (NBP):
  - To what extent can cost-benefit analyses based on probabilities and judgement (eg type I and II error ratios) be useful for policies?
  - DSTIs are deemed useful in itself… but compared to other macroprudential tools?

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How to keep statistics' customers happy? Use micro-databases![1]

Filipa Lima and Inês Drumond,

Bank of Portugal

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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 or the central banks and other institutions represented at the meeting.

How to keep statistics' customers happy? Use micro-databases!

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Abstract[1]

This paper illustrates how the Banco de Portugal *has been able to meet new and more detailed statistics users' needs while keeping the respondents' burden at an acceptable level, by exploring a number of available statistical micro-databases. The paper is structured around two main subjects. We first exploit the necessary preconditions to effectively explore micro level data sources. In this respect, the existence of a unique key identifier and reference data are of the upmost importance. Secondly, we detail some concrete examples where the use of micro-data is of the highest relevance, including (i) the new statistical products created to meet data needs that emerged while Portugal was under the Economic and Financial Assistance Programme; and (ii) the* ad hoc *requests to assess the exposure of both the financial and the non-financial sectors to a certain entity, country or financial instrument. In this context, special attention is dedicated to the use of micro-data for financial stability purposes, given the importance of following very closely the existing interlinkages between financial institutions, and between those financial institutions and the non-financial sector.*

***Keywords*:** micro-databases; reference data; macro-financial linkages; financial stability.

JEL code: C18; C81

[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.

1. Introduction

As highlighted in the context of the G20 Data Gaps Initiative, the burst of the financial crisis has clearly shown the degree of interconnection and integration of the economies and markets worldwide. The crisis caught supervisors, policy makers and investors unprepared to deal with areas poorly covered by the datasets available at the time. On the one hand, as policy makers and supervisors soon realised, the information gaps identified were not related with the quality of economics and financial statistics *per se*, which was already very high, but instead on their availability and comparability across countries. In particular, due to the interconnections amongst economies and financial institutions, information gaps clearly emerged from exposures underlying complex instruments and off-balance entities, and from cross-border linkages between financial institutions. On the other hand, market players and investors were unsettled by uncertainty and lack of reliable information, with consequent negative repercussions on the stability of financial markets.

The G20 Data Gaps Initiative Report identified data gaps towards which an urgent response was needed, to avoid keeping stakeholders unprepared against financial turmoil. In the report, the G20 specified a set of 20 recommendations to be implemented in the years to come, which addressed the shortcomings identified, namely the vulnerability of domestic economies to shocks, the need for a better communication of official statistics, the insufficient identification of risk building-up in the financial sector and the spillover effects of cross-border financial linkages between countries.

National central banks who naturally generate and have access to significant amounts of data are thus under pressure to address these shortcomings. However, trying to keep up with the rapid changes of the economy and continuously adapting the statistics to new phenomena has some serious limitations. Conventional data collecting systems cannot simply keep on expanding indefinitely to cope with the need to fill in the information gaps perceived by the users or in anticipation to their future data requirements. In 2013, the *Banco de Portugal* organised the Porto Workshop on Integrated Management of Micro-databases aimed at promoting the discussion within the central banking community with a view on overcoming such limitations. In that context, we came to the conclusion that it makes sense to exploit the largely unused statistical potential of the available micro-databases covering different areas of the economy and the financial markets. Once statistically edited, these micro-data might play an important role in enhancing the efficiency of central banks' statistical systems. The granular nature of this information, together with an almost full coverage of the relevant population, offers increased flexibility as regards the compilation of new statistics and a more rapid response to *ad hoc* data requirements from the users. In general, this approach is technically easy to implement and with relatively low costs associated. The evolution in network and communication protocols, database systems and multidimensional analytical systems has somewhat removed the potential disadvantages of having to deal with the significant amounts of data normally associated with the handling of micro-databases. In addition, these developments created the objective conditions for the statistical systems based on the so-called stove-pipe model, in which statistics in individual domains have developed independently from each other, to evolve to the next level, based on coherent and fully integrated data systems, enabling rapid data exploration, multidimensional analysis and cross-referencing of multiple sources with different granularities.

These efforts are already producing results, as put forward in this paper. In particular, and after describing, in Section 2, the importance of micro-databases and how they are build up and currently managed by the *Banco de Portugal* , Section 3 focuses on the identification of those micro-databases, and Section 4 on the current multiple uses of those micro-databases. Section 5 focuses more specifically on the use of micro-data for financial stability purposes and Section 6 concludes.

2. Micro-databases: why and how?

The *Banco de Portugal* (hereinafter referred to as "the Bank") has been exploring the statistical potential of a number of available micro-databases, which cover different areas of the economy and the financial system, with the aim of enhancing the effectiveness and efficiency of its statistical system while keeping the respondents' burden at an acceptable level. However, to reap the maximum potential of these databases, it is essential to take an additional step and, instead of viewing them in isolation as standalone data repositories, putting them together in a single fully integrated and highly granular data system. By connecting the information contained in each individual database, this data system will boost the potential associated with each database considered individually.

2.1 Question: *Why?* Answer: *Clear benefits for statistical production!*

The main benefit of statistical compilation systems based on item-by-item reporting is their flexibility. This flexibility is manifold, both for respondents and compilers since it:

a. Increases the ability of the system to deal with changes in the statistical requirements, especially in cases where further details in existing breakdowns are needed (in most cases these situations do not imply any intervention in the reporting system);

b. Facilitates changes in the reporting scheme as they typically consist of additional granular items (new dimensions) that will not need to be transformed or aggregated by respondents;

c. Prevents data redundancy, promoting in practice the principle that "data should be collected only once";

d. Enables a more efficient data quality management; and, above all,

e. Improves dramatically the responsiveness to *ad hoc* requests.

One thing that we have learned with the global financial crisis is that aggregate figures are not sufficient to fully grasp developments in economic and financial variables as they refer to the average of distributions. These data should be complemented with micro-data, which enable exploring the heterogeneity hidden behind aggregate numbers. In fact, in many situations, the tails of the distribution provide the most important information, and that clearly explains why these data became crucial in recent times.

2.2 Question: *How?* Answer: *Through a Business Intelligence (BI) framework!*

Achieving a fully integrated highly granular data system is no easy task; it cannot be accomplished overnight. Attaining the afore-mentioned goals hinges on an effective cooperation between different functions of the Bank, based on the sharing of knowledge and the identification of the information needs of both users and producers. A stepwise approach is warranted, whereby the integration proceeds in a gradual and phased manner.

With this in mind, the Bank has been revamping its information model, including a streamlined governance structure, a revisited relationships' management model and a continually improving information architecture based on micro-data and a Data Warehouse (DW). Three main dimensions constitute the cornerstones of this integrated information model: the governance structure, a relationships' management model and the information architecture.

Governance structure

The clear definition of an Information Governance Structure aims at ensuring a proper alignment between the strategic and operational levels of decision, which are mediated by the integrated management of information. In this context, the various departments within the Bank that are originators/users of information have the decentralized responsibility, in collaboration with the department accountable for the centralized management of information, of analyzing in a critical manner the data and the metadata that are most important for them and ensure their quality. They also collaborate on the identification of the functional requirements, having in mind the integrated and shared management of information – the identification of functional requirements is the basis for the consolidation of logical and technological architecture.

Relationships' management

Given the large number of stakeholders, an effective relationships' management is essential, namely to introduce greater efficiency in the communication process, normalizing and formatting it in the customer's perspective. It is based on two cornerstone principles:

a. Information is a key asset of the Bank so it must be managed in an integrated way.

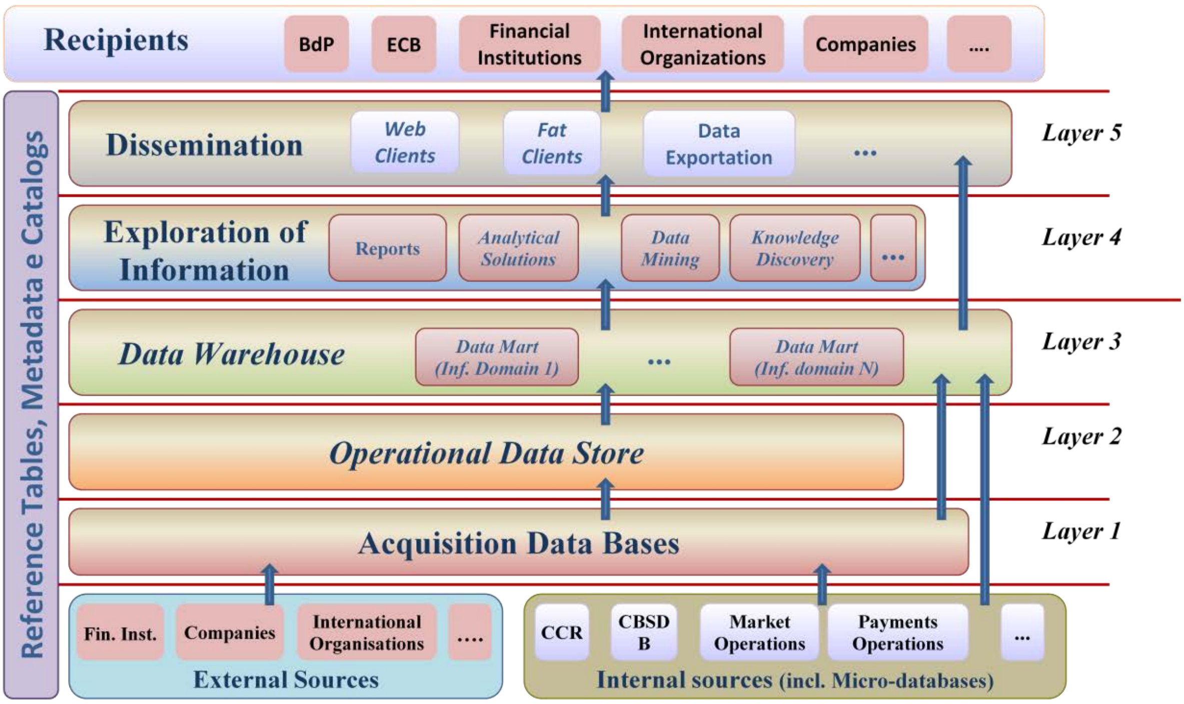
b. The exploration and analysis of information are distributed activities, typically related to the needs and tasks of each department.

Moreover, an efficient management of information should be based on shared management, which requires a separation of responsibility between the "originator/user of information" and the "manager of information". The former is best done in a decentralized way by each department, while the latter should be concentrated in a single department. In fact, given that information is a common good, it should be managed by specialists – these specialists are better placed to collect, classify, manipulate, store, recover and disseminate information.

Information architecture

The information architecture aims at ensuring the quality, auditability and manageability of the data. It is also used to establish levels of responsibility in the management of information, separating the activities related to the organization and processing of information from the analysis and exploration activities. It is based in five layers where the division between the information management and the exploration and analytics activities occurs from the 3rd to the 4th layer, as it can be seen in Figure 1.

Figure 1 – The information architecture



This information model is organised according to the principles of Business intelligence (BI) – "*a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions*" (Globalgate – IT Solutions). Simply put, BI is about getting the right information to the right people at the right time, so that they can make good decisions that improve organisational performance.

The Bank's BI framework is built upon three pillars: a data warehouse, centralised reference tables and a common IT platform. The data warehouse guarantees a central access point to every statistical data, independent of the input source or the production process; the centralised reference database provides common reference data and enables cross linking information from different sources and systems; the consistent usage of a common technological infrastructure across the multiple information systems makes it easier to integrate and reuse components and promotes data access efficiency and transparency to final users.

The centralised reference database is nuclear to the system and aims at harmonising or linking the different concepts present in the data. The Master Data Management (MDM), collects, consolidates, stores and delivers reference data (*e.g.*, countries, currencies, financial sectors, institutional sector, economic activity and size) that are used across the systems. For example, a register of financial institutions has been kept for long, and there is an on-going effort to streamline the process of gathering data from several sources and consolidating it into an historical register of all resident companies.

3. The micro-databases managed by the Bank

The use of integrated micro-databases for statistical purposes constitutes the cornerstone of the Bank's long-term strategy as regards not only the statistical function, but also other areas within the central banks' competencies – inter alia monetary policy, financial stability and supervision. In this respect, the following statistical micro-databases should be highlighted:

a. The Central Credit Register (CCR), which contains granular information on credit on a borrower-by-borrower basis (and, in some cases, including details which provide loan-by-loan information) with a virtually full coverage.

b. The Central Balance Sheet Database (CBSD), which holds accounting and financial information covering almost exhaustively the existing non-financial corporations (NFCs).

c. The Securities Statistics Integrated System (SSIS) database, a security-by-security and investor-by-investor system of both securities holdings and issuances. SSIS complements the CCR data on loans with data on securities and, from a portfolios' perspective, it is a powerful tool to measure the exposure of banks and non-banks to specific issuers; additionally, putting together the information contained in SSIS and CCR provides a more complete overview of the exposure and indebtedness of the financial system as a whole.

d. 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 NFCs sector and monetary policy transmission, the Bank 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 confined to banks with volumes of €50 million or higher).

Moreover, following the creation of the Single Supervisory Mechanism, and the need of better and timelier data for supervision purposes, the Bank is currently assessing the feasibility of integrating in its information architecture also supervisory data with the goal of obtaining synergies in the joint management of banking statistics and supervisory data.

4. The multiple uses of micro-databases: from *ad hoc* requests to new statistical products

One of the most remarkable examples of the responsiveness of one of the micro-databases just described (the SSIS) took place in September 2008, one day after the announcement of the bankruptcy of Lehman Brothers. The European Central Bank (ECB) requested the Eurosystem to provide within the next 24 hours all the available information regarding holdings of shares and debt of Lehman Brothers and its subsidiaries, including a set of details as, for instance, the country and sector breakdown of holders. A list of relevant International Securities Identification Numbers (ISINs) was distributed to facilitate the query. The request was obviously very urgent, sensitive and exceptional. In a couple of hours, the Bank was able to reply to the ECB providing the full answer to the request and even a number of relevant additional ISIN were identified and also provided. Fortunately, Portuguese institutions had only minimal exposure to Lehman Brothers. The security-by-security model of the SSIS and its high level of coverage (both for issues and holdings) were of paramount importance to address this important *ad hoc* request in such an effective way.

The response to the data requests associated to the 2011-2014 EU/IMF Financial Assistance Programme to Portugal also constitutes a particular example of how the efficiency gains spilled over. The Programme brought about an increased need to closely monitor the Portuguese economy in a timely fashion which, in turn, prompted additional data needs for this purpose. Specifically, the data requests involved identifying the public and private non-financial sectors debt, along several dimensions and breakdowns.

The two following example illustrate the advantages underlying statistical compilation systems based on item-by-item models and on building micro-data databases:

a. The production of "amortisation plans" for banks, general government and state-owned enterprises (SOEs), with the amortisation/redemption amounts, on an annual basis until 2020 and from 2021 onwards, of debt securities, domestic loans and external loans.

b. The production of a new statistical product called "non-financial sector indebtedness" aggregating the amounts of non-consolidated debt resulting from issues of debt securities (held by residents and non-residents), domestic loans, external loans and trade credits. Data are presented combining and crossing different dimensions of analysis, namely: debtor and creditor institutional sectors, type of instrument, original maturity, sector of economic activity and size of companies. It was the first time that the Bank used an integrated approach with such a high number of different statistical domains. The result was an innovative achievement at international level and led to a new chapter in the Statistical Bulletin in the beginning of 2012,[2] which is updated on a monthly basis.

General government statistics are also enhanced by the use of information available in the various micro-databases. In this respect, it is worth mentioning the publication of a Supplement to the Statistical Bulletin[3] on General Government Statistics where the different concepts of public debt are presented. Moreover, in March 2014, the Bank decided to bring forward the publication of monthly statistics on general government debt by about 20 days. These data are now disseminated in the first business day of the second month after the reference period.

The successful implementation of the new manuals (BPM6 and ESA 2010) also relied heavily on the existence of micro-databases, particularly in what concerns the flow of funds. Financial accounts data include both the financial transactions and stocks of the different institutional sectors. For the flow of funds representation, financial accounts data have to be available on a from-whom-to-whom basis, between the different domestic institutional sectors of a given economy, as well as with the rest of the world. More specifically, according to the SNA 2008, *"the flow of funds is a three dimensional presentation of financial statistics where both parties to a transaction as well as the nature of the financial instrument being transacted are elaborated"* (see §27.9). The compilation is done on a quadruple-entry basis, whereby each transaction is recorded for the two institutional sectors involved and as a change in both assets and liabilities. In practice, this is achieved by constructing highly detailed from-whom-to-whom matrices with information on creditor and debtor sectors, financial instrument and assets/liabilities.

In February 2015, Portugal completed the requirements for adherence to the IMF's Special Data Dissemination Standard (SDDS) Plus – the highest tier of the Data Standards Initiatives,[4] thus being part of the first cluster of countries joining the IMF's newest data initiative, at its inception. From the first group of 8 countries, only the Netherlands and Portugal met all of the 9 new data categories; in our case, this was only possible due to the combined use of our micro-databases.

Finally, the Bank has recently taken decisive steps towards further exploring the informational potential of the CCR and balance sheet databases in an ongoing project that aims at creating an in-house credit assessment system (ICAS). This system will provide the Bank with its own internal credit risk assessment system, thus reducing its dependence on external sources. Against the background of the recent economic and financial crisis and the shortage of assets liable to be used as collateral in monetary policy operations, these systems have recently been gaining importance within the Eurosystem, as can be seen by the increasing number of NCBs that have introduced them. In fact, at

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[2] Please see the press release on the new chapter on non-financial indebtedness.
[3] http://www.bportugal.pt/en-US/Estatisticas/PublicacoesEstatisticas/Tumbnails%20List%20Template/....pdf
[4] http://www.imf.org/external/np/sec/pr/2015/pr1546.htm

the current juncture, a more pressing business case for ICAS stems from monetary policy purposes, for which ICAS will provide an evaluation of debtors' credit notation.

5. New tools for financial stability

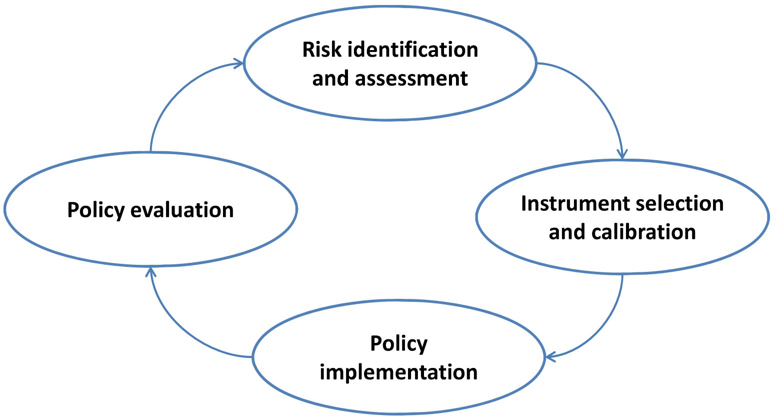
One of the main lessons learned from the recent financial and economic crisis was the need to monitor not only each individual financial institution but also to follow very closely the strong interlinkages between financial institutions, on the one hand, and between those financial institutions and non-financial sector, on the other hand. These interlinkages proved to be, in certain circumstances, a threat to financial stability and, in this context, represent a challenge for financial supervisors.

In fact, several market failures and externalities justify the deepening and broadening of financial supervision: (i) the role of financial sector in propagating and amplifying the effects of shocks on the real economy (*e.g*., through fire sales and herd behaviour); (ii) the exposure of the financial sector to those shocks (*e.g.*, the "sudden stop" of capital flows across different economies that occurred during the euro area sovereign crisis); and (iii) the existing interlinkages between different financial institutions, which may increase their exposure to risks (*e.g.*, institutions that are too big or too interconnected to fail).

Against this background, macroprudential policy, whose main objective is to increase the resilience of the financial sector to systemic shocks, became one of the most important tools for policy makers to promote financial stability. Macroprudential policy focuses not only on how to avoid or attenuate the building up of imbalances or vulnerabilities over time (cyclical dimension), but also on how to avoid or attenuate the building up of imbalances or vulnerabilities within the financial sector that arise through the existing interlinkages between different financial institutions (cross-sectional or structural dimension).

In line with other economic policies, the adoption of macroprudential policies relies on the definition of intermediate objectives (*e.g.*, avoid excessive credit growth and indebtedness and excessive direct and indirect exposure concentrations (ESRB, 2014)) and on the development of a set of indicators and analytical tools used (i) to monitor the threats to financial stability, (ii) to signal when a specific macroprudential instrument should be activated and (iii) to evaluate the impact of macroprudential policy (see Figure 2).

Figure 2 – Macroprudential policy cycle



Source: ESRB (2014)

Macroprudential policy is relatively new in Europe, when compared to other economic policies, thus raising interesting challenges for the macroprudential supervisor. One of these challenges relies on which data, variables and analytical tools to use at each stage. The support of statistical tools is of key importance in this context. In particular, the availability of micro-data and the link between the macro ("macro aggregates") and the micro ("micro-data") becomes crucial for macroprudential policy, given the importance of focusing on the afore-mentioned links across financial institutions and between the latter and the non-financial sector.

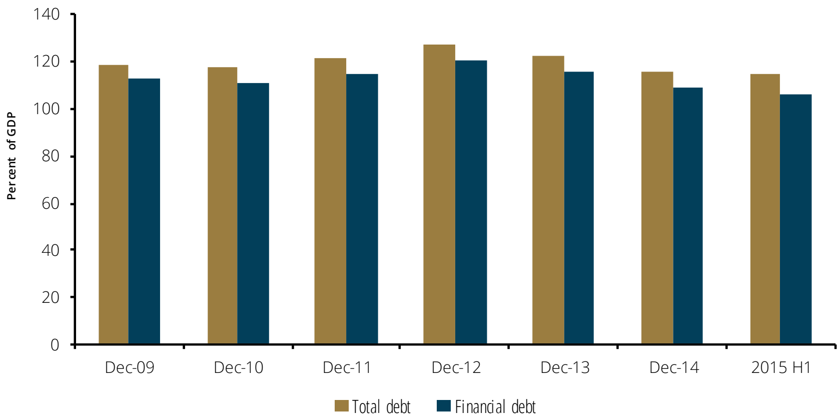
The importance of statistical tools for financial stability: an example based on the Portuguese non-financial corporate sector and the underlying links with the banking sector

The combination of high levels of indebtedness in both private and public sectors represents one of the biggest challenges faced by some European Union Member States, including Portugal: in contrast with some other "historical deleveraging episodes", there is very limited room for manoeuvre to compensate the impact of deleveraging in one particular sector by temporarily increasing indebtedness in other sectors. In this context, evaluating the sustainable level of debt and, consequently, the deleveraging needs of the different sectors becomes crucial. The scale and pace of deleveraging, the impact on the financial sector and the underlying feedback loops across sectors require close monitoring given their potential impact on economic activity and financial stability.

The corporate sector has deserved special attention in Portugal, due to the still high levels of debt observed in this sector, the underlying high level of non-performing loans (NPLs) associated with non-financial corporations (NFCs) in the Portuguese banks' balance sheet, and the importance of NFCs' activity to the economic recovery.

The current context represents a significant challenge, as pointed out by the Bank in the most recent edition of the Financial Stability Report. On the one hand, and despite the significant adjustment that took place during the crisis when looking at flow variables – like the net borrowing by firms –, stock variables (as the debt to GDP ratio) have not adjusted that much, when compared to pre-crisis levels (see Figure 3). On the other hand, for the economy to recover, firms need to continue having access to credit. That is, there is the need to reconcile further deleveraging of the NFC sector with economic growth.

Figure 3 – Non-financial corporations' debt (% of GDP)



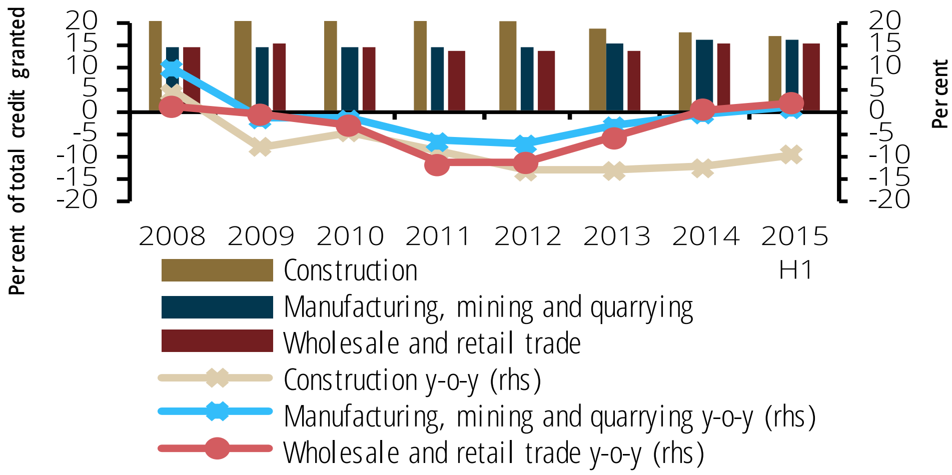
Source : *Banco de Portugal*

The reallocation of resources becomes crucial in this context: in order to guarantee the convergence of NFCs' debt to more sustainable levels, the new financing should flow towards the most productive projects associated with robust and financially viable firms. At the same time, measures aimed at decreasing at a faster pace the stock of NFCs' debt and the underlying stock of banks' NPLs must be assessed.

This is a clear example where macro-data are not sufficient to monitor this process and to assess the potential impact of the aforementioned measures. These involve, necessarily, disaggregated micro-data on NFCs, on the financial sector and on the feedback effects between the two.

Against this background, several analytical tools have been developed by the Bank based on micro-data. Focusing first on the NFCs' sector and on the resource allocation question, micro-data are being used to assess whether the available financing resources – coming mainly from the banking sector – are being allocated to the most productive sectors and whether firms belonging to these sectors are being granted credit at better conditions. Data taken from the CCR show, for instance, that the stock of credit granted by the Portuguese banks to the NFC sector during the crisis decreased more significantly in the non-tradable sectors and that it even increased for the exporting firms, which are less dependent on the domestic recovery (see Figure 4).

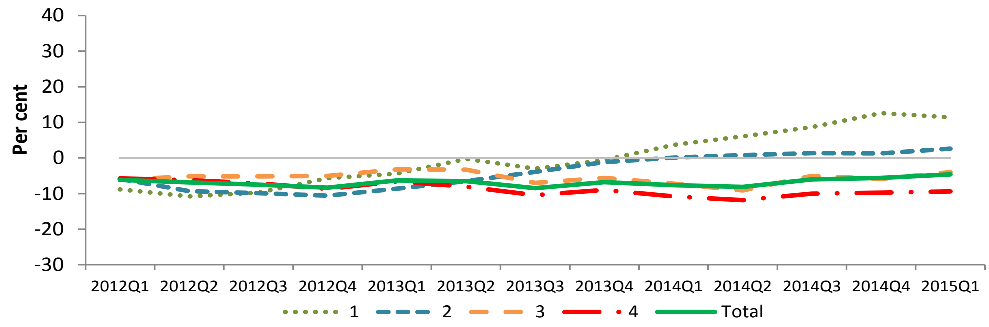
Figure 4 – Share and annual rate of change of credit granted to construction, manufacturing and retail trade sectors



Source : *Banco de Portugal*

Using data from the CBSD and the CCR to estimate a z-score model, it is possible to conclude that, on aggregate, Portuguese banks are granting credit mostly to less risky firms (see Figure 5). 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 (obtained on the basis of corporate micro-data).

Figure 5 – Total loans granted by risk category/ year-on-year growth rate



Level 1: less risky firms; level 4: riskiest firms

Source : *Banco de Portugal*

Despite the adjustment process that took place during the crisis, and as previously mentioned, the stock of NFCs' debt and the underlying stock of NFCs' NPLs in banks' balance sheet are still significant in Portugal. In order to assess whether further measures are needed to spur the pace of NFCs' deleveraging and the potential impact of those measures in both sectors, additional micro-data, also focusing on banks' balance sheet, are needed. In this context, one of the main strands of work relies on banks' capacity to further clean up their balance sheets. For this assessment, data taken from the CCR and from the Banks' Large Exposure database can be used to assess the coverage rate (both by impairments and by different types of collateral) of a significant share of NPLs in banks' balance sheets and to estimate the impact of the writing off of those NPLs on banks' capital position.

Part of the afore-mentioned information is collected regularly and a joint work by the Bank's Financial Stability and the Statistics Departments – using data from the CCR and the CBSD, as well as financial accounts and monetary statistics – has led to the setting up of the "Corporate Debt Restructuring Monitor", which is used to assess the latest developments in terms of NFCs' deleveraging and NFCs' NPLs in banks' balance sheets.

This is just an example on how the statistical tools and, in particular, micro-data are of utmost importance for macroprudential policy and to assess and monitor risks and vulnerabilities to financial stability. But many others could also be pointed out. Just to mention a few: (i) the assessment of risks underlying Portuguese banks' exposure to specific assets, (ii) the identification of systemically relevant financial institutions, that took place in 2015 and involved data on banks' size, importance, complexity and interconnectedness and (iii) the impact assessment on the potential impact of the introduction of macroprudential measures, such as capital buffers.

6. Concluding remarks

The increasing demand for comprehensive, detailed and high-quality information has led the Bank to increase its statistical exploration of available micro-databases. In fact, conventional data collection systems cannot keep on expanding indefinitely in reaction to the ever-increasing need to fill in information gaps or future data requirements. In this respect, several advantages can be pointed out in micro-data such as, good population coverage, increased flexibility, relatively low reporting costs and faster response to *ad hoc* data requirements. To properly manage such detailed, comprehensive and complex information, a robust state-of-the-art data system is of the essence, boosting appropriate IT tools and solutions able to respond to the challenges ahead.

This has proved to be quite relevant in different areas followed by the Bank, including for financial stability purposes – the current financial crisis has shown the importance of complementing macro-data with micro-data in order to (i) better monitor the risks to financial stability, (ii) signal when a specific macroprudential instrument should be activated and (iii) evaluate the impact of macroprudential policy. Against this background, several analytical tools have been developed by the Bank based on micro-data.

Furthermore, in addition to the developments and improvements carried out at national level, 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:

a. ***The Analytical Credit Dataset (AnaCredit).*** Efforts of conceptual harmonisation and convergence have already started regarding 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 European System of Central Banks (ESCB) project is the setting up of a long-term framework for the collection of harmonised granular credit data.

b. ***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).

c. ***The Legal Entity Identifier (LEI)***.[5] 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. 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] http://www.leiroc.org/

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

The Bundesbank's Research Data and Service Centre (RDSC) - Gateway to treasures of micro data on the German Financial System[1]

Stefan Bender and Patricia Staab, Deutsche Bundesbank

[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 or the central banks and other institutions represented at the meeting.

The Bundesbank's Research Data and Service Centre (RDSC)

Gateway to Treasures of Micro Data on the German Financial System

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Abstract

The Deutsche Bundesbank collects monetary, financial and external sector statistical data, comprehensive sets of indicators and seasonally adjusted business statistics. **Aggregated data** which are relevant for macroeconomic analysis are published in its macroeconomic time series databases. The Bundesbank is one of the largest data producers in Germany and its data of high quality. This applies also to its **micro data** - quality-tested administrative data covering the fields of banks, securities, enterprises and household finance.

In order to improve the sharing of micro data between Bundesbank departments, a **House of Micro Data (HoM)** is being created on the basis of the existing statistical data warehouse infrastructure. The underlying multidimensional data classification standard offers an ideal means of linking, comparing and consolidating micro data.

For external researchers, the Bundesbank also provides free of charge access to its micro data for research purposes. Due to legal requirements and in order to meet data protection requirements, individual data can be made available only under certain restrictions. Therefore, the Bundesbank has established its **Research Data and Service Centre (RDSC)** in order to provide researchers access to the Bundesbank's micro data in the context of independent scientific research projects.

The Centre grants access to most of the data during **research visits** at the Bundesbank in Frankfurt (Germany), where visiting researchers have the opportunity to view and analyse these data during research projects in a secure environment. Only **anonymized output** is leaving the RDSC.

RDSC staff members ensure that the micro data provided are **documented** in detail and **archived**. In addition, the RDSC conducts **supplementary methodological and descriptive research** based on the data sets created, and it **collaborates with researchers** within and outside the Bundesbank.

Mandate

Since[1] its inception, the Bundesbank has provided broad and in-depth macroeconomic data to analysts, researchers and the general public. On the other hand, for quite some time little thought was given to providing anonymised individual-bank, firm, securities or household data – micro data.

However, detailed economic and financial stability issues, coupled with progress made in micro econometric modelling, have recently caused a spike in demand for granular data. In addition, plummeting storage and processing costs have made it easier to maintain and provide separately compiled individual-firm statistics calculated in accordance with data protection regulations and legal requirements.

Why are micro data relevant for central banks? In addition to their key task of monetary policy, central banks perform several regulatory and statistical functions. Research shows that key implications of monetary policy can hardly be uncovered using aggregate data:

- Effects of monetary policy differ across banks, firms, and households. Without taking such heterogeneity into account, the channels through which monetary policy affects prices are difficult to establish.
- Similar conclusions hold for other policy areas.
- The risk-taking effects of monetary policy – and thus financial stability implications – cannot be detected without using granular data.
- Assessing the effects of regulatory policies likewise requires granular data.

The Bundesbank – like other central banks – produces datasets which are highly valuable for policy analysis and research. So far, most of these datasets have been used to provide aggregate statistics and ad hoc analysis of specific policy issues. However, policy evaluation can make better use of them, as there is significant knowledge of data and institutional background.

Since systematic use of these data for policy analysis was up to now often constrained by time, IT-resources and legal restrictions, the Bundesbank launched a large-scale initiative called **IMIDIAS (Integrated Micro data-based Information and Analysis System)** aimed at making better use of existing data both for policy analysis as well as internal and external researchers.

[1] This paper can be seen as an update of von Kalkreuth (2014). There is a straight line from his more conceptual paper to the first realisation, which are presented here.

The Bundesbank's IMIDIAS Initiative

In 2013[2], the Bundesbank Statistics Department received the mandate to establish an integrated interdepartmental information system for analytical and research purposes based on micro data for various user groups (financial stability, research, monetary policy, supervision): IMIDIAS.

IMIDIAS aims to encourage cooperation with (internal and external) researchers, promote evidence-based policy-making and support policymaking processes.

In order to fulfil these goals, IMIDIAS provides several key components:

- An **integrated data management concept**, ideally based on a multidimensional data classification standard, to enable the formation of a consolidated data repository
- A data ware house infrastructure based on this concept and able to contain the data: The **House of Micro data (HoM)**
- A service unit dedicated to support internal and external data analysts and researchers: The **Research Data and Service Centre (RDSC)**

The House of Micro data (HoM)

The House of Micro data stores **clean copies of micro data**, thus the pre-existing statistical processes will be left intact. Technically the HoM is based on the central **statistical data ware house** environment already in use by the Bundesbank's Statistics Department. The data sets are registered by an comprehensive inventory, identified by a common **potential analysis** and chosen by the **IMIDIAS steering committee** consisting of data owners and data users.

Since 2014, the IMIDIAS steering committee has been established and several actions regarding the HoM have been performed under its guidance:

– A coordinated and standardized **inventory list** of data assets at the Bundesbank, comprising the data of all relevant business units

– Several micro data / master data **pilot projects** successfully testing the capability of the recipient infrastructure

– A **potential analysis** of data sets on the inventory consisting of the main components relevance - sustainability - legal requirements - costs and leading to the identification of **twelve content projects** to form the first wave of HoM contents.

– Set up of a common framework for HoM content projects and an **IMIDIAS project office** to coordinate and control the activities

[2] See also Irving Fisher Committee on Central Bank Statistics (2015), p. 40-41 for a description of IMIDIAS and the House of Micro data.

Meanwhile the content projects have been launched and are at different stages of realisation:

Status of Projects

Status	Count	Contents
Finished	1	Profit and Loss Accounts
Implementation phase	1	Monthly balance sheet statistics
Investigation phase	10	COREP (two data sets), EADB, Corporate balance sheets, CSDB, Quarterly borrowers' statistics, Securities Holdings Statistics, TARGET2, TMS, TOP

The Research Data and Service Centre (RDSC)

The RDSC was established in 2014 as a part of the Bundesbank's Statistics Department and has since taken over several tasks formerly performed in the Bundesbank's Research Centre.

The RDSC offers access for non-commercial research to (highly sensitive) Bundesbank micro data and aims to be the single point of contact in this field for all internal and external researchers. In the long run its richest source of data will be the HoM, but the RDSC does not have to rely exclusively on this supply line. By end of November 2015, the RDSC's twelve employees situated in the centre of Frankfurt supervised over 150 active research projects, performing tasks like

- Generating (linked) micro data
- Offering advisory service on data selection and data advices (data handling, research potential, scope and validity of data)
- Providing data access (guest stays in Frankfurt, working with available software like Stata and SAS, partly MatLab and Gauss) and data protection (in particular a disclosure review service)
- Documenting data and methodological aspects of the data (available in English)

Besides the supervision of research projects the RDSC organizes conferences and workshops regarding micro data issues. In order to meet the researchers on equal footing the RDSC staff spend part of their time to work on supplementary methodological and descriptive research projects (in close cooperation with the Bank's business areas and the Research Centre).

The RDSC is part of a greater community: regarding the national side, the RDSC is part of the German data infrastructure (German Data Forum; RatSWD). At the international side, the RDSC has a lot of contacts to other Central Banks where there a similar plans to give access to microdata. The RDSC has presented the approach for data access for example at the NBER Summer Institute or the IMF Statistical Forum.

Data Access in the RDSC

Introduction/General[3]

The RDSC satisfies data protection requirements[4], because it reviews incoming requests for access to micro data according to legal requirements. Applicants have to hand in an application form, expose and CV to get an approval by the RDSC. It goes without saying that access is only possible for non-commercial research.

It grants access to most of the data during research visits at the Bundesbank in Frankfurt (Germany), where visiting researchers have the opportunity to view and analyze these data during research projects in a secure environment. For this purpose the RDSC provides twelve working places for guest researchers without any external interface (internet, CD, USB) in Frankfurt.

Only anonymized output is leaving the RDSC, such as the SUF of the German PHF-study which is sent in an encrypted email.

In the near future the RDSC aims to also provide remote execution – still, relating to the complexity of the data, a guest stay in advance will always be required.

Excursion: Methods and Applications to ensure data security

In practice, a data disseminator like the Bundesbank has to resolve the dilemma: on the one side to offer data with the largest possible information potential for research, on the other side to guaranty privacy for the units in the data.[5]

There are two main concepts for solving the dilemma (and of course the combination of both):

- statistical disclosure control techniques and/or
- access through a Research Data Centre (RDC)

The term **statistical disclosure control** refers to concepts and methods relating to ensure the confidentiality of micro and aggregated data that are to be published.[6] Statistical disclosure control refers to methodology used to design

[3] Some relevant paragraphs were taken out of the papers by Hochfellner, Müller and Schmucker (2014) and/or Hochfellner et al. (2012) and translated into the conditions of the Deutsche Bundesbank.

[4] For a description of the institutional framework, see Irving Fisher Committee on Central Bank Statistics (2015), p.39-40.

[5] From a legal point of view, two conflicting constitutional principles operate: (a) the personal right to informational self-determination (privacy) and (b) the academic freedom.

[6] An elaborate description of methods concerning statistical disclosure control can be found in Willenborg and de Waal (2001). Various international research collaborations are engaged in the development of technical solutions addressing data confidentiality (e.g., Hundepool et al., 2010). Various methodological research endeavors work on improving statistical disclosure control procedures (e.g., Drechsler & Reiter, 2009).

statistical outputs in a way that someone with access to that output can't related a known individual (or other responding unit) to an element in the output. To give a simple example, if means and percentages are presented for a large number of people, it will be impossible to infer an individuals' value from such output, even if one would know that a certain individual or unit contributed to the formation of that mean or percentage. The probability to infer information about an individual unit from statistical output can vary. If information is presented for subgroups or in multivariate tables with small cell sizes, the risk for disclosure increases. Thinking this through it becomes obvious pretty quickly that researchers are limited if they would be restricted to the use of data disseminated with these statistical disclosure techniques.

For that reason, in Germany and other countries more and more **Research Data Centres (RDCs)** had been established over the past two decades. Here qualified researchers gain access to micro-level data after they are sworn in to protect the confidentially of the data they access and access is only given within a secure computing environments, for instance, in a RDCr (Lane, Heus, & Mulcahy, 2008). Strong input and output control is in place to ensure that published findings comply with the privacy regulations. Because some data are still too confidential to be released as micro data, or because access should be given broader and not just to those being able to visit RDCs, sometimes synthetic data are created. Here key features of the original data are preserved but noise is added to the data so that no individual record can be found exactly (Drechsler 2011). Examples for such synthetic data are the public use file for the Survey of Income and Program Participation (SIPP).

The main task of data disseminators is to safeguard anonymity of the statistical units being analyzed. This is always associated with the aggregation level of the information that has to be protected. In general, the spectrum of degrees of anonymization ranges from the original data product to aggregated statistics. Restrictions on data access depend on the anonymization strategy that is used. Aggregated statistics may be publicly available on the Internet, whereas restricted data should only be transmitted with approval and verification. The relationship of anonymity and accessibility is outlined in Figure 1. It shows the broad range between original data and aggregated statistics and between unrestricted and restricted data access.

These aspects determine the scope of action of data disseminators in Germany, but not only in Germany. Being a data disseminator of restricted data in an international network, a RDC has a somewhat smaller radius of action. In general, following rule applies: The higher the degree of anonymity, the more flexible the ways of data access that can be used. For instance, sensitive information requires strongly regulated data access. Thus, for all different kinds of data access possibilities, a RDC ensures data security by means of various procedures.

To coordinate the procedures, a RDC – and so the RDSC - implements a portfolio approach following Lane et al. (2008) and Ritchie (2011). Basically, the RDSC distinguishs between measures implemented prior to data usage, and those that take place following data usage. Prior to data usage, access is regulated by data use agreements. In addition, data are anonymized depending on the kind of data access. After data usage the results of analyses conducted using restricted data undergo disclosure review to verify compliance with data protection legislation.

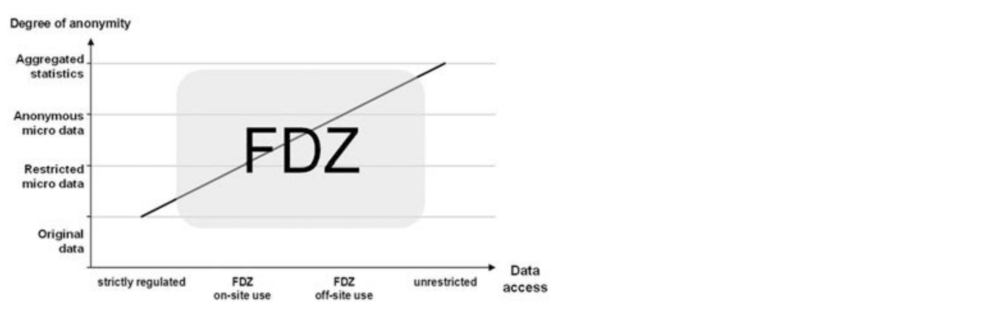

Figure 1. Degree of anonymity and data access at the RDC (FDZ: Forschungsdatenzentrum)

Disclosure Control Prior to Data Usage

Lane et al. (2008) suggest a portfolio approach to achieve data protection while granting data access to researchers. They distinguish data protection according to four subfields, namely, technical, organizational, statistical, and legal protections. The Bundesbank's RDSC adapts their portfolio approach, which is in line with the basic principles of data disseminators worldwide, and therefore well suited to establish data protection strategies within secure computing environments.

<u>Eligibility of data usage:</u>

In most secure computing environments, access to confidential micro data is conditioned on specific regulations the data disseminator must comply with. In accordance with the German legal regulations, the use of RDSC data is linked to certain conditions. To clarify whether these conditions are met, a request for data access has to be submitted.

<u>Regulations on data access:</u>

After the data request has been approved, data use agreements are developed in which the conditions for using them are regulated. Data usage is only permitted for the specific project within the period stipulated in the agreement. The researchers who are entitled to access the data are specified; this group of people is to be kept as small as possible. All data use agreements contain bans on disclosing data to third parties, linking the data to other micro data, and identifying individuals.

Disclosure Control after Data Usage

Aggregated data in which it is impossible to identify either individuals or establishments or banks are classified as absolutely anonymous. However, results from aggregated micro data displayed in tables are not automatically considered absolutely anonymous. If, for example, displayed cells contain only one bank or firm or person that aggregated table is not classified as anonymous. As problems like this frequently arise when analyzing restricted data, all results have to undergo disclosure review prior to releasing research output. The control of research outputs cannot be integrated entirely into a standardized and automated procedure (Gomatam, Karr, Reiter, & Sanil, 2005). Instead, the statistical disclosure control must always be tailored to the individual case at hand (Ritchie, 2011).

Prior to the publication of every research paper containing results from analyses conducted at the RDSC, the results are subject to disclosure control by the RDSC for the reidentification of individual observation units. Prior to submitting a research paper, the RDSC therefore asks every researcher to check whether it contains any micro data. If the disclosure control by the RDSC finds that it still contains micro data, the researcher will then be required to submit a corrected version of the research paper. At least five working days are needed for every submission and resubmission for disclosure control.

A closer look at the data

The Bundesbank's micro data cover the fields of

- Banks (e. g. monthly balance sheet statistics, external position of banks, quarterly borrowers statistics, MFI interest rate statistics),
- Securities (e. g . securities holdings statistics)
- Enterprises (e. g. Micro database Direct Investment, Statistics on International Trade in Services, corporate balance sheets), and
- Household finance (e. g. Panel on Household Finances).

Several (international) research networks draw on Bundesbank micro data, e. g. the International Banking Research Network (IBRN)[7] or the MiDi informal network. Also, it joins in several ECB activities such as the Competitiveness Research Network (CompNet)[8]. The German PHF-study data it provides pertains to the European household panel.Some datasets have already been created and compiled by the Bundesbank's Research Data and Service Centre, with more to follow. These hold great potential for the analysis of financial stability. The following paragraphs name a few examples.

– the leverage ratios of individual institutions can be examined using detailed information from the banks' **Monthly balance sheet statistics (BISTA)**. The BISTA list domestic banks' assets and liabilities on the books at the end of the month along with the analytically important breakdown of the balance sheet items by type, term and the debtor's/borrower's sector. These micro data enable us to form weighted sector-level aggregates; for instance, they could be weighted by each institution's total assets in order to incorporate the variety of institutions' sizes. This helps us to take into account the heterogeneity within the banking industry.

– The loans to enterprises and households in Germany reported in the BISTA are further broken down by sector in the **Quarterly borrowers' statistics (VJKRE)**. Balance sheet statistics and borrowers statistics, in particular, are an important element of financial stability analysis. Network models can be used to identify

[7] http://www.newyorkfed.org/IBRN/index.html

[8] https://www.ecb.europa.eu/home/html/researcher_compnet.en.html

the bilateral relationships between banks or between banks and insurance corporations. On this basis, risk transmission can be observed in detail through the credit channel within the networks, for example.

– The **External position of banks (AUSTA)** records on a monthly basis the claims and liabilities of banks in Germany and their foreign branches and subsidiaries vis-à-vis foreign banks, enterprises and households, as well as general government according to recipient country. These data enable us to assess how macroprudential regulatory measures in other countries affect German banks' business with non-residents.

– The **MFI interest rate statistics (ZISTA)** measure the interest rates applied by domestic banks in Germany and the corresponding volumes of euro-denominated deposits and loans to euro-area resident households and non-financial corporations. Information is collected on month-end holdings and intra-month new business alike. One purpose for which this information is important is analysing real estate in order to identify the potential financial stability risk of lending in this sector and in a test scenario assuming a possible loan default.

– The **Corporate balance sheets (USTAN)** obtained from non-financial companies for Bundesbank refinancing operations provide some indication of the probability of company defaults, and this information can be used to analyse the probability of credit defaults and the resulting risks to the banking sector.

– Household assets and debts are a key aspect in the assessment of an economy's financial stability. For example, loan-financed property purchases in the private sector in the USA or Spain weighed on banks' balance sheets through the credit channel amidst increased defaults among these borrowers. The analysis and assessment of systemic risk to the German financial system stemming from the residential real estate market is central to the ongoing work of the German Financial Stability Committee. The Deutsche Bundesbank's **"Panel on Household Finances" (Private Haushalte und ihre Finanzen, or PHF)** survey supplies information on households' balance sheets, including their debt, pension plans, saving and income, data on employment, consumption, attitudes and expectations with regard to the economic situation, and a large number of demographic characteristics. The data enable a better understanding of issues such as saving and consumption, the distribution of wealth, insolvency risks or the characteristics of mortgage borrowers.

– The **Securities Holdings Statistics (WP-INVEST)** capture the total securities holdings of all deposit account-keeping banks domiciled in Germany at ISIN level, broken down by customer group. When a company founders or fails, this affects not only creditors but also shareholders or holders of other debt issued by that company. Micro data on securities indicate to some degree where, what volume of and in which sector securities are being held, and thus enable us to analyse contagion in securities markets. This is necessary for assessing the stability not only of the banking sector but also of the insurance sector, where securities make up the lion's share of investments.

Conclusion

Accessing data through the Bundesbank's RDSC is the best way for using highly sensitive data. The Bundesbank hopes to (further) stimulate international research and policy analysis with these data. Accessing the data is comparatively easy and inexpensive.

Further information on the Bundesbank's Research Data and Service Centre, the anonymised datasets provided for independent scientific research and on the special access channels required for data protection purposes may be found on the website www.bundesbank.de\fdsz or via email to fdsz@bundesbank.de

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

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The Centralised Securities Database (CSDB) - Standardised micro data for financial stability purposes[1]

Asier Cornejo Pérez and Javier Huerga, 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 or the central banks and other institutions represented at the meeting.

The Centralised Securities Database (CSDB) - Standardised micro data for financial stability purposes

Asier Cornejo Pérez and Javier Huerga[1]

Abstract

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. The CSDB is accessible by the entire European System of Central Banks (ESCB) and is updated on a daily basis with input from several commercial data providers and more than twenty national central banks. It provides full micro data on securities by all issuers, including the financial sector. This standardised database is already used across several statistical and non-statistical domains and provides all users with a single set of information, herby reducing asymmetries and inconsistencies in the data analysis.

After introducing the relevance of security-by-security databases to support the compilation of consistent and comparable securities statistics in the context of the G-20 Data Gaps Initiative and the new Handbook on Securities Statistics, a brief introduction to the CSDB is provided, and concrete examples on how CSDB could contribute to financial stability analysis are presented in this note. The examples include aspects like the refinancing needs of deposit-taking corporations (DTCs), i.e. banks, their funding structure in terms of securities, the costs of financing, their risk on the basis of ratings, the degree of standardisation and other possible uses of the CSDB. Examples at national and euro area level on these issues are presented only for illustration of the potential use of a security-by-security database, being neither official statistics nor policy recommendations.

Keywords: Financial stability indicators, euro area, debt securities, security-by-security databases

JEL classification: G21 Banks • Depository Institutions • Micro Finance Institutions • Mortgages, G32 Financing Policy • Financial Risk and Risk Management • Capital and Ownership Structure • Value of Firms • Goodwill

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We would like to thank all European System of Central Banks colleagues who contribute to the development and operation of the Centralised Securities Database (CSDB).

1. Introduction

Securities statistics is one of the areas in which room for improvement was identified by the Financial Stability Board and the International Monetary Fund in their report to the G-20 Finance Ministers and Central Bank Governors in 2009.[2] The benefit of improved securities statistics was agreed by all G-20 economies and the G-20 Finance Ministers and Central Bank Governors have recently concluded that providing consistent and comparable securities statistics is a priority for their statistical work for the period 2015-2021 in the context of the second phase of the Data Gaps Initiative[3]. Good securities statistics are crucial both to understand the diversification of funding sources and the exposures of both issuers and creditors, including the nonfinancial sector.

There is growing evidence that this objective requires a more diverse statistical compilation and can better be addressed through security-by-security databases (s-b-s). This is also recognised in the Handbook on Securities Statistics (*Handbook*), which was completed in 2015 following recommendation 7 on the G-20 report. The *Handbook* provides a high level description of the potential content and benefits of a security-by-security database.[4] Furthermore the *Handbook* explicitly mentions the Centralised Securities Database (CSDB) as a prominent example of a s-b-s database.

If we link these developments with the increasing interest in micro-data for economic analysis, it is somehow surprising the current limited use of CSDB for financial supervision purposes in the European System of Central Banks (ESCB). This limited use is possibly due to lack of knowledge about the CSDB and absence of a user-friendly tool to access the data. The objective of this paper is to address the first of these obstacles by presenting the main features of the CSDB and its usefulness as source of data for financial stability purposes. This is expected to increase awareness on the potential uses of CSDB and s-b-s databases in general.

The paper is organised as follows. Section 2 provides general remarks on micro data and standardisation followed by section 3 with a description of the CSDB, covering its content, data flow and current uses. Section 4 presents a number of concrete examples on how the CSDB could be used for financial stability purposes, such as refinancing needs of financial institutions, funding through securities, the costs of financing of these institutions, risks analysis based on ratings information and degree of implementation of international standards like the LEI among all securities issuers. Section 5 concludes with a general assessment of the potential use of the CSDB for financial stability purposes.

The examples in this paper are illustrations of the potential of the CSDB in the financial stability area and not intended as an in-depth analysis or policy recommendations. The indicators shown have been selected and calculated by the authors and are not official ECB statistics.

2 ` Recommendation 7 in the "The Financial Crisis and Information Gaps", Financial Stability Board and International Monetary Fund, 29 October 2009.

3 New recommendation 7 in the "Sixth Progress Report on the Implementation of the G-20 Data Gaps Initiative", Financial Stability Board and International Monetary Fund, September 2015.

4 Refer to Annex 4 of the "Handbook on Securities Statistics", Bank for International Settlements, European Central Banks and International Monetary Fund, 2015.

2. Micro-data and standardisation

2.1. Micro-data versus macro-data

A s-b-s database, like the CSDB, offers features that cannot be matched by pre-aggregated data. Micro-data can be compiled on a multipurpose basis and be customised ex-post for each specific analysis or used to produce new aggregates in a flexible way without recurring to multiple requirements to reporting agents. The CSDB also offers attributes not covered in aggregate data and the possibility to combine them.

S-b-s databases also allow the use of micro-data as such, permitting to analyse individual or specific groups of instruments and issuers. In this way the complete picture comes up, going beyond just aggregates or averages. For example, by using the CSDB it is possible to extract the full distribution of any particular attribute contained in it.

Timeliness is an additional advantage of the CSDB. In a s-b-s data individual information does not need to pre-aggregated but rather can be individually received and recorded on a daily basis. While the implementation of new statistical standards typically takes years, a large part of the new concepts in the Handbook on Securities Statistics can almost immediately be applied by using a s-b-s database. Some examples using the CSDB are later presented in this note. The information provided s-b-s is also efficient from the point of view of statistical compilers as it allows to check the data only once for multiple purposes

Moreover, s-b-s databases, like the CSDB, are also for the benefit of reporting agents. Typically reporting agents need to adjust their information systems to comply with statistical and supervisory reporting. A s-b-s database reduces the burden on reporting agents by limiting their reporting obligations, given that the rest of the information can be completed by the statistical compiler by using different sources and the database.

2.2. Standardisation

The use of international standards in financial markets is necessary in order to ensure transparency. In the case of securities, two international standards are especially needed, namely the International Securities Identification Number (ISIN)[5] and the Legal Entity Identifier (LEI)[6]. The ISIN uniquely identifies the negotiable instruments, the LEI uniquely identifies the institutions, in particular the issuers of negotiable instruments.

Precisely, one of the key features of s-b-s databases is standardisation. While aggregate data may hide different non-harmonised components, the compilation of s-b-s data requires the existence and application of unique identifiers.. In turn,

[5] As defined in the *Handbook*, para. 2.3, one of the criteria for a financial instrument to be considered negotiable is to be allocated an ISIN.

[6] The importance of data standardisation in respect of securities through the adoption of international standards, e.g. LEI, has been explicitly recognised in the recent progress report on data gaps - "Sixth Progress Report on the implementation of the G-20 gaps initiative", Financial Stability Board and International Monetary Fund, September 2015.

standardisation permits further links between different databases increasing the usefulness of individual data, e.g. permitting to connect issuers and holders of securities.

The CSDB only contains securities which have an ISIN. Given that the CSDB is a database on securities a unique identification of the securities is needed in order to avoid duplicities. If the ISIN code were not required double (or higher number) of entries of the same security would occur, resulting in the uselessness of the whole data. It is recognised that this approach may leave outside CSDB part of the market. However, it ensures that most and the most relevant securities are correctly and uniquely recorded in the CSDB.

Fact-finding exercises reveal that debt securities without ISIN issued in the euro area may amount to less than 1% of the total amount outstanding, although may be more relevant 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 (e.g. investment funds) issued without ISIN may be more substantial but is difficult to prove because the very absence of a unique international identifier makes it more difficult the compilation of statistical data.

Regarding the LEI, due to its current incomplete implementation the CSDB accepts different type of identifiers, paying especial attention to proprietary identifiers of commercial data providers and national identifiers provided by NCBs. These identifiers are particularly relevant as they are used, in the absence of full implementation of the LEI, to group the securities under the common issuer.

At the same time, a s-b-s database can also be used to monitor the degree of implementation of international standards. For example, the CSDB can be used to monitor the degree of implementation of the LEI among issuers of securities, as shown in section 4.

3. The Centralised Securities Database (CSDB)

3.1. A brief description

Operational since 2009, the CSDB is a s-b-s database with the aim of holding complete, accurate, consistent and up-to-date information on all individual securities relevant for the statistical and, increasingly, non-statistical purposes of the ESCB. It is a single information technology infrastructure that 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, estimated or defaulted) as well as information on ratings (covering securities, issuance programmes, and all rated institutions 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. The CSDB currently contains information on over six million non-matured or “alive” debt securities, equities and mutual fund shares/units plus approximately nine million matured or “non-alive” (e.g. matured, early redeemed or cancelled) securities. Chart 1 illustrates this coverage.

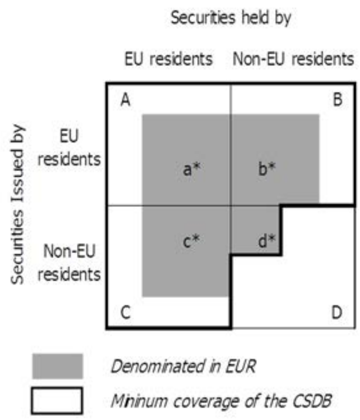
Developed by the ECB, the CSDB is jointly operated by the members of the ESCB and it is only accessible by them, i.e. it is not available for public purposes. The CSDB uses data from commercial data providers, national central banks and other existing sources. Based on automatic algorithms, the most plausible value for each attribute is selected and gaps (in particular for prices and income) are filled with reliable estimates. The system makes use of expertise within the ESCB to enhance data quality.[7]

The CSDB provides consistent results and harmonisation of concepts and calculations for all users together with efficiency in the data reporting, which reduces the burden from reporting agents, and improves the data compilation process.

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



In September 2015, the nominal values of debt securities issued by all euro area residents amounted to approximately €16.7 trillion, with more than 80% denominated in euro. The total market capitalisation of quoted shares was around €6.3 trillion. By sector, debt securities account for more than 45% of the total government debt, 47% for monetary and financial institutions and 7% of the outstanding borrowing of non-financial corporations.

3.2. Information data flow

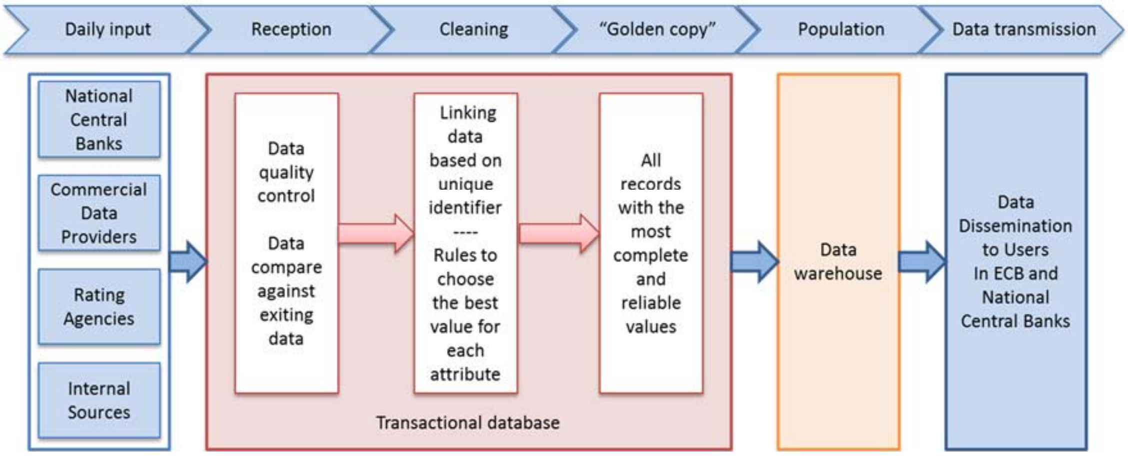
The CSDB is a multi-source system that receives approximately 2.5 million prices and 300.000 records on reference information per day. The data is acquired automatically from all sources by the transactional system accessible via a web user interface, also called CSDB Portal. Upon reception, the data is compared against the existing or previously reported information. If large deviations are detected on the provision by

7 In accordance with the Guideline ECB/2012/21 of 26 September 2012 on the data quality management framework for the Centralised Securities Database.

one source, the data will be stopped to be further analysed by the system operators, aiming at ensuring data stability and data quality. Moreover, invalid data are filtered out at the start of the process.

Chart 2

Centralised Securities database information flow



Once data reception has finalised, the pooled data usually contains inconsistent information that needs to be cleaned. This “cleaning process” is automatically started by the system every evening. This is done on the basis of automatic rules to choose the best (most plausible) value for each attribute where sources might be equal or contradictory. One of the main steps of this process is the grouping of the information provided by each source.

Following the standards, the CSDB uses the International Securities Identification Number (ISIN) as the unique identifier for grouping on instruments information. On the entity identification, currently several identifiers are being used for grouping, but the Legal Entity Identifier (LEI) is also loaded since December 2014 and the use of the LEI as the unique entity identifier is foreseen for the future.

Prices and other information may be missing for some securities, especially private placements, unquoted equities and rarely traded securities. The CSDB contains automatic routines to fill the gaps, which depend on the nature of the missing information, what other relevant information is available, and the type of instruments. Using information from the same or similar securities, and also statistical estimation methods where necessary, the CSDB fills the gaps in the best, most consistent way possible. The result is a “golden copy” of the data, which combines the best features of the sources drawn on.

This golden copy is extracted on a monthly basis to the second module of the system, the data warehouse. Since October 2015, daily extractions are also done for a subset of securities, including among them eligible assets for ECB monetary policy operations and government securities. Data is produced with a timeliness of t+6 days for monthly information and t+1 for daily data, which provides users with very quick information. The data are released to end-users and the whole ESCB.

Box 1

CSDB development – agile versus waterfall approach

Being a micro database, the CSDB data model speaks the language of the financial markets and its generic approach allows developing the system in smaller and quicker iterations. One of the main characteristics of the CSDB is the iterative-incremental approach in the development process. As opposed to the waterfall approach, the CSDB has around three releases per year, approximately every 4-6 months. This development process helps to satisfy user needs quicker and more effectively.

The development is technically guided and promotes automation version reliance manual work. It is driven by experience and not only by theoretical requirements which increases efficiency. Moreover, the CSDB development ensures transparency and flexibility together with a common solution for all purposes.

3.3. Current users

Overview of current CSDB users

Table 1

Statistical purposes	Non-statistical purposes
Balance of payments statistics	Monetary policy
Investment Fund Statistics	Fiscal policy
Financial Vehicle Corporation Statistics	Market operations
Securities Holdings Statistics	Risk management
Securities Issues Statistics	Research
Other	Other

4. Usage of CSDB for financial stability purposes – examples

The CSDB can be used to compile all basic statistics on securities issues by country, sector, original maturity or currency as established in the Handbook. At the same other more advanced indicators can also be produced. This section provides a set of specific examples where the CSDB data could be used for financial stability purposes. It is noted that all data in this paper have been extracted from the CSDB, which may deviate in some cases from other data sources. Furthermore, the data presented are the results of ad-hoc calculations by the authors and not official statistics. The examples are intended as illustrations of the potential of the CSDB in the financial stability area and not intended as an in-depth analysis or policy recommendations.

4.1. Refinancing needs

Refinancing needs of debt securities, also called debt service, refers to the necessary funds in order to honour the obligations in respect of the interest and, at redemption, of the principal of the securities issued. Refinancing needs are a relevant component of financial stability analysis, as concentration of deposit-taking corporations (DTCs), i.e. banks, refinancing needs in the very short-term and/or in particular points in time may be an indication of current or future liquidity difficulties. Aggregate statistics usually provide data in terms of the original maturity of the securities issued, typically with a short-term/long-term breakdown. However, aggregates according to original maturity do not permit to know the refinancing needs over time. For that reason the *Handbook* recommends the compilation of statistics according to remaining maturity in addition to the traditional breakdowns by original maturity.

A s-b-s database such as the CSDB makes it possible to calculate scheduled future redemption for each individual security and aggregate them according to remaining maturity criteria. Following the recommendations in the *Handbook* it is possible to calculate figures according to the original maturity breakdown, short-term (up to one year) / long-term (over one year) and divide the original long-term figures into those with a remaining maturity up to one year and those over one year. In this way it is possible to know all securities maturing in one year time, aggregating short-term securities and long-term securities maturing in the short-term.

Table 2 shows the amount outstanding on alive debt securities issued by euro area DTCs in all currencies, with a breakdown by country. Data according to both original maturity and remaining maturity are presented. The data show the relevance of having information by remaining maturity in addition to the traditional original maturity. For example, while only around 11% of the amounts outstanding in the euro area are short-term according to the original maturity, more than 29% are short-term according to remaining maturity. The differences are especially large in some small countries (e.g. Lithuania, Slovenia, Lithuania, Ireland), but also quite relevant in larger countries (e.g. Germany, Spain).

Debt securities issued by DTCs

Table 2

Debt securities issued by DTCs amount outstanding breakdown by euro area countries and original/residual maturity, end-Sept 2015 (Eur bn, percentage)

	Total securities	Original maturity			Remaining maturity		
		Short-term	Long-term	% Short-term/Total	Short-term	Long-term	Short-term/Total
Austria	163.4	9.3	154.1	5.7%	36.5	126.9	22.4%
Belgium	51.1	24.9	26.2	48.8%	27.4	23.7	53.6%
Cyprus	2.3	0.0	2.3	0.8%	0.1	2.2	2.7%
Estonia	0.0	0.0	0.0	62.5%	0.0	0.0	62.5%
Finland	93.7	10.3	83.5	11.0%	25.9	67.8	27.7%
France	1,159.0	214.5	944.6	18.5%	359.2	799.8	31.0%
Germany	1,432.4	141.0	1,291.4	9.8%	437.8	994.6	30.6%
Greece	57.9	44.7	13.2	77.3%	52.7	5.2	91.0%
Ireland	58.6	6.3	52.4	10.7%	21.4	37.2	36.5%
Italy	636.9	0.4	636.5	0.1%	148.6	488.3	23.3%
Latvia	0.8	0.0	0.8	0.2%	0.2	0.5	30.7%
Lithuania	0.0	0.0	0.0	51.7%	0.0	0.0	76.1%
Luxembourg	55.6	14.0	41.6	25.2%	24.1	31.5	43.3%
Malta	0.4	0.0	0.4	0.0%	0.0	0.4	2.3%
Netherlands	550.4	45.9	504.5	8.3%	136.6	413.9	24.8%
Portugal	63.9	0.0	63.9	0.0%	10.3	53.6	16.2%
Slovakia	4.3	0.0	4.3	0.2%	0.9	3.3	22.3%
Slovenia	1.2	0.0	1.2	0.0%	0.4	0.8	30.4%
Spain	330.7	15.0	315.7	4.5%	82.2	248.5	24.9%
Euro area	**4,662.6**	**526.3**	**4,136.3**	**11.3%**	**1,364.4**	**3,298.2**	**29.3%**

Source: Authors calculations, Centralised Securities Database (CSDB)

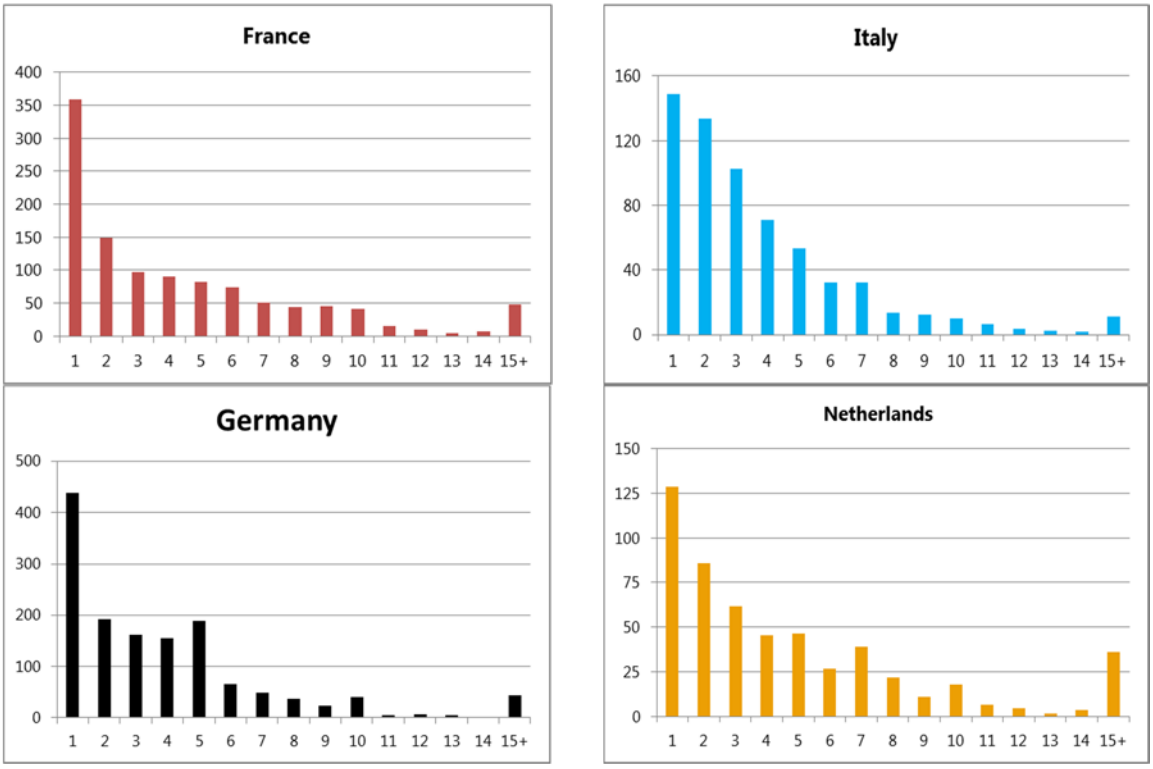
A more granular picture of the refinancing needs of DTCs, either individually or at any aggregation level it is also possible by using CSDB s-b-s data.

For example, refinancing needs of debt securities issued by DTCs in the four largest issuers of debt securities in the euro area are presented in chart 3. The chart contains debt securities principal amounts to be redeemed (no interest payment), with a breakdown by remaining maturity. Debt securities have been grouped by number of years to redemption, rounding up. Securities with a remaining maturity above 15 years have been grouped under the category “+15”.

Chart 3

Debt securities issued by DTCs

Debt securities issued by DTCs amount outstanding, end-Sept 2015, by remaining maturity (years, Eur bn)



Source: Authors calculations, Centralised Securities Database (CSDB)

4.2. Securities Funding of Deposit-taking Corporations

The funding structures of the entities also matter for financial stability purposes. A contribution to the global financial crisis came from the overreliance by some DTCs on certain types of funding, in particular wholesale funding and, some DTCs were vulnerable because their equity capital levels were inadequate.

Since the crisis, new regulations have aimed to make financial systems safer (including Basel III capital and liquidity regulations and over-the-counter [OTC] derivatives reforms) and ensure financial stability. . Without entering into risks considerations, there are some indications that healthy DTCs tend to have more equity and less debt (in particular less short-term debt), lower loan-to-deposit ratios, and more diversified funding structures that improve DTCs' stability.

The complete funding structure of the bank covers equity, debt securities, loans and deposits. In this context, the information on the CSDB allows to analyse how bank funding structures in terms of marketable liabilities and capital have changed over time, in the area of securities, and how these structures affect financial stability. Chart 4 shows the evolution of the securities funding structure for Italy and Spain since 2012 to 2015. The ratios are calculated based on the total amount outstanding for debt securities and the market capitalisation of the equity for each reference date. The information for equity is based on market prices. Moreover, the CSDB allows looking into the breakdowns based on original maturity or based on residual maturity.

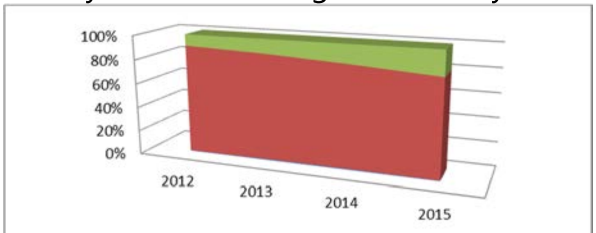
In both countries the tendency shows a reduction of the relative weight of debt securities and progressive increase of equity. For Italy, long term debt experienced a reduction of more than 10% based on original maturity. However, when looking at the structure based on residual maturity, the payments on less than one year remain around 20%, which indicates a reduction on the payments over one year. For Spain, DTCs have experienced larger changes possibly due to the distress suffered by the Spanish DTCs during the financial crisis and the corrections on capital ratios are much larger. Based on original maturity, the long term debt securities reduced from 79% to 60% from 2012 to 2015. Moreover, the same pattern can be seen in the analysis based on residual maturity with a drop of the payments in more than one year from 63% to 47%. When comparing both countries, the ratios of Italian DTCs are much larger than the Spanish DTCs.

Chart 4

DTCs' securities funding structure based on the CSDB

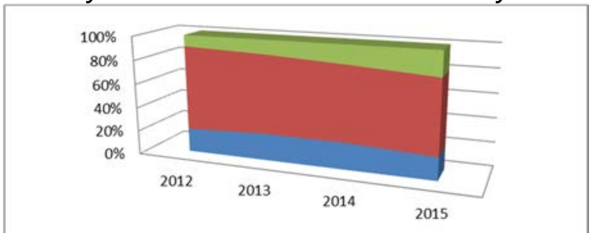
Evolution of securities funding by year for Italy and Spain broken down by original and residual maturity, total outstanding amounts for liabilities (long/short term, less/over one year) and market capitalisation of equity, end-Sept 2015 (percentage, years)

Italy – based on original maturity



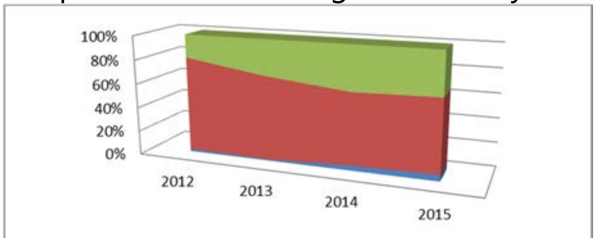
	2012	2013	2014	2015
Equity	9.32%	11.74%	15.53%	20.16%
Long term	90.37%	87.47%	83.68%	79.44%
Short term	0.31%	0.79%	0.79%	0.40%

Italy – based on residual maturity



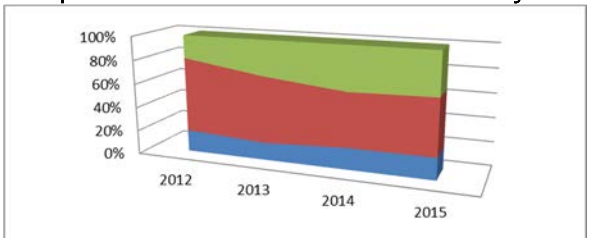
	2012	2013	2014	2015
Equity	9.32%	11.74%	15.53%	20.16%
Over 1 Year	70.90%	65.71%	62.25%	60.87%
Less than 1	19.78%	22.55%	22.22%	18.97%

Spain – based on original maturity



	2012	2013	2014	2015
Equity	19.15%	29.56%	36.75%	35.08%
Long term	78.81%	69.45%	59.08%	59.76%
Short term	2.04%	0.99%	4.17%	5.16%

Spain – based on residual maturity



	2012	2013	2014	2015
Equity	19.15%	29.56%	36.75%	35.08%
Over 1 Year	62.54%	55.87%	45.11%	46.72%
Less than 1	18.31%	14.57%	18.14%	18.20%

Source: Authors calculations, Centralised Securities Database (CSDB)

4.3. Costs – Interest rate and yield to maturity

DTCs cost of financing through the issue of securities is a basic indicator for financial stability purposes and possibly an input for other measures. The *Handbook* does not directly prescribe the compilation of interest rates or other cost measures. However this topic is closely related to other relevant aspects of securities statistics as made explicit in the Annex 1 to the *Handbook* regarding the comparisons between market value and nominal value for debt securities.

As a first example of the type of indicators that can be compiled by using s-b-s information is the current interest rate applied on existing securities issued by CDTs. This information provides the current cost of financing in the markets for DTCs.

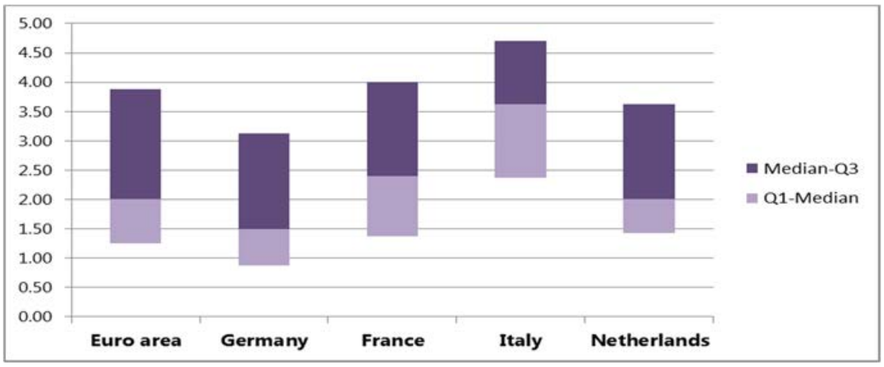
Chart 5 shows the inter-quartile levels and dispersion in interest rates, computing both explicit interest through coupons and implicit interest rate through the difference between issue and maturity prices, weighted by outstanding amounts for alive debt securities denominated in all currencies issued by DTCs in the euro area as a whole and in the largest euro area countries in terms of issues of securities by the DTC sector, by September 2015. The chart shows the interest rate of securities with remaining maturity between two and four years, excluding index-linked, floaters, securities with embedded option features and covered bonds. Furthermore, only securities with an explicit coupon and with available issue and redemption prices have been considered in order to maximise homogeneity and data quality, even if that has resulted in the reduction of the population of securities considered.

The results show that that the median for the euro area is near 2%, while the interquartile dispersion is more than 260 basis points, making explicit the different financing costs across securities. In terms of country comparisons, Germany shows less financing costs, with median close to 1.5%, France higher levels and dispersion, only partially overlapping with Germany. The Netherlands shows a median around 2% but lower dispersion than the total euro area. Italy has clear higher levels, with a median above 3.5%.

Chart 5

Intra-quartile interest rates

Intra-quartile interest rates of plain vanilla existing debt securities issued by DTCs with remaining maturity between 2 and 4 years, weighted by amount outstanding, end-Sept 2015 (percentage)



Source: Authors calculations, Centralised Securities Database (CSDB)

A complementary perspective of DTCs financing costs is provided by the yield to maturity. The yield to maturity (YTM) is defined as the total interest rate that could be earned by an investor who buys a debt security at market price, assuming that the bond will be held until maturity, and that all coupon and principal payments will be made on schedule. YTM can also be interpreted as the cost of financing of the issuer should need to issue a debt security for the period of the remaining maturity. The *Handbook* (para. 7.69) considers yield spreads as an indication of the relative creditworthiness of individual issues, which could be used to develop a statistical classification for debt securities by default risk.

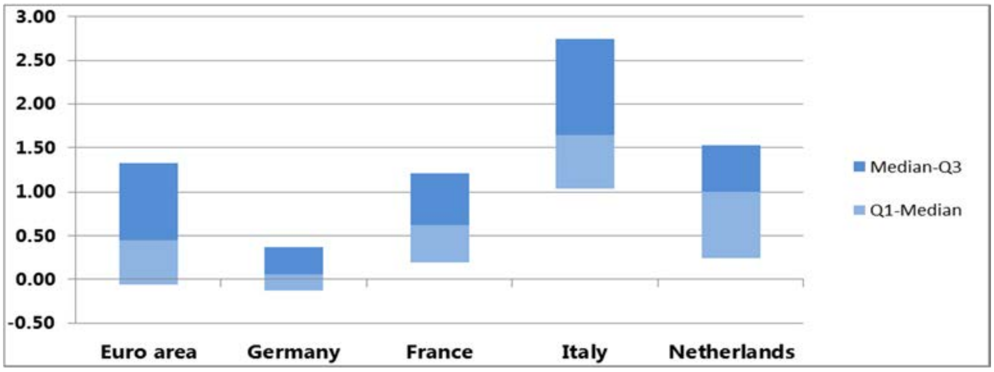
This recommendation of the Handbook can be developed in many different ways. In the context of the euro area financial stability it seems particularly important to measure the YTM dispersion of securities issued by DTCs in the euro area as a whole and in each member state as well as the dispersion in each country.

Chart 6 shows the inter-quartile levels and dispersion in YTM weighted by outstanding amounts for alive securities denominated in all currencies issued by DTCs in the euro area as a whole and in the largest euro area countries in terms of issues of securities by the DTC sector, by September 2015. The chart shows the YTM of securities with remaining maturity between two and four years, with the same population of instruments as described before

Chart 6

Intra-quartile YTM

Intra-quartile YTM of plain vanilla debt securities issued by DTCs with remaining maturity between 2 and 4 years, weighted by amount outstanding, end-Sept 2015 (percentage)



Source: Authors calculations, Centralised Securities Database (CSDB)

The median for the euro area is below 0.5% reflecting the current monetary policy stance, while the interquartile dispersion is more than 130 basis points. These levels already give an indication that DTCs could generally refinance their existing medium-term debt securities at a lower cost if they were issued today instead than in the past. However more relevant is possibly the different situations across countries. While Germany shows a very uniform picture with a median close to 0%, France has higher levels and dispersion, only partially overlapping with Germany. The Netherlands shows a median around 1% with a similar pattern as France. Italy shows even higher levels and dispersion.

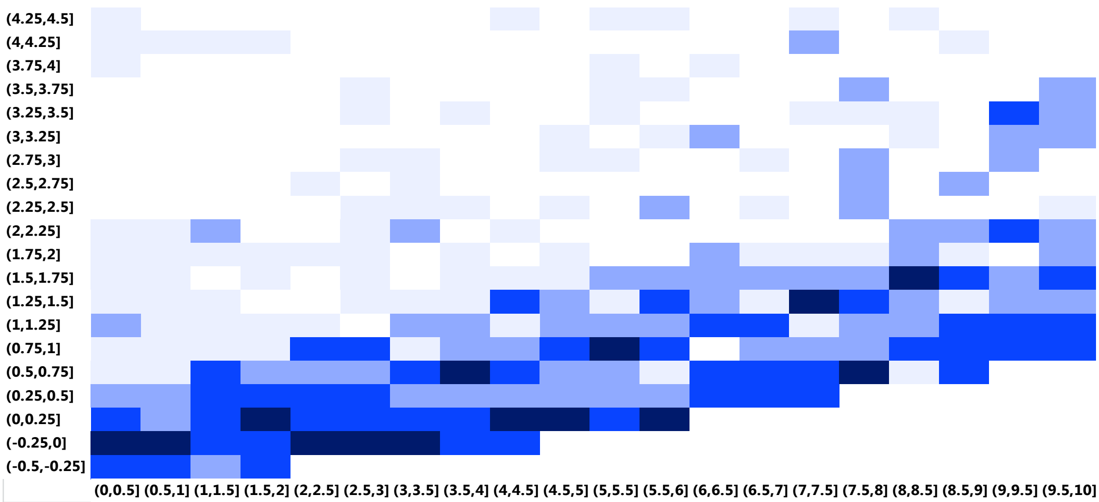
A s-b-s database can also be used to build yield curves. It is noted that a yield curve implies the selection of a single rate for each point in time, through selection of the different possibilities. A first approximation towards the yield curve type of construction and analysis can be done through a heat map of the outstanding amounts related to each remaining maturity and YTM.

Chart 7 below shows a heat map of the outstanding amounts of debt securities denominated in euro by remaining maturity and YTM. The chart shows the relative relevance of the different levels of YTM per remaining maturity intervals. Those YTM levels with the highest concentration of securities in terms of amount outstanding are showed in darker colours. The chart is a first approximation to a YTM curve by linking the darkest areas. It is visible the current low slope of the curve as well as the increase in dispersion with highest remaining maturity.. .

Chart 7

Yield to maturity of securities issued by euro area DTCs

Heat map of the concentration in terms of amount outstanding of securities issued by euro area DTCs by intervals of remaining maturity (horizontal axis, years) and YTM (vertical axis, percentage rates) by end-Sept 2015



Source: Authors calculations, Centralised Securities Database (CSDB)

4.4. Risk profiles

There are different ways to measure and analyse risks. One of them is analysing the ratings information provided by the rating agencies, as mentioned in the Handbook (para. 7.64 ss). In addition to reference information, the CSDB contains ratings information on securities and entities coming from the main rating agencies. This information can be used to analyse the risk profiles of specific countries, sectors as well as specific entities or instruments.

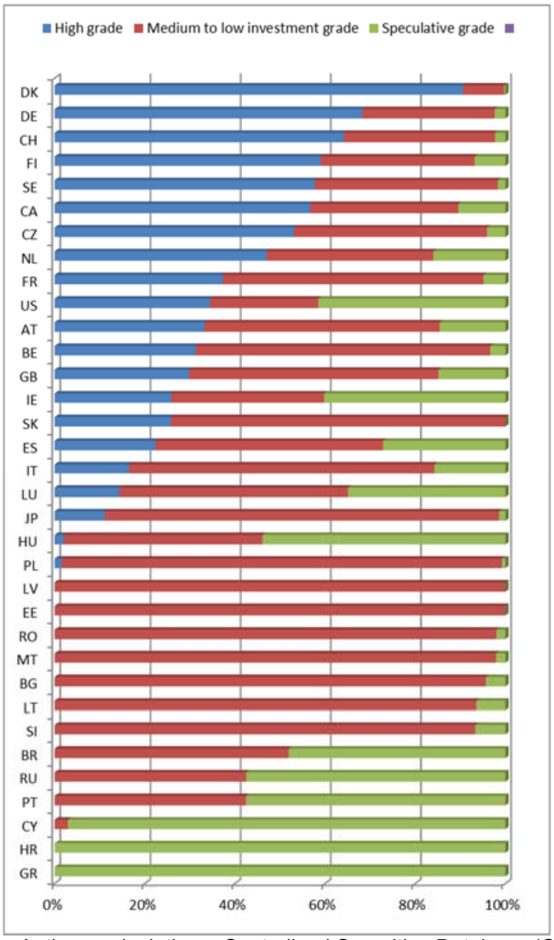
Chart 8 shows an example of country risk profiles based on the assessment made for all instruments rated in the respective country. In general, the country risk refers to the risk of investing or lending in a country. This risk could come from possible changes in the business environment that might affect operating profits or the value of assets in the country. The assessment of the risk is being made by the rating agencies and the information can be used in different ways. In the example, all instruments with an ISIN code rated in the country are considered and then the highest scale rating is selected by comparing the ratings of all agencies.

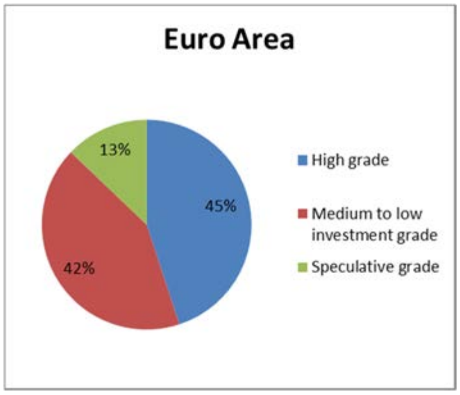
The results shows countries like Denmark, Germany or Switzerland with a less risky profile, i.e. more than 60% of the instruments rated in that country have a high grade when comparing all rating agencies. At the same time, other countries like Greece, Croatia or Cyprus have riskier profile with almost all instruments under speculative grade. Portugal, Russia or Brazil are also considered risky with just some 40% of instruments in a medium to low investment grade. When looking to the whole euro area, around 45% of the instruments are rated with high grade, 42% with medium to low investment grade and 13% with speculative grade.

Chart 8

Risk profile by country

Risk profile based on all instruments rated by Standard & Poors, Moody's and Fitch for the respective country and euro area, end-Sept 2015





Source: Authors calculations, Centralised Securities Database (CSDB)

4.5. Standardisation - LEI

As previously explained the use of international standards in financial markets is necessary in order to ensure transparency. The CSDB started to receive LEI information in 2014. Therefore the CSDB can be used to monitor the implementation of LEI among securities issuers, i.e. going beyond the total global figures of LEI allocated, around 400,000 by end-September 2015. While data should be taken with some care, as they may be biased by the different degree of reporting among CDPs, it may still provide a view of the minimum level of implementation of the LEI on securities issuers across global geographical areas.

Table 3 shows the coverage of the LEI in the CSDB in terms of number of instruments, capitalisation (aggregating amounts outstanding on debt securities and market capitalisation on shares), and number of issuers of securities. The data show that coverage in terms of number of securities is relatively high in the euro area and in the EU, 85.7% and 72.6% of the instruments in euro area and non-euro area countries respectively, somehow lower in terms of market capitalisation and much lower, 18.7% and 10.4% in terms of total number of issuers. It must be taken into account that most of the large issuers of securities, at least in the EU, already have an assigned LEI while possibly many small issuers have not yet applied for it. Nevertheless an important exception is the EU governments, which have generally not yet requested a LEI. Regarding the rest of the world, Table 3 shows a much lower coverage of the LEI, which may be due to an effective delayed implementation or to limited information reported by CDPs. In any case it can be affirmed that at least half of the global capitalisation recorded in the CSDB is issued by an institution with an LEI.

LEI coverage on issuers of securities

Table 3

Overview of LEI coverage on issuers of securities, end-Sept 2015 (Eur Bn)

	Count of Instruments			Amount outstanding and market capitalisation			Count of Issuers		
	Total in CSDB	of which with LEI	% over the Total in CSDB	Total in CSDB	of which with LEI	% over the Total in CSDB	Total in CSDB	of which with LEI	% over the Total in CSDB
EU - Euro Area	2,074,963	1,797,170	86.6%	33,650	23,706	70.4%	197,538	39,561	20.0%
EU - Non Euro Area	417,456	299,326	71.7%	12,957	7,403	57.1%	78,729	8,504	10.8%
United States	2,434,890	485,059	19.9%	60,673	36,684	60.5%	177,524	11,031	6.2%
Japan	36,482	11,450	31.4%	13,188	1,371	10.4%	11,074	211	1.9%
Rest of the World	1,402,823	738,248	52.6%	65,999	17,977	27.2%	301,936	9,031	3.0%
Total	6,366,614	3,331,253	52.3%	186,468	87,141	46.7%	766,801	68,338	8.9%

Source: Authors calculation, Centralised Securities Database (CSDB)

Giving the rapidly growing global number of LEIs and the current coverage in the CSDB it can be expected a relatively high coverage in terms of total securities in a few years. A quick improvement in the coverage would result if all EU governments had an LEI, which would increase coverage in terms of outstanding amounts and market capitalisation up to 82% for the whole EU. Nevertheless a full coverage can possibly only be achieved, as in the case of ISIN, through compulsory rules applicable to the securities issuers and initiatives by public authorities..

4.6. Other examples

Many other uses of CSDB in the context of financial stability could be possible. In the first place it is noted that any of the data above can be drilled-down in the CSDB to the individual issuer and/or the individual security. Due to the current commercial licenses and statistical confidentiality rules individual information cannot be presented in this paper but is fully available to ESCB internal users.

Other possible indicators built on s-b-s data could be based on combination of the different analysis by crossing the different data and/or by using other classification criteria recommended in the Handbook such as type of interest rate or currency of denomination. Additional breakdowns by original and/or remaining maturity could also be implemented. Aggregates by all economic sectors and subsectors of especial interest (e.g. FVC) are also feasible.

Further details by type of security, e.g. separately identifying covered bonds, asset backed securities (ABS), securities linked to inflation, interest rate or asset price, convertible bonds, etc. It would also be possible to identify the international debt securities according to the three criteria specified in the Handbook (para. 7.62), namely listing in a market located in a foreign country, ISIN with a foreign or international code, or issued in a foreign currency, in similar ways as applied in BIS debt securities statistics

Furthermore, additional possibilities may include concentration measures by sector and country, analysis of dependencies of costs on market size and risk, the calculation of yield curves per sector or subsector, and further extension of the data along time, i.e. in the form of time series, just to mention a few.

Additionally, it is thinkable not only to obtain totals and averages on any of the above mentioned concepts but also dispersion measures like range, quartiles, standard deviation, asymmetry measures and any other feature related to the whole distribution of a certain variable.

Going beyond the calculation of aggregate figures for publication, a s-b-s also offers the opportunity to use micro-data as such. In ultimate terms the full potential of s-b-s database is only exploited if it empowers the users to drill-down on any aggregate, provides full flexibility for the (possibly internal) user to build its own aggregates as required for the particular use of the data and also directly use micro-data at the level of individual institutions and securities.

5. Conclusion

The need for correct, complete and timely data on securities has been recognised as one of the data gaps in relation to financial stability since the beginning of the crisis. These data needs can be better addressed through s-b-s databases. The CSDB is a prominent example of a micro-data on securities containing reference information, prices and ratings on securities, as well as ratings data on institutions and programmes. However, the current use of CSDB for financial stability purposes is still limited. This limited use is possibly due to a combination of lack of visibility and absence of a user-friendly tool to access the data.

This paper addresses the first of the obstacles mentioned above by presenting the main features of the CSDB and explaining why the CSDB is a useful source of data for financial stability purposes. In particular the main features of the CSDB have been described and several concrete potential uses of the CSDB in the context of financial stability have been presented. These have covered the funding of financial institutions through securities, their funding costs, risks of financial institutions in comparison with other sectors, refinancing needs of financial institutions and degree of extension of the LEI among the issuers of securities. The potential uses presented are very much line with the content of the new Handbook on Securities Statistics.

Many other uses of the CSDB related for financial stability purposes are conceivable, either in isolation or together with other databases, e.g. on securities holdings. By the presentation of just a few examples of the possible uses of the CSDB in this field this paper just intends increase awareness on these possibilities and prepare the ground for an overall strategy on the use of s-b-s micro-data that aims to reach the full potential use of these new data sets.

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Market concentration in the euro area bond markets - an application with granular sectoral securities holdings statistics[1]

Martijn Adriaan Boermans, Netherlands Bank

[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 or the central banks and other institutions represented at the meeting.

Market concentration in the euro area bond markets

An application with granular sectoral securities holdings statistics

Martijn Adriaan Boermans[1,2]

Abstract

In 2015 the ECB has made a new granular dataset on securities holdings available for research purposes. In this paper we use security-by-security data to examine the market concentration of bond holdings among euro area investors. The focus of this research is on long-term debt securities issued by euro area residents. To study the distribution of bond ownership, we calculate a Hirschman-Herfindahl Index (*HHI*) for each individual bond held by euro area residents. Using data over the first quarter of 2015 we show that bond ownership is strongly concentrated for about half of the individual bonds. The level of market concentration is highest among sovereign bonds and bank debt securities. We find significant differences in market concentration by issuer country and holder sectors. According to our sectoral measure of market concentration, debt issued by residents from Germany, France and Italy are held in the most concentrated fashion among euro area investors. Furthermore, compared to other holder sectors the European banking sector tends to invest in bonds that are characterized by the highest concentration of bond ownership. These findings have important ramifications for financial stability analysis and the understanding of financial market structures.

Keywords: market concentration, bond ownership, debt holdings, securities statistics.

JEL classification: G11, G12, G23, G32.

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Views expressed are those of the author and do not necessarily reflect those of De Nederlandsche Bank.

[2] I am grateful to valuable comments from Maciej Anacki, Melle Bijlsma, Pim Claassen, Raymond Chaudron, Antonio Rodriguez Caloca, Jon Frost, Robert Vermeulen and participants of the BIS Irving Fisher Committee (IFC) Workshop organized by the National Bank of Poland in December 2015. Are errors are mine.

1. Introduction

Most economists agree that market concentration hampers not only competition, but leads to price distortions and impedes economic performance. For the functioning of financial markets, high ownership concentration among bond holders also poses various risks. For instance, when government debt from a certain country is mostly financed by domestic insurance corporations, then shocks to this holding sector can have large impact on the government bond prices and thus borrowing costs. Similarly, on the demand side, if there is a high concentration of ownership of an individual bond, then a single potential buyer could at the margin spur the price of the debt instrument with a small trade. Highly concentrated bond holdings can therefore hamper liquidity, as the probability to matched trades of the bond increases with the number of potential sellers and buyers. In recent years, there are strong indications that debt holdings are becoming more concentrated and thus leading to concerns about market liquidity, price shocks and financial stability in the debt market (see Rubin, 2007; Jacoby & Zheng, 2010; Fender & Lewrick, 2015; Boermans et al., 2016; Steins Bisschop et al., 2016).

In this context it is important to enhance our understanding of bond ownership concentration by measuring dispersion of debt holdings. In this study we measure the level of market concentration among bond holders in the euro area debt market. To do so we exploit a unique security-by-security holdings dataset covering the holdings of euro area investors. In order to measure concentration, one needs security-by-security data on bond holdings across a large group of investors. Looking at a too narrow set of investors implies that for only very few bonds large market concentration can be established. Granular holdings information for a wide range of investors is typically hard to come by.

Due to lack of data, the focus in the literature has been on market concentration in quoted shares, because there are disclosure arrangements in place for large equity holders. Using information on quoted share with majority block ownership, Heflin and Shaw (2000) study the impact of ownership blocks for 260 US quoted stocks on market liquidity. They find that high concentration increases the bid-ask spreads for equity, thus suggesting that higher concentration can have negative economic impact. Similar results were found for Canadian stocks (see Attig, Fong, Gadhoum & Lang, 2006).

The Eurosystem collects security-by-security holdings information under a mandatory reporting requirement scheme. These data allow us to get detailed information among investments *per security* by European investors, including of bond holdings. Therefore, we are able to have an unique, new and granular view of the European bond market. However, we only have data on the sectoral holdings. That is, we do not know the individual end-investor in a certain bond but only the aggregate holdings of all individual end-investors for a particular sector from an individual euro area country.

Steins Bisschop *et al.* (2016) use similar data to study the impact of two recent stress periods in the bond market; the Taper Tantrum in 2013 and the Bund Tantrum in 2015. They show that the importance of market concentration in the European bond markets has increased over the past years. In addition, market concentration is one of the key explanations for the high price volatility observed during the Bund Tantrum. In this paper we build on their methodology to measure market concentration and provide readers a more granular look at market concentration in the bond markets.

The paper proceeds as follows. We start in Section 2 with a description of how our measure of market concentration per individual bond are established. Section 3 provides researchers with some guidance and measures to prepare the large security-by-security dataset for analysis. We also explain what type of data was used using some summary statistics. In general, the observed holdings of euro area bonds in this study are very large, around EUR 5.7 trillion. Section 4 presents our main results and Section 5 concludes.

2. Measuring market concentration

We construct a measure of market concentration using the Hirschman-Herfindahl Index (*HHI*). The idea here is that for each outstanding debt instrument we know the value of the principal on the issuance side, and, on the holdings side we observe all portfolio investments by the key euro area investor sectors *per country*.[3] This mean that we can determine the *distribution of ownership*.

We define the *HHI* as follows:

(1) $HHI = \sum_{i=1}^{n} s_i^2$

Here, s_i represents the share of the observed holdings in a bond i of a particular sector k in country j. The *HHI* ranges from 0 to 1, where 1 means complete concentration whereas a score close to zero implies a wide distribution among bondholders across countries and sectors in the euro area.[4] For example, if we only observe a single sector from one country holding a bond, then the *HHI* is equal to 1. Bear in mind two issues with our market concentration measurement.

First, we have sectoral holdings data. Within a particular country j, the concentration of bond holdings among sector k could still be held by various individual end-investors (of which, unfortunately, we have no information). For example, if we observe that a German government bond is held only by, let's say, German banks, then for that bond we would observe a maximum concentration of 1. Still, it is well-possible that there are hundreds of German banks holding the particular German government bond in question. We thus do not know the number of individual entities within a sector holding the bond, neither how such holdings are distributed within the holding sector.

Second, we only include bonds in the analysis for which euro area investors have a relative high ownership share. That is, by our selection criteria we only include an individual debt instrument if the aggregated observed level of concentration ranges between 0.5 and 1. We do so because we cannot account for the dispersion of holdings where investments by non-euro area residents are significant. In those cases we miss vital information on the market concentration that cannot be estimated.

[3] A major benefit of granular data is that we can use the holdings information based on International Security Identification Numbers (ISINs) to link it to issuer information. All enrichments are based on the Centralised Securities Database (CSDB).

[4] We distinguish six investor sectors and 19 investor countries. Hence, the lowest concentration score would be obtained if all 114 pairs of investors hold an equal amount, thus giving a *HHI* of 0.0088.

Taking these two issues of sector holding information and non-euro area holdings into account, interpretation of the results needs to be done with care.

Box 1

Calculating market concentration with the HHI: an illustration

Let us illustrate how market concentration based on the *HHI* is derived. First, let's take a single bond issuance *i*. For example, in November 2008 the Dutch central government issued a debt instrument (with ISIN code NL0006527525) with a (principal) notional amount of EUR 3 billion, denominated in euro's, with a coupon rate of 1.5% and maturing in October 2017. For this individual security we observe, per country *j*, which sector *k* holds this bond, and how much each sector from each country invests in this bond *i*.

Let's assume that there are three holding countries (*j*=3), with investors only from the banking sector (*k*=1). Each investor sector (banks) holds EUR 800 million, so in total EUR 2.4 billion is held by euro area investors. The remaining EUR 0.6 billion is unobserved and thus held by non-euro area investors or by minority investor sectors excluded from our dataset. The euro area holdings are greater than 50% of the bond size so the bond *i* is included in our analysis (majority ownership rule). The share of non-euro area investors is dropped for the measurement of concentration. Hence we get the following:

For each k_j, s_i is 1/3 (800/2,400). Next we take the squared terms $(1/3)^2=1/9$. Then we take the sum of the squared shares of each sector-country holdings, thus 1/9+1/9+1/9=1/3, or 0.33.

When are market concentrations high?

To give readers some broad guidance on the interpretation of the *HHI* we provide preliminary indications on when the dispersion of bond ownership in our dataset can be considered large. Because we do not observe the end-investors, this is a tricky question because if only one sector in a single country has the full ownership of a particular bond, it could still imply high dispersion of ownership *within* the sector of that country. Nonetheless, there is wide literature on the interpretation of the *HHI*, however applicable to very different contexts.

For example, the measurement is often applied by anti-trust agencies to determine the degree of market concentration in terms of competition. The market shares are used to calculate the *HHI* scores, where score of 0.25 are considered as high concentration, scores between 0.15 and 0.25 are moderate concentration and scores below 0.15 are unconcentrated. We suggest the following conservative rough interpretations of our *HHI*, taking into account that (i) we observe only the bond holdings are the sector level and not the individual level, and, (ii) we exclude non-euro area holdings (since we have no priors on the ownership dispersion of non-euro area holdings).

HHI	Interpretation for bond holdings
0-0.10:	*Low market concentration*
0.10-0.25:	*Moderate concentration*
0.25-0.50:	*High concentration*
>0.50:	*Very high concentration*

Scores between 0 and 0.10 suggest that in the case of an equal amount invested by a particular sector-country combination that at least 10 different sector-countries need to hold the bond, and, combined has at least 50 percent of the total amount outstanding. For a score up to 0.25, the number of particular sector-country combinations with equal amounts of holdings rises to a limit of 4, which is considered a moderate level of concentration.

3. Granular securities holdings information

Data

Data on bond holdings among euro area investors at the sector level were obtained from the sectoral Securities Holdings Statistics from the European System of Central Banks (ESCB). The national central banks from the euro area have a mandatory Eurosystem security-by-security reporting framework in place (ECB Regulation 2012/24). National central banks aggregate the reported data by sector to the ECB. The ECB distributes a carefully checked and high confidential dataset back to national central banks, with all holdings by sector-country per individual bond. Data collection thus requires high efforts by national central banks and the ECB before accomplishment. First data were obtained over 2013Q4 (see ECB, 2015).

We use data for the first quarter of 2015. This period was carefully chosen. It was a period where European bond markets had relatively calmed after the European sovereign debt crisis, thus allowing us a relative free interpretation of the data that is not strongly driven by market circumstances. Note that the data exclude the holdings by monetary authorities (including the ECB). This is in principle not a huge issue as the observed holdings cover the major share of the market. In March 2015 the ECB initiated its Public Sector Purchase Programme (PSPP) with monthly debt purchases of EUR 60 billion. Because this program just took off, the impact on the bond holdings will be limited to the purchases in March 2015. Hence, 2015Q1 data should give a rather complete idea of the levels of market concentration among the holdings of European bonds, defined narrowly as bonds issued by euro area residents.

The data are available for a wide range of holding sectors and in principle cover all debt securities issued by euro area residents. We include investments from the five largest financial sectors (banks, investment funds, insurance corporations, pension funds, and other financial intermediaries excluding financial vehicle corporations)[5] and households.

Data preparation

For the data preparation, we use the following criteria. We focus on bonds issued by euro area residents with an original maturity of at least 365 days, that is, long-term debt securities. We only include debt instruments with a principal of more than EUR 10 million, which in practice are almost all bonds. We also exclude third-party holdings information and securities that can have double listings (e.g. under Rule 144A) or those that are not "alive" anymore (e.g. distressed debt). In several cases we have missing information on amount outstanding, which were discarded as this is required information for the calculation of market concentration. Also, all short-positions were dropped as this would make the measurement of the market

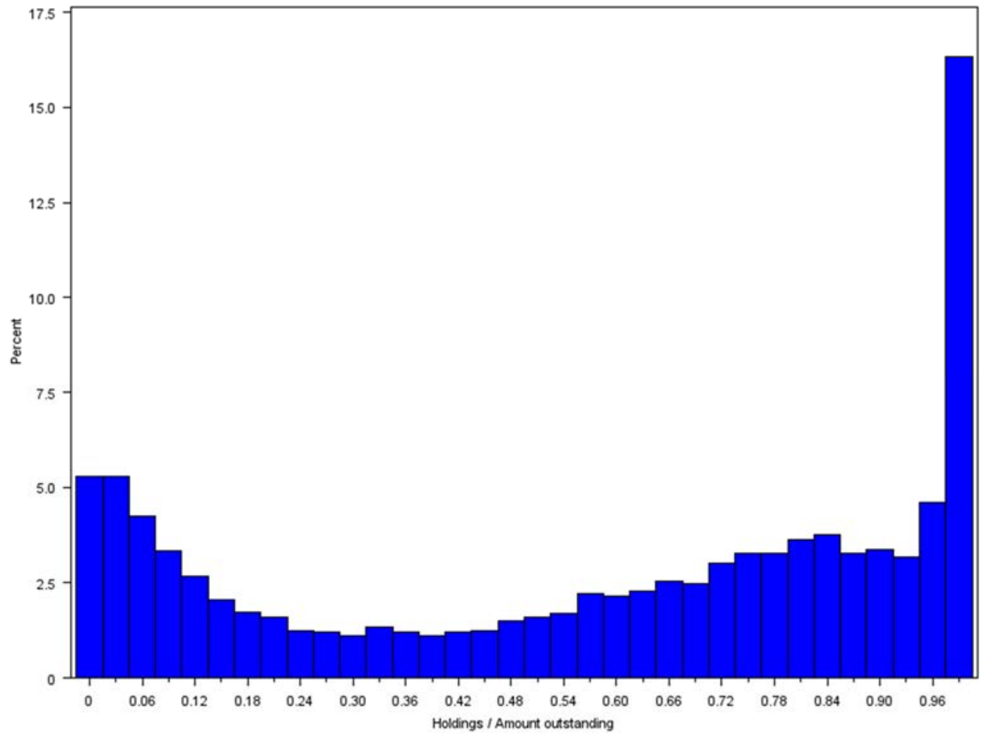
[5] The sector classifications are based on a more detailed version of the European System of Accounts (ESA) 2010. In particular, sector S.125 other financial intermediaries excludes investments by financial vehicle corporations, also known as special purpose vehicles (SPVs). Other financial sectors are based on S.122, S.124, S.128 and S.129. S.14 is classified as households, data that was collected via European custodian reporting.

concentration more difficult. In addition, observations where the total holdings exceeded the amount outstanding were excluded.[6] After these actions, the coverage of the security-by-security data used is the analysis is still very good.[7] In other words, these data preparation measures are highly advised to ensure high quality data while not dropping to many observations from the analysis.

Summary statistics of the sample

To get a first sense of the dispersion of ownership in the sample, Figure 1 shows the dispersion across all individual holders per sector and country as a ratio to the amount outstanding of the bond. That is, we simply divide the observed value of the portfolio investment position by the principal value.

Figure 1: A simple look a bond holder dispersion



Note: sample of 11,139 European bonds. Data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings.

[6] There are three explanations for this: first, short positions; second, quality issues on the holdings side; third, quality issues on the amount outstanding side. Still, this occurs in less than 1 percent of the observations.

[7] The ECB has calculated that the coverage of the security-by-security holdings data for debt securities is 92% for debt instruments issued in the euro area if one includes the observed non-euro area holdings for the dataset as well. However, they find a coverage of 60% among euro area residents; a figure highly comparable to ours although we incorporated strict data cleaning measures (see ECB, 2015 for detailed). Hence, the coverage of the securities holdings information of our sample is very good and our data cleaning exercises seem to have caused only minor adjustments.

The problem of this measure as shown in Figure 1 is that it does not take into account how other investor sectors from other countries hold positions in a particular bond. The *HHI* does pick up the structure of the dispersion by taking the sum of the squared investment shares in a single bond.

We conduct our analysis on the subset of bonds that are predominantly held by euro area investors. Hence, we exclude a set of bonds for which the total holdings of the euro area investors are less than 50 percent. In practice this leads us to drop about a third of the individual bonds (see Figure 1). The reason for this is that we do not have information on the dispersion of holdings by non-euro area residents.

Let us explain the implications. For example, a bond with, say, 40 percent ownership in our dataset could be held for the residual 60 percent by either say, a single American hedge fund, thus having a very high degree of market concentration, or, the bond ownership could potentially be widely dispersed across investors in various non-euro area countries. Because we have no priors on the unobserved dispersion of bond holdings, we prefer to exclude these bonds.

The majority observed ownership rule leads to a final sample of 6,935 uniquely observed bonds and 105,731 holder sector, holder country observations, compared to 11,139 bonds before this criterion. In terms of market concentration, we find that for 57.8 percent of the bonds issued by euro area residents, euro area investors own at least half of bond. In other words, we show that European bonds are primarily owned by European investors. The total holdings at nominal value of the sample is EUR 5.7 trillion.

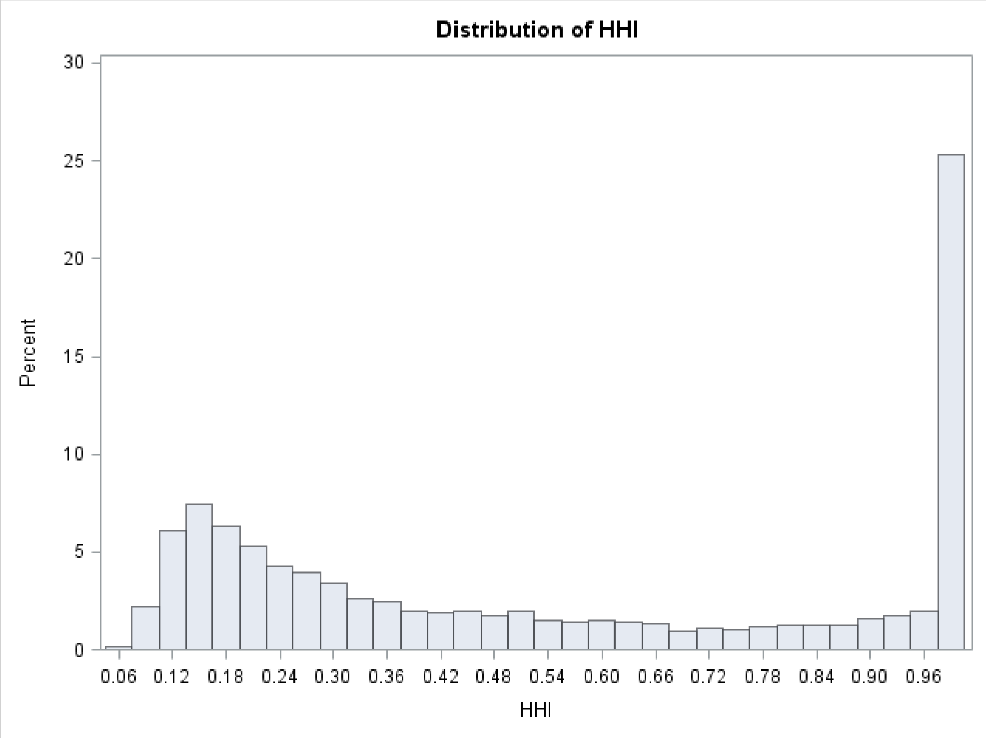
4. Results

Low dispersion in bond ownership?

Figure 2 presents the distribution of the *HHI* based on securities holdings information among euro area investors in debt securities issued by euro area residents . In general, the results indicate a rather low level of dispersion among bond ownership. In some cases, the levels of concentration are very high. In 22.3 percent of the cases we find a *HHI* of 1, indicating complete concentration. This is a significant amount of cases (1,546 bonds).[8] In other words, for these bonds we known that there is full ownership in one particular sector in a single euro area country. In addition, in another 25.5 percent of the cases the *HHI* ranges between 0.5 and 1, suggesting that a single sector from one country holds the large majority of the bonds. Hence, we find that for 47.5 percent of the bonds the concentration levels among euro area investors is very high, with an *HHI* above 0.5 (see Figure 2).

[8] This is also visible in Figure 1, where about 17 percent of the bonds are held by one investor sector from a single country. The difference in percentages points arises from the majority ownership rule required for the calculation of the *HHI* (see Box 1).

Figure 2: Market concentration in the European bond market



Note: Distribution of concentration across 6,935 bonds issued by euro area residents and held by euro area investors (105,731 holder sector-country combinations). Data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings.

We find that the average *HHI* is 0.54 with a standard deviation of 0.35. This can be considered as a very high level of concentration, however, the average is skewed by the complete concentration figures (with *HHI*=1). In only 1.7 percent of the cases we find low levels of market concentration with a HHI below 0.10. In general, this implies that for those instances there is a wide dispersion among investors in those bonds. Figure 2 also shows a bump between 0.10 and 0.25, suggesting moderate levels of concentration. Here we find moderate concentration for 29.6 percent of the bonds, with a *HHI*. Note that the median is 0.46, thus suggesting that about half of the bonds have high to very high levels of concentration while the other half low to moderate levels of concentration.

Let us emphasize that not all bonds show high concentration levels. The selection of bonds already implies that we have to exclude all debt instruments with a high degree of ownership outside the euro area. Hence, we cannot conclude that there is a low dispersion of bond ownership, yet we can say that a significant proportion of bonds is concentrated among a single sector-country holder (about 47 percent).

Concentrations by issuer sector

We are interested if certain type of bonds are more concentrated than others. A good starting point for the analysis is to differentiate bonds by issuer sector. Table 1 shows that the levels of concentration are the greatest in the European bank bonds. The average *HHI* is 0.34, indicating high levels of concentration of debt issued by European banks. We also find high levels of market concentration among government related bonds with an average *HHI* of 0.31. The results show moderate levels of concentration for non-bank financial bonds and non-financial corporate bonds, combined called corporate bonds. Here the *HHI* ranges between 0.23 and 0.24.

These outcomes from Table 1 are important for the understanding of the European bond markets, where we find that ownership of sovereign and bank debt are generally strongly concentrated compared to corporate debt securities. Specifically, European bank bonds and government related bonds show high market concentration in terms of ownership among euro area investors.

Table 1: Bond ownership, breakdown by issuer sector

Issuer sector	HHI		No. of observations
	mean	std. dev.	
Bank bonds	0.34	0.21	31,033
Government related bonds	0.31	0.18	19,601
Non-bank financial bonds	0.23	0.18	26,960
Non-financial corporate bonds	0.24	0.16	28,137

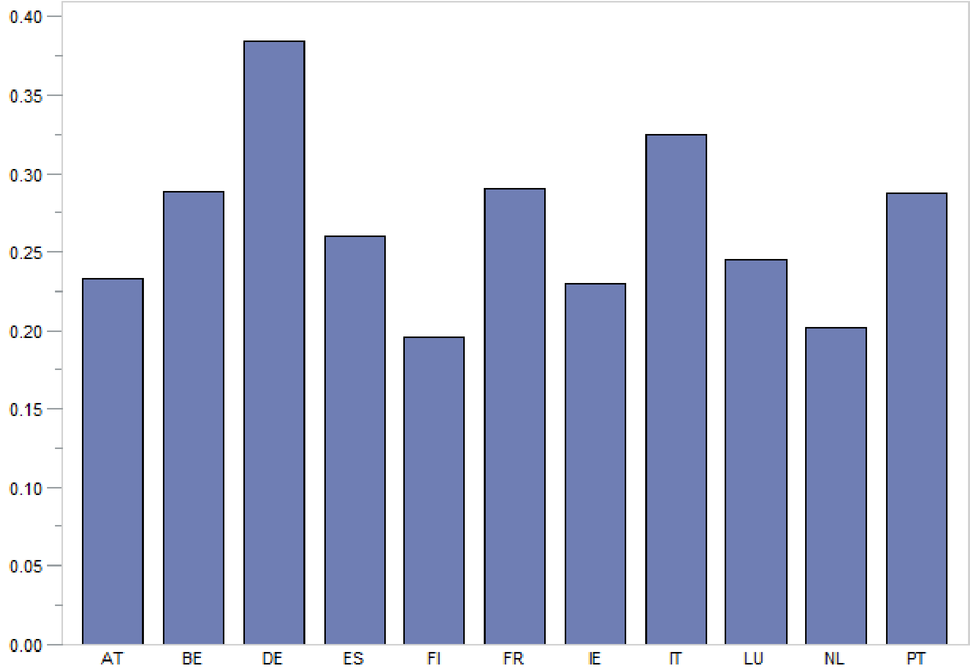
Note: Classifications based on ESA2010. Non-financial corporate bonds consists of issuer sector S.11; bank bonds comprise S.122; non-bank bonds include all S.12 sectors except for S.122 (MFI's); government related bonds are from S.13. Data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings. Distribution of concentration are calculated for 6,935 bonds issued by euro area residents and held by euro area investors (105,731 observations of holder sector-country combinations).

Concentrations by issuer country

In this section we elucidate how the concentration of bond holdings varies by issuer country. Note that we only have a partial view of the bond holdings for those with high ownership among euro area investors. Figure 3 displays the average concentration scores per issuer country for which we have at least 1,000 debt securities

In general, we find that German, French and Italian bonds that are held for at least 50 percent by euro area investors are held to a large extent in a very concentrated fashion. That is, for German bonds, that average market concentration score is 0.38 (S.D. = 0.24), which we consider a high level of concentration. The scores for France (0.29) and Italy (0.33) can also be considered high. Other countries with high concentration scores are Belgium (0.29), Portugal (0.29) and Spain (0.26).

Figure 3: Variation in bond holdings concentration across issuer country



Note: data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings. Distribution of concentration are calculated for 6,935 bonds issued by euro area residents and held by euro area investors (105,731 observations of holder sector-country combinations).

We find moderate concentration scores for debt issued by residents from the Finland and the Netherlands, with *HHI* below 0.20. Also moderate scores are found for Austria (0.23), Ireland (0.23) and Luxemburg (0.24).

To interpret these market concentrations, one needs to take into account that concentrated holdings within a large country by a single sector could potentially still mean there the actual dispersion is higher than observed (as mentioned before). However, from a financial stability perspective this still means that the holdings of German, French and Italian bonds for a significant part rely on investors from a single country and sector, which does signal potential market concentration risks. In contrast, Finnish and Dutch bonds have a much wider range of holder sector, holder country investors.

To conclude, we find that there is wide issuer country heterogeneity that in part is explained by the type of data and threshold criteria for non-euro area investments. For financial stability such differences between countries are important as they may affect the efficiency of different transmission channels. That is, a crisis in a certain sector of a large country could potentially have large aggregate effects because of the concentrated nature of the bond ownership. Nonetheless, the findings indicate that large European economies such as France, Germany and Italy tend to have the highest bond holder concentrations at the sector-country holder level. Debt issued in the Netherlands, Finland, Ireland and Luxembourg show the greatest dispersion of ownership among euro area investors.

Concentrations by holding sector

For each holding sector we calculate the levels of concentration separately. There is significant sector heterogeneity in the average levels of bond dispersion, depending on the holding sector. We find that banks typically hold bonds with the highest *HHI* (on average 0.34), see Table 2. In other words, the European banking sector tends to hold debt securities that are less dispersed in sector-country ownership.

All other sectors, with the exception of pension funds also tend to invest in bond that have high market concentration of ownership. Because of the large number of observations, the differences between each sector are still significant (with the expection of investment funds and households), however, in economic terms we suggests only to conclude that we find that European banks invest much more strongly in bonds with high market concentration compared to other sectors.

These results are important for the understanding the potential risks and transmission channels among investor sectors in the European bond markets. Banks are potentially most at risk for bond market shocks, while pension funds seem most resilient.

Table 2: Bond ownership, breakdown by sector of the holder

Investor sector	HHI		No. of observations
	mean	std. dev.	
Banks	0.34	0.27	20,655
Investment funds	0.27	0.18	28,605
Other financial intermediaries	0.28	0.21	8,701
Insurance corporations	0.26	0.16	23,844
Pension funds	0.24	0.15	10,105
Households	0.27	0.20	13,773

Note: Classifications based on ESA2010. Non-financial corporate bonds consists of issuer sector S.11; bank bonds comprise S.122; non-bank bonds include all S.12 sectors except for S.122 (MFI's); government related bonds are from S.13.

5. Conclusion

We propose a measurement of market concentration based on the well-known Hirschman-Herfindahl index. European bonds are by majority owned by European investors. Yet, we show that there is wide variation in the level of ownership dispersion across *individual* European debt instruments.

The analysis is based on a large set of security-by-security data on bond holders of euro area investors in 2015Q1. We show that the average market concentration in individual bonds is generally high, especially among sovereign debt and bank bonds. We also find that the European banking sector tends to hold bonds with the lowest levels of dispersion of ownership.

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Annex 1: Market concentrations by bond size

We divide the bonds in four categories based on the size of the principal, measured in nominal values (in euro). The groupings are based on the observed size by quantiles (see Table 3). Here we are interested if the market concentration differs by the size of the individual bonds. It appears that the market concentration deceases with the bond size.

Table 3: Bonds by size of the principal (in EUR)

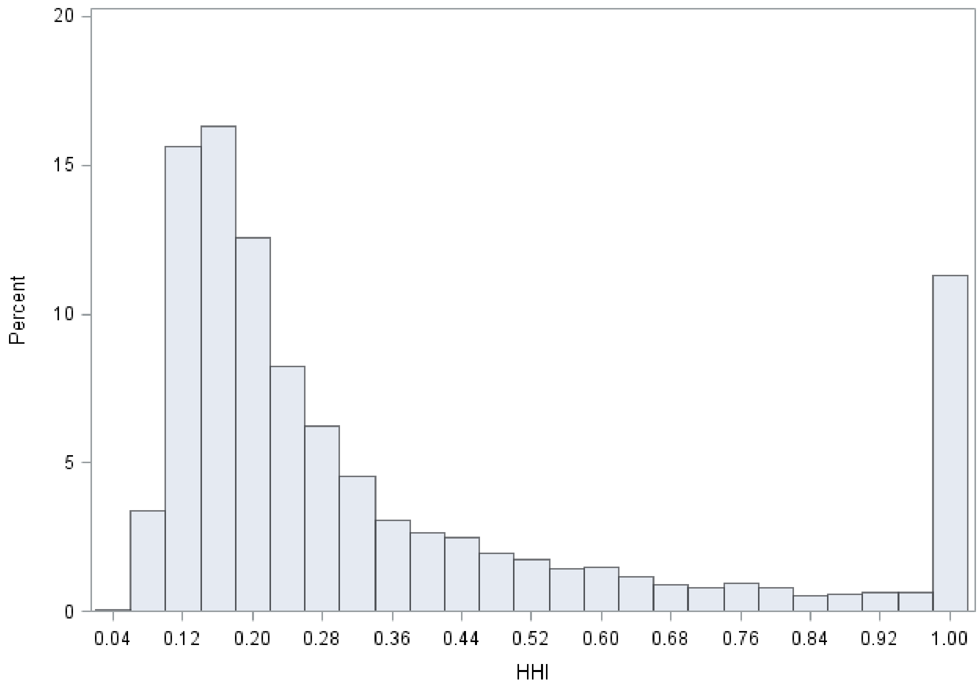
Bond size category	Size cut-off		*HHI*
Small	10 million	200 million	0.78
Medium	200 million	500 million	0.57
Medium to large	500 million	1 billion	0.40
Large	1 billion	max	0.38

Note: Data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings. Distribution of concentration are calculated for 6,935 bonds issued by euro area residents and held by euro area investors (105,731 observations of holder sector-country combinations).

Annex 2: Worldwide bond issuance

In this annex we replicate the result, but with two important generalizations. First, we look at all bond holdings, regardless of the residence of the issuer. That is, we take the full scope of the world wide bond market on the liabilities side of the market. Second, we restrict the minimum bond size to EUR 500 million instead of EUR 10 million. We do so because the data quality of foreign bonds, defined as those issued by non-euro area residents may be of lower data quality. Such possible issue will not be a grave for larger bonds. In this way we are left with 17,699 bonds and observe a total number of 233,719 holder country by holder sector combinations.

Figure A2: Market concentration of global bonds for euro area holders



Note: Data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings. Distribution of concentration are calculated for 17,699 bonds issued worldwide and held by euro area investors (233,719 observations of holder sector-country combinations).

For the global bond market, concentration levels are much lower (as expected). The average *HHI* is 0.36 (S.D. = 0.29) compared to 0.55 (S.D. = 0.35) for European bonds. Still, this marks a high level of concentration. Figure A2 shows that for 10.6 percent of the bond holdings, there is full market concentration with a *HHI*=1. In addition, for 12.3 percent we find a *HHI* between 0.5 and 1, also indicating very high market concentration. Hence, for the global bond market, 22.3 percent of the bonds show very high market concentration, compared to 47.5 percent for the European bonds.

Hence, our general findings that there is relative high market concentration in the ownership of European bonds applies to a much lesser extent to non-euro area issuances. That is, our euro area investor perspective does not allow us to pick up the full dynamics of the global bond market, and therefore we find much lower market concentration. Still, for the bonds included we again find high concentration among government bonds and near high concentration for bonds issued by global banks.

Table A2 further tests the heterogeneity of ownership concentration by issuer sector. Here we also find the highest market concentration in sovereign bonds and bank debt securities. Compared to Table 1 for European bonds, the concentrations are somewhat lower, although in economic terms the difference for government securities are rather low.

Table A2: Bond ownership, breakdown by issuer sector

Issuer sector	HHI		No. of observations
	mean	std. dev.	
Government related bonds	0.28	0.16	20,045
Bank bonds	0.24	0.16	36,043
Non-bank financial bonds	0.19	0.14	29,902
Non-financial corporate bonds	0.21	0.11	29,281

Note: Classifications based on ESA2010. Non-financial corporate bonds consists of issuer sector S.11; bank bonds comprise S.122; non-bank bonds include all S.12 sectors except for S.122 (MFI's); government related bonds are from S.13. Data were obtained from the ESCB SHS-S, own calculations based on 2015Q1 holdings. Distribution of concentration are calculated for 17,699 bonds issued worldwide.

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Warsaw, Poland, 14-15 December 2015

The Portuguese Central Credit Register: a powerful multipurpose tool, relevant for many central bank functions[1]

João Cadete de Matos, Bank of Portugal

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 or the central banks and other institutions represented at the meeting.

The Portuguese Central Credit Register: a powerful multi-purpose tool, relevant for many central bank's functions[1]

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Director, Statistics Department

Abstract

The Portuguese Central Credit Register (CCR) – managed by the Statistics Department of the Banco de Portugal *– contains monthly granular information on credit on a borrower-by-borrower basis and includes, in some cases, details that provide loan-by-loan information with a virtually complete coverage.*

These features have enabled the Banco de Portugal *to use its CCR data for a variety of purposes, namely:*

- a. *To compile very comprehensive statistics on credit, with breakdowns by institutional sector of the borrower, branch of activity, purpose, size of the firms, location/region and amount of credit*
- b. *To assess credit concentration and distribution*
- c. *To measure overdue loans and overdue loans' ratio*
- d. *To understand the risks underlying banks' balance sheets*
- e. *To create an in-house credit risk assessment system in the* Banco de Portugal*.*

Given these multi-purpose uses, the Portuguese CCR has proved to be a powerful tool, relevant for many central bank's functions, namely for banking supervision, financial stability, monetary policy, economic research and compilation of statistics.

Keywords: Micro-data; Central Credit Register; Financial Stability; Data Collection; Central Bank statistics

JEL Code: C80; E50

1. Introduction

The Central Credit Register (CCR) is an information system managed by the Statistics Department of the *Banco de Portugal* (hereafter referred to as "the Bank"), which contains granular information on credit granted by the institutions participating in the system (all resident credit-granting institutions)

[1] I would to thank Luís D'Aguiar, from the Statistics Department, for his valuable contributions to this paper.

on a borrower-by-borrower basis and, in some cases, including details which provide loan-by-loan information, with a virtually complete coverage.

The CCR was established in 1978, at the time covering only the credit liabilities of non-financial corporations (NFCs) – households were included later, in 1993. The main goal of the CCR is to provide the credit institutions with data relevant for their assessment of the risks attached to granting credit – aggregate information on the credit liabilities of each client (borrower) *vis-à-vis* the financial system as a whole.

The use of CCR data for the compilation of statistics was authorized in 1996. However, the responsibility for the management of the database and all its related services was assigned to the Statistics Department only in 1999. Since then, a number of developments were introduced aiming at improving the CCR's coverage and usability, namely the establishment of a bilateral exchange of individual credit data among the 7 European countries that signed a Memorandum of Understanding (in 2005),[2] the inclusion of the potential credit liabilities of personal guarantors (in 2007) and the implementation of a new information system that introduced additional breakdowns at the level of credit data and a greater efficiency in identifying private individuals (2009).

More recently, (i) the CCR coverage was extended to include new reporting institutions (essentially NFCs that buy credit portfolios from the resident financial sector); (ii) a new analytical data system for data analysis and exploration was developed; (iii) additional details were included to allow for the individual identification of loans used as collateral in Eurosystem financing operations; and (iv) additional breakdowns were introduced (*e.g.*, new collateral types, original and residual maturity brackets, non-performing loans and restructured loans).

According to CCR's legal framework,[3] apart from the compilation and publication of statistics, CCR data is also used by the Bank for several other purposes, namely, the prudential supervision of credit institutions, the analysis of the financial system's stability, the implementation of monetary policy and for research.

This paper is organised as follows: the next section presents a short overview of the Portuguese CCR; section three illustrates how CCR data are being used in the context of the compilation of credit statistics; section four discusses briefly the Bank's involvement in the AnaCredit project; section five addresses the recent creation of an In-house Credit Assessment System in the Statistics Department;

[2] The seven original Signatories of the 2005 Memorandum of Understanding on the exchange of information among CCRs were the NCBs of Austria, Belgium, France, Germany, Italy, Portugal and Spain. A few years later, the NCBs of the Czech Republic and Romania also joined this group.

[3] The Portuguese CCR is regulated by Decree-Law no. 204/2008, of 14 October, Bank's Instruction no. 21/2008, of 15 January 2009 and National Commission for Data Protection's Authorization no. 4241/2011 of 27 April. It is also mentioned in a provision of the Bank's Organic Law (Art. 17º - 1). The use of and access to CCR data is in compliance with the provisions laid down in specific laws issued by Portuguese Parliament and by the National Commission for Data Protection.

section six considers the use of CCR data for banking supervision, financial stability, monetary policy and economic research; lastly, section seven concludes.

2. Description of the Portuguese Central Credit Register (CCR)

The CCR's main goal is to assist the participating entities in their risk assessment when granting loans. Hence, these entities have access to aggregate information on the credit liabilities of each borrower[4] *vis-à-vis* the whole CCR reporting institutions.

Borrowers also have the legal right to access their respective information stored in the CCR. In case of missing or wrong information, borrowers must address the reporting institution to change or update its information, since the Bank is not legally authorized to correct the information itself.

Currently, 188 institutions (of which 146 are banks) report data to the CCR and around 6.2 million borrowers are registered with effective or potential (*e.g.*, credit lines) credit data.

As mentioned above, the CCR database contains information on actual and potential credit granted by participants to borrowers. Actual credit includes all the loans granted by the participants (mainly resident financial institutions) and actually taken up – *inter alia*, loans for house purchase, loans to purchase cars, furniture and other consumer goods or services, loans for the acquisition of shares or bonds, payment of bills of exchange or other commercial bills, overdrafts, leasing or factoring operations, and balances on credit card transactions. Potential credit consists chiefly of irrevocable commitments by participants, such as available credit on credit cards, credit lines, pledges given by participants and other credit facilities which may become actual debt.

Participants are all resident financial institutions granting credit – *i.e.*, banks (including savings banks and mutual agricultural credit banks) and other credit institutions (*e.g.*, credit financial companies, financial leasing companies, factoring companies and credit-purchase financing companies). Additionally, other non-financial entities with credit-related activity may also be designated by the Bank to participate in the CCR. This is, for example, the case of some non-financial companies that buy credit portfolios from the financial sector.

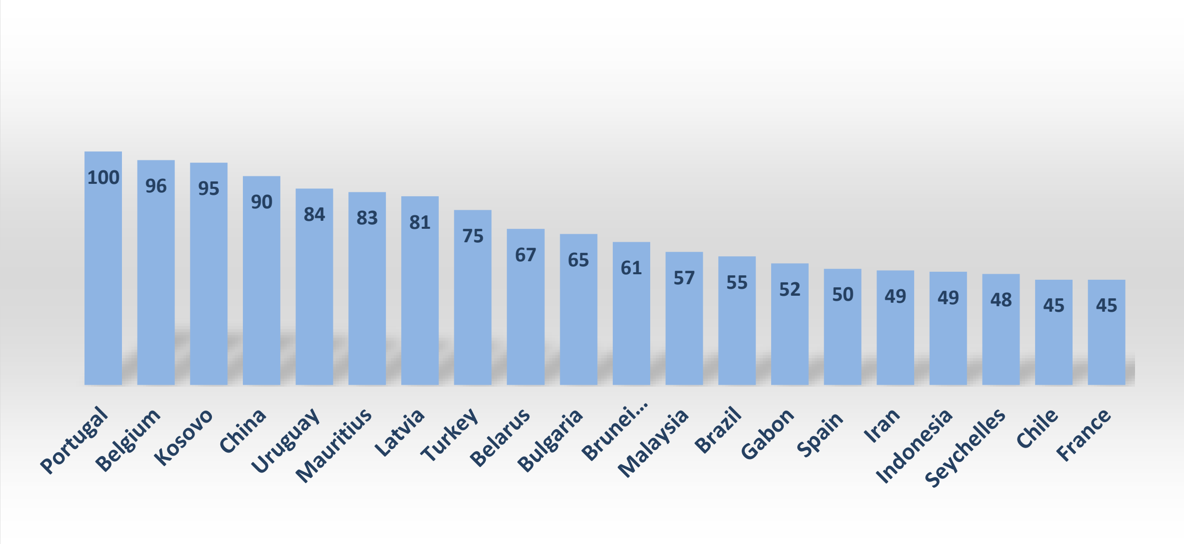
Borrowers are resident or non-resident entities, both private individuals and legal persons, receiving credit from the participant institutions. The identification of resident borrowers is made using the tax payer number; for the identification of non-residents, reporting institutions must provide a code (unique for each borrower in each institution), the name, an identification document and the country of residence.

Data has to be reported to the CCR on a monthly basis, with reference to the end of each month, until the 6th working day following the end of the reference period. Participants are obliged to supply

[4] Or of each potential client, when the client asks for a loan or authorizes the entity to access information on it.

the CCR with information on the outstanding amount of the borrower's actual or potential liabilities whenever its value exceeds 50 (fifty) Euros. This very low threshold has allowed the Portuguese CCR to lead the world ranking of public credit registries in term of coverage (please see Figure 1. below).

Figure 1. Credit registry coverage (as a % of the adult population[5])



Source: World Bank, *Doing Business 2016*

Participants have to classify loans according to a list of attributes and dimensions, using the following variables to classify the loans:

a. Type of liability of the borrower – identifies the commitment the borrower has *vis-à-vis* the credit institution (for example, individual credit, joint credit, personal guarantee).
b. Status of the loan – shows the type of liability represented by the loan and if there is any degree of non-compliance with the repayment schedule (*e.g.*, drawn credit in a regular situation, undrawn credit, overdue loans, written-off loans).
c. Type/purpose of the loan – identifies the credit instrument used, sometimes referring to the purpose of the loans (*e.g.*, current accounts, credit card, factoring with or without resource, housing loans, consumer credit and car credit).
d. Original and residual maturity – identified according to a list of predefined brackets.

[5] Credit registry coverage reports the number of individuals and firms listed in a credit registry's database as of 1 January 2015, with information on their borrowing history within the past five years, plus the number of individuals and firms that have had no borrowing history in the past five years but for which a lender requested a credit report from the registry in the period between 1 January 2014 and 1 January 2015. The number is expressed as a percentage of the adult population (the population age 15 and above in 2014 according to the World Bank's World Development Indicators). A credit registry is defined as a database managed by the public sector, usually by the central bank or the superintendent of banks, that collects information on the creditworthiness of borrowers (individuals or firms) in the financial system and facilitates the exchange of credit information among banks and other regulated financial institutions (while their primary objective is to assist banking supervision).

e. Number of days the loan is past due – in case of default, the number of days since the loan has defaulted is identified according to a list of predefined brackets.
f. Currency – identifies the currency of denomination of the loan.
g. Type and value of collateral or guarantee securing the loan (when existing).
h. Identification of special characteristics associated to loans – information to be used internally by the Bank, which allows the identification of, *inter alia*, securitised loans (derecognized and non-derecognized), syndicated loans, loans used as collateral for monetary policy operations, non-performing loans.
i. Value of monthly repayments – only for some types of personal loans.

The Portuguese CCR also collects information on the insolvency status of the borrower, both for private individuals and companies or other legal entities. This information is provided by the Portuguese Courts of Law.

Figure 2. highlights the comprehensiveness of the Portuguese CCR: currently, none of the other credit registers of the countries that signed the Memorandum of Understanding on the exchange of information among CCRs (see footnote 1) is in a position to collect information on the full set of variables depicted in the table below.

Figure 2. Comparison among European public credit registers

Variables collected	Austria	Belgium	Czech Republic	France	Germany	Italy	Portugal	Romania	Spain
Credit status	Y	Y	Y	Y	Y	Y	Y	Y	Y
Liability level	Y	Y	Y	Y	Y	Y	Y	Y	Y
Purpose of the loan	N	N	Y	N	N	N	Y	N	Y
Original maturity	N	Y	Y [3]	Y	N	Y	Y	Y	Y
Residual maturity	N	Y	Y [4]	N	N	N	Y	N	Y
Overdue loans	Y	Y	Y	Y	N	Y	Y	Y	Y
Type of collateral	Y	N	Y	N	Y	Y	Y	Y	Y
Value of collateral	N	Y	N	N	Y	N	Y	Y	N [5]
Bankruptcy status	Y	Y	N	Y	N	Y	Y	Y	Y
Currency	N	Y	Y	N	N	N	Y	Y	Y
Country where the loan was granted	Y	Y	Y	Y	Y	N	Y	N	Y
Data on personal guarantors	N [1]	Y [2]	N	N	Y	N	Y	N	Y

[1] Only for the types of credit derivatives indicated in Article 204 of Regulation (EU) No. 575/2013, used for hedging purposes, the protection seller has to be specified.
[2] For consumer and mortgage lending.
[3] Variables collected directly are "Date of origin" and "Maturity date". "Original maturity" is calculated using these variables.
[4] Variable collected directly is "Maturity date". "Residual maturity" is calculated using this variable.
[5] This data will be collected from 31 December 2016.

3. The use of CCR data for the compilation and dissemination of statistics

The compilation of comprehensive statistics on credit granted is one of the various goals of the Portuguese CCR. With this in mind, credit instruments and other variables related to the classification of loans are defined in such a manner that they are meaningful for economic analysis. Also, borrowers have to be classified according to proper statistical criteria (*e.g.*, by institutional sector, sector of economic activity, firm size and region of residence). Since the participating institutions only report the borrowers' identifications (*i.e.*, their taxpayer numbers), the statistical classification of the resident borrowers is made in the Bank, mostly by means of a business register managed by the Statistics Department.

Statistical information based on the Portuguese CCR data is made available to users on a monthly/quarterly basis. In both cases, the main focus is loans granted by the financial sector to the resident entities classified as NFCs, non-profit institutions serving households and households.

The set of statistical indicators disclosed monthly includes:

a. Outstanding amounts of loans granted and the correspondent annual change of rate.
b. Overdue loans ratios.
c. The percentage of borrowers with overdue loans.

These indicators are compiled for borrowers belonging to the NFCs and households sectors. In the former sector, information is also broken down by firm size and also made available for exporting companies. In case of households, a breakdown according to the purpose of the loan is also included. Data using the above-referred metrics are provided for non-profit institutions serving households without any additional details.

More detailed information is disseminated on a quarterly basis, both for the outstanding amounts of regular loans and for loans in default. In the latter case, two indicators are published: overdue loans ratio and percentage of borrowers with overdue loans. In the case of NFCs, for the referred metrics, data is further broken down by:

a. Region of residence of the company headquarters (according to NUTS[6] classification)
b. Economic activity sector (according to NACE[7] sections)
c. Brackets of total amount of loans per borrower.

As to households, data are further broken down by:

a. Purpose of the loan
b. Region of residence (according to NUTS classification and by municipality)
c. Brackets of total amount of loans per borrower.

[6] Nomenclature of Territorial Units for Statistics.

[7] Statistical Classification of Economic Activities in the European Community.

The Bank has the intention to enlarge the set of statistical indicators on loans that are compiled on the basis of CCR data, and has scheduled its dissemination to the 1st quarter of 2016. The type of additional indicators envisaged include: (i) loans broken down by size of the firm, maturity (original and residual) and type of collateral; and (ii) indicators on the average number of financial institutions granting loans to NFCs or to households.

The high-quality figures that can be obtained from specific breakdowns of CCR credit data are of great importance for economic analysis and for quality control. In addition, the use of the CCR has made it possible to reduce the reporting requirements in the context of the Bank's Monetary and Financial Statistics (MFS), thus alleviating the participants' reporting burden and curtailing data redundancy.

The following example, concerning the breakdown by branch of economic activity of credit granted to NFCs, illustrates this point. The referred breakdown has been included in the MFS reporting requirements from 1990 to 2002. Yet, the data reported during this period showed a number of weaknesses in terms of quality due to the need for the reporting agents to aggregate the information according to various statistical criteria prior to its submission to the Bank. Given that the CCR provides an alternative source for such data, with higher quality, the MFS data collection system in force since January 2003 no longer requires the breakdown by branch of economic activity.

4. The CCR as a tool for banking supervision, financial stability, monetary policy and economic research

The prevailing CCR legal framework already foresees that, besides statistical compilation, data can be used in the context of other specific functions of the Bank, such as banking supervision, financial stability analysis, monetary policy and research.

4.1 Using CCR data for banking supervision and financial stability

In the domain of banking supervision, CCR data have been used in the assessment of credit risk and concentration of risk exposures, both at micro and macro level, and for the improvement of on-site inspection practices.

In this context, it is worth mentioning the Bank's Early Warning System (EWS), whose aim is to identify companies showing a high probability of default as a result of an excessive level of indebtedness to be assessed taking into consideration the ability to generate cash flow and/or the existing capital structure. Through this system, the Bank intends to encourage credit institutions to be proactive in identifying and defining appropriate procedures and solutions in the treatment of such companies.

The EWS relies heavily on the information available in the Portuguese CCR – and also on data from the Bank's Central Balance-Sheet Database (CBSD) –, which are used to calculate a predefined set of five financial ratios, determined for each company regardless of the industry or sector in which it operates:

a. Two financial ratios (Total Debt to EBITDA[8] and EBITDA Interest Coverage) are classified as core ratios in accordance with Standard & Poor's Corporate Ratings Framework.
b. Three additional ratios are considered as supplementary ratios due to the fact they foster the understanding of a company's financial risk profile, capturing other critical risk dimensions, such as profitability and leverage (FFO to Total Debt[9], Gearing, Return on Capital).

As regards the Bank's financial stability function, both the CCR statistics disclosed in the Bank's Statistical Bulletin and the granular data available from the CCR database are extensively used.

Granular data are crucial for (i) research purposes, allowing for the crossing/analysis of various dimensions and characteristics of loans/debtors/creditors; and (ii) analysis objectives.

These data are typically used, *inter alia*, in the:

a. Analysis of distribution measures by loan/debtor classes according to the activity sector, exposure size, firm size, type of guarantee, performing status and other characteristics (assessment of risks stemming from the household and NFCs sectors).
b. Distinction of financial situation of NFCs with positive, null or negative changes in borrowing (together with data from the Bank's CBSD).[10]
c. Breakdown of above by activity branch and by size[11] (together with data from the Bank's CBSD).
d. NFCs' credit performance following credit restructuring.
e. Effects of the age in NFCs bank relations in credit spreads (with the interest rate statistics database).
f. Credit trends of largest indebted NFCs.
g. Credit history of high growth corporations.

Given its homogeneity and comparability with other datasets, CCR data allow for complementary analysis to aggregated data by providing distribution measures. Granular data enable better testing and monitoring of the banks' results in face of more comprehensive scenarios (*e.g.*, stress testing).

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[8] EBITDA is an acronym for "Earnings Before Interest, Taxes, Depreciation and Amortization".

[9] FFO ("Funds from Operations") is given by (EBITDA - Net Interest - Income Taxes).

[10] Used together with data from the Bank's CBSD.

[11] *Id*.

Moreover, some macroprudential tools require the use of characteristics that are only available in granular datasets (such as real estate collateral amount and debt instalments).

4.2 Using CCR data for monetary policy

Within the monetary policy framework, CCR has been used as an auxiliary tool in the identification of loans used as collateral in Eurosystem financing operations. In particular, the CCR collects the data needed to evaluate the risks associated with the acceptance of bank loans as collateral of monetary policy credit operations.

The general documentation on Eurosystem monetary policy instruments and procedures requires:

a. All Eurosystem credit operations to be based on adequate collateral (underlying assets provided by the counterparties).
b. Underlying assets to fulfill certain criteria in order to be eligible for Eurosystem monetary policy operations.
c. A single framework for eligible assets common to all Eurosystem credit operations.

The single framework comprises two distinct asset classes:

a. Marketable assets.
b. Non-marketable assets (namely, credit claims).

CCR is relevant for eligibility assessment (and *ex post* verification) of credit claims. CCR is also relevant for the elaboration of collateral generation capacity estimates of domestic counterparties on credit claims, asset back securities (ABS) and covered bonds.

Each National Central Bank (NCB) is responsible for the eligibility assessment of a subset of assets. The Bank is responsible for the eligibility assessment of:

a. Marketable assets traded in Portugal.
b. Non-marketable assets granted by domestic counterparties and presented as collateral to the Bank.

Since February 2012, NCBs are allowed, as a temporary measure, to accept as collateral for Eurosystem credit operations additional performing credit claims. These credit claims should satisfy specific eligibility criteria proposed by the NCBs and approved by the ECB Governing Council. In general, the use of CCR data allows for:

a. Verifying the existence of the credit claims.
b. Confirming the major characteristics of the credit claims.
c. Simplifying the report for monetary policy purposes.

4.3 Using CCR data for economic research

The Bank's economic research function has been using CCR micro-data for several research papers and analysis, frequently combining this data with other micro-data sources, like the Bank's CBSD.

A good example of the usefulness of this information can be found in *Augusto, F. & Félix, S.* (2014), where the authors examine the impact of bank recapitalization on firms' access to credit. Starting from the several private and public capital injections experienced by the Portuguese banks during the recent global financial crisis, the paper investigates the impact of bank recapitalizations on the supply of credit in the period between the first quarter of 2010 and the fourth quarter of 2013. Their results suggest that bank bailouts contributed to an increase in the supply of credit. This effect is negatively related to the capital buffer of recapitalized banks and applies to the sectors of manufacturing and trade. There is no evidence that bank recapitalizations contributed to a selective behavior in the supply of credit towards distressed firms compared to other firms. The main dataset used in this analysis is the Bank's CCR. The granularity of these data allows considering sophisticated micro-econometric approaches to identify the effects of the bank recapitalization on the supply of credit. The information reported in the CCR allows for the construction of several credit performance indicators, related to firms' overdue credit. This study includes two firm distress indicators based on firms' overdue credit (as reported in the CCR). The sample includes 201,768 non-financial corporations and 327,777 loans (firm-bank pairs). The results suggest that firms have on average two banking relationships.

Another example can be found in *Farinha, L. & Félix, S.* (2014). This paper examines the importance of credit demand and credit supply-related factors in explaining the evolution of credit granted to Portuguese small and medium-sized enterprises (SMEs). The results suggest that the interest rate is a strong driver of SMEs' demand for bank loans, as well as their internal financing capacity. On the other hand, credit supply mostly depends on the firms' ability to generate cash-flows and reimburse their debt, and on the amount of assets available to be used as collateral. The model was estimated for the period between 2010 and 2012, and the estimated coefficients were used to compute the probability of credit rationing. The results suggest that a considerable fraction of Portuguese SMEs were affected by credit rationing in this period.

5. The creation of an ICAS in the Statistics Department

The bank has recently taken decisive steps towards further exploring the informational potential of the CCR and balance sheet databases in creating an In-house Credit Assessment System (ICAS).

This system will provide the Bank with its own in-house credit risk assessment system, thus reducing its dependence on external sources. Against the background of the recent economic and financial crisis and the shortage of assets liable to be used as collateral in monetary policy operations, these systems have recently been gaining importance within the Eurosystem, as can be seen by the increasing number of NCBs that have introduced them (Austria, Belgium, France, Italy, Germany, Slovenia and Spain). In fact, at the current juncture, a more pressing business case for ICAS stems from monetary policy purposes, for which ICAS will provide an evaluation of debtors' credit notation.

But the benefits of such a system are not exclusive to monetary policy. In fact, there is a broad range of advantages to different business areas, in particular regarding banking supervision and financial stability. First and foremost, starting with banking supervision, the credit notations derived from ICAS could be used as a benchmark to gauge those provided by institutions with their own internal notation system. Furthermore, the computation of sectoral default probabilities could also be envisaged, providing a useful input for stress-testing. As for financial stability, the monitoring of developments in the non-financial sector (and the potential building up of imbalances) would benefit from an indicator of NFCs credit risk, which could serve, at least, two purposes: on the one hand, to identify situations of potential financial fragility in a set of companies of a particular economic activity sector; on the other hand, to contribute in assessing other risks stemming from the NFCs sector. Other business areas such as economic analysis and statistical functions would also stand to gain from ICAS's outputs.

Against this background, CCR data is essential for the good performance of the ICAS. In line with the Basel III default definition and the guiding principles for the identification of defaults, default observations are determined using the CCR data, namely:

a. Data on legal proceedings (legal defaults) are obtained automatically from the CCR (public information).

b. Data on all remaining elements of the reference default definition are obtained automatically via Portuguese commercial banks reporting to the CCR.

This information is crucial to calibrate the econometric models and also for the assessment of the ICAS performance.

In addition, the remaining credit information (*e.g.*, non-performing loans, loan volume, number of banks and write-offs) is used by analysts to supplement the information given by the econometric model. These indicators support the analyst's decision of revising the company's rating upwards or downwards.

6. The AnaCredit project and its impact in the Portuguese CCR

Central credit registers are a fundamental tool to monitor and manage credit risk, as well as to provide an overview of credit exposures and the level of indebtedness of both resident and non-resident borrowers *vis-à-vis* national financial intermediaries.

In order to get a better overview of the level of indebtedness of the borrowers across European Union Member-States the European System of Central Banks has been exploring, since 2007, the potential statistical use of CCRs.[12] In particular, it sought to understand to which extent their content may be enhanced and adapted to euro area and European Union statistical needs, to alleviate the statistical reporting burden and to increase transparency.

Against this background, the European Central Bank (ECB) launched the so-called AnaCredit[13] project in 2011, together with experts from both the statistical and credit registers' areas of a number of euro area and non-euro area national central banks.

Three main issues were especially under scrutiny:

a. Identifying a core set of information to meet main users' needs and the necessary data attributes and level of harmonisation of definitions / methodologies.
b. Considering the governance, legal and confidentiality issues.
c. Exploring the identification of entities and loans and the CCRs' links to other data sources such as micro databases and business registers.

Following this avenue, a joint Statistics Committee (STC) / Financial Stability Committee (FSC) Task Force on Analytical Credit Datasets (co-chaired by the Banco de Portugal) was established in 2013. The overarching aim of this task force was the setting up of a long-term framework for the collection of harmonised granular dataset on bank loans in the euro area.

In order to fulfil the AnaCredit requirements, the Portuguese CCR will be redesigned and will adopt a new philosophy: a loan-by-loan basis. The preparatory work regarding the implementation of this new CCR information system has already started, in collaboration with the Bank's IT Department, and it has progressed in terms of the evaluation of data requirements, not only to comply with the AnaCredit requirements but also with the data needs of both financial institutions and internal users. Although the first stage of AnaCredit will comprise only loans granted by banks to legal entities, the Portuguese CCR will keep the current coverage both in terms of participating institutions and borrowers.

[12] Data sharing with other countries' CCRs follows the rules of the 2005 Memorandum of Understanding on the exchange of information among CCRs and are based on reciprocity.

[13] The name AnaCredit stands for "Analytical Credit Datasets".

So far, it is clear that some functionalities of the current CCR should be kept: (i) different reporting rules for static and dynamic data; (ii) identification of borrowers using a unique code (the use of the taxpayer number will continue to be mandatory for residents in Portugal); (iii) statistical classification of borrowers will be made in the Bank through its business register; (iv) the monthly backflow data to the financial system will be approximately the same; (v) corrections to reported data will be made only by the reporting institutions; and (vi) the system itself should be composed by two components (transactional and analytical).

Moreover, new options are being considered given the CCR data users requirements (both AnaCredit and internal users), *inter alia*:

a. Classification of participating institutions according to data needs (different types of institutions may report different sets of data).
b. Identification of different types of data (characterization of counterparties, contracts and related instruments and guarantees; financial data, on a monthly basis; accounting data, on a quarterly basis; credit risk data).
c. Definition of different deadlines for each type of data.

The new CCR system is expected to “go live” six months before the beginning of the reporting for AnaCredit (no overlap with current system will occur, given that a test phase shall be included in the project development).

7. Concluding remarks

The Portuguese CCR has been created with the objective of providing the participating institutions with relevant information to better understand the risk associated with a specific credit contract or borrower. That being said, the CCR holds also nowadays a significant potential for other purposes: the prevailing CCR legal framework already foresees that data can be used in the context of specific functions of the Bank, such as statistical compilation, supervision, economic research, financial stability analysis and monetary policy.

The use of CCR data for statistical purposes has allowed, *inter alia*, an improvement in the quality of monetary financial institutions (MFIs) and other financial institutions (OFIs) balance sheet statistics (*e.g.*, greater accuracy in the MFIs’ classification of the institutional sector of the counterparties receiving credit), a better assessment of credit developments, including the possibility of analysing different breakdowns, and the conception of new statistical products, without imposing additional reporting requirements and burdens on respondents.

In the context of monetary and financial statistics (MFS) the use of CCR data has been facilitated given the fact that: (i) both domains share the same data source (*i.e.* the same reporting institutions);

(ii) the content of the reported information is coherent, since the CCR covers a complete range of credit liabilities; (iii) they both have identical reporting frequency and timeliness; and (iv) both the CCR and MFS are integrated in the same Division in the Bank's Statistics Department. On the whole, the high-quality figures that can be obtained from specific breakdowns of CCR credit data are of great importance for economic analysis and for quality control.

In the domain of banking supervision and regulation, CCR has been used in the assessment of credit risk and concentration of risk exposures, both at micro and macro level, and for improvement of on-site inspection practices. Economic research has been using CCR micro-data for several research papers and analysis, frequently combining this data with other micro-data sources, like the CBSD. Within the monetary policy framework, CCR has been used in the identification of loans used as collateral in Eurosystem financing operations.

The data reported to the CCR has gained relevance with the current indebtedness situation of the Portuguese economy combined with the pressing need of economic agents in all sectors to deleverage their activity, including the banking sector. CCR data combined with other micro-data databases (namely securities holdings and issues and corporate balance-sheet data) has been a key factor in meeting all the data demands in the context of the economic and financial assistance programme.

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Approach to the assessment of credit risk for non-financial corporations. Evidence from Poland[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 or the central banks and other institutions represented at the meeting.

Approach to the assessment of credit risk for non-financial corporations. Evidence from Poland

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Abstract

This paper presents the PD Model and Rating System for non-financial corporations in Poland, developed on the basis of individual data from the following databases: (i) balance-sheet and profit and loss account data from Amadeus (Bureau van Dijk) and Notoria, (ii) credit information from the Prudential Reporting (NB300) managed by Narodowy Bank Polski and (iii) insolvency data from The National Court Register (KRS). These analyses can be used to reduce the risk of adverse effects on the financial sector.

The statistical model is built on logistic regression model, and produces an estimate of the annual Probability of Default (PD) of the assessed company. Models were estimated on categorized variables transformed using the weight of evidence (WoE) approach. The outputs of the Scorecard are used in the PD model. The purpose of the Scorecard is to differentiate between good and bad clients by estimating the Probability of Default (PD) during the following 12 months. Performance measurement purposes and thus model's ability to differentiate between good and bad clients was measured using Gini's coefficient, Kolmogorov-Smirnov statistic, and Information Value.

Keywords: Credit Risk, Scoring Methods, Rating System, Calibration

JEL classification: C190, G210

Contents

Introduction

Among the key activities of the banking sector that constitute the foundations of the financial system in every country, the correct management of assets and liabilities should be distinguished. The impact of the performance of those tasks by banking institutions is crucial for the development of the country's economy, which was evidenced by the financial crisis that begun in 2007 in the United States.

Assessment of Credit Risk, and especially ensuring accuracy and reliability of credit ratings by means of validation is of critical importance to many different market participants (Winkler, 2005). Definition "Credit Risk": traditional (risk of loss due to a debtor's non-payment of a loan (default)); mark-to-market definition (risk of losses due to a rating-downgrade (i.e. an increased probability of default) or the default of a debtor). Basel Committee explains a default event on a debt obligation in the two following ways:

- It is unlikely that the obligor will be able to repay its debt to the bank without giving up any pledged collateral;

- The obligor is more than 90 days past due on a material credit obligation.

This article presents a suggestion for an internal credit assessment system. The main risk indicators are described, which demonstrate the financial standing of companies registered in Poland. The article presents both a scoring assessment and a rating system. The purpose of the Scorecard is to differentiate between good and bad firms by estimating the Probability of Default (PD) during the following 12 months. The analysis was performed with the use of a logistic regression on categorized variables transformed using the weight of evidence approach. Scoring methods have been used to create an indicator for grading the companies in the case of defaults. While developing the model, the number of potential predictors was reduced on the basis of Information Value (IV) statistics. The quality of the model is assessed according to the most popular criteria, such as the GINI statistics, the Kolmogorov-Smirnov test (K-S) and Area Under Receiver Operating Characteristic (AUROC). Rating is a risk assessment that determines the ability of a given entity (company) to manage its debt. For many investors, it plays a crucial role while making a decision on committing resources to a given operation. Rating enables the assessment of the financial strength of business entities and the estimation of the risk associated with commercial and credit transactions. It provides an early warning about any possible problems in terms of cash flow and offers a chance to react quickly. The summary presents a migration matrix. Migration matrices are widely applicable to financial risk management. In the credit risk estimation process, the entity is assigned one of several rating classes (statuses), while its assessment (rating) is determined by the Markov chain transition matrix. The likelihood that the borrower is insolvent, i.e. that it transitions into the default state, is read from the migration matrix.

Key Purposes for the Assessment of Credit Risk of Companies by Central Banks:

- keeping track of the (credit risk of the) economy from a macro-economic perspective;
- assessing credit quality of collateral in the context of monetary policy operations;
- assessing and ensuring financial market stability from a macro-prudential perspective.

The first part of the paper presents a review of literature. Next, the methodology used for estimating the model is described. Then the detailed information on the database is presented, together with the characteristics of the variables used in the estimation, estimation results and conclusions.

Rating system

Appropriate risk assessments are one of the most important aspects of the activity of financial institutions. In 1999, the Basel Committee on Banking Supervision published several postulates for changes in 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 postulate was the reinforcement of the risk management process in the banking sector. One of the key changes was the introduction of the possibility of internal risk management, and therefore – determination of the minimal capital requirements. In particular, the bank can select among three approaches. The first of them, which is a continuation of the approach presented by the previous regulation, obliges the bank to maintain the ratio between the minimal capital 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 using one of the IRB approaches is obliged to estimate the likelihood of insolvency for each loan granted. A popular method of achieving that is credit scoring. Financial institutions can use external scoring or rating assessments (external rating approach), however, they are applicable to only several, 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 "lower" classes, which are denoted by digits or appropriate abbreviations, such as "AAA". It is therefore a process of discretization of the default probability estimations. On one hand, this causes a certain loss of accuracy, and on the other hand, this approach 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 manual relocation of entities to higher of lower rating classes.

Together, the default probability determination model and the master scale are known as the rating system. It 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 an individual and macroeconomic component. A high level of migration of units to lower classes is expected in the period of economic growth, and to higher classes at the 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 . There is also a broad range of intermediate hybrid approaches, which include individual elements of those two methods.

It is worth referring to the guidelines of the Eurosystem, consisting of the European Central Bank and central banks in countries within the euro zone. In order to ensure financial stability within the European Union, framework principles of debt-or credit assessment were established, known as ECAF (European Credit Assessment Framework), which include instructions in regard to acceptable forms of collateral for lending transactions as part of open market operations. According to the guidelines, quality assessment of a given asset is carried out with the use of credit rating allocated in accordance with the standards that enable a clear and reliable comparison of the creditworthiness of entities. The rating tools currently used for the verification of assets eligible for monetary policy operations are: external entities described as rating agencies (ECAI), internal credit assessment systems (ICAS), internal counterparty rating systems (IRB) and independent external institutions (RT). The abovementioned group, provided for in the Eurosystem, are obliged to comply with the formal terms while carrying out a credit assessment of a given entity, in particular, to apply the definition of default fully consistent with the definition recommended by Basel II. The first of the sources listed, ECAI, refers to agencies whose rating publications can be used – according to the Basel Committee - while calculating risk-weighted assets: DBRS, FitchRatings, Moody's and Standard & Poor's. In this case, the ratings need to be public, and the process of their allocation needs to be objective, independent and clear. The ICAS source includes Deutsche Bundesbank, the Banco de España, the Banque de France, the Oesterreichische Nationalbank, the Banca d'Italia and, since 2013, the Banque Nationale de Belgique and Banka Slovenije. Whereas in terms of the external ratings mentioned above, the counterparty which has received approval from a financial supervisory body to use this tool is obliged to submit appropriate information to the Eurosystem, at least once per year, to enable continued applicability of the system to be determined. The last source of credit assessment, RT, refers to entities whose estimated credit ratings are not announced publicly.

Literature review

Credit Scoring Statistical Techniques

A wide range of statistical techniques are used in building the scoring models (Table 1).

Credit Scoring Statistical Techniques

Source: own calculation Table 1

Method	Authors
Weight-Of-Evidence measure	Bailey, 2001; Banasik et al., 2003; Siddiqi, 2006; Abdou, 2009
Regression analysis	Lucas, 1992; Henley, 1995; Hand, Henley, 1997; Hand, Jacka, 1998
Discriminant analysis	Altman, 1968; Desai et al., 1996; Hand, Henley, 1997; Caouette et al., 1998; Hand et al., 1998; Sarlija et al., 2004; Abdou, Pointon, 2009; Wiginton, 1980; Crone, Finlay, 2012
Probit analysis	Finney, 1952; Grablowsky, Talley, 1981
Logistic regression	Lenard et al., 1995; Desai et al., 1996; Lee and Jung, 2000; Baesens et al., 2003; Crook et al., 2007; Abdou et al., 2008; Wiginton, 1980; Yap, Ong, Husain, 2011; Kočenda, Vojtek, 2009; Stepanova, Thomas, 2002; Thanh Dinh oraz Kleimer, 2007; Crone, Finlay, 2012
Linear programming	Yang, Wang, Bai, Zhang, 2004
Cox's proportional hazard model	Stepanova, Thomas, 2002
Support Vector Machines	Deschaine, Francone, 2008
Decision trees	Baesens et al., 2003; Stefanowski, Wilk, 2001; Thomas, 2000; Fritz, Hosemann, 2000; Hand, Jacka 1998; Henley, Hand, 1996; Coffman, 1986; Paleologo et al., 2010; Yap, Ong, Husain, 2011; Kočenda, Vojtek, 2009; Frydman, Altman, Kao,1985; Novak, LaDue, 1999; Thomas, Bijak, 2012; Crone, Finlay, 2012
Neural Networks	Amari, 2002; Al Amari, 2002; Gately, 1996; Irwin et al., 1995; Masters, 1995; Palisade Corporation, 2005; Desai, Conwey, Crook, Overstreet,1996; Crone, Finlay, 2012
Genetic algorithms and genetic programming	Goldberg, 1989; Koza, 1992; McKee and Lensberg, 2002; Etemadi et al., 2009; Huang et al., 2006; Huang et al., 2007
Markov switching model and Bayesian estimation	Chuang, Kuan, 2011; Frydman, Schuermann, 2008; Jacobs, Kiefer, 2011; Tasche, 2013

Statistical tools and methods used to establish scoring models correspond to the most popular and effective methods used in statistics for modelling similar phenomena with binary explanatory variables. For that reason, the dominant method for a long time remained the discriminant analysis, described by, among others, Forgy, Myers (1963) and Altman (1968). Over time , the developments in computer technology stirred great interest in logistic regression, which became the most widely used tool for building scoring models, applied, among others, by Wiginton (1980) and Kleimeier, Dinh (2007). An important advantage of the logit model relates to a better adjustment of the logistic distribution to the issue analysed when compared to normal distribution. The discriminant analysis and the probit model, however, require an assumption of a normal distribution of variables. The popularity of logistic regression resulted from, among others, the reliability of estimations based on the available scope of data and the range of probability results contained within the range 0 to 1, which simplifies interpretation of the phenomenon that is being explained. An important factor, while selecting methods, is also the ease of interpretation of the results. The biggest advantages of the nonparametric model (decision tree), used by Altman, Kao, Frydman (1985), LaDue, Novak (1999), are its intuitive character, ease and effectiveness. The use of the survival analysis (Stepanova, Thomas, 2002; Baesens, Gestel, Poel, 2005; Andreeva, 2006; Pazdera, Rychnovsky, Zahradnik, 2009; Giambony, 2012), in particular, the comparison between Cox proportional and nonproportional models, is justified when the researcher wishes to focus not only on creating a model of default probability, but also on determining the time of its occurrence. Cox proportional model is characterised by the assumption, often not actually met, of the stability of hazard over time; the nonproportional model is free of this flaw. However, the direct benefit of using the duration analysis is determination of the default probability, changeable in time, for the analysed product. Baesens, Gestel and Poel (2005) verified the hypothesis on the superiority of the predictive power of artificial neural network models over logit models and Cox proportional model. According to the authors, Cox model is superior to the logit model due to its universal approximatively characteristics and also as it is not necessary to make assumptions on the baseline hazard function. Whereas its flaw is the inability to cope with nonlinear correlations between variables which need to be indicated by the researcher beforehand.

The neural networks used by, among others, Convay, Crook, Desai, Overstreet (1997), Baesens, Gestel and Poel (2005) generate satisfactory results, which are not inferior to the results obtained using parametric methods, however, the interpretation and understanding of the results obtained is much more complicated. According to Baesens, Gestel and Poel (2005), neural network models lack most limitations imposed by Cox proportional hazards model. In case of the simplest neural network model, censored observations are removed from the dataset, thus determining the estimator load. Whereas Ohno-Machado model uses a diverse neural network, which facilitates implementation of censored observations throughout their existence in the dataset.

In terms of satisfying the requirements relating to the application of a given method, nonparametric methods have an advantage, as they do not make assumptions on the functional form of the correlation. They are more effective in finding interactions between explanatory variables. Every method has its strengths and weaknesses, therefore the selection of the right method should be determined by the type of issue to be analysed.

Is selection of a statistical method really that important? In the study by Yap, Ong, Husain (2011), the discriminative power of a model created with the use of decision trees (CHAID algorithm) was much lower than the results obtained with the use of logistic regression. Kočenda and Vojtek (2009), who used the CART algorithm, were unable to decide which of the models was better, whereas Thomas, Edelman, Crook (2002) compared the percentage of correct classifications for various statistical methods in several studies (Table 2.)

A comparison of percentage correctly classified from publish research

Source: Thomas L., Edelman D., Crook J., Credit scoring and its applications, Philadelphia, 2002, p. 101-103

Table 2

Method/Authors	Henley (1995)	Boyle (1992)	Srinivisan, Chakrin (1987)	Yobas (1997)	Desai (1997)
Linear regression	43,4	77,5	87,5	68,4	66,5
Logistic regression	43,3	-	89,3	-	67,3
Decision tree	43,8	75,0	93,2	62,3	-
Math programming	-	74,7	86,1	-	-
Neutral nets	-	-	-	62,0	66,4
Genetic programming	-	-	-	64,5	-

The percentage of correct classifications obtained with the use of various methods most often does not differ significantly within one study. This was explained by Lovie and Lovie (1986) as the flat maximum effect, which means that results close to optimal can be achieved in multiple ways, with the use of various combinations of variables or parameter estimations. For that reason, most methods are able to come close to the optimum solution, but further significant improvements in the model's efficiency can be achieved by improving the quality of the available data rather than by changing methodology. For that reason, it is crucial while selecting the research method to consider all good and bad points and to choose the method that is most suited to the issue at hand.

Calibration and mapping to Ratings

This subsection 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.

At first, the form 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 of approximating conditional score distributions for defaults and entities with a good financial standing to the parametric distribution which can be expressed with the use of a density function and distribution functions (Dey, 2010; Bennett, 2003; Krężołek, 2007; Tasche 2006; Tasche 2008; Tasche 2009). Taking into consideration that those distributions are usually rightward or leftward skewed, only those of the types of distributions are described 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). On that basis, with the use of Bayes formula, it is possible to define PD values. Those methods are recommended for the purpose of calibration of a score which is not interpreted as probability (e.g. the score as a result of discriminant analysis).

The second group covers various variants of regression on binary variables denoting the default status of a given company (Tasche, 2009; Neagu, Keenan, 2009; Koenker, Yoon, 2009; Neagu, Keenan, Chalermkraivuth, 2009; Zadrozny, Elkan, 2002; Van der Burgt, 2008). They are universal methods facilitating calibration of a score which can be interpreted as 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 adjustment and Box-Cox transformation of the explanatory variable. Apart from that, each regression can also use the polygonal curve model. Another option is the quasi-moment-matching method and isotonic regression. Based on the probability values found, the rating is allocated with the use of the master scale with set threshold values for individual classes.

Data description

The empirical analysis was based on the individual data from different sources (from the years 2007 to 2012), which are:

- Data on banking defaults are drawn from the **Prudential Reporting (NB300)** managed by Narodowy Bank Polski. Act of the Board of the Narodowy Bank Polski no.53/2011 dated 22 September 2011 concerning the procedure and detailed principles of handing over by banks to the Narodowy Bank Polski data indispensable for monetary policy, for periodical evaluation of monetary policy, evaluation of the financial situation of banks and bank sector's risks.
- Data on insolvencies/bankruptcies come from a database managed by The **National Court Register (KRS)**, that is the national network of Business Official 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. 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; 26 ratios. *Notoria OnLine* standardized format of financial statements for all companies listed on the Stock Exchange in Warsaw.

The following sectors were removed 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); civil law partnership, state owned enterprises, branches of foreign entrepreneurs.

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 at least 1.5 Mio EUR for each reporting date.

The dataset, after its initial preparation and while keeping only the observations on which the model can be based, contained 5091 records. However, the number of observations marked as "bad" was 298 (Table 3). While creating a sample to establish and validate the model, the results of Crone and Finlay's (2012) analysis were taken into account. The proposal for replicating "bad" observations and adding them to all "good" observations was rejected due to the excessive size of the dataset that would be created as a consequence. The added value arising from the increased number of observations would be insignificant in practical terms, however, extending the calculation time would be significant. For that reason, it was decided that all "bad" observations will be added to a selected part of observation from the other class. The proportions were established at 20:80 for several reasons. A smaller number of "good" observations drawn would cause difficulty with drawing a representative sample. Whereas a higher number would extend the calculation time while improving the quality of the model only slightly.

General statistics for 2012

Source: own calculation Table 3

Number of obligors	Thereof Insolvent	Thereof defaulted	Insolvency rate	Default rate
5091	28	298	0,55%	5,85%

Before estimating the model it was tested whether the constructed sample is representative following the results of the non-parametric Wilcoxon-Mann-Whitney test, Kołogomorow-Smirnow test and the parametric *t-Student* test for equality of averages for the continuous variables and the χ^2 Pearson test and the *Population Stability Index* (PSI) for the discrete variables. The PSI coefficient is applied in order to investigate the differences in distribution of two categorized variables. The higher the value of the coefficient, the greater the statistical distance between the distributions.

The training and validation samples were divided at the ratio of 70:30. This proportion was chosen as an average value between the most popular divisions found in literature, ranging from 60:40 to 80:20.

Forecasting defaults concern only companies that had impaired loans (loans from portfolio B for which objective evidence of impairment and decrease in the value of expected cash flows have been recognised (*in banks applying IFRS*) or loans classified as irregular pursuant to the Regulation of the Minister of Finance regarding principles for creating provisions for the risk of banking activity (*in banks applying the Polish accounting standards*)).

Based on the literature, the potential defaults predictors were chosen with the focus on financial indicators. Signals for deteriorating financial condition of the company are: negative dynamics for revenue, assets and equity, decreasing profits, negative equity, increasing indebtedness, problems with financial liquidity, deteriorating operating efficiency and decreasing investment in tangible assets. Explanatory variables that characterize the company's financial state were constructed, such as: turnover dynamics, asset dynamics, equity dynamics, profitability, indebtedness, liquidity and operating efficiency. The analysis included not only the current values of the indicators but also their statistical properties (for example the median) based on different time frames (for example a 2 years average).

Methodology

Construction of credit scoring model

In order to construct an indicator which would enable assessing the probability of a company to go default, a logistic regression was used. Due to a high number of financial indicators of a company's condition (explanatory variables) in the initial analysis the predicting force of each was determined (Gini coefficient[i], Information Value Indicator) followed by clustering in order to limit the size of the analysis. Thanks to this variable selection procedure it was possible to avoid the collinearity problem, which was assured by calculating the appropriate *Variance Inflation Factor*[ii] statistics. The model was estimated on categorized variables transformed using the weight of evidence (*WoE*) approach. The *WoE* transformation is often used for the creation of scoring models using logistic regression, because such a transformation allows maintaining linear dependence in regard to the logistic function. In addition, *WoE* conveys information on the relative risk associated with each category of the particular variable, with a large negative value indicating a higher risk of default.

$$WoE_i = ln\left(\frac{p_i^{non-default}}{p_i^{default}}\right)$$

where:

i	-	category
$\mathrm{p_i^{non-defaults}}$	-	the percentage of non-default companies that belong to category *i*
$\mathrm{p_i^{defaults}}$	-	the percentage of default companies that belong to category *i*.

The categorisation was based on the division with the highest information value (*IV*), which measures the statistical Kullback-Leibler distance (*H*) between the defaults and non-defaults. The *IV* statistic, based on the *WOE*, allows measuring the predicting force of a particular characteristic. The *IV* value depends on the number of categories and division points. The variables for which the *IV* does not exceed 0.1 are assumed to be weak in their relative predicting force, while values exceeding 0.3 bear evidence of a strong discriminating force (Anderson, 2007).

$$IV = H(q^{non-defaults}||q^{defaults}) + H(q^{defaults}||q^{non-defaults}) = \sum_i (p_i^{non-defaults} - p_i^{defaults})WoE_i$$

where:

q - density function.

The final model was created following the top-down approach. Based on the estimated parameters, weights for particular explanatory variables were determined. As a result, a set of financial indicators allowing to grade companies was obtained and *default* probabilities were assigned to companies.

Calibration & Mapping to rating

In order to perform the calibration, the scores were bucketed with (more or less) same number of defaults in each bucket. After that, Default Rate in each bucket was transformed. Such modified Default Rate was transformed into odds.

PD was calculated using the below formula:

$$PD = e^X / 1 + e^X$$

where:

$$X = \beta_2 * SCORE + \beta_1$$

The theoretical relationship between the **score** and **logarithm of odds** (which from the nature of logistic regression should be linear) was used to obtain estimates of the calibration function. The accuracy of obtained estimated *PD*'s for each calibration function was tested Population Stability Index. According to common usage of the *PSI*, values between 0 and 0,1 mean no significant changes. After obtaining PD values, scores were mapped to ratings according to the master scale.

The calibration of the scoring system which is another important task in scoring model validation.

- **The first group of tests** can only be applied to one single rating grade over a single time period *(binomial test Clopper and Pearson, binomial test Agresti and Coulla, binomial test Wald, corrected binomial test Wald, binomial test Wilson, corrected binomial test Wilson, one-factor-model, moment matching approach and granularity adjustment)*.
- **The second group of tests** provide more advanced methods that can be used to test the adequacy of the default probability prediction over a single time period for several rating grades (*Spiegelhalter test, Hosmer-Lemeshow test, Blöchlinger test*).

Results

The research was performed on the sample included companies observed in 2011. In Model the default probability was predicted for a one year horizon.

After performing the initial data analysis, a dataset was prepared, based on which the model could be built. The models were estimated using logistic regression, preceded by one-dimensional and multidimensional analysis. Many of the 611 explanatory variables available which were not excluded during the previous stages of research are correlated, which negatively affected the estimations of the logistic regression model. Variable correlation partly results from the manner of establishing the dataset, as on the basis of one general variable, multiple detailed variables were established with the use of various aggregates and timelines. Therefore, the selection of variables based on which the logistic regression model is to be estimated will take place in two stages. During the first phase, variables characterised by the lowest predictive power measured with the use of the Information Value statistics will be rejected. Next, cluster analysis will be used to select the best variables from the groups of correlated variables.

The first stage of establishing the model, i.e. the reduction of the number of variables, will be performed with the use of automatic categorisation (predictive power maximising division) in order to calculate the Information Value. Categorisation of all variables was performed in the following variants, by dividing them into 3, 4, 5 or 6 categories. Finally, the division was selected in which the statistical value was the highest, and each category established had at least 2% of the training sample, in order to ensure stable results. In case of variables that did not meet the observation number requirement in any automatic configuration and which were characterised by a high Information Value, manual categorisation was used in order to correct the insufficient number in the categories. The statistical value equal to 0.1 was determined as the minimum value to make variables eligible for further analysis. The selection of this value complies with the value most widely found in literature, especially where there is a sufficient number of explanatory variables of a high predictive power in the dataset. Due to the high number of variables which met the requirement of the minimum Information Value, it was decided that the maximum of three variables with the highest statistical value, originating from the same original class, are to be used for further analysis.

After the conclusion of the one-dimensional analysis, 85 explanatory variables remained in the dataset, which then underwent cluster analysis. The division into groups was carried out until the percentage of explanatory variables in each of them was higher than or equal to 70%. In order to eliminate excessive correlation between variables in the model, only one variable was chosen from each cluster.

Having selected 20 variables, the last stage of the model establishment process was commenced with the use of a stepwise regression algorithm. The limit value, p-value, for adding of removing a variable form the model, was determined at 0.05. The algorithm stopped after 10 iterations (Table 4.), during which variables were only added to the model. The greatest weight was assigned to the indicator of ROA (16%).

In the definition of the regulatory body, validation involves a range of techniques used to verify the model's ability to distinguish between "bad" and "good" entities and the calibration quality of the estimated parameters, facilitating correct quantification of the risk incurred. Although the Basel Committee assigns the obligation of controlling the validation process to the local authorities who establish detailed guidelines, Basel II includes six fundamental principles in regard to this issue:

1. the bank is obliged to validate the scoring model,

2. the validation determines the assessment of the predictive power of the model and ratings used, as part of which four characteristic features of the model are analysed:

- objectivity – the model used ensures a standardised process of allocating risk parameters to borrowers,

- accuracy – achieving small acceptable deviations between the estimated risk parameters and the actual implementations,

- stability – risk parameters are constant for the same risk,

- conservatism – the use of restrictive risk parameters in case of unverified information,

3. the validation process is carried out at least once per year,

4. there is no single common validation method,

5. validation concerns both qualitative and quantitative assessment,

6. the validation results are assessed by an independent entity .

Final scorecard

Source: own calculation Table 4

Variables	Weight in the total grade in %	Value		Partial grade
Credit period (Creditors / Operating revenue)*360	6,16%	-INF	36.175	57
		36.175	73.873	34
		73.873	+INF	0
Industry sectors	8,84%	Industry		83
		Construction		0
		Trade		108
		Transport		31
		Other services		43
EBIT	8,04%	-INF	372	0
		372	4696	44
		4696	+INF	78
Bank-firm relationships	11,80%	one bank		99
		two or more banks		0
ROCE	6,87%	-INF	-4.501	0
		-4.501	12.641	59
		12.641	+INF	85
ROA	16,39%	-INF	-10.49	0
		-10.49	1.907	53
		1.907	6.502	91
		6.502	+INF	189
Solvency ratio (Liability based)	7,96%	-INF	26.221	0
		26.221	54.097	30
		54.097	94.483	50
		94.483	+INF	80
(Interest due / Total exposure)*100 (median of 4 q)	14,05%	-INF	0.016	121
		0.016	0.035	89
		0.035	0.193	44
		0.193	+INF	0
(Bank loans denominated in PLN / Total exposure)*100 (median of 6 q)	9,33%	-INF	6.796	84
		6.796	67.72	44
		67.72	+INF	0
(Open credit lines / Total exposure)*100 (median of 6 q)	10,53%	-INF	1.553	0
		1.553	23.77	25
		23.77	+INF	99
Hosmer - Lemeshow Test			Test statistic	p-value
			11,1666	0,1924

In accordance with the guidelines of Basel II, the decision to implement the scoring model should be determined by the results of the validation process: the discriminatory power and calibration quality. The validation process used in practice by banks involves filling out a validation report, taking into consideration qualitative and quantitative validation. In regard to the first of them, it should be noted that the data used for the purpose of this paper meet the requirements of Basel II both in terms of the definition of default applied, the timeline and the representativeness of the selected sample, while the direction of impact of the majority of variables is consistent with business logic.

Even though there is no single common method of validating scoring systems, the Basel Committee recommends the use of the Gini coefficient (Accuracy Ratio) and its graphic equivalent - the CAP curve. The Basel Committee also points to techniques popular in theoretical literature and in the banking practice, such as: the ROC curve, AUROC measure, Pietra index, Bayes error rate, measures based on entropy, e.g. CIER, IV coefficient, divergence, Kendall and Somers'D parameter, Brier score.

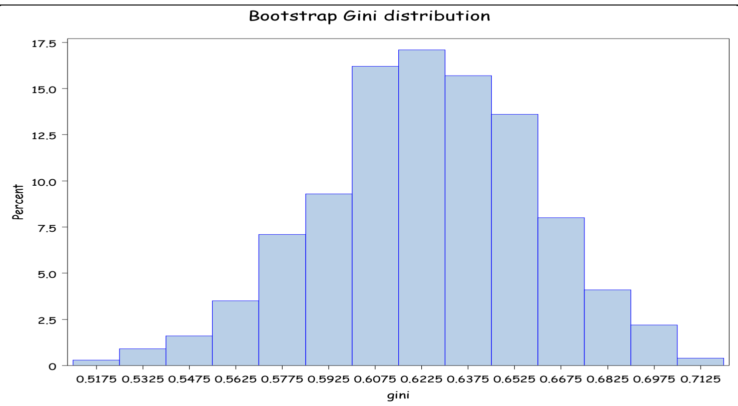
The GINI and K-S value of the model were equal to, respectively, 62.3 and 51.4, which means satisfactory discrimination. The hypothesis on the combined insignificance of explanatory variables in the model was rejected (p-value = 0.000). While using the Wald method, tests were carried out on the significance of individual variables separately and the p-value for each of them was below the established 5% significance level. There are also no grounds to reject the zero hypothesis on the good adjustment of the model to the data (p-value = 0.19). The VIF (Variance Inflation Factor) value does not indicate any issues of excessive collinearity.

While using the bootstrap method, the stability of the calculated GINI value was verified. To achieve this, a sample was drawn and returned a thousand times, which contained 2/3 observations from the original set.

Results of bootstrap analysis for Gini coefficient

Source: own calculation

Graph 1

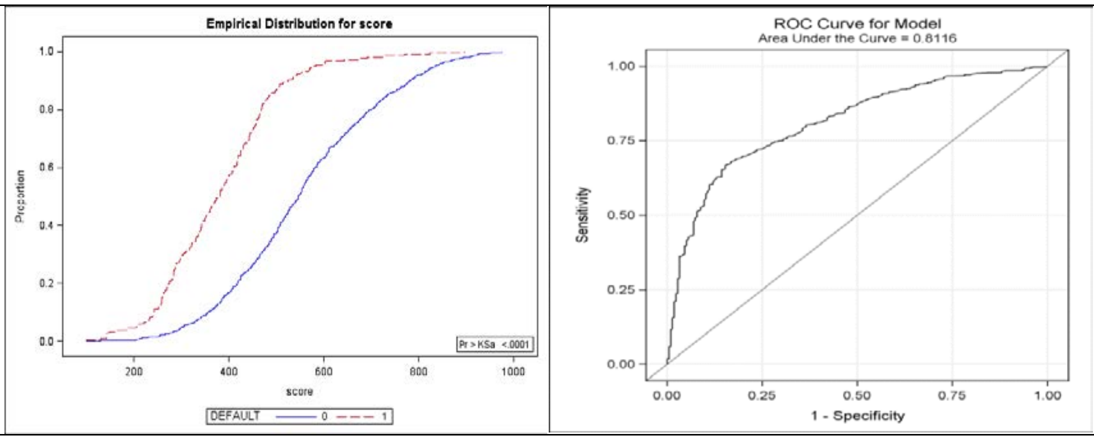


The operation of the model was verified with the use of a validation set. The hypothesis on the combined insignificance of the parameters was rejected (p-value = 0.000). There are also no grounds to reject the zero hypothesis on the insignificance of individual explanatory variables in the model. The GINI and K-S values were equal to, respectively, 68.5 and 54.9, which confirms the stability of the results of the control set. The hypothesis on the good adjustment of the model was rejected for the validation set (p-value equal to 0.2867).

In order to analyse the appropriate cut-off point, Graph 2. is presented of the empirical distribution functions for "good" and "bad" entities, on the basis of which the K-S value is calculated. The maximum difference between those two distribution functions is achieved for 483 scoring points, which means that in order to maximise the percentage of correct classifications, the cut-off point should be established at this value. The ROC curve was prepared for the training sample. The AUROC value was equal to 0.8116, which means a satisfactory quality model. In terms of the validation sample, the graph of the ROC curve looked very similar, while the AUROC value was equal to 0.80.

Empirical distribution for score (K-S) and ROC curve on development sample

Source: own calculation | Graph 2



In order to evaluate the classification power of the model established, the following were also used: the CAP concentration curve and the directly related Gini coefficient. From the mathematical perspective, the curve presents a correlation between the distribution function of the score obtained for the insolvent group and the distribution curve of the score of the entire sample.

Population Stability Index was used to test for variables' time stability. As suggested by literature the rule of rejecting the hypotheses that default rate distributions are close to each other is when PSI exceeds 0.25. Default rate distributions for the model observation date (2011) were compared to 3 other moments in time (Table 5).

Population Stability Index

Source: own calculation | Table 5

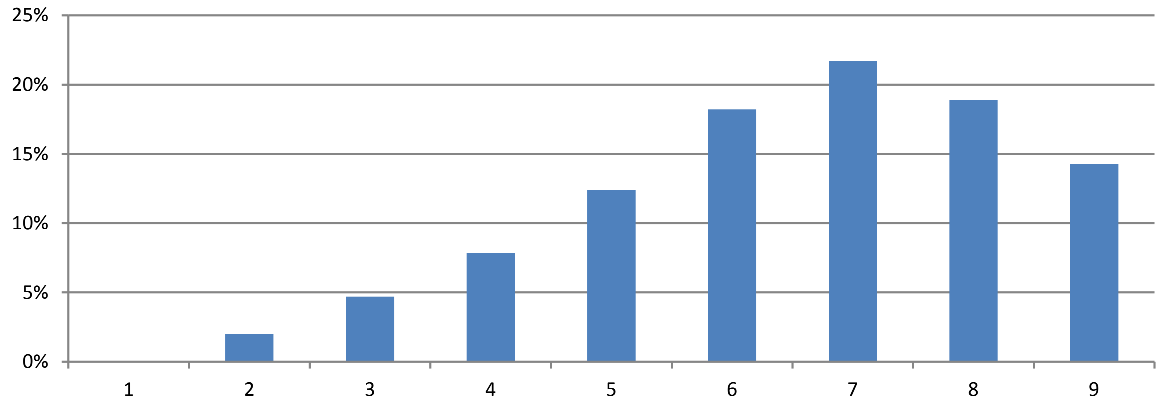
Variables	PSI in 2010	PSI in 2009	PSI in 2009
Credit period (Creditors / Operating revenue)*360	0,026	0,021	0,019
Industry sectors	0,018	0,061	0,099
EBIT	0,013	0,015	0,020
Bank-firm relationships	0,009	0,024	0,010
ROCE	0,050	0,064	0,019
ROA	0,024	0,065	0,060
Solvency ratio (Liability based)	0,015	0,033	0,033
(Interest due / Total exposure)*100 (median of 4 q)	0,011	0,022	0,039
(Bank loans denominated in PLN / Total exposure)*100 (median of 6 q)	0,012	0,016	0,007
(Open credit lines / Total exposure)*100 (median of 6 q)	0,009	0,013	0,012

The available values of the PD parameter for individual risk classes determine their calibration.

Rating

Source: own calculation

Graph 3



The first method recommended by the Basel Committee is verification (backtesting) which involves comparison of the estimated PD ex ante values assigned to individual risk classes with ex post values. Among the recommended statistical tests that facilitate backtesting, the Basel Committee distinguishes: the binomial test, Hosmer-Lemeshow test, normality test, traffic lights approach. The biggest challenges related to the verification of the PD parameter on the basis of statistical tests are the limitations arising from the required dataset, in particular, the rarity of defaults and their correlation. Due to the existing correlation, the insolvency indicators observed systematically exceed the levels of probability obtained, if they are estimated with the assumption of independency of events. As a consequence, most tests are characterised by conservatism and, based on that, even a well-calibrated model receives a low mark. On the other hand, tests which take correlation into consideration only in extreme circumstances allow for the low-quality calibration of a model to be determined. For that reason, the Basel Committee recommends that banks should also use a complementary tool – benchmarking, which involves the identification of differences between the values of estimated parameters obtained with the use of various statistical techniques or external comparative data.

Score ranges per rating with average PD

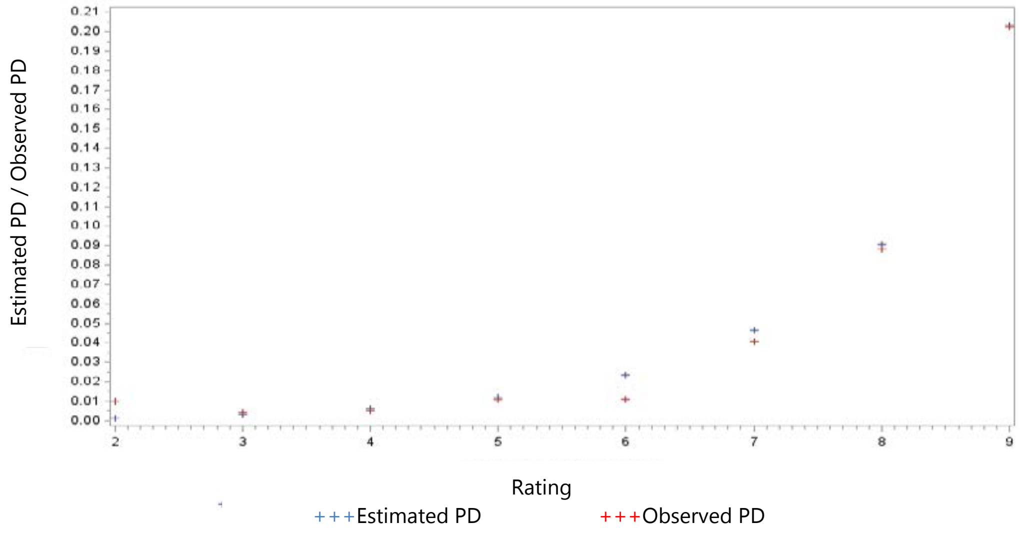
Source: own calculation Table 6

Rating	Min score	Max score	Masterscale average PD	Estimated PD	Observed PD
1	977		0,07%	0%	0%
2	897	977	0,14%	0,15%	0,98%
3	811	896	0,28%	0,31%	0,42%
4	725	810	0,57%	0,59%	0,50%
5	638	724	1,13%	1,17%	1,11%
6	551	637	2,26%	2,36%	1,08%
7	461	550	4,53%	4,66%	4,07%
8	366	460	9,05%	9,08%	8,84%
9		365	18,10%	20,33%	20,25%

Another element of the validation of scoring models is the verification of the correctness of default probability allocation to specific risk classes. The calibration quality is especially important in terms of the calculation of credit reserves. The initial assessment of the element described was carried out on the basis of a graphic summary of the model and the observed PD parameter for individual risk classes. In order to carry out the calibration, the model parameter was determined as the average PD parameter value for each rating. Based on Graph 4., a slight deviation was determined between the estimated and actual PD parameters for specific groups.

Monitor Calibration

Source: own calculation Graph 4



While validating model calibration, it is worth testing the calibration power of individual classes, as well as the entire rating system. In case of testing individual classes, it 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 were carried out: one-factor-model, 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 the observed and the estimated default probability. For the purpose of this research, also the Spiegelhalter and Blöchlinger tests were used, which facilitate verification of the calibration power achieved in a different manner to the Hosmer-Lemeshow test.

The model calibration testing procedure was commenced with the use of the Spiegelhalter, Hosmera-Lemeshow[iii] and Blöchlinger tests. Based on the test statistical values, the models are considered to have a good calibration power. Apart from testing the rating calibration as a whole, there is a range of tests which allow for the calibration to be assessed in terms of individual rating classes. Six variants of the binomial test were used, along three tests which take correlation into consideration. While performing the first of the abovementioned tests, examining each individual risk class separately, the zero hypothesis on the correct allocation of default probability is not to be rejected.

The use of the IRB approach forces banks to perform periodic validation of the quality of rating systems used, with the aim to verify the discrimination and calibration power, as well as system stability. The stability refers to the level of migration between individual rating classes and changes in the values of model parameters over time. Usually, migration matrices are used for the purpose of assessment.

Migration Matrix

Source: own calculation

Table 7

		Rating 31/12/2011									
		1	2	3	4	5	6	7	8	9	
Rating 31/12/2010	1	0	1	0	0	0	0	0	0	0	1
		0%	100%	0%	0%	0%	0%	0%	0%	0%	100%
	2	0	49	19	10	4	3	0	0	0	85
		0%	57,65%	22,35%	11,76%	4,71%	3,53%	0%	0%	0%	100%
	3	0	20	92	52	35	11	3	1	0	214
		0%	9,35%	42,99%	24,30%	16,36%	5,14%	1,40%	0,47%	0%	100%
	4	0	5	46	130	87	69	14	8	1	360
		0%	1,39%	12,78%	36,11%	24,17%	19,17%	3,89%	2,22%	0,28%	100%
	5	0	0	14	73	180	159	68	17	3	514
		0%	0%	2,72%	14,20%	35,02%	30,93%	13,23%	3,31%	0,58%	100%
	6	0	1	6	29	109	265	218	78	24	730
		0%	0,14%	0,82%	3,97%	14,93%	36,30%	29,86%	10,68%	3,29%	100%
	7	0	0	1	3	24	134	394	207	65	828
		0%	0%	0,12%	0,36%	2,90%	16,18%	47,58%	25%	7,85%	100%
	8	0	0	0	1	9	40	114	364	176	704
		0%	0%	0%	0,14%	1,28%	5,68%	16,19%	51,70%	25%	100%
	9	0	0	0	1	1	3	26	90	323	444
		0%	0%	0%	0,23%	0,23%	0,68%	5,86%	20,27%	72,75%	100%
		0	76	178	299	449	684	837	765	592	3880

Migration Matrix

Source: own calculation Table 8

	+1	+2	+3	+4	+5	+6	+7	+8	+	
	0 0,00%	26 0,67%	67 1,73%	107 2,76%	143 3,69%	177 4,56%	140 3,61%	90 2,32%	750 19,33%	worsened ratings
	-1	-2	-3	-4	-5	-6	-7	-8	-	
	1 0,03%	19 0,49%	62 1,60%	126 3,25%	242 6,24%	303 7,81%	311 8,02%	269 6,93%	1333 34,36%	improved ratings

While analysing the transition matrix (Table 8) in terms of ratings allocated to companies in 2011 and 2010, it can be seen that in case of 46% of companies the rating remained unchanged. Nearly 57.65% of companies which were allocated the second rating category in 2010, kept this rating, while around 72.75% of companies which scored the worst in 2011 remained in the highest risk group. The rating worsened in case of 19.33% of companies, while a higher rating in 2011 compared to 2010 was assigned to 34.36% of companies.

Conclusions

Appropriate risk assessments are one of the most important aspects of the activity of financial institutions. Assessment of Credit Risk of Companies by Central Banks important for many reasons, a.o. for: Banking Supervision and Evaluation of Financial Stability, Assessment of Credit Quality of Collateral.

This article has the aim of constructing PD Model and Rating System for non-financial corporations in Poland, developed on the basis of individual data from the following databases: (i) balance-sheet and profit and loss account data from Amadeus (Bureau van Dijk) and Notoria, (ii) credit information from the Prudential Reporting (NB300) managed by Narodowy Bank Polski and (iii) insolvency data from The National Court Register (KRS).

The statistical model is built on logistic regression model, and produces an estimate of the annual Probability of Default (PD) of the assessed company. Models were estimated on categorized variables transformed using the weight of evidence (WoE) approach. The outputs of the Scorecard are used in the PD model. Performance measurement purposes and thus model's ability to differentiate between good and bad clients was measured using Gini's coefficient, Kolmogorov-Smirnov statistic, and Information Value.

In order to perform the calibration, the scores were bucketed with (more or less) same number of defaults in each bucket. After that, Default Rate in each bucket was transformed. The theoretical relationship between the score and logarithm of odds was used to obtain estimates of the calibration function. After obtaining PD values, scores were mapped to ratings according to the master scale.

In accordance with the guidelines of Basel II, the decision to implement the scoring model should be determined by the results of the validation process: the discriminatory power and calibration quality.

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[i] The *Gini* coefficient is used for a one dimensional assessment of the discriminating force of a variable. For this purpose a model with only one explanatory variable is estimated and the coefficient measures its predicting force. GINI=$1-\sum_{i=1}^{n}\left((c_i^{defaults}-c_{i-1}^{defaults})(c_i^{non-defaults}-c_{i-1}^{non-defaults})\right)$, where $c_i^{defaults}$ is the cumulative share of defaults in the category *i* of the chosen trait. The result is equivalent to the Somer's D statistic.

[ii] The VIF statistic is defined based on the determination coefficient for a regression of a dependent variable X_j in respect to other explanatory variables R_j^2 $\left(VIF=\frac{1}{1-R_j^2}\right)$.

[iii] For example, as a result of the second test, the statistical value of χ_7^2=12.56 was obtained, on the basis of which there are no grounds to reject the zero hypothesis on the consistence of the distributions compared at level of statistical significance 0.05, as a consequence, good quality calibration was determined.

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Determinants of credit in the Polish banking sector before and after the GFC according to information from the NBP Senior Loan Officer Survey. Does supply or demand matter?[1]

Zuzanna Wośko,
Narodowy Bank Polski
(Poland)

[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 or the central banks and other institutions represented at the meeting.

Irving Fisher Committee Workshop: *Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges.*

Title:

Determinants of credit in Polish banking sector before and after the Great Financial Crisis according to information from Senior Loan Officer Opinion Survey data. Does supply or demand matter?

Zuzanna Wośko[1]

Abstract

The paper investigates the problem of most important determinants of bank lending in Poland according to qualitative information of banks from the Senior Loan Officer Opinion Survey. The analysis takes into consideration banks' answers on the purpose of the change of their lending before and after the crisis. The research which bases on the panel regressions as well as disequilibrium econometrics models allows to decide, which factors – supply or demand had more important influence on lending growth in particular periods of time. Estimated models use bank-level and aggregated quarterly data concerning three loan segments – corporate, housing and consumer from the half of 2005 to the end of 2014.

Key words: credit growth, senior loan officers opinion survey, demand for loans, supply of loans, credit growth modelling

JEL: E51, G21, G01

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1. Introduction

The sharp decline in world economic activity during the late of the last decade, which is generally considered the largest downturn since the Great Depression also influenced the Polish banking system and its credit dynamics. Following the world financial crisis, banks curbed supply of loans by considerably tightening the standards and terms of granting them.
Before the crisis, the lending growth in Poland was strong, most notably due to housing loans, which was the consequence of both households' rising demand for dwellings, supported by the increasing availability of credit and its relatively low cost, and limited supply on the residential property market which elevated prices. The price rise caused a feedback in the form of growing demand, triggered by, among others, an expected further price rise, which in turn stimulated higher demand for loans.
A significant role in this process was played by strong easing of standards and terms of granting loans by banks and the related low loan spreads observed in the pre-crisis period. This development stemmed from strong competition among banks, leading some institutions to focus on raising a market share at the expense of diligent credit risk assessment (Financial Stability Report. July 2010., p. 35).
The accumulation of imbalances has been disrupted by the last financial crisis. Due to tightening the standards and terms of granting loans. Demand, particularly from enterprises, also fell.
After a period of tightened policy, from 2011 one could observe the start of a gradual process of easing the standards and terms of granting loans by banks.

This paper investigates the problem of most important determinants of bank lending in Poland before and after the crisis. The key issue is the role of demand and supply factors in this process – if the demand or the supply was the main driver of lending growth? Or, maybe, both factors influenced the credit in the same way?
To achieve this research goal two kinds of approach were applied. Both were using the qualitative information of banks from the Senior Loan Officer Opinion Survey. However the first one, on aggregated data, supported with other banking and macro data leads to the conclusions about dominations of regimes in particular periods of time – demand or supply. Here, disequilibrium econometrics methodology was used. The second one bases on the panel regressions. Panel models are estimated on bank-level quarterly data. The conclusions on the

possible impact of different factors are made using significance test of regressors in two subsamples.

Both approaches consider three loan segments – consumer, housing and corporate from the half of 2005 to the end of 2014.

The structure of the paper is as follows: chapter 2 summarizes literature on assessing the impact of demand and supply factors on credit growth, chapter 3 describes econometric methodology applied to the research. Detailed information on empirical part of the paper are included into chapter 4 and 5, where the data and results of the analysis are included. The most important findings are collected in *Conclusions*.

2. Literature

Estimation of credit demand and supply has become a key issue of many economic publications. They present not only very wide range of methodologies but also applications to many countries. But the operational goals of researchers can vary.

Some authors aim at receiving very general information about influence of demand-side and supply-side variables on credit growth. Others want to find exact trajectories of non-observable demand and supply, and finally, there are some trying to receive a zero-one answer about dominating regime for particular time unit.

Vast literature on loan demand-supply decomposition can be classified according to granularity of data and quantitative methodologies which have been applied.

Aggregated data are usually used in disequilibrium econometrics models, which consist of demand and supply linear equations together with optimization function which defines observable volume of credit as minimum of demand and supply. Such approach can be found in Laffont & Garcia (1977), Sealey (1979), Ito & Ueda (1981), Stenius (1983), Artus (1984), Martin (1990), Pazarbasioglu (1997), Ghosh and Ghosh (1999), Hurlin & Kierzenkowski (2002), Burdeau (2014). The aim of mentioned papers were, amongst others, the analysis of credit crunch in particular country (Canada, USA, Japan, Finland, Korea, Indonesia, Thailand) or the investigation of monetary transmission channel (for example, Poland in Hurlin & Kierzenkowski 2002).

Another tool of decomposing the supply and demand for loans in order to investigate monetary channels was also done in the literature by using VECM (Vector of Error

Correction Models) methodology. Imposing appropriate economic restrictions on variables and then finding cointegrating vectors can reveal quantitatively unobservable demand and supply side. Such research were presented by, for example, Kakes (2000), Calza (2006), Mello & Pisu (2009), Łyziak et al. (2014).

There are also relatively new approaches to disentangling supply and demand of loans such as Dynamic Factor Models (DFM). Balke, Zeng (2013) applied such methodology, in which the demand and supply of credit are one of the unobservable common factors in the model using 65 macro and financial variables of quarterly and monthly frequency.

However there is much less research on demand and supply of loans based on panel data. One of most known research is Del Giovane, Eramo, Nobili (2010) who used bank-level data from Eurosystem Bank Lending Survey – the answers of banks on the demand and supply of loans. Asea, Blomberg (1997) estimated two regimes of lending growth - high and low risk in the model, where the margin on loans in a particular bank depends on the real cost of financing of the bank, the share of risky loans in the bank and the set of macroeconomic variables. Brown, Kirschenmann, Ongena (2010) used two logit panel models - firms' decisions to request FX loans and banks' decision to grant FX loans. The first equation can be regarded as the approximation of loan demand and the second as realized demand.

This paper uses two different approaches from the literature to Polish data. On aggregate data the disequilibrium econometrics approach has been used and on disaggregated, bank-level data somewhat similar analysis to Del Giovane, Eramo, Nobili (2010) has been applied.

3. Methodology

As mentioned above, in this paper the econometric framework of modelling credit dynamics includes two approaches. The first one is time series regression on aggregated data with the use of disequilibrium econometric approach (regime-switching model) and the second one is panel regression on disaggregated (bank level) data.

Disequilibrium approach mentioned in previous chapter is usually applied to aggregated data. It bases on the system of separate demand and supply equations together with optimization function which defines observable volume of credit as minimum of demand and supply:

$$Y_t^s = X_t'\alpha + \xi_{st}$$
$$Y_t^d = Z_t'\beta + \xi_{dt} \quad , \qquad (1)$$
$$Q_t = \mathrm{Min}(Y_t^s, Y_t^d)$$

where Q is observable value of loans (dynamics of the stock of loans), and Y are nonobservable values of supply (s) and demand (d), X is a matrix of supply regressors (determinants) and Z matrix of demand regressors (determinants). It is also assumed, that vector $\xi_t = (\xi_{st}, \xi_{dt})'$ is i.i.d. , $N(0, \Omega)$ where:

$$\Omega = E(\xi_{st}\xi_{dt}') = \begin{pmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{pmatrix} \qquad (2)$$

In the process of estimation using Maximum Likelihood method (ML), the following vector of structural parameters is estimated: $\theta = (\alpha\ \beta\ \sigma_1\ \sigma_2\ \sigma_{12})'$. In presented research, following the suggestions for example Hurlin & Kierzenkowski (2002), the starting parameters were taken from one step OLS estimations of separate equations of demand and supply, substituting demand and supply values by historical values of loan dynamics.

The probability of being in the demand regime in period t can be formulated using following formula:

$$P(Y_t^d < Y_t^s) = P(Z_t'\beta + \xi_{dt} < X_t'\alpha + \xi_{st})$$

$P(Y_t^d < Y_t^s) = P\left(\frac{\xi_{dt}-\xi_{st}}{\sigma} < \frac{X_t\alpha - Z_t\beta}{\sigma}\right)$ where $\sigma^2 = \sigma_d^2 + \sigma_s^2$ when the random variables are independent. Assuming that $\frac{\xi_{dt}-\xi_{st}}{\sigma} \sim N(0,1)$, then:

$P(Y_t^d < Y_t^s) = \Phi\left(\frac{X_t\alpha - Z_t\beta}{\sigma}\right)$ where $\Phi(.)$ is a CDF of normal distribution.

And probability of demand regime is given by:

$$P(Y_t^s < Y_t^d) = 1 - \Phi\left(\frac{X_t'\alpha - Z_t'\beta}{\sigma}\right)$$

In case of disaggregated approach, equations were estimated with the use of unbalanced data[2] from commercial banks.

Let us assume the model:

$$y_{it} = \mathbf{x}_{it}'\boldsymbol{\beta} + \alpha_i + \varepsilon_{it} \qquad (3)$$

where t=1,2,...,T and i=1,2,...,N, $[\mathbf{x}_{it}]_{1xK}$, $[\beta]_{Kx1}$, $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$.

The problem of incompleteness was solved using a Tx1 vector of selection indicators:

[2] The panel is unbalanced due to mergers in the banking sector.

$s_i = (s_{i1}, \dots, s_{iT})'$, where $s_{it} = 1$ if (x_{it}, y_{it}) is observed and zero otherwise. Such indicators are included into the parameters' estimator.

Equations of lending growth were estimated with the use of the OLS while allowing the standard errors (and variance–covariance matrix of the estimates) to be consistent when the disturbances from each observation are not independent, and specifically, allowing the standard errors to be robust to each bank having a different variance of the disturbances and to each bank's observations being correlated with those of the other banks through time. Nevertheless, some of the equations are dynamic. Dynamic panel regression with AR(m) can be presented as:

$$y_{it} = \delta y_{i,t-m} + x_{it}' \beta + \alpha_i + \varepsilon_{it} \qquad (4)$$

where δ is a scalar. The issue of estimator's properties in dynamic unbalanced panel regressions was more developed in Wośko (2015).

4. Data

Almost all the research cited in chapter 2 on demand and supply of loans use change of the stock of loans to approximate flow of new credit. However it should be considered that such measurement is biased, amongst others, by repayments, loan sale transactions and securitization. For example, Giovane et al. (2010) excluded securitization from the dynamics of credit and it improved the significance of the statistical influence of variables from the SLOS.

In order to identify regimes correctly, first of all, one need to exclude the rate of depreciation of loans (amortization). But reporting bank standards in Poland does not allow for accurate separation of repayment of loans. The same problem occurs in case of loan sale transactions. Lending growth can be distorted especially in case of consumer loans. In this segment of loans sale transactions are common in Poland, contrary to corporate loans. Information about loan sale transactions is rather poor.

Therefore we have to use simple measure of new loans using quarterly difference of stock of loans in case of aggregated data and quarterly rate of growth in case of disaggregated data ignoring above mentioned problem. But we are aware of consequences of such simplification.

Main source of data to the research is Senior Loan Officers Opinion Survey (SLOS). SLOS is regularly carried out by Narodowy Bank Polski since 2003 Q4. It is directed at CEOs/executives chairing credit committees at commercial banks and the content is similar to analogous ECB and Fed surveys. Aggregate results are presented in the form of diffusion indices (net percent of answers) published on NBP website. Depending on supervisory needs, the survey contains additional ”descriptive” questions. Usually such national surveys cover a large part of loan portfolio of the banking system. The Polish survey covers 26-30 commercial and cooperative banks responsible for more than 80% of existing credit portfolio. It covers three market segments: corporate loans (distinction between SMEs and large enterprises with regard to lending standards), housing loans and consumer loans. As the questions in the survey concern changes in the particular bank’s policy in a relatively short period of time (from quarter to quarter), it is the obvious that the majority of answers in the sample indicated lack of change (between 50 and 80% depending on the question asked). The largest percent of not-applicable answers was recorded in the case of housing loans, as some banks had not been extending housing loans at all. The most rare answer option among banks was “eased considerably”, which means that banks were reluctant to ease drastically their policy from quarter to quarter (see more in Wośko 2015).

The full list of variables (survey, banking and macro indicators) used in the research was included in Table 1.

5. Results

5.1. Aggregate approach

The selection of variables to final specifications in disequilibrium model was made according to following steps. Very broad list of potential regressors (see Table 1) was narrowed using the t-test of Pearson coefficient of correlation. Not only coincident, but also lagged relations were taken into account. The results of selection are presented in Table 3 and the conclusions are as follows:

a) In case of corporate segment the list of significant variables was relatively long comparing to housing and consumer segment.

b) Most significant correlations the corporate credit growth had with such demand-side variables as questions from SLOS concerning current and forecasted demand of SMEs and large companies for long term loans, questions about reasons of demand change like fixed capital needs, inventories, mergers funding, change of loan standards and terms. Other significant demand factors are, amongst others, percentage of requested loans, consumer and production prices, GDP growth, Polish stock market index, return on sales.

c) The strongest supply-side relations in case of corporates had questions about current standards for all types of loans (both short and long-term), questions concerning supply causes such as demand and credit risk reasons (also large exposures) and forecasts of supply for loans for SME. Indicators of capital adequacy, funding abilities and credit risk in banking system also passed the test as expected.

d) Interest rate changes also were significant. Both national loan interest rates: interbank – WIBOR and corporate– RCR had strongest coincident relation and foreign interest rates influenced loans with two-quarter time lag.

e) The strongest determinants of housing loans from the tested list were economic situation, change of standards and terms of loans, wages, consumer confidence indicator, foreign exchange rate, interest rates.

f) Change of consumer loans was significantly correlated with economic situation of households, consumption, GDP, change of terms of loans, change of incomes, employment, capital adequacy ratio, foreign funding, funding gap, provisions to loans to households, competition on the market and interest rates.

Next, the selected variables were divided into two groups – demand and supply side. Simple linear regressions of demand and supply were tested, were demand and supply were represented by observable credit change. Tests of significance, colinearity check enabled to select final set of variables (regressors). These are:

1a. demand for corporate loans - net percent of the answers from the survey about reasons for the change in demand: DEMCAUSECOR_DEBTRESTR(-2), DEMCAUSECOR_MERGERS(-1), DEMCAUSECOR_TERMSCHNG(-2), and consumer prices CPIQ(-1), change of interest rate D(RCR), stock market index WIG(-2), index of consumer sentiment - CSI(-1), government support for SMEs - MINIMIS.

1b. supply of corporate loans – capital adequacy ratio CAR, change of deposit rate for corporates D(DRCORP), foreign funding FLIAB(-2), non-performing loans ratio INPLCORP, provisions to loans ratio PROV, change of loan interest rate for corporates D(RCR), net percent of answers from the survey concerning credit standards for large companies, of short-term loans STANDARDS_LCSHORT(-2), forecast of supply of loans for SMEs SUPPLYF_SMELONG(-2), and government support for SMEs - MINIMIS

2a. demand for housing loans –net percent of answers from the survey concerning forecasts of demand DEMANDF_HOUS, reasons of demand changes DEMCAUSEHOUS_STANDARDSCH, and other variables, such as change of LIBOR or FX rate D(LIBORCHF3M), CHF(-2), change of loan interest rate D(RH), consumer sentiment indicator CSI(-1).

2b. supply of housing loans – net percent of answers from the survey concerning reasons of change in supply SUPCAUSEHOUS_ECONOMICSIT(-2), CAR, change of deposit rate for households D(DRHOUHLDS), non-performing loan ratio INPLHOUSHLDS, change of interest rate of zloty and CHF housing loans D(RH), D(LIBORCHF3M), and introducing government programme GOVP.

3a. demand for consumer loans – net percent of answers from the survey concerning reasons of change in demand DEMCAUSECONS_ECONOMICSIT(-1), DEMCAUSECONS_TERMSCHNG(-2), change in interest rate of consumer loans D(RC(-1)), change in overall consumption D(CONS) and seasonal factors (Z).

3b. supply of consumer loans – capital adequacy ratio CAR, foreign funding FLIAB(-2), funding gap GAP(-2), ratio of non-performing loans for households INPLHOUSHLDS, provisions to loans PROV(-2), change of interest rate of consumer loans D(RC(-2)), causes of supply according to survey such as collateral SUPCAUSECONS_COLL and demand SUPCAUSECONS_DEMAND(-2), recommendation of Polish FSA (RECT) and seasonal factors (Z).

Final specifications of regressors for each loan segment were put into disequilibrium model in the form (1)[3]. Firstly, initial parameters were obtained using OLS method and then nonlinear optimization of regime-switching model was made with the use of the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm which is one of the quasi-Newton methods of optimizing. Vectors of initial and optimal parameters are included in Table 4, 5 and 6 together with significance tests. At Figure 5, 6 and 7 quarterly changes of estimated demand and supply are given together with historical values of observable credit changes. Figure 8, 9, 10 includes probabilities of supply and demand regimes estimated for particular periods.

In case of corporate loans, from 2004 to 2008 banks were easing credit policy (see Figure 1). That time banks also declared relatively high demand for loans from enterprises (and Figure 3). The results of estimation suggest that at the beginning of this period demand was slightly higher than supply and just before the Crisis tendency has reversed. It means that at that second period easier credit standards, increasing supply of credit did meet the financial needs

[3] However to simplify the analysis, we assume $\sigma_{12} = 0$.

of corporates. In 2009 banks curbed supply of loans, however the results suggest that such deep drop of credit dynamics to negative values was driven more by decreasing demand. Early after the crisis, in 2011, the demand was increasing faster than supply, as financial needs connected with infrastructure investments of football competition Euro 2012 quickened. Supply did not increase much, and even went down in the second half of 2012 as banks tightened credit policy due to worsening quality of loans of enterprises involved in infrastructure projects connected with Euro 2012. Increasing prices of materials raised the real costs comparing to agreed contracts which led large infrastructure companies to financial problems. From 2014 the supply of credit to corporates increased faster than demand showing rather reluctance of firms towards taking a loan.

In case of housing credit to households, results suggests that until 2007 demand and supply were more or less in equilibrium. However before the lending crisis supply regime started to dominate. The second period of disequilibrium was just after the Crisis, till 2012, where demand was lower than supply (see Figure 6).

Consumer loan segment before the Crisis was more demand-regime dominated and after the Crisis supply regime was more frequent (Figure 7).

5.2.Bank-level approach

Bank-level approach focuses on the analysis of the influence of particular demand and supply variables on the credit dynamics before and after the last financial crisis.

For each segment of loans two specifications were tested in two subsamples. First specification is basing on results included in Wośko (2015), where statistically and predictively best specifications of panel models of credit growth in Poland were found. Equations include both, demand and supply variables. Second specification uses in the role of regressors the data gathered only from SLOS on disaggregated level. These are answers concerning credit policy (credit standards) and demand for loans.

According to Polish characteristics of the consequences of world financial crisis, the timeline was divided into periods "before the Crisis", it means to the end of 2008, and "after the Crisis", which starts from 2011. Both panel equations were estimated on these two subsamples. Tables from 7 to 12 include the results of estimations.

According to Wośko (2015), the growth of corporate loans in Poland depends strongly on past developments in this category, banks' policy expectations from the last quarter, past GDP rate of growth, and from 2014 onwards – the government guarantee programme for SMEs. In case

of corporate segment, as the first specification, similar equation was estimated (see Table 7). The second equation includes only answers from the survey regarding large and SMEs and concerning short and long term loans (Table 8).
Estimations of both specifications in two subsamples suggest the strong rise of significance of supply factors of credit in the period after the Crisis.

In case of segment of housing loans, the conclusions are quite similar to corporate, however the rise in significance of supply factors is smaller. But in fact, in the period after the Crisis, answers on the questions concerning supply had higher values of the test of significance (see Table 9 and 10).

The growth of consumer loans depends on past banks' policy and on the last-quarter change of consumer sentiment indicator (see Table 11). Consumer loans are the short-term financing of consumer goods, these are loans at current accounts, credit card accounts, etc. The higher the optimism concerning the following months, the more prominent the rise of household expenses, as households predict that their credibility will improve.
Estimation of growth of consumer loans in two subsamples of both equations has shown decrease of information value of both demand and supply factors in the second subsample (Table 11 and 12). In other words, significance of demand as well as supply factors decreased after the Crisis.

6. Conclusions

This paper described the influence of demand and supply determinants on the credit growth in the sector of commercial banks in Poland. The main idea of the concept was to use survey information in the form of panel data from Senior Loan Officers Opinion Survey (SLOS). The main objective of included models was answer about possible changes in tendencies of the influence of demand and supply factors as the result of the last financial crisis at the disaggregated (for particular banks, different types of loans) and aggregated (the commercial banks' sector) level.
Two methodological approaches were used. First one, on aggregated data, was time series regression with the use of disequilibrium econometric approach (regime-switching model) and the second one was a panel regression on disaggregated (bank level) data.
The results received on the bank-level data suggest increasing significance of supply factors after the Crisis in case of corporate and housing loans. Results on aggregated data with the

use of regime-switching model confirm these results in case of corporate loan segment. However disequilibrium (aggregated approach) suggest also increase of probability of supply side in consumer loans in the period following GFC.

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Table 1
Variables tested in the models of supply and demand and their transformations (in parentheses).

abbreviation	**description**	**details**	**supply/ demand side**
(D)CSI	consumer sentiment indicator (quarter-to-quarter change)	Source: Polish Central Statistical Office	D
(G)RGDP	gross domestic product (rate of growth, constant prices)	Source: Polish Central Statistical Office	D
(G)WIG	Warsaw Stock Exchange Index (rate of change)	Source: Reuters	D
CHF/PLN, EUR/PLN, USD/PLN	exchange rates	Source: NBP	D,S
(R)CONS	consumption (constant prices)	Source: Polish Central Statistical Office	D
CPI	consumer products inflation (q/q)	Source: Polish Central Statistical Office	D
ECI	business climate indicator	Source: Polish Central Statistical Office	D
SPI	sold production of industry (q/q)	Source: Polish Central Statistical Office	D
PPI	production prices of industry	Source: Polish Central Statistical Office	D
(D)EMPL	number of employed in the corporate sector	Source: Polish Central Statistical Office	D
INC	households' disposable income	Source: Polish Central Statistical Office	D
HHP	Housing prices q/q	Source: NBP	D
ROE,ROA,ROS	profitability ratios of corporates	Source: Polish Central Statistical Office	D
U	unemployment rate	Source: Polish Central Statistical Office	D
WAGE	average wage	Source: Polish Central Statistical Office	D
(D)WIBOR3M, (D)LIBORCHF3M, (D)LIBOREUR3M	interbank interest rates	Source: NBP, Reuters	D,S
(D)DRH	deposit interest rate - households	Source: NBP	S
(D)DRC	deposit interest rate - corporates	Source: NBP	S
(D)FGAP	Funding gap - the difference between the sum of loans to non-financial sector and government and the sum of deposits from these sectors as a percentage of loans.	Source: NBP	S
(D)IBGAP	total interbank loans of the bank minus its total interbank borrowings, as fraction of bank's assets (quarter-to-quarter change)	Source: NBP	S
(G)LOANSC	consumer loans (quarter-to-quarter growth)	Source: NBP	regressand
(G)LOANSCR	corporate loans (quarter-to-quarter growth, constant prices)	Source: NBP	regressand
(G)LOANSH	housing loans (quarter-to-quarter growth, constant prices)	Source: NBP	regressand
CAR	capital adequacy ratio	Source: NBP	S
FLIAB	liabilities from foreign financial institutions to total assets	Source: NBP	S
govp	Binary variable. Government support plan for families buying their first flat ("Rodzina na	Source: own computations	S

	swoim")		
minimis	Binary variable. Government support for SMEs in the form of loans guarantee plan. ("1" from 2013, "0" otherwise)	Source: own computations	S
(D)NPLHoushlds	non-performing loans – loans from households	Source: NBP	S
lNPLHoushlds	non-performing loans ratio – loans from households	Source: NBP	S
(D)NPLcons	non-performing loans - consumer loans	Source: NBP	S
(D)NPLcorp	non-performing loans - corporate loans	Source: NBP	S
(D)NPLhousing	non-performing loans - housing loans	Source: NBP	S
lNPLcons	non-performing loans ratio - consumer loans	Source: NBP	S
lNPLcorp	non-performing loans ratio - corporate loans	Source: NBP	S
lNPLhousing	non-performing loans ratio - housing loans	Source: NBP	S
PROV	provisions to loans, annualized data	Source: NBP	S
(D)RC	interest rate – consumer loans	Source: NBP	D,S
(D)RCR	interest rate – corporate loans	Source: NBP	D,S
rect	Binary variable ("1" from second half of 2013, "0" otherwise). Adjustment to Recommendation T of the Polish Financial Authority which eased the standards of consumer loans	Source: own computations	S
(D)RH	interest rate – housing loans	Source: NBP	D,S
req	percentage of enterprises applying for credit - survey data	Source: NBP	D
accept	the share of approved loan applications - survey data	Source: NBP	
Standards_LCShort	current credit policy (credit standards) concerning short-term loans to large companies	Source: NBP	S
Standards_LCLong	current credit policy (credit standards) concerning longterm loans to large companies	Source: NBP	S
Standards_SMEShort	current credit policy (credit standards) concerning short-term loans to SMEs	Source: NBP	S
Standards_SMELong	current credit policy (credit standards) concerning long-term loans to SMEs	Source: NBP	S
SupCauseCor_capital	Reasons for changes in lending policy - current or expected capital position of the bank	Source: NBP	S
SupCauseCor_monetary	Reasons for changes in lending policy – decisions of central bank on monetary policy	Source: NBP	S
SupCauseCor_economicsit	Reasons for changes in lending policy - risk related to the expected economic situation	Source: NBP	S
SupCauseCor_industryrisk	Reasons for changes in lending policy – industry risk	Source: NBP	S
SupCauseCor_largeexp	Reasons for changes in lending policy – risk related to large borrowers	Source: NBP	S
SupCauseCor_npl	Reasons for changes in lending policy – change in the share of non-performing loans	Source: NBP	S
SupCauseCor_competit	Reasons for changes in lending policy – changes in competition pressure	Source: NBP	S
SupCauseCor_demand	Reasons for changes in lending policy – change in demand for corporate loans	Source: NBP	S
SupCauseCor_other	Reasons for changes in lending policy – other reasons	Source: NBP	S
Demand_LCShort	Demand for loans – short term loans for large companies	Source: NBP	D

Demand_LCLong	Demand for loans – long term loans for large companies	Source: NBP	D
Demand_SMEshort	Demand for loans – short term loans for SMEs	Source: NBP	D
Demand_SMElong	Demand for loans – long term loans for SMEs	Source: NBP	D
DemCauseCor_fixedcapital	Reasons for changes in demand for corporate loans - changes in demand for financing fixed assets (investments)	Source: NBP	D
DemCauseCor_inventory	Reasons for changes in demand for corporate loans - changes in financing needs for inventories and working capital	Source: NBP	D
DemCauseCor_mergers	Reasons for changes in demand for corporate loans - changes in demand for financing mergers and acquisitions	Source: NBP	D
DemCauseCor_debtrestr	Reasons for changes in demand for corporate loans - changes in demand for financing debt restructuring	Source: NBP	D
DemCauseCor_othersources	Reasons for changes in demand for corporate loans - the use of alternative sources of financing	Source: NBP	D
DemCauseCor_termschng	Reasons for changes in demand for corporate loans - change of corporate loans terms	Source: NBP	D
DemCauseCor_stndchng	Reasons for changes in demand for corporate loans – change of corporate loans standards	Source: NBP	D
DemCauseCor_other	Reasons for changes in demand for corporate loans – other reasons	Source: NBP	D
SupplyF_LCShort	Foreseen supply of short term loans for large companies	Source: NBP	D
SupplyF_LClong	Foreseen supply of long term loans for large companies	Source: NBP	S
SupplyF_SMEshort	Foreseen supply of short term loans for SMEs	Source: NBP	S
SupplyF_SMElong	Foreseen supply of long term loans for SMEs	Source: NBP	S
DemandF_LCShort	Foreseen demand for loans – short term loans for large companies	Source: NBP	D
DemandF_LCLong	Foreseen demand for loans – long term loans for large companies	Source: NBP	D
DemandF_SMEshort	Foreseen demand for loans – short term loans for SMEs	Source: NBP	D
DemandF_SMElong	Foreseen demand for loans – long term loans for SMEs	Source: NBP	D
Standards_hous	current credit policy (credit standards) concerning housing loans	Source: NBP	S
Standards_cons	current credit policy (credit standards) concerning consumer loans	Source: NBP	S
SupCauseHous_capital	Reasons for changes in lending policy in case of housing loans - current or expected capital position of the bank	Source: NBP	S
SupCauseHous_monetary	Reasons for changes in lending policy in case of housing loans – decisions of central bank on monetary policy	Source: NBP	S
SupCauseHous_economicsit	Reasons for changes in lending policy in case of housing loans - risk related to the expected economic situation	Source: NBP	S
SupCauseHous_marketsit	Reasons for changes in lending policy in case of housing loans – housing market situation	Source: NBP	S
SupCauseHous_npl	Reasons for changes in lending policy in case of housing loans –change in the share of non-performing loans	Source: NBP	S

SupCauseHous_competit	Reasons for changes in lending policy in case of housing loans – changes in competition pressure	Source: NBP	S
SupCauseHous_demand	Reasons for changes in lending policy in case of housing loans – changes in demand	Source: NBP	S
SupCauseHous_other	Reasons for changes in lending policy in case of housing loans – other reasons	Source: NBP	S
SupCauseCons_capital	Reasons for changes in lending policy in case of consumer loans - current or expected capital position of the bank	Source: NBP	S
SupCauseCons_monetary	Reasons for changes in lending policy in case of consumer loans – decisions of central bank on monetary policy	Source: NBP	S
SupCauseCons_economicsit	Reasons for changes in lending policy in case of corporate loans - risk related to the expected economic situation	Source: NBP	S
SupCauseCons_coll	Reasons for changes in lending policy in case of corporate loans – required collateral	Source: NBP	S
SupCauseCons_npl	Reasons for changes in lending policy in case of corporate loans –change in the share of non-performing loans	Source: NBP	S
SupCauseCons_competit	Reasons for changes in lending policy in case of corporate loans – changes in competition pressure	Source: NBP	S
SupCauseCons_demand	Reasons for changes in lending policy in case of corporate loans – changes in demand	Source: NBP	S
SupCauseCons_other	Reasons for changes in lending policy in case of consumer loans – other reasons	Source: NBP	S
Demand_hous	Current demand for housing loans	Source: NBP	D
Demand_cons	Current demand for consumer loans	Source: NBP	D
DemCauseHous_housmarket	Reasons for changes in demand for housing loans - changes in housing market	Source: NBP	D
DemCauseHous_spending	Reasons for changes in demand for housing loans - changes in consumer spending	Source: NBP	D
DemCauseHous_othersources	Reasons for changes in demand for housing loans – the use of alternative sources of financing	Source: NBP	D
DemCauseHous_economicsit	Reasons for changes in demand for housing loans – change in economic situation of households	Source: NBP	D
DemCauseHous_termschng	Reasons for changes in demand for housing loans – changes in terms of loans	Source: NBP	D
DemCauseHous_standardschng	Reasons for changes in demand for housing loans – changes in loan standards	Source: NBP	D
DemCauseHous_other	Reasons for changes in demand for housing loans – other reasons	Source: NBP	D
DemCauseCons_durables	Reasons for changes in demand for consumer loans - changes in demand for financing durable goods	Source: NBP	D
DemCauseCons_securities	Reasons for changes in demand for consumer loans - changes in demand for financing purchases of securities	Source: NBP	D
DemCauseCons_othersources	Reasons for changes in demand for corporate loans – the use of alternative sources of financing	Source: NBP	D
DemCauseCons_economicsit	Reasons for changes in demand for consumer loans – change in economic situation of households	Source: NBP	D
DemCauseCons_termschng	Reasons for changes in demand for consumer	Source: NBP	D

	loans – changes in terms of loans		
DemCauseCons_standardschng	Reasons for changes in demand for consumer loans – changes in loan standards	Source: NBP	D
DemCauseCons_other	Reasons for changes in demand for consumer loans – other reasons	Source: NBP	D
SupplyF_hous	Foreseen supply of housing loans	Source: NBP	S
SupplyF_cons	Foreseen supply of consumer loans	Source: NBP	S
DemandF_hous	Foreseen demand for housing loans	Source: NBP	D
DemandF_cons	Foreseen demand for consumer loans	Source: NBP	D

(G)- growth rate, (D) – first difference, (R)- constant prices, (Z1, Z2,….) – seasonal factors

Table 2
Descriptive statistics of data used in aggregated data model

	Mean	Median	Max	Min	Std.Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.	Obs.
ACCEPT	84.34	85.84	91.70	66.67	5.52	-1.43	5.01	20.78	0.00	41
CAR	13.76	13.95	15.77	10.88	1.37	-0.53	2.31	3.03	0.22	45
CHF	2.93	2.95	3.62	2.09	0.46	-0.18	1.74	3.20	0.20	45
CONS	202413.70	202617.20	268262.00	138134.00	39639.42	-0.01	1.65	3.49	0.17	46
CPI	98.39	98.85	110.71	83.48	9.29	0.00	1.50	4.32	0.12	46
CPIQ	100.61	100.50	102.07	99.46	0.70	0.28	2.15	1.99	0.37	46
DEMAND_CONS	0.13	0.16	0.67	-0.54	0.31	-0.15	2.35	0.97	0.62	46
DEMAND_HOUS	0.13	0.15	0.97	-0.69	0.42	0.13	2.33	0.97	0.61	46
DEMAND_LCLONG	0.23	0.25	0.79	-0.60	0.33	-0.41	2.59	1.59	0.45	46
DEMAND_LCSHORT	0.18	0.19	0.60	-0.46	0.23	-0.30	3.00	0.68	0.71	46
DEMAND_SMELONG	0.19	0.19	0.70	-0.52	0.28	-0.23	2.54	0.81	0.67	46
DEMAND_SMESHORT	0.22	0.21	0.76	-0.29	0.22	0.30	3.02	0.71	0.70	46
DEMANDF_CONS	0.44	0.53	0.87	-0.32	0.30	-0.79	2.87	4.82	0.09	46
DEMANDF_HOUS	0.24	0.30	0.97	-0.83	0.42	-0.57	3.07	2.51	0.29	46
DEMANDF_LCLARGE	0.33	0.38	0.85	-0.31	0.32	-0.22	1.97	2.41	0.30	46
DEMANDF_LCSHORT	0.34	0.32	0.75	-0.20	0.23	-0.20	2.32	1.19	0.55	46
DEMANDF_SMELONG	0.38	0.45	0.93	-0.62	0.38	-0.69	2.89	3.63	0.16	46
DEMANDF_SMESHORT	0.43	0.47	0.91	-0.07	0.25	-0.28	2.29	1.55	0.46	46
DEMCAUSECONS_DURABLES	0.23	0.24	0.96	-0.67	0.43	-0.22	2.28	1.35	0.51	46
DEMCAUSECONS_ECONOMICSIT	0.07	0.03	0.93	-0.71	0.41	0.24	2.62	0.72	0.70	46
DEMCAUSECONS_OTHER	0.09	0.04	0.68	-0.38	0.19	0.61	5.13	11.51	0.00	46
DEMCAUSECONS_OTHERSOURCE	-0.11	-0.09	0.32	-0.57	0.19	-0.16	3.25	0.33	0.85	46
DEMCAUSECONS_SECURITIES	0.01	0.00	0.86	-0.74	0.25	0.44	8.00	49.30	0.00	46
DEMCAUSECONS_STANDARDSCH	0.13	0.11	0.73	-0.74	0.33	-0.30	3.03	0.71	0.70	46
DEMCAUSECONS_TERMSCHNG	0.22	0.16	0.82	-0.31	0.31	0.14	2.15	1.55	0.46	46
DEMCAUSECOR_DEBTRESTR	0.12	0.02	0.71	-0.40	0.22	0.66	3.45	3.68	0.16	46
DEMCAUSECOR_FIXEDCAPITAL	0.31	0.42	0.99	-0.91	0.54	-0.74	2.34	4.97	0.08	46
DEMCAUSECOR_INVENTORY	0.35	0.38	1.00	-0.40	0.36	-0.34	2.43	1.53	0.47	46
DEMCAUSECOR_MERGERS	0.06	0.05	0.55	-0.65	0.26	-0.55	4.20	5.09	0.08	46
DEMCAUSECOR_OTHER	0.07	0.02	0.66	-0.61	0.21	0.13	5.70	14.12	0.00	46
DEMCAUSECOR_OTHERSOURCES	-0.06	-0.06	0.21	-0.26	0.10	0.05	2.82	0.08	0.96	46
DEMCAUSECOR_STNDCHNG	0.03	0.01	0.32	-0.55	0.18	-0.90	4.42	10.09	0.01	46
DEMCAUSECOR_TERMSCHNG	0.07	0.06	0.62	-0.48	0.24	-0.24	2.95	0.44	0.80	46
DEMCAUSEHOUS_ECONOMICSIT	0.04	0.01	0.76	-0.86	0.38	-0.10	2.65	0.31	0.86	46
DEMCAUSEHOUS_HOUSMARKET	0.21	0.35	0.97	-0.88	0.53	-0.50	2.18	3.20	0.20	46
DEMCAUSEHOUS_OTHER	0.09	0.06	0.78	-0.44	0.24	0.33	3.75	1.91	0.39	46
DEMCAUSEHOUS_OTHERSOURCE	-0.04	-0.04	0.59	-0.52	0.22	0.31	4.66	5.99	0.05	46
DEMCAUSEHOUS_SPENDING	0.02	0.00	0.65	-0.54	0.24	0.32	3.30	0.98	0.61	46
DEMCAUSEHOUS_STANDARDSCH	0.01	0.05	0.69	-0.85	0.32	-0.59	4.15	5.22	0.07	46
DEMCAUSEHOUS_TERMSCHNG	0.11	0.08	0.94	-0.83	0.41	-0.09	2.51	0.52	0.77	46
DINC	206843.10	204976.00	283927.00	143316.00	37965.48	0.12	1.84	2.63	0.27	45
DRCORP	0.04	0.04	0.06	0.02	0.01	0.09	2.45	0.63	0.73	45
DRHOUHLDS	0.04	0.04	0.06	0.02	0.01	0.17	2.72	0.37	0.83	45
EMPL	5260.35	5364.00	5549.00	4000.00	322.25	-1.78	6.83	46.85	0.00	41
EUR	4.09	4.11	4.78	3.35	0.31	-0.11	3.31	0.26	0.88	45
FLIAB	0.12	0.14	0.20	0.04	0.05	-0.36	1.56	4.87	0.09	45
GAP	-0.01	0.08	0.14	-0.27	0.15	-0.69	1.75	6.58	0.04	46
GOVP	0.52	1.00	1.00	0.00	0.51	-0.09	1.01	7.67	0.02	46
HHP	136.67	141.86	158.68	90.11	16.74	-1.30	4.09	12.98	0.00	39
INPLCONS	0.13	0.12	0.18	0.07	0.04	0.16	1.59	4.00	0.14	46
INPLCORP	0.12	0.11	0.27	0.06	0.05	1.49	5.01	24.70	0.00	46
INPLHOUSHLDS	0.07	0.07	0.13	0.04	0.02	1.05	5.07	16.75	0.00	46
INPLHOUSING	0.03	0.03	0.05	0.01	0.01	0.51	2.85	2.01	0.37	46
LIBORCHF3M	0.74	0.25	2.96	-0.69	0.99	1.19	3.04	10.82	0.00	46
LIBOREUR3M	1.84	1.53	5.28	0.03	1.55	0.73	2.42	4.73	0.09	46
LOAN_COR	193007.20	206927.00	266684.10	116001.70	52782.87	-0.27	1.55	4.61	0.10	46
LOAN_HOUS	193876.60	210647.90	365036.50	29575.83	118043.40	-0.09	1.43	4.78	0.09	46
LOANS_CONS	103412.20	126887.70	138741.20	41875.23	36646.45	-0.59	1.63	6.27	0.04	46
MINIMIS	0.20	0.00	1.00	0.00	0.40	1.53	3.35	18.29	0.00	46
PPI	387.75	379.98	438.19	326.89	34.97	0.07	1.53	4.17	0.12	46
PPIQ	102.46	102.40	109.57	97.33	3.27	0.37	2.48	1.54	0.46	46
PROV	0.01	0.01	0.02	0.00	0.00	0.34	2.31	1.76	0.41	45
RC	0.15	0.15	0.16	0.09	0.01	-2.01	8.23	81.55	0.00	45
RCONS	199496.20	200569.60	271934.60	137373.60	40576.89	0.03	1.72	3.17	0.21	46
RCR	0.06	0.06	0.08	0.04	0.01	-0.43	2.93	1.40	0.50	45
RECT	0.15	0.00	1.00	0.00	0.36	1.94	4.75	34.63	0.00	46
REQ	24.38	23.89	33.19	16.70	4.63	0.23	1.89	2.46	0.29	41
RGDP	181.03	180.85	240.73	137.66	25.95	0.25	2.51	0.93	0.63	45
RH	0.07	0.07	0.09	0.05	0.01	0.15	2.43	0.77	0.68	45
ROS	5.19	5.23	6.40	4.30	0.60	0.16	2.10	1.74	0.42	46
STANDARDS_CONS	0.00	0.05	0.56	-0.79	0.36	-0.62	2.58	3.25	0.20	46
STANDARDS_HOUS	-0.15	-0.08	0.49	-0.90	0.32	-0.69	2.93	3.69	0.16	46
STANDARDS_LCLONG	-0.06	0.00	0.35	-0.82	0.21	-1.39	5.86	30.45	0.00	46
STANDARDS_LCSHORT	-0.01	0.02	0.26	-0.83	0.19	-2.24	10.01	132.74	0.00	46
STANDARDS_SMELONG	-0.05	-0.02	0.33	-0.89	0.26	-1.02	4.38	11.58	0.00	46
STANDARDS_SMESHORT	0.01	0.04	0.63	-0.90	0.28	-0.81	4.66	10.37	0.01	46
SUPCAUSECONS_CAPITAL	0.01	0.00	0.52	-0.47	0.16	0.81	6.66	30.73	0.00	46
SUPCAUSECONS_COLL	-0.03	0.00	0.17	-0.44	0.11	-2.39	9.22	118.15	0.00	46
SUPCAUSECONS_COMPETIT	0.34	0.26	0.95	-0.08	0.30	0.49	2.02	3.71	0.16	46
SUPCAUSECONS_DEMAND	0.20	0.10	0.73	-0.20	0.23	0.77	2.51	4.99	0.08	46
SUPCAUSECONS_ECONOMICSIT	-0.06	0.00	0.54	-0.90	0.30	-0.83	3.91	6.90	0.03	46
SUPCAUSECONS_MONETARY	-0.04	0.00	0.56	-0.51	0.23	-0.16	3.69	1.12	0.57	46
SUPCAUSECONS_NPL	0.00	0.02	0.55	-0.66	0.26	-0.27	3.12	0.58	0.75	46
SUPCAUSECONS_OTHER	-0.05	0.00	0.69	-0.79	0.26	-0.12	4.53	4.62	0.10	46
SUPCAUSECOR_CAPITAL	-0.05	0.00	0.41	-0.90	0.26	-1.09	4.87	15.91	0.00	46
SUPCAUSECOR_COMPETIT	0.18	0.19	0.49	-0.09	0.13	0.03	2.45	0.58	0.75	46
SUPCAUSECOR_DEMAND	0.08	0.08	0.50	-0.23	0.15	0.52	3.79	3.28	0.19	46
SUPCAUSECOR_ECONOMICSIT	-0.05	0.07	0.79	-0.99	0.45	-0.47	2.39	2.41	0.30	46
SUPCAUSECOR_INDUSTRYRISK	-0.16	-0.08	0.42	-0.75	0.25	-0.56	2.93	2.39	0.30	46

SUPCAUSECOR_LARGEEXP	-0.06	-0.01	0.31	-0.60	0.17	-0.98	5.26	17.10	0.00	46
SUPCAUSECOR_MONETARY	-0.05	0.00	0.15	-0.48	0.11	-1.90	8.07	76.79	0.00	46
SUPCAUSECOR_NPL	-0.07	-0.03	0.31	-0.63	0.19	-0.85	3.88	6.99	0.03	46
SUPCAUSECOR_OTHER	-0.05	-0.02	0.46	-0.36	0.17	0.38	3.88	2.63	0.27	46
SUPCAUSEHOUS_CAPITAL	-0.07	0.00	0.21	-0.67	0.16	-2.16	8.80	100.41	0.00	46
SUPCAUSEHOUS_COMPETIT	0.22	0.23	0.87	-0.25	0.25	0.21	2.81	0.40	0.82	46
SUPCAUSEHOUS_DEMAND	0.14	0.12	0.85	-0.50	0.23	0.36	4.31	4.32	0.12	46
SUPCAUSEHOUS_ECONOMICSIT	-0.10	0.00	0.48	-1.00	0.32	-1.00	3.89	9.15	0.01	46
SUPCAUSEHOUS_MARKETSIT	0.06	0.00	0.84	-0.77	0.34	0.22	3.58	1.01	0.60	46
SUPCAUSEHOUS_MONETARY	-0.03	0.00	0.25	-0.40	0.09	-1.07	8.67	70.53	0.00	46
SUPCAUSEHOUS_NPL	-0.08	-0.03	0.13	-0.52	0.14	-1.82	5.97	42.23	0.00	46
SUPCAUSEHOUS_OTHER	-0.19	-0.12	0.38	-0.95	0.29	-1.04	3.55	8.82	0.01	46
SUPPLYF_CONS	0.05	0.12	0.61	-0.81	0.36	-0.61	2.61	3.11	0.21	46
SUPPLYF_HOUS	-0.07	-0.09	0.74	-0.86	0.36	-0.01	2.93	0.01	0.99	46
SUPPLYF_LCLONG	-0.03	0.01	0.37	-0.69	0.23	-1.04	4.16	10.85	0.00	46
SUPPLYF_LCSHORT	0.05	0.06	0.55	-0.60	0.22	-0.75	4.57	8.99	0.01	46
SUPPLYF_SMELONG	0.05	0.12	0.67	-0.65	0.33	-0.39	2.28	2.19	0.33	46
SUPPLYF_SMESHORT	0.13	0.23	0.75	-0.65	0.33	-0.67	2.71	3.57	0.17	46
U	11.41	9.85	20.70	6.60	3.96	1.04	2.70	8.52	0.01	46
USD	3.09	3.12	3.91	2.12	0.38	-0.25	3.71	1.42	0.49	45
WAGE	102.68	102.80	107.80	99.10	2.05	0.56	2.68	2.53	0.28	45
WIBOR3M	4.52	4.43	6.80	1.85	1.24	-0.10	2.60	0.38	0.83	46
WIG	41391.21	41979.31	61739.93	20333.69	10853.91	-0.24	2.26	1.49	0.48	46
WWUK	-25.46	-26.60	-5.60	-44.90	10.13	0.23	2.35	1.19	0.55	45

Table 3

Results of the selection of most significant correlations with loan dynamics (quarterly change).

significant correlations	lag of significant correlation			correlation coefficients			prob. (t-stat.)		
variable	d(LOAN_COR)	d(LOAN_HOUS)	d(LOANS_CONS)	d(LOAN_COR)	d(LOAN_HOUS)	d(LOANS_CONS)	d(LOAN_COR)	d(LOAN_HOUS)	d(LOANS_CONS)
ACCEPT	1	-	-	0.558	-	-	0.000	-	-
CAR	0	0	0	-0.527	-0.473	-0.680	0.001	0.003	0.000
CHF	2	2	-	-0.458	-0.468	-	0.005	0.004	-
CONS	-	-	0	-	-	-0.573	-	-	0.000
CPIQ	1	-	-	0.329	-	-	0.044	-	-
DEMAND_CONS	-	-	1	-	-	0.392	-	-	0.015
DEMAND_LCLONG	1	-	-	0.571	-	-	0.000	-	-
DEMAND_SMELONG	1	-	-	0.394	-	-	0.014	-	-
DEMANDF_HOUS	-	0	-	-	-0.339	-	-	0.037	-
DEMANDF_LCLARGE	2	-	-	0.449	-	-	0.006	-	-
DEMANDF_SMELONG	2	-	-	0.582	-	-	0.000	-	-
DEMCAUSECONS_ECONOMICSIT	-	-	1	-	-	0.647	-	-	0.000
DEMCAUSECONS_OTHER	-	-	1	-	-	0.437	-	-	0.006
DEMCAUSECONS_TERMSCHNG	-	-	2	-	-	0.394	-	-	0.017
DEMCAUSECOR_DEBTRESTR	2	-	-	-0.498	-	-	0.002	-	-
DEMCAUSECOR_FIXEDCAPITAL	1	-	-	0.564	-	-	0.000	-	-
DEMCAUSECOR_INVENTORY	1	-	-	0.383	-	-	0.018	-	-
DEMCAUSECOR_MERGERS	1	-	-	0.623	-	-	0.000	-	-
DEMCAUSECOR_STNDCHNG	2	-	-	0.446	-	-	0.006	-	-
DEMCAUSECOR_TERMSCHNG	2	-	-	0.517	-	-	0.001	-	-
DEMCAUSEHOUS_ECONOMICSIT	-	2	-	-	0.364	-	-	0.029	-
DEMCAUSEHOUS_SPENDING	-	-	1	-	-	0.372	-	-	0.022
DEMCAUSEHOUS_STANDARDSCH	-	0	-	-	-0.349	-	-	0.032	-
DEMCAUSEHOUS_TERMSCHNG	-	0	-	-	-0.334	-	-	0.040	-
DINC	-	-	2	-	-	-0.640	-	-	0.000
DRCORP	0	-	-	0.496	-	-	0.002	-	-
DRHOUHLDS	-	0	-	-	0.389	-	-	0.016	-
EMPL	-	-	2	-	-	-0.422	-	-	0.010
EUR	-	1	2	-	-0.588	-0.575	-	0.000	0.000
FLIAB	2	-	2	-0.398	-	-0.497	0.016	-	0.002
GAP	2	-	2	-0.347	-	-0.490	0.038	-	0.002
INPLCORP	0	-	-	-0.571	-	-	0.000	-	-
INPLHOUSHLDS	-	0	0	-	-0.362	-0.557	-	0.025	0.000
LIBORCHF3M	2	2	-	0.574	0.436	-	0.000	0.008	-
LIBOREUR3M	1	1	-	0.588	0.397	-	0.000	0.014	-
NPLCORP	0	-	-	-0.443	-	-	0.005	-	-
PPIQ	0	-	-	0.354	-	-	0.029	-	-
PROV	0	-	2	-0.478	-	-0.680	0.002	-	0.000
RC	-	-	2	-	-	-0.453	-	-	0.006
RCONS	-	-	0	-	-	-0.570	-	-	0.000
RCR	0	-	-	0.334	-	-	0.040	-	-
REQ	0	-	-	0.123	-	-	0.463	-	-
RGDP	-	-	1	-	-	-0.594	-	-	0.000
GRGDP	3	-	-	0.587	-	-			
RH	-	0	-	-	0.375	-	-	0.020	-
ROS	2	-	-	0.516	-	-	0.001	-	-
STANDARDS_LCLONG	2	-	-	0.521	-	-	0.001	-	-
STANDARDS_LCSHORT	2	-	-	0.395	-	-	0.017	-	-
STANDARDS_SMELONG	2	-	-	0.552	-	-	0.001	-	-
STANDARDS_SMESHORT	2	-	-	0.430	-	-	0.009	-	-
SUPCAUSECONS_COLL	-	-	0	-	-	-0.348	-	-	0.032
SUPCAUSECONS_COMPETIT	-	-	2	-	-	0.376	-	-	0.024
SUPCAUSECONS_DEMAND	-	-	2	-	-	0.429	-	-	0.009
SUPCAUSECOR_DEMAND	2	-	-	0.364	-	-	0.029	-	-
SUPCAUSECOR_LARGEEXP	2	-	-	0.366	-	-	0.028	-	-
SUPCAUSECOR_NPL	2	-	-	0.475	-	-	0.003	-	-
SUPCAUSEHOUS_CAPITAL	-	0	-	-	-0.443	-	-	0.005	-
SUPCAUSEHOUS_ECONOMICSIT	-	2	-	-	0.349	-	-	0.037	-
SUPPLYF_SMELONG	2	-	-	0.553	-	-	0.001	-	-
SUPPLYF_SMESHORT	2	-	-	0.468	-	-	0.004	-	-
USD	2	2	1	-0.633	-0.596	-0.553	0.000	0.000	0.000
WAGE	1	2	-	0.479	0.348	-	0.002	0.038	-
WIBOR3M	0	0	0	0.462	0.365	0.447	0.004	0.024	0.005
WIG	2	-	-	0.576	-	-	0.000	-	-
WWUK	1	1	-	0.566	0.435	-	0.000	0.006	-

Table 4

Results of optimization of likelihood function for corporate loans segment. Initial parameters, final parameters and value of log likelihood.

equation	variable	coefficient	z-statistics	Prob.
demand for corporate loans	C	-21281.81	-0.417894	0.6760
	DEMCAUSECOR_MERGERS(-1)	8736.259	4.641278	0.0000
	DEMCAUSECOR_TERMSCHNG(-2)	6251.653	3.357885	0.0008
	CPIQ(-1)	220.0528	0.435886	0.6629
	D(RCR)	55358.57	0.943508	0.3454
	D(WIG)	-0.494536	-4.720471	0.0000
	Z1	2071.670	2.861342	0.0042
	sigma	1762.319	5.095865	0.0000
supply of corporate loans	C	48487.32	6.009759	0.0000
	CAR	-3604.720	-4.666727	0.0000
	D(DRCORP)	584789.6	2.244399	0.0248
	FLIAB(-2)	-15930.40	-1.233510	0.2174
	INPLCORP	34085.32	0.814243	0.4155
	D(RCR)	-416004.7	-1.032788	0.3017
	STANDARDS_LCSHORT(-2)	11692.46	3.434518	0.0006
	SUPPLYF_SMELONG(-2)	217.4226	0.094338	0.9248
	MINIMIS	5565.652	3.639962	0.0003
	sigma	3417.71	4.663135	0.0000
min log likelihood				-789.0142
Akaike info criterion				36.68246
Schwarz criterion				37.41236
Hannan-Quinn criter.				36.95314

Table 5

Results of optimization of likelihood function for housing loans segment. Initial parameters, final parameters and value of log likelihood.

equation	variable	coefficient	z-statistics	Prob.
demand for housing loans	C	17874.23	4.800784	0.0000
	CHF(-2)	-2452.712	-1.291575	0.1965
	DEMANDF_HOUS	-2584.934	-1.793909	0.0728
	DEMCAUSEHOUS_STANDARDSCH	-2158.200	-0.816606	0.4142
	D(LIBORCHF3M)	-10953.22	-2.939347	0.0033
	D(RH)	-47490.82	-0.317556	0.7508
	WWUK(-1)	195.2982	2.151385	0.0314
	sigma	1894.496	5.355470	0.0000
supply of housing loans	C	23670.65	2.930178	0.0060
	CAR	-508.6283	-1.206371	0.2360
	D(DRHOUHLDS)	588226.7	0.836535	0.4087
	INPLHOUSHLDS	-150069.8	-1.913552	0.0641
	D(LIBORCHF3M)	-9761.165	-3.234188	0.0027
	D(RH)	-537689.9	-0.875950	0.3872
	SUPCAUSEHOUS_ECONOMICSIT(-2)	9611.780	2.538338	0.0159
	GOVP	2633.097	1.034987	0.3080
	LTV	-2802.511	-0.865009	0.3931
	Z2	3411.483	1.696637	0.0989
	sigma	1347.777	5.974410	0.0000
min log likelihood				-756.4043
Akaike info criterion				36.11183
Schwarz criterion				36.93099
Hannan-Quinn criter.				36.41391

Table 6

Results of optimization of likelihood function for consumer loans segment. Initial parameters, final parameters and value of log likelihood.

equation	variable	coefficient	z-statistics	Prob.
demand for consumer loans	C	1233.377	3.017181	0.0026
	DEMCAUSECONS_ECONOMICSIT(-1)	3348.003	3.231196	0.0012
	DEMCAUSECONS_TERMSCHNG(-2)	1009.439	1.389395	0.1647
	D(RC(-1))	-1531.403	-0.032531	0.9740
	D(CONS)	0.031155	0.741954	0.4581
	Z1	-2032.031	-1.941255	0.0522
	Z2	1007.659	1.598990	0.1098
	C	1233.377	3.017181	0.0026
	sigma	922.1606	4.361497	0.0000
supply of consumer loans	C	3961.788	0.881497	0.3780
	CAR	-244.0535	-1.126053	0.2601
	FLIAB(-2)	13763.18	0.696223	0.4863
	GAP(-2)	-5619.373	-0.967252	0.3334
	INPLHOUSHLDS	5648.826	0.374139	0.7083
	PROV(-2)	-251822.6	-2.212459	0.0269
	D(RC(-2))	-6962.054	-0.184980	0.8532
	SUPCAUSECONS_COLL	-4577.608	-2.513269	0.0120
	SUPCAUSECONS_DEMAND(-2)	3044.757	3.187189	0.0014
	RECT	210.8637	0.175602	0.8606
	Z1	-1643.450	-3.091594	0.0020
	Z3	1110.004	2.164574	0.0304
	sigma	742.8768	6.193842	0.0000
min log likelihood				-699.8304
Akaike info criterion				33.52700
Schwarz criterion				34.38712
Hannan-Quinn criter				33.84418

Table 7

Results of estimation of the equation of corporate loans growth

	Before the Crisis						After the Crisis					
	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]		Coef.	Std. Err.	z	P>z	[95% Conf. Interval]	
GLOANSCR(-4)	0.082	0.072	1.140	0.254	-0.059	0.223	0.041	0.216	0.190	0.848	-0.381	0.464
SUPPLYF_ SMESHORT(-1)	1.482	1.102	1.340	0.179	-0.679	3.642	5.330	2.634	2.020	0.043	0.167	10.494
SUPPLYF_ SMESHORT(-3).	-0.190	1.073	-0.180	0.860	-2.293	1.913	3.611	1.454	2.480	0.013	0.760	6.461
GRGDP(-2).	1.047	0.718	1.460	0.145	-0.359	2.454	-2.760	1.615	-1.710	0.088	-5.926	0.406
minimis	(omitted)						2.234	4.657	0.480	0.631	-6.893	11.361
dummies (mergers)												
_cons	-4.849	7.351	-0.660	0.509	-19.256	9.559	-13.169	8.325	-1.580	0.114	-29.486	3.148

The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 8

Results of estimation of the equation of corporate loans growth. Survey data as regressors.

	Before the Crisis						After the Crisis					
	Coef.	Std.	z	P>z	[95% Conf. Interval]		Coef.	Std.	z	P>z	[95% Conf. Interval]	
STANDARDS_LCSHORT	1.238	1.914	0.650	0.518	-2.512	4.989	14.825	5.701	2.600	0.009	3.651	25.998
STANDARDS_LCLONG	-0.298	1.756	-0.170	0.865	-3.739	3.143	7.489	4.743	1.580	0.114	-1.806	16.784
STANDARDS_SMESHORT	1.270	1.170	1.090	0.278	-1.023	3.563	-14.643	4.070	-3.600	0.000	-22.620	-6.665
STANDARDS_SMELONG	-0.723	0.975	-0.740	0.459	-2.634	1.189	-13.754	4.391	-3.130	0.002	-22.360	-5.148
DEMAND_LCSHORT	-1.165	1.330	-0.880	0.381	-3.772	1.442	-0.018	3.913	0.000	0.996	-7.688	7.652
DEMAND_LCLONG	2.011	1.402	1.430	0.151	-0.736	4.758	5.968	5.244	1.140	0.255	-4.309	16.246
DEMAND_SMESHORT	0.328	1.362	0.240	0.809	-2.342	2.998	-4.675	3.326	-1.410	0.160	-11.194	1.843
DEMAND_SMELONG	-1.639	1.553	-1.060	0.291	-4.684	1.406	-8.569	3.941	-2.170	0.030	-16.293	-0.844
SUPPLYF_LCSHORT(-1)	-1.422	2.158	-0.660	0.510	-5.651	2.807	-5.987	6.578	-0.910	0.363	-18.879	6.905
SUPPLYF_LCLONG(-1)	-1.276	1.738	-0.730	0.463	-4.682	2.130	-1.459	4.950	-0.290	0.768	-11.161	8.244
SUPPLYF_SMELONG(-1)	0.459	1.861	0.250	0.805	-3.189	4.107	3.723	5.274	0.710	0.480	-6.613	14.060
SUPPLYF_SMESHORT(-1)	1.659	1.732	0.960	0.338	-1.736	5.055	8.075	5.281	1.530	0.126	-2.275	18.426
DEMANDF_LCSHORT	1.490	1.469	1.010	0.310	-1.389	4.370	-4.172	7.159	-0.580	0.560	-18.203	9.860
DEMANDF_LCLONG	-1.325	1.609	-0.820	0.410	-4.479	1.829	-5.066	6.343	-0.800	0.424	-17.498	7.365
DEMANDF_SMESHORT	-1.479	1.470	-1.010	0.314	-4.361	1.403	4.188	6.261	0.670	0.504	-8.083	16.459
DEMANDF_SMELONG	-0.792	1.257	-0.630	0.529	-3.256	1.672	6.171	7.337	0.840	0.400	-8.209	20.550
dummies												
_cons	10.825	6.655	1.630	0.104	-2.218	23.868	22.392	9.864	2.270	0.023	3.059	41.726

The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 9

Results of estimation of the equation of housing loans growth

	Before the Crisis						After the Crisis					
	Coef.	Std.	z	P>z	[95% Conf. Interv.]		Coef.	Std.	z	P>z	[95% Conf. Interv.]	
GLOANSH(-1)	0.287	0.200	1.430	0.152	-0.106	0.679	0.258	0.166	1.550	0.120	-0.067	0.583
SUPPLYF_HOUS(-2)	2.914	4.643	0.630	0.530	-6.186	12.015	-1.464	1.030	-1.420	0.155	-3.483	0.556
RH(-1)	-936.294	459.497	-2.040	0.042	-1836.890	-35.697	181.297	120.588	1.500	0.133	-55.051	417.644
dummies (mergers)												
_cons	70.820	41.954	1.690	0.091	-11.409	153.049	-1.647	9.198	-0.180	0.858	-19.676	16.381

The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 10

Results of estimation of the equation of housing loans growth. Survey data as regressors.

	Before the Crisis						After the Crisis					
	Coef.	Std.	z	P>z	[95% Conf. Interval]		Coef.	Std.	z	P>z	[95% Conf. Interval]	
SUPPLY_HOUS	-0.039	2.035	-0.020	0.985	-4.028	3.950	-0.612	1.390	-0.440	0.660	-3.336	2.113
DEMAND_HOUS	2.270	1.054	2.150	0.031	0.204	4.335	2.154	1.037	2.080	0.038	0.121	4.186
SUPPLYF_HOUS(-1)	-0.118	2.055	-0.060	0.954	-4.146	3.909	2.003	1.129	1.770	0.076	-0.211	4.216
DEMANDF_HOUS	2.564	1.811	1.420	0.157	-0.985	6.113	-2.058	1.163	-1.770	0.077	-4.338	0.222
dummies (mergers)												
_cons	-6.019	11.751	-0.510	0.608	-29.050	17.012	2.842	5.940	0.480	0.632	-8.801	14.485

The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 11
Results of estimation of the equation of consumer loans growth

	Before the Crisis						After the Crisis					
	Coef.	Std.	z	P>z	[95% Conf.Interval]		Coef.	Std.	z	P>z	[95% Conf.Interval]	
SUPPLY_CONS(-5)	4.243	1.886	2.250	0.025	0.545	7.940	3.993	2.000	2.000	0.046	0.073	7.913
DCSI	-0.746	0.331	-2.250	0.024	-1.395	-0.096	0.664	0.831	0.800	0.424	-0.964	2.292
rect	(omitted)						-23.764	17.590	-1.350	0.177	-58.240	10.711
dummies (mergers)												
_cons	-20.107	8.898	-2.260	0.024	-37.547	-2.667	16.815	14.384	1.170	0.242	-11.376	45.007

The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Table 12
Results of estimation of the equation of consumer loans growth. Survey data as regressors.

	before the Crisis						after the Crisis					
	Coef.	Std.	z	P>z	[95% Conf.Interval]		Coef.	Std.	z	P>z	[95% Conf. Interval]	
SUPPLY_CONS	-0.885	0.746	-1.190	0.235	-2.347	0.577	0.426	1.949	0.220	0.827	-3.395	4.247
DEMAND_CONS	2.191	0.652	3.360	0.001	0.914	3.468	0.586	2.371	0.250	0.805	-4.061	5.234
SUPPLYF_CONS(-1)	1.909	0.920	2.070	0.038	0.105	3.714	0.501	1.545	0.320	0.746	-2.527	3.529
DEMANDF_CONS(-1)	3.825	1.222	3.130	0.002	1.431	6.219	-0.203	1.592	-0.130	0.899	-3.323	2.917
dummies (mergers)												
_cons	-23.975	7.466	-3.210	0.001	-38.608	-9.342	-0.830	11.880	-0.070	0.944	-24.115	22.454

The Prais-Winsten estimator. The Huber/White/sandwich estimator of the covariance matrix of parameter estimates was used.

Figure 1

Banks' lending policy (credit standards) – corporate loans. Aggregated data from SLOS (net percent).

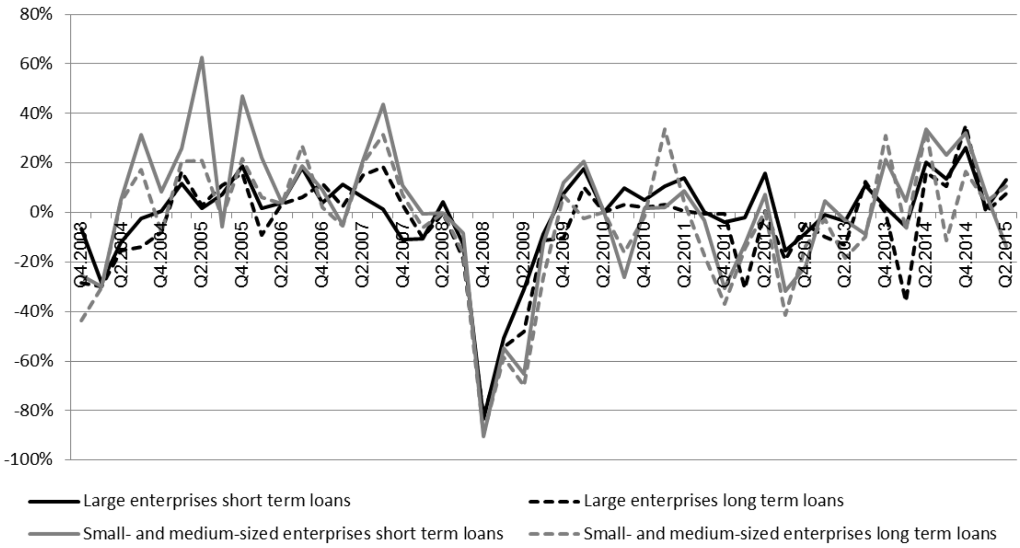


Figure 2

Banks' lending policy (credit standards) – loans for households. Aggregated data from SLOS (net percent).

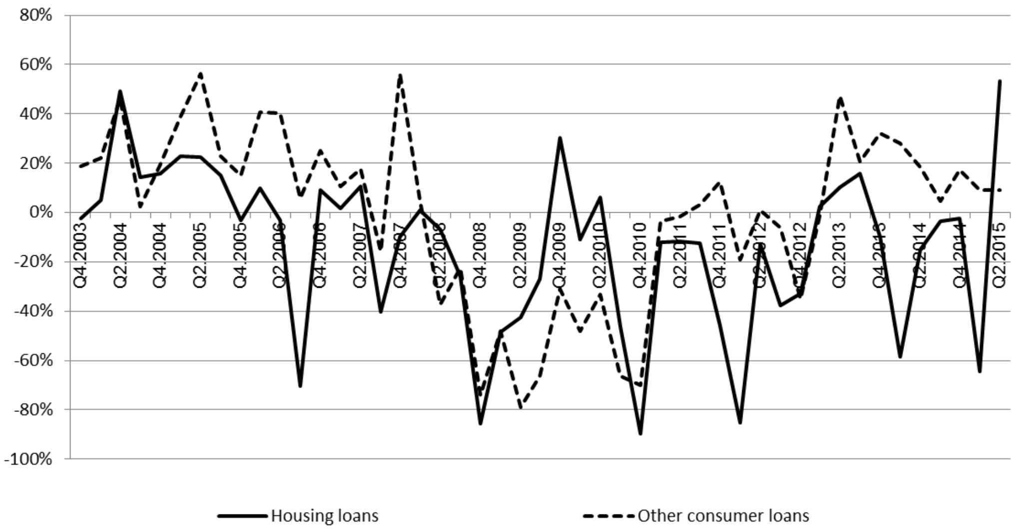


Figure 3

Banks' declared demand for corporate loans. Aggregated data from SLOS (net percent).

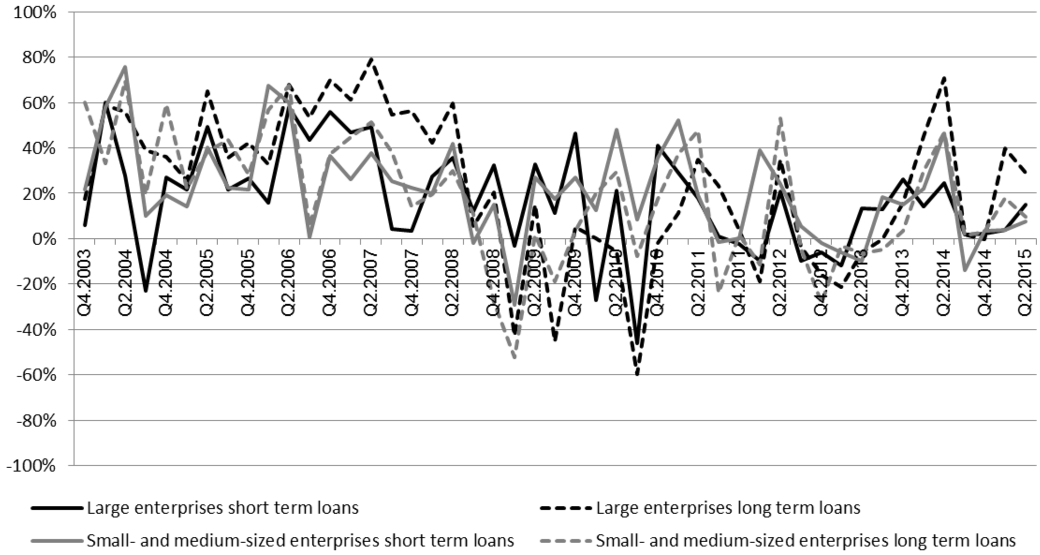


Figure 4

Banks' declared demand for loans for households. Aggregated data from SLOS (net percent).

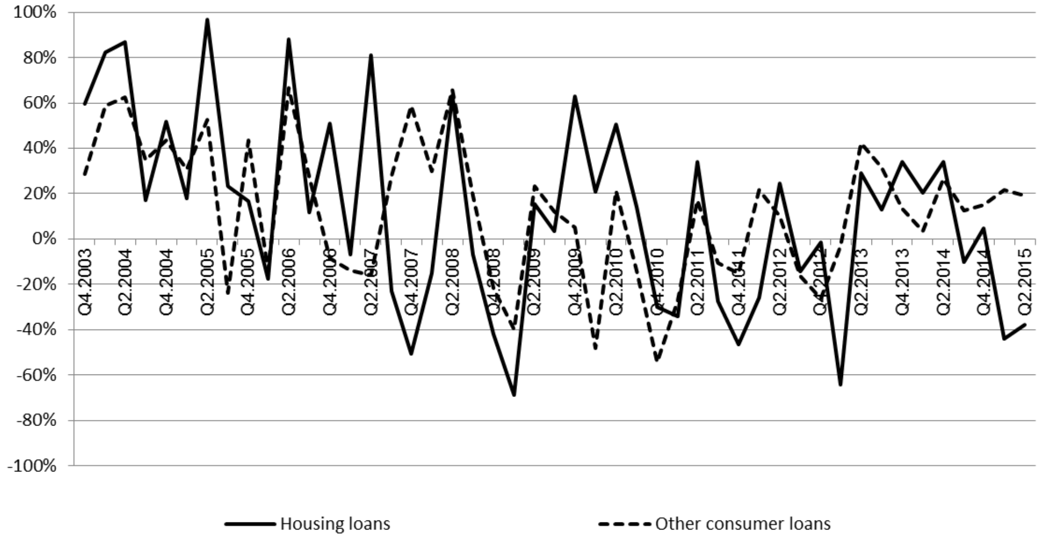


Figure 5

Estimated demand and supply of corporate loans versus historical corporate lending. Quarterly changes in zloty bln (left panel), yearly changes in zloty bln (right panel).

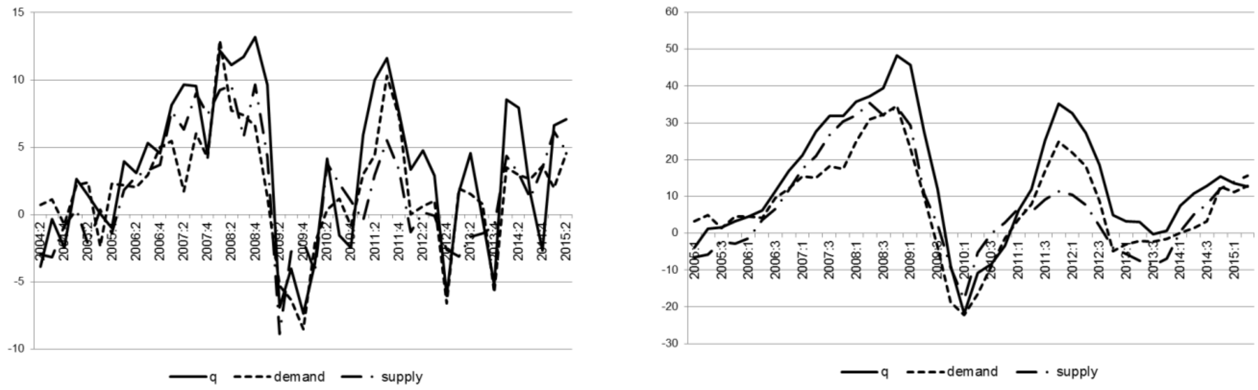


Figure 6

Estimated demand and supply of housing loans versus historical housing loans. Quarterly changes in zloty bln (left panel), yearly changes in zloty bln (right panel).

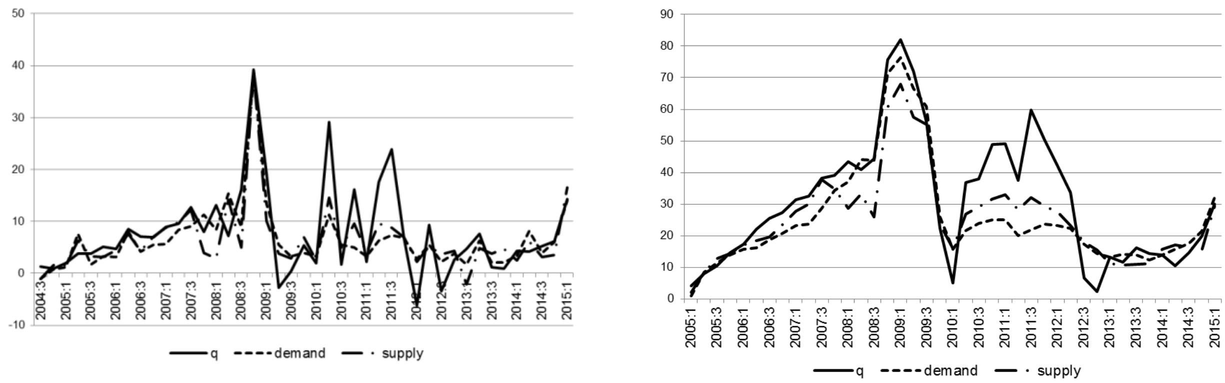


Figure 7

Estimated demand and supply of consumer loans versus historical consumer loans. Quarterly changes in zloty bln (left panel), yearly changes in zloty bln (right panel).

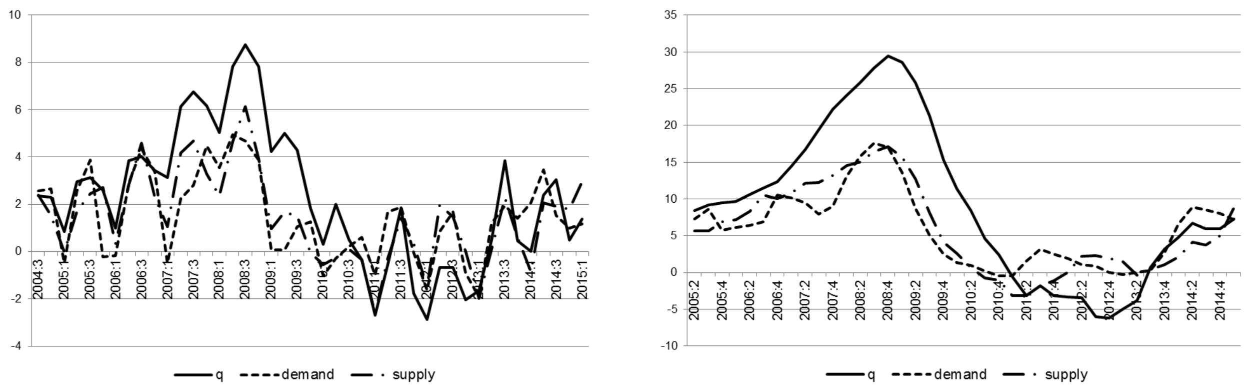


Figure 6

Estimated probability of demand and supply regimes – corporate loans.

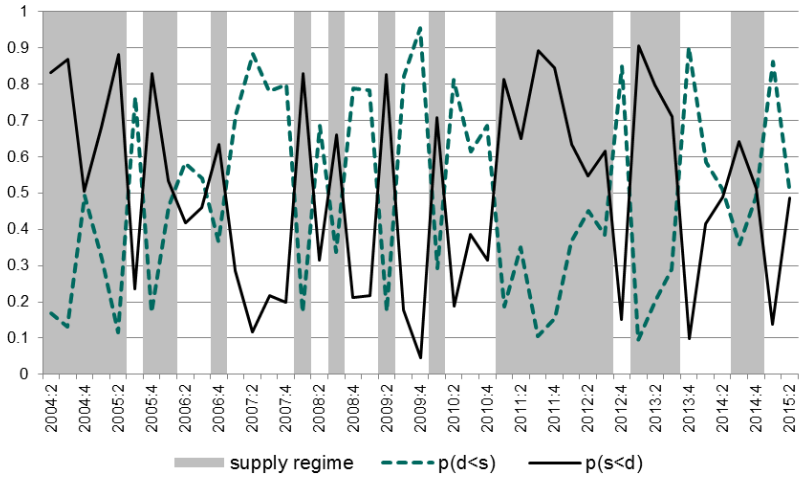


Figure 7

Estimated probability of demand and supply regimes – housing loans.

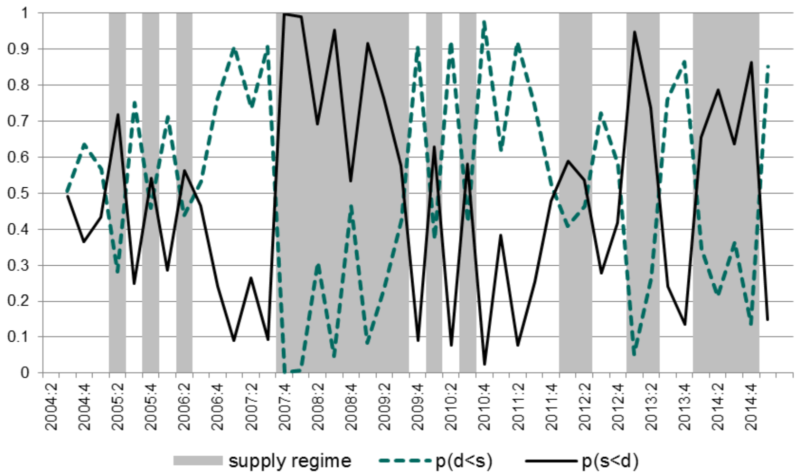
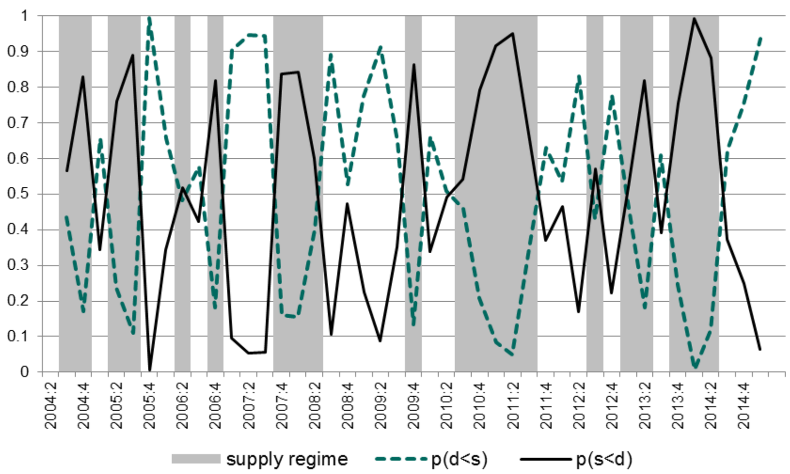


Figure 8

Estimated probability of demand and supply regimes – consumer loans.



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Network analysis using EMIR credit default swap data: Micro-level evidence from Irish-domiciled special purpose vehicles (SPVs)[1]

Kitty Moloney, Oisin Kenny and Neill Killeen,
Central Bank of Ireland

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 or the central banks and other institutions represented at the meeting.

Network analysis using EMIR credit default swap data:

Micro-level evidence from Irish domiciled special purpose vehicles (SPVs)

Oisin Kenny, Neill Killeen and Kitty Moloney[1]

Abstract

This paper analyses European Market Infrastructure Regulation (EMIR) trade repository data on credit default swaps (CDS) reported by a sample of domestic counterparties in Ireland. Using network analysis techniques, we explore to what extent these micro-level data can be used to improve regulators' understanding of the topology of the CDS network in Ireland. Despite data quality issues such as lack of information regarding duplicate trades and reference entities, we observe significant interconnectedness and concentration in the Irish CDS market. In particular, we focus on the derivative activities of special purpose vehicles (SPVs) as they are a key component of the shadow banking system. We identify SPVs who are net sellers of CDS contracts with linkages to regulated, non-domestic monetary financial institutions (MFIs). Overall, our analysis points to the importance of access to good quality micro-level regulatory data when monitoring financial stability risks.

[1] The views expressed in this paper are those of the authors and do not necessarily represent the views of the Central Bank of Ireland or the ESCB. We would like to thank Gareth Murphy, Ray Guthrie, Francisco Alcaraz-Garcia, Yann Le Dreff, Naoise Metadjer, Brian Godfrey, Billy Clarke, Eoin Cashin, Niamh Lynn, John Harte, Peter O'Mahony, Giuseppe Insalaco, Suzanne Power and Pierce Daly for helpful comments on earlier drafts. Corresponding author: kitty.moloney@centralbank.ie

Contents

1. Introduction

The global financial crisis highlighted the lack of transparency in the over-the-counter (OTC) derivative market and, in particular, the credit default swap (CDS) market. When the U.S. based investment bank Lehman Brothers collapsed in 2008, the lack of information on privately negotiated derivative contracts coupled with their complexity significantly increased uncertainty and counterparty credit risk. The inclusion of this previously discounted risk factor into market participants' models resulted in a sharp decline in market liquidity and led to contagion across a range of financial markets. Owing to these developments, G20 leaders agreed at the September 2009 summit in Pittsburgh that all OTC derivative contracts should be reported to a trade repository (TR) and that all standardised OTC derivative contracts should be cleared through a central counterparty (CCP).[2]

The European Union regulation on derivatives, central counterparties and trade repositories, the European Market Infrastructure Regulation (EMIR) introduces new reporting requirements to improve market transparency and reduce the risks associated with the derivatives market. The new regulation came into force in 2012 and requires counterparties that enter into any form of derivative contract to report transaction-level information to a TR.[3] EMIR provides an opportunity for regulators to map the OTC derivative market to monitor financial stability risks.

Financial counterparties (FCs) and non-financial counterparties (NFCs) are within scope of EMIR for reporting requirements.[4] Both parties to a derivative transaction must report the transaction to a TR.[5] There are three main additional requirements for NFCs engaging in derivative activity above a certain threshold (referred to as NFC+'s) and all FCs, although only one is currently in force (Nov. 2015).[6] They are required to mark-to-market or mark-to-model their outstanding positions on a daily basis and they shall be required to clear certain classes of

[2] Central counterparties are authorized entities which provide three main functions: clearing, settlement and custody.

[3] The reporting obligation for all asset classes began on 12 February 2014 and the clearing obligation for standardised products has yet to commence. There are six trade repositories currently registered with ESMA in accordance with EMIR. DTCC Derivatives Repository Ltd., Krajowy Depozyt Papierow Wartosciowych S.A, Regis-TR S.A., UnaVista Limited, CME Trade Repository Ltd., and ICE Trade Vault Europe Ltd.

[4] Financial counterparties are defined in Article 2 (8) EMIR as credit institutions, investment firms, investment funds (i.e. UCITS and alternative investment funds (AIFs)) or their management companies, institutions for occupational retirement provision (IORPs), and undertakings in insurance, assurance, and reinsurance. Non-EU AIFs are also included in this definition if their manager is authorised or registered in the EU. Non-financial counterparties are defined in Article 2 (9) EMIR as an undertaking established in the EU other than a CCP or a financial counterparty. These include small and medium-sized enterprises.

[5] One party can delegate their responsibility to the other counterparty. Where a clearing obligation exists, the trade can be reported by a CCP on behalf of both entities involved.

[6] EMIR introduces thresholds for the purpose of the clearing obligation. Based on gross notional values, the clearing thresholds for OTC derivatives are €1 billion for credit and equity derivatives and €3 billion for interest rate, foreign exchange, commodity derivatives, and other derivatives. If a firm or an undertaking surpasses one of these thresholds, they must inform ESMA and their regulator immediately. They must maintain their position above the threshold for a period of thirty working days to trigger the clearing obligation and they will then become a NFC+. If a firm or an undertaking exceeds one threshold for a particular derivative class, then they must clear all other classes of derivatives.

standardised derivatives such as plain vanilla interest rate swaps and CDS contracts through a central counterparty (CCP), and to apply risk mitigation techniques for derivatives that are not centrally cleared (e.g. post bilateral margins).[7]

Previous academic studies suggest that non-bank financial institutions play an important role in the market structure of the European CDS market (Clerc *et al.*, 2014). Motivated by this literature, we seek to examine whether micro-based EMIR data can be used to improve regulators' understanding of the topology of the CDS network in Ireland and to see if it can illustrate the activities of one sub-group within the financial sector, special purpose vehicles (SPVs). We note the limitations of the EMIR dataset (due to quality of reporting issues) and rather than focus too heavily on the full market network, we drill down into the SPV sub-sector as a case study of the financial system. SPVs are involved in a range of activities including securitisation, loan origination, and other financial activities. They are included under the measure of shadow banking applied by Ireland for the Financial Stability Board's Annual Monitoring Report 2015.[8] Interestingly, SPVs are currently classified as NFCs under EMIR. We analyse their activity within the EMIR dataset to see if the classification of SPVs as NFCs is appropriate.

This paper adds to the growing literature on financial networks and systemic risk. We extend the existing literature by focusing specifically on the Irish CDS market and on the CDS positions of shadow banking entities (SPVs) and their counterparties. Similar to the findings of Peltonen *et al.* (2014), we observe a scale-free degree distribution in the Irish CDS network whereby a high concentration of links exists amongst a core of several non-domestic monetary financial institutions (MFIs) and other financial intermediaries (OFIs) while other counterparties on the periphery transact with only a few nodes.[9] In addition, our analysis of micro-level data identifies SPVs as large net sellers of CDS contracts to non-domestic MFIs. These SPVs are components of the shadow banking sector in Ireland and are subject to limited regulatory oversight relative to, for example, collective investment schemes (Godfrey *et al.,* 2015). In terms of policy implications, our analysis points to the importance of incorporating new micro-level data when assessing potential sources of financial stability risk.

7 Central clearing of CDS, when implemented, may alleviate some of the counterparty risk externalities in OTC markets as the risk is centralised into the CCP (Acharya and Bisin, 2011).

8 The FSB (2014) defines shadow banking as *"credit intermediation involving entities and activities fully or partially outside of the regular banking system."*

9 A scale-free degree distribution follows a power law distribution where a few major nodes (hubs) are connected to a large number of nodes who have only a few connections themselves. Examples of a scale-free distribution in real-world networks are the internet and social networks. Links are also known as edges in the network literature. Monetary financial institutions (MFIs) are credit institutions, non-credit institutions (primarily money market funds), national central banks, and the ECB whose business takes deposits from entities other than MFIs and provides credit and/or investments in securities (ECB, 2015a).Other financial intermediaries (OFI) are corporations or quasi-corporations, except for insurance corporations and pension funds, that engage primarily in financial intermediation by way of incurring liabilities in forms other than currency, deposits, and/or close substitutes for deposits from institutional entities other than MFIs (ECB, 2015a). They include in particular those engaged primarily in long-term financing, such as corporations engaged in financial leasing, financial holding corporations, dealers in securities and derivatives (when dealing for their own account), venture capital corporations and development capital companies. As financial vehicle corporations (FVCs) and other SPVs typically engage in financial intermediation, they are normally included in the definition. However, for the purposes of this paper, we treat FVCs and other SPVs collectively as SPVs and separate them from other OFIs.

The rest of the paper is structured as follows. Section 2 discusses the role of CDS contracts during the financial crisis and situates our work within the existing literature. Section 3 presents the EMIR TR data used in our analysis and introduces the network analysis techniques applied. The results of our network analysis are presented in Section 4 along with a brief discussion on interconnectedness and potential systemic risks. Section 5 concludes.

2. The role of the CDS market during the financial crisis

2.1 Credit default swaps explained

A credit default swap (CDS) is an over-the-counter (OTC) credit derivative that protects the buyer against loss of principal (known as the notional) due to a specified reference entity experiencing a credit event (Mengle 2007).[10] In return for this protection, the buyer pays a periodic premium to the seller (known as the spread) until the end of the contract. If the reference entity experiences a credit event, the protection buyer can claim payment from the seller minus the recovery value of the underlying asset. CDS contracts were widely used prior to the crisis due to their liquidity relative to the reference entity's bonds, and their leverage (which enables large positions with little capital investment). CDS contracts and other derivatives were also used as hedging tools to reduce a bank's required regulatory capital or as part of a tax or accounting strategy to alter the treatment of a particular asset (Gregory 2012).

2.2 The role of the CDS market during the global financial crisis

Many factors contributed to the global financial crisis.[11] CDS exposures contributed to the propagation of shocks across financial markets and borders. As noted by the EU Commission (2009 p. 5):

> The near-collapse of Bear Sterns in March 2008, the default of Lehman Brothers on 15 September 2008 and the bail-out of AIG on 16 September highlighted the fact that OTC derivatives in general and credit derivatives in particular carry systemic implications for the financial market.

The opaqueness of the OTC derivative market, whereby information on privately negotiated contracts was only available to the contracting parties, engendered a great deal of uncertainty among market participants (Coudert and Gex, 2011). Systematic risk in the CDS market arises from the leverage and the concentration of positions in a few financial counterparties. This uncertainty coupled with the systematic risk in the CDS market served to significantly increase

10 A credit event typically occurs when the there is a default or some other activity, such as a restructuring of debt, which effects the market value of the reference entity's debt.

11 Reinhart and Rogoff (2009), Brunnermeier (2009), and Taylor (2009) provide succinct analyses of the global financial crisis.

counterparty credit risk in the financial system.[12] For example, in 2008 Lehman Brothers had almost half a trillion dollars' worth of CDS contracts written against its debt and held around 1.5 million CDS positions with around 8,000 unique counterparties while maintaining a single A credit rating (Gregory, 2012).

The collapse of two major CDS market participants in close succession made other participants acutely aware of their exposure to counterparty credit risk, leading to a flight to less risky assets and contagion in other markets. The high degree of interconnectedness in the CDS market made it more vulnerable to common shocks in the financial system and substantially increased the probability of systemic default risk (i.e. the probability that several financial institutions default simultaneously) as noted by Giglio (2011). Further compounding these factors was the failure of counterparty risk mitigation methods (e.g. posting collateral) and the failure of SPVs to function as intended (Gregory, 2012). The bailout of AIG illustrates the ease with which counterparty risk transforms into systemic risk. As a result, counterparty credit risk was at the centre of the regulatory response to the global financial crisis.

Arora *et al.* (2012) sets out the three main sources of counterparty credit risk in the CDS market. The first source of counterparty credit risk is the risk that the CDS seller is undercapitalized in the event of a credit event. The second risk is the risk that the CDS seller becomes insolvent and the buyer becomes a general unsecured creditor of the CDS seller. The third risk is the risk of a CDS buyer losing their claim on collateral posted by the seller in the event that the seller becomes insolvent and the collateral has been rehypothecated to another CDS buyer.

An additional source of counterparty credit risk is wrong-way risk, which arises when reference entities and sellers of CDS contracts become strongly correlated. It is when the credit quality of a reference entity is tied to that of the CDS counterparty's ability to pay (i.e. the exposure to the reference entity is high when the counterparty is more likely to default). Wrong-way risk is exacerbated in the CDS market due to the high level of concentration of counterparties and the common industry practice of using offsetting transactions. Peltonen *et al.* (2014) note that the CDS market is highly concentrated and dominated by financial counterparties. ECB (2009) suggest that the global financial crisis has further increased market concentration owing to the exit of some major CDS players such as Bear Stearns, Merrill Lynch, and Lehman Brothers. Further increasing wrong-way risk, the most traded CDS contracts have reference entities in the financial sector and this leaves the market vulnerable to double defaults. The case of Lehman Brothers illustrates the systemically destabilising effects of the default of both a major CDS dealer and a highly traded reference entity (Coudert and Gex, 2011). Furthermore, CDS market participants usually terminate positions or hedge their counterparty credit risk by entering into another transaction that has the opposite sign. These offsetting transactions reduce an individual counterparty's net exposure, but collectively create a complex web of exposures that ultimately increases counterparty credit risk. Counterparty risk mitigation techniques (i.e. bankruptcy remote vehicles and collateral) can themselves create other types of risk such liquidity, legal and operational risks (Gregory, 2012).

[12] According to Thompson (2010), counterparty credit risk can be defined "*as the risk that when a claim is made, the insurer will be unable to fulfil its obligations*."

Entrusted with the mandate of financial stability, regulators are responsible for mitigating counterparty credit risk as a component of systemic risk. A large body of literature has emerged since the global financial crisis focusing on the identification, measurement, and modelling of systemic risk. Systemic risk is jointly identified by the IMF, BIS and FSB (2009) as a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy. Of particular importance to regulators is the form of systemic risk that destabilises the financial system and precipitates macroeconomic downturns. Bisias *et al.* (2012) offers a comprehensive review of the landscape of tools designed to model this form of systemic risk. Our paper contributes to the growing literature on systemic risk by using network analysis as a tool to examine the interconnectedness of the Irish CDS market with particular emphasis on SPVs drawing on new regulatory data on derivative positions of Irish domiciled entities.

3. Data and network analysis

3.1 Data cleaning

As the EMIR trade repositories' databases are a new source of data, we outline in this section how we prepare the data and the limits of our dataset. EMIR trade repository data contain information on a CDS transaction's type, counterparties and reference entities along with other characteristics. In order to map the interconnectedness of the Irish CDS market, we use trade repository data reported under EMIR by a sample of Irish domiciled entities on 1 September 2015. These data are based on outstanding CDS transactions drawn from the six registered trade repositories.

Our raw sample contains 260,928 transactions. However, over 234,000 of these transactions involve two non-Irish counterparties trading in CDS contracts with a bespoke index or basket listed as the reference entity.[13] On this basis, we exclude these transactions from our initial dataset, which reduces to 26,294 positions. The dual reporting obligation of EMIR provides two reports of the same trade and we match and remove duplicate trades.

Our procedure for matching duplicate trades is as follows: first, we separate the European Economic Area (EEA) from the non-EEA transactions using the 'Trade with non-EEA counterparty' field (the latter will not have a matching trade as they are not required to report). Our initial dataset contains 19,328 trades between two EEA counterparties and 6,966 trades between EEA and non-EEA counterparties. Second, we rely primarily on the unique trade identifier (UTI) along with the contract's fundamental characteristics (i.e. counterparties and their trading capacities, notional values, reference entities, and maturity dates) to match the EEA trades. We find 6,449 CDS contracts that are reported by both counterparties using this method. In addition, we utilize the distribution of the notional amounts to discover 450

[13] TRs send these transactions to the Central Bank of Ireland as it cannot be surmised if the underlying reference entity is of Irish domicile.

positions with two different UTIs but the same fundamental characteristics.[14] Despite being able to pair 6,899 trades, we are unable to match 5,530 transactions as they are linked to only one UTI and have a notional amount that appears once or more than twice.[15] These trades may represent counterparties choosing different UTIs for the same contract or could indicate that the other counterparty has not yet reported the trade. Adding back in the non-EEA transactions, we arrive at a reduced sample of 19,395 unique CDS contracts. Unique trade identifiers provide a good starting point for identifying duplicate trades, but our analysis underscores the need for ensuring that each trade has one UTI and that the counterparties to a trade consistently populate this field with the same value.[16]

Prior to conducting our network analysis on the remaining 19,395 unique CDS contracts, we clean the data by examining the notional values for outliers and exclude transactions with unidentifiable values for counterparties and missing reference entities. Following Peltonen *et al.* (2014), we exclude 202 trades with gross notional values below €1,000 as this may reflect misreporting. After the removal of these outliers, we are left with €117.1 billion in gross notional. We are unable to identify 24 counterparties so we exclude the 232 CDS contracts attached to them. There are 3,858 trades that are omitted because they contain either no value or a placeholder value for the reference entity. Our total exclusions include 4,292 transactions. We see our final dataset as a sample rather than the full population.

3.2 Data categorisation and the netting process

As illustrated in Table 1 below, the cleaned dataset includes 15,103 unique CDS contracts reported by Irish domiciled companies on 1 September 2015. There are 373 counterparties or nodes in our sample that hold 1,875 bilateral positions with one another on 897 global reference entities. Due to inconsistencies of self-reporting in the EMIR data (see Annex 1) we divide the counterparties into 6 entity types: MFIs, OFIs (not including SPVs), SPVs, insurance companies (ICs), pension funds (PFs), and non-financial corporations (NFCs).[17] Counterparties trade in the CDS market with notional amounts denominated in nine different currencies: EUR, GBP, USD, JPY, AUD, IDR, COP, BRL, and NOK. Gross notional values are generally seen to overstate the actual levels of risk in the CDS market. This is because counterparties typically offset purchase and sale transactions to reduce their net exposures and thus their credit risk. Net notional values represent the net exposure

[14] We pair trades with only two transactions for a specific notional amount as long as they have the same counterparties trading in the same capacity, the same reference entity, and the same maturity date.

[15] We found over 500 transactions that have the same trade identifier, but have different underlying characteristics. We treat these transactions as unique contracts as they cannot be reliably identified as a pair by any of the other characteristics.

[16] In addition, the 'Action type' field would greatly assist regulators in identifying duplicate trades as it identifies trades as new, modifications, cancellations, or valuation updates. In our dataset this field is generally left blank.

[17] MFIs, ICs, PFs and OFIs are identified on financial regulator or central bank registers where relevant; SPVs are identified through the ECB register of FVCs or through the Central Bank of Ireland internal database if not found through these sources, all other entities are identified through publicly available information. Non-financial corporations are corporations or quasi-corporations that are not engaged in financial intermediation, but mostly produce goods and non-financial services (ECB, 2015b).

between CDS sellers and buyers. A caveat to this approach is that in liquidation, a counterparty may not offset positions; they may manage their claims in a more strategic manner. For the netting process, we are assuming that all counterparties follow the International Swaps and Derivatives Association (ISDA) Master Agreement and make good on the claims against them.[18]

Our netting process begins by rolling counterparties up to the counterparty family or holding group level (as outlined by DTCC, 2011). This changes the entity type for some of the nodes (e.g. an OFI may become a MFI at the group level). We then estimate the net notional value by offsetting purchase and sale positions by counterparty pair for each reference entity to arrive at one net buyer or net seller. There are 2,419 trades with unspecified reference entities and therefore we are unable to net these transactions owing to a lack of information on the specific index or basket underlying the contract.[19] Excluding these transactions removes approximately €37.4 billion in gross notional from our sample (almost half the gross notional in our sample dataset).[20] We net the remaining 12,431 unique CDS contracts with a gross notional value of €50.8 billion.[21] The number of contracts falls to 4,598 and the notional falls to €40.0 billion. This represents a net-over-gross notional ratio of 78.7 per cent. The ratio is high in comparison to other empirical papers.[22] This may be due to the netting process or to data quality issues as mentioned above.[23]

Next, we construct a sub-sample of derivative transactions reported by SPVs domiciled in Ireland. In total, there were 451 transactions reported by Irish domiciled SPVs. SPVs provide a useful case study for the examination of transaction-level CDS data as they are currently classified as NFCs under EMIR. While our sub-sample of SPVs is small (see Table 1), the network based on these data provides a useful insight into some of the OTC derivative activities of shadow banking entities.

18 The ISDA Master Agreement is used as a basis for most market participants' OTC derivatives contracts to dispel any legal uncertainties that may arise and to provide defined methods for mitigating counterparty risk. It specifies the general terms of the bilateral agreement with respect to, among other things, netting, collateral, and the definition of default and other termination events. The Master Agreement also ensures closeout netting in the event of a counterparty's default. Closeout netting allows for the immediate termination of all outstanding contracts between a counterparty and a defaulted institution and for the offsetting of the amount that is owed by each counterparty to each other to arrive at a single net payment to one counterparty. This process is favoured by market participants because it allows the surviving institution to immediately realise its gains against its losses on its positions with the defaulted counterparty and to place itself first in the bankruptcy queue for receiving its net payment (assuming its gains exceed its losses). See chapter 4 of Gregory (2012) for a more detailed discussion.

19 EMIR allows counterparties to enter an 'I' or a 'B' as the reference entity when the index or basket does not have a unique identifier such as an ISIN.

20 The breakdown of the figure is 2,299 indices with €33.4 billion in notional and 120 bespoke baskets with €4.0 billion in notional.

21 We remove 15 compression trades as these will become redundant once the netting is complete. Compression trades are multilateral netting agreements typically executed by a third party that reduce the number of trades and the gross notional amounts into a net notional position while maintaining the same risk profile of the trades.

22 Peltonen *et al.* (2014) compute a net-over-gross notional ratio of 8.2 per cent.

23 This is a further caveat of our results. We consider our results therefore as a sample of entity type interconnectedness rather than a presentation of the complete CDS network.

Our network analysis of derivative transactions is subject to a number of limitations. First, our dataset is a sub-sample of derivative transactions which renders our network incomplete. Network analysis of derivative positions of entities at a European or global level would allow for a more detailed analysis of systemic risks and the potential implications for financial stability. Second, our analysis includes outstanding derivative transactions on 1 September 2015 and therefore provides a snapshot of the CDS market topology at this point in time. Time-series data would allow for a more detailed analysis of the changing topology of the Irish CDS market. Third, as highlighted by Clerc *et al.* (2014), further information on netting and collateralisation would be required in order to assess fully the potential contagion paths and financial stability risks in the CDS market. Fourth, as detailed above, we observe significant data quality issues within our sample which restricts our network analysis. Many of the data limitations we experienced have also been highlighted by the FSB (2015) in their recent review of EMIR. Owing to these data availability and reporting issues, our network measures and results should be interpreted with a degree of caution.

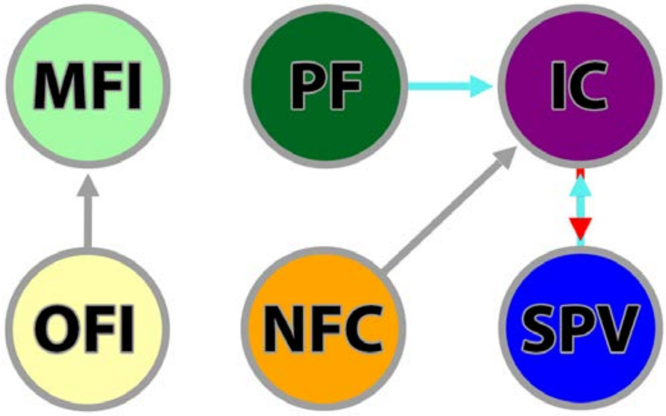
3.3 Network analysis

Network analysis allows researchers and regulators to map the interconnectedness of derivative transactions and their possible contagion paths. It also aids the understanding of systemic risk across a range of financial systems and sectors (Haldane, 2009; Bech and Atalay, 2010; Minoiu and Reyes, 2013; Clerc et al., 2014; Alves et al., 2015). From a regulatory and policy perspective, network analysis can be utilised to take a macro-view of a particular market in order to examine the topology of a network.

In our analysis, each counterparty to a CDS transaction is a node in the network. For example, if a SPV enters into a derivative transaction with a MFI, both the SPV and the MFI are listed as nodes in our network. Links between nodes are weighted and represent the sum of either the net value of CDS purchases or sales across one or several transactions. In line with previous studies in the literature, the links between nodes in our network are also directional (from the buyer of the CDS contract to the seller). If the arrow points towards the node, this indicates that the node is a net bilateral seller. Chart 1 illustrates these network analysis concepts.

Network Analysis Conventions

Chart 1



Note: We colour the nodes based upon the institution's publicly available industry classification. Light green nodes are MFIs, yellow are OFIs, dark green are PFs, purple are ICs, orange are non-financial corporates (NFCs), and blue are SPVs. The arrow pointing towards a node indicates that it is a net bilateral seller of CDS contracts for one or several reference entities. The arrow pointing away from a node indicates that it is a net bilateral buyer of CDS contracts from another node. The colour of the link represents the value of the sum of either the net bilateral buying positions or the sum of the net selling positions. Grey arrows are positions below €100 million, red are equal to or above €100 million and below €1 billion, and light blue are equal to or above €1 billion. Node size is proportional to the total exposure. As shown in Chart 1, the OFI is a net bilateral buyer of CDS contracts from the MFI. The net bilateral buying position is below €100 million (as indicated by the grey link) and represents the sum of the net buying positions across reference entities. The MFI only sells CDS contracts to the OFI and does not buy CDS contracts from any other node. The IC has a net bilateral selling position with the PF and the SPV for equal to or above €1 billion (light blue link). It also is a net seller of CDS contracts to the NFC for below €100 million (grey link). The IC is a net buyer of CDS contracts from the SPV for equal to or above €100 million and below €1 billion (red link). So it holds both a net bilateral buying position and a net bilateral selling position with the SPV. Just to note, the net multilateral position would be arrived at by offsetting the net bilateral buying position against the net bilateral selling position. The net multilateral positions are not shown on our graphs, but they are discussed in the results section (Table 3).

There are a growing number of academic studies which employ network analysis techniques in the economics and finance literature. For example, Minoiu and Reyes (2013) assess the dynamics of the global banking network using data on cross-border banking activities for 184 countries from 1978-2010. In an earlier study, Bech and Atalay (2010) explore the network topology of the federal funds market with banks acting as nodes and loans from one bank to another as the directed links. A small but growing literature has applied network analysis techniques to the CDS market. For example, Peltonen *et al.* (2014) show how the global CDS market has similar properties to the interbank market and is concentrated around fourteen major dealers. Clerc *et al.* (2014) examine the European CDS market structure and find that some non-bank financial counterparties are important players while Alves *et al.* (2015) employ network analysis techniques to examine the linkages of EU insurance groups.

We analyse our network based on a number of commonly used indicators. We first consider two simple measures of degree centrality: *degree* and *strength*. We compute *in-degree* as the number of incoming links which corresponds to nodes that are net bilateral CDS sellers. *Out-degree* is based on the number of outgoing links and represents nodes that are net bilateral CDS buyers. Adding up *in-* and *out-degree* yields the *degree* or the total number of net bilateral exposures. To capture the size of these net exposures, we use *strength*. *In-strength* represents the sum of the net bilateral selling positions with other counterparties while *out-strength* is estimated by summing the net bilateral buying positions.

Two common measures used in the literature to represent a node's interconnectedness are betweenness centrality and eigenvector centrality. *Betweenness centrality* can be used to measure how often a node appears on the shortest path between nodes in the network (Freeman, 1979). It allows the identification of major hubs in networks. *Eigenvector centrality* measures the importance of a node within a network by measuring the number of counterparties that are directly exposed to it and also takes into account all of the other counterparties that are indirectly exposed to a node through their links with these counterparties. Eigenvector centrality could be used to pinpoint systemically important nodes.[24] We normalise betweenness (to the betweenness index) and eigenvector centrality (to eigenvector centrality score) to ensure comparability across networks.

4. Results

4.1 CDS network visualisations

Chart 2 displays the gross notional position of the Irish CDS network at 1 September 2015. In terms of connectivity, we see that the network is quite concentrated with a number of key nodes at its core. The most connected nodes are seven non-domestic MFIs and one non-domestic OFI. As expected, these nodes are G16 dealers (i.e. the largest 16 derivative dealers worldwide, see Clerc *et al.* 2014 for the specific institutions) and globally systemically important banks (G-SIBs) with linkages to over a hundred counterparties.[25] The largest two dealers in the centre of the network are linked to 150 and 142 unique counterparties respectively. The circle of nodes outside the inner core of dealers is comprised of companies with a degree between ten and a hundred and nodes with less than ten links are on the perimeter of the network. The former group has one MFI and two OFIs with large CDS exposures (as denoted by the larger node size relate to their degree cohort). The majority of SPVs are on the outer layer of the network and do not appear to be highly interconnected players in the overall CDS network in Ireland. We do, however, observe a couple of MFIs and SPVs in the periphery of the network with few linkages but large total exposures.

Chart 3 examines the Irish CDS network after we introduce our netting procedure. We note that the number of nodes in the network falls owing to the merging of counterparties into group level as part of the netting process and due to perfectly offsetting positions. This illustrates the degree to which netting reduces risk in the CDS market and is consistent with the findings in the literature. The net network has mainly the same highly interconnected nodes as in the gross notional network.[26] Again, the majority of SPVs in the net network are in the outer layer. The

[24] Eigenvector centrality is defined mathematically as $\lambda v = Av$ where A is the adjacency matrix of the network graph, λ is a constant known as the eigenvalue, and v is the eigenvector of degree centrality. The x times x adjacency matrix (where x is the number of nodes) is formed by assigning a 1 to a node pair if there is a link between them and a 0 if there is no link. The eigenvector is a x times 1 vector containing each node's degree centrality.

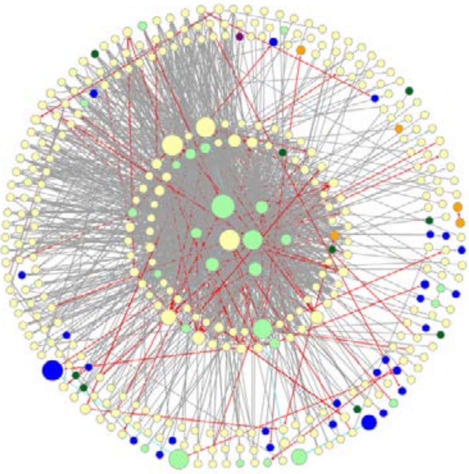
[25] The FSB releases an annual list of globally systemically important banks (FSB 2015b).

[26] The OFI in the gross network becomes a MFI in the net network due to netting based on counterparty family level.

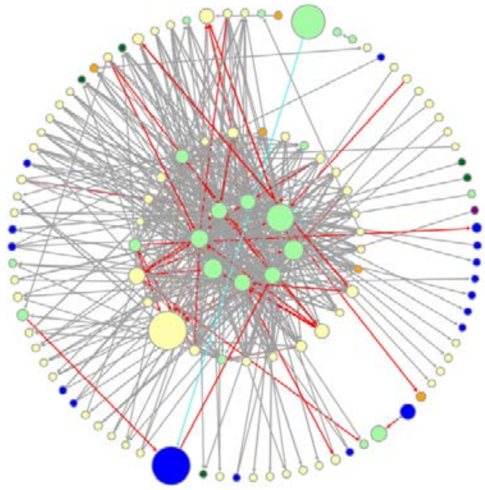
MFIs and SPVs identified on the periphery in the gross network remain in the same place in the net network, but their net CDS exposures are relatively larger than the inner core of dealers. We also observe a reduction in the number of OFIs with significant exposures in the middle circle of the net network.

Irish CDS Network

Gross Notional Outstanding Chart 2



Net Notional Outstanding Chart 3



Source: EMIR data from 1 September 2015 and authors' calculations.

4.2 Descriptive statistics

Table 1 displays the topology of the three networks: the gross, the net, and the net SPV network. Looking at the net networks, Irish domiciled institutions hold buying or selling positions in CDS contracts with, on average, five other counterparties while SPVs typically hold their positions with one other counterparty. The mean in- or out-strength in the net CDS market is €341.9 million (Table 1) whereas for the SPV network it is €401.6 million.[27] We note that the nodes in the Irish CDS network follow a fat-tailed (power law) degree distribution (similar to Clerc *et al.,* 2014 and Peltonen *et al.,* 2014).[28]

[27] Comparing SPVs' contracts to NFCs' contracts, we note that NFCs trade with on average 2 counterparties with an in- or out- strength of €40.5 million.

[28] This implies that a small number of counterparties are exposed to a large number of counterparties but the majority of counterparties are exposed to only a few counterparties. Using the Kolmogorov-Smirnov test, we fail to reject the null that the degree distribution follows a power law distribution at the 1 per cent significance level.

Topology of the Irish CDS Market

Table 1

	Gross	Net	Sub-Sample of Irish SPVs (Net)
Nodes	373	117	30
Links	1,875	619	36
Unique CDS Trades	15,103	4,598	360
Reference Entities	897	846	328
Density	1.4	4.6*	4.1*
Mean In- or Out-Degree (no. of links)	5.0	5.3	1.2
Mean In- or Out-Strength (size of link, €m)	238.2	341.9	401.6

Source: EMIR data from 1 September 2015 and authors' calculations. * Indicates that these density measures (ratio of actual to possible links) are high relative to other studies. In 2011, Clerc *et al* (2014) observe a density of 0.6 per cent for European reference entities and Peltonen *et al.* (2014) calculate a density of 0.5 per cent for global reference entities.

Table 2 below shows the top-10 counterparties in the Irish CDS market. For out-strength, G16 dealers are more present at the top of the rankings as there are three in the top five. There is only one G16 dealer ranked fifth out of the top ten institutions by net multilateral selling position, thereby corroborating the finding in the literature that the G16 dealers or the G-SIBs engage in a great deal of netting and have correspondingly low multilateral positions (Peltonen *et al.*, 2014 and Clerc *et al.*, 2014). The nodes with the largest in-degree are MFI 5 and MFI 12 who trade with 38 counterparties. Meanwhile, the nodes with the largest out-degree is MFI 6 who trades with 37 counterparties. The top nine nodes by in-degree are G16 dealers and G-SIBs as are the top eight by out-degree. These different metrics provide valuable supervisory information for the identification of risks to the financial system.

Top-10 counterparties in the Irish CDS market

Table 2

Rank	In-degree		Out-degree		In-strength (€ m)		Out-strength (€ m)		Net multilateral selling position (€ m)		Eigenvector centrality score	Betweenness index
1	MFI 5*	38	MFI 6*	37	OFI 22	8,548.2	OFI 16	7,349.6	OFI 22	8,390.1	MFI 5*	MFI 5*
2	MFI 12*	38	MFI 5*	35	SPV 19	8,268.3	MFI 5*	3,466.0	SPV 19	7,808.9	MFI 12*	MFI 10*
3	MFI 6*	36	MFI 41*	31	MFI 5*	2,222.4	MFI 9*	2,564.1	OFI 18	1,924.1	MFI 41*	MFI 6*
4	MFI 10*	34	MFI 12*	29	SPV 63	2,049.3	MFI 41*	2492.5	SPV 63	1,804.2	MFI 6*	MFI 12*
5	MFI 41*	32	MFI 10*	28	OFI 18	1,944.8	MFI 13	2,049.3	MFI 30*	565.2	MFI 9*	MFI 41*

6	MFI 7*	31	MFI 9*	28	MFI 12*	1,444.6	OFI 1	1,736.0	NFC 54	555.9	MFI 7*	MFI 7*
7	MFI 9*	30	MFI 8*	28	MFI 7*	1,172.6	MFI 12*	1,574.0	SPV 59	506.6	MFI 3*	MFI 8*
8	MFI 8*	27	MFI 3*	27	MFI 41*	1,097.6	MFI 8*	1,554.4	OFI 20	336.4	MFI 8*	MFI 9*
9	MFI 3*	26	OFI 1	18	MFI 10*	1,087.8	MFI 6*	1,494.1	OFI 46	239.0	OFI 22	OFI 22
10	OFI 22	14	OFI 4	13	MFI 6*	966.2	MFI 10*	1,484.4	OFI 23	89.0	MFI 10*	MFI 3*

Source: EMIR data from 1 September 2015 and authors' calculations. * Indicates the institution is a G-SIB and a G-16 dealer.

Table 3 displays the net multilateral positions and market shares of each sector in the Irish CDS market.[29] OFIs and SPVs are the dominant market participants on the sell side, holding a combined 93.2 per cent of the outstanding net multilateral positions in the market. On the buy side, we see MFIs as the largest market participant with a 78 per cent market share while OFIs represent 20.2 per cent of the market. In particular, we find ten SPVs holding net multilateral selling positions totalling €10.3 billion and seven SPVs are net multilateral buyers of CDS contracts for a total of €262.6 million in net notional. With regard to the distribution of net multilateral positions, the Irish CDS market is comprised of 61 per cent CDS contract buyers and 39 per cent CDS contract sellers, in comparison to the European CDS market, which is made up of 18 per cent net multilateral sellers and 82 per cent buyers according to Peltonen *et al.* (2014).

Net Multilateral Positions and Market Shares by Sector

Table 3

Sector	Net multilateral selling position (€ m)	Market share (%)	Sector	Net multilateral buying position (€ m)	Market share (%)
OFI	11,178.7	48.5	MFI	17,978.1	78.0
SPV	10,317.4	44.7	OFI	4,652.4	20.2
MFI	889.4	3.9	SPV	262.6	1.1
NFC	625.5	2.7	NFC	126.4	0.5
PF	47.1	0.2	IC	20.7	0.1
			PF	18.1	0.1

Note: EMIR data from 1 September 2015 and authors' calculations.

Overall, our network metrics suggest that the Irish CDS market is small and concentrated amongst a few key players while counterparties appear to be highly

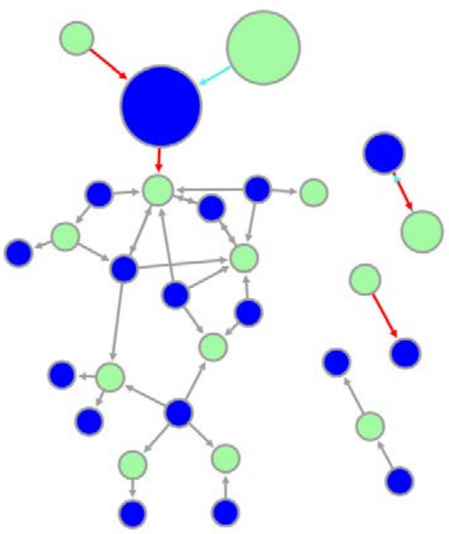
29 The net multilateral position is estimated by offsetting the net bilateral buying position against the net bilateral selling position. Thus a net multilateral selling position indicates that once offset the entity is a net seller. Due to the high asymmetry of CDS returns, net sellers can carry a disproportionate share of systemic counterparty risk in the CDS market (Clerc *et al.*, 2014). This risk can be intensified by inadequately capitalised protection sellers (Cont and Minca, 2014).

exposed to individual nodes reflecting a scale-free network. According to Callaway *et al.* (2000), scale-free networks are strongly resilient to the failure of any particular node. Therefore, if an institution were to fail, the probability of it being a dealer is small given the existence of a large number of nodes with low degree centrality. Even if a dealer or a hub were to fail, the CDS network structure and connectivity would largely remain intact due to the presence of the other dealers. However, the Irish CDS network is vulnerable to the simultaneous failure of a few major dealers, and it accordingly has the robust-yet-fragile property (Haldane 2009).

Next, we limit our network to a sub-sample of CDS transactions between SPVs and other counterparties. As shown in Chart 4, we observe significant interconnectedness between SPVs and non-domestic, regulated MFIs. While the network metrics employed in this paper point to a less interconnected network compared to the full sample of transactions, we see that some SPVs are net sellers of CDS contracts with a net notional of over €100 million and that these shadow banking entities are trading bilaterally with non-domestic regulated MFIs.[30] Given that these SPVs are subject to limited regulatory oversight, our analysis suggests that micro-based data such as EMIR trade repository data can be useful for examining potential contagion paths and risks to financial stability which may transmit from the shadow banking sector to the banking sector. In this light the categorisation of SPVs as NFCs in EMIR may need to be reviewed.

Irish CDS Network, Net Notional

SPVs Sub-Sample Chart 4



Source: EMIR data from 1 September 2015 and authors' calculations.

[30] This finding has been independently verified through the EMIR unit in the Central Bank of Ireland.

5. Conclusion

This paper examines the Irish CDS markets using new derivative transaction data arising from the implementation of EMIR. We highlight some of the limitations of the EMIR transaction data as it currently stands and suggest improvements. Ensuring that all counterparties agree and populate the trade ID field, the reference entity field, and the action type field would greatly assist regulators in matching duplicate trades and in the netting process. Due to the current limitations in the data, we treat our final dataset as a representative sample rather than as the full population of transactions.

Our analysis finds that the Irish CDS market is small and concentrated. Similar to the findings of Peltonen *et al.* (2014), we observe a scale-free degree distribution in the Irish CDS network whereby a high concentration of links exists amongst a few non-domestic MFIs and OFIs. In addition, our analysis of micro-level data identifies a number of SPVs who are large net sellers of CDS contracts with significant linkages to regulated non-domestic MFIs. These SPVs are non-bank financial institutions, components of the shadow banking system in Ireland, and categorised as NFCs under EMIR. We conclude that EMIR transaction data can be used to highlight activity for further investigation by market supervisors. On the whole, our analysis points to the importance of incorporating new micro-level data when assessing potential sources of financial stability risks arising from the shadow banking sector.

Annex 1: Inconsistencies of self-reporting in the EMIR data

Taking an initial look at the gross data, we observe some inconsistencies in the self-reporting of companies as to whether they are a financial counterparty (FC) or a non-financial counterparty (NFC). As shown in Table 5, FCs represent 54.2 per cent of total derivative trades in our final sample with NFCs representing 10.5 per cent. Under EMIR, only the reporting counterparty has to provide their classification (or a third party on behalf of the counterparty), and they are not required to classify the other counterparty to the transaction. In 24.3 per cent of trades the other counterparty is not classified. For example, only 10 of the 31 SPVs with outstanding CDS positions were required to fill out their status and of these, 6 identified as NFCs, 3 as FCs, and 1 as both a FC and a NFC. In total 4.7 per cent of counterparties report as a FC in some transactions and as a NFC in others. The 'Corporate sector of the counterparty' field might supplement these inconsistencies and provide more information on the nature of the companies' activities, but it is unreported for many transactions. Therefore, we introduce our own classifications as set out below in section 4.2. These classifications are consistent with publicly available information and provide more insight into the functions of the companies involved in CDS transactions rather than the binary classification under EMIR (i.e. FC or NFC).

Classifications of counterparties and other counterparties in EMIR transaction data

Table 5

Classification	Percentage
Financial Counterparty	54.2
Non-Financial Counterparty	10.5
Financial & Non-Financial Counterparty	4.7
N/A (Always other counterparty)	24.3
Financial Counterparty & Blank	4.3
Financial Counterparty, Non-Financial Counterparty & Blank	1.0
Non-Financial Counterparty & Blank	0.8
Blank	0.2

Source: EMIR data from 1 September 2015 and authors' calculations. The other counterparty has no obligation to identify itself under EMIR, and N/A refers to counterparties that are always the other counterparty for all their transactions.

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Fluctuations of cross-border portfolio investment flows caused by Japan's mutual funds: Fund-level micro data analysis[1]

Naoto Osawa, Bank of Japan

[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 or the central banks and other institutions represented at the meeting.

Fluctuations of Cross-Border Portfolio Investment Flows Caused by Japan's Mutual Funds: Fund-level Micro Data Analysis

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Abstract

In the highly globalized current financial world, analyzing financial stability issues in one country requires better understanding of portfolio investment inflows from abroad. For example, searching for yield European global banks took a significant risk by heavily investing in MBS in the US, significantly contributing to the boom and bust cycle of US subprime markets, which led to the Global Financial Crisis (GFC). Despite traditionally playing a non-dominant role in cross-border transactions unlike institutional investors such as global banks and life insurance companies, similarly in Japan, searching for yield mutual funds (MFs) of their unique monthly distributing type which paid out a pre-determined amount of distributions regardless of funds performance took a significant risk, inevitably selling their foreign assets to generate cash for distributions following GFC – a built in mechanism of pro-cyclical fire sale. This paper uses individual fund-level micro data to analyze a role Japan's MFs played in fluctuations of cross-border portfolio investment flows since 2000. Contrary to the existing macro data of Balance of Payments statistics, micro data, in addition to solving the third party problem, help to identify and assess the magnitude of the fire sale by providing information on individual funds' transactions such as purchases, redemptions, distributions, and share prices.

Keywords: monthly distributing mutual funds; distributions from the principal; fire sale of assets

* The author is grateful to colleagues at the Bank of Japan for their comments and suggestions. The views expressed in this paper are those of the author and do not necessarily reflect the views of the Bank of Japan or its staff members.

1. Introduction

Cross-border portfolio investment flows played a significant role in the credit boom and bust cycle, and the subsequent Global Financial Crisis (GFC) during the 2000s. In the highly globalized current financial world, analyzing financial stability issues in one country requires better understanding of portfolio investment inflows from abroad.

For example, according to Shin (2011), European global banks, searching for yield, took a significant risk and channeled portfolio investment flows, funded in the wholesale funding market via MMFs by issuing CDs, CPs and ABCPs in the US, into MBS and other structured products in the US. These cross-border portfolio investment flows, in addition to a traditional intermediation role between savers and borrowers within the US, raised the leverage in the mortgage market in the US, by expanding the balance sheet of European global banks via cross-border transactions. Those cross-border transactions significantly exacerbated the buildup and unwinding of credit and the market collapse, contributing to the boom and bust cycle of US subprime housing loan markets.

Risk of Cross-Border Portfolio Investment Flows

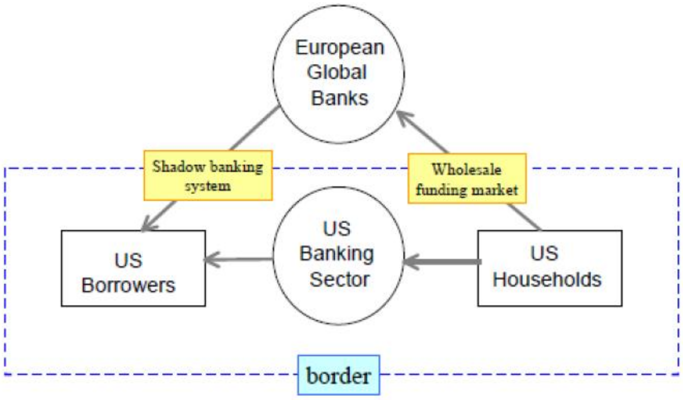


Figure 1. European global banks add intermediation capacity for connecting US savers and borrowers

Source: Shin (2011), Author

The above example of European global banks' risk taking behavior exacerbated by their leveraging reflected a traditionally dominant role played in cross-border portfolio investment flows by institutional investors such as global banks and life insurance companies. While mutual funds (MFs), a traditionally non-dominant player in cross-border transactions, had not typically built up significant financial risks due to no leveraging, investment flows of Japan's MFs on behalf of searching for yield individual investors in the form of cross-border portfolio investment – similarly destabilizing albeit not to the extent of Europe – contributed to fluctuations of securities markets in major advanced and emerging economies. This reflected increasingly popular monthly distributing type of MFs which pay out pre-determined amount of distributions regardless of funds performance. Given the amount of distributions, poor market performance forced MFs to sell their assets to generate cash for distributions – a built in mechanism of pro-cyclical fire sale. In particular, as most assets were concentrated in foreign securities denominated in foreign currencies, a sharp appreciation of yen in the aftermath of GFC reduced net asset value of MFs, causing a sharp disposition of cross-border portfolio investment flows by MFs and destabilizing foreign securities markets. Although the fire sale has sharply declined following yen's sharp reversal of its course since late 2012, the stock of assets in monthly distributing MFs remains substantially high and rising against the background of the rising elderly population who demand steady monthly distributions, posing a significant risk to securities markets in advanced and emerging market economics going forward.

This paper, by using individual fund-level micro data of disclosed financial statements, analyzes a role Japan's MFs played in fluctuations of cross-border portfolio investment flows since 2000. Using micro data makes it possible to address the following two issues which the existing aggregate-level macro data, ie, Balance of Payments (BOP) statistics, cannot. First, micro data provide information on individual funds' assets which are invested via third locations such as tax haven Cayman Islands, giving an answer to the third party problem where the true asset holder cannot be identified in cross-border statistics. Second, micro data provide information on individual funds' transactions such as purchases, redemptions, distributions, and share prices, assessing how investors behave in relation to market movements (eg, buying shares when prices increase or buying when prices decline). This in turn makes it possible to identify and assess the magnitude of fire sale of assets by MFs which are estimated at 3-4 trillion yen (or 37.5-50 billion US dollars).

The rest of the paper is organized as follows. Section 2 explains limitations of aggregate data for risk analyses, in particular associated with mutual funds, and usefulness of micro data which can address those limitations. Section 3 introduces a unique example of mutual funds in Japan embedded with a financial stability risk and describes how using micro data can quantify the magnitude of fire sale. Section 4 concludes the paper by drawing implications for other East Asian countries.

2. Usefulness of Micro Data

While in recent years cross-border portfolio investment flows have been increasingly playing a significant role in global financial stability, aggregate data – ie, BOP statistics even with its recent upgrade from BPM5 to BPM6 – have not satisfactorily filled data gaps, still posing significant challenges to statisticians and analysts. BOP statistics have mainly two limitations for risk analyses. First, recording only immediate destination countries/regions of cross-border transactions, BOP statistics do not provide information on ultimate holders of assets when transactions are further made via the immediate location to the third location – the third party problem. For example, most of investment fund shares/units held by the Other Financial Corporations in Japan which include mutual funds are reported in BOP statistics to be invested in tax haven Cayman Island whose share is 55.3% of total assets (see the table below). Contrary to this figure, many MFs in Japan hold their assets through fund of funds whose assets are invested in major advanced and emerging market economies. Second, BOP statistics at the aggregate level do not provide information on individual transactions such as quantities and prices which are useful to analyze investors' decision-making processes.

Stocks of Investment Fund Shares/Units by Regions

(end 2014, trillion yen)

Regions	Central Bank	General Gov't	Deposit-taking Corp	Other Financial Corp	Non-financial Corp, HHs	Total
USA	-	-	1.9	8.0	0.2	10.1
Cayman Island	-	0.0	11.0	32.2	2.4	45.7
Luxembourg	-	0.0	0.4	8.4	2.8	11.6
Others	-	0.0	1.5	9.6	0.9	11.8
Total	-	0.0	14.8	58.2	6.3	79.2

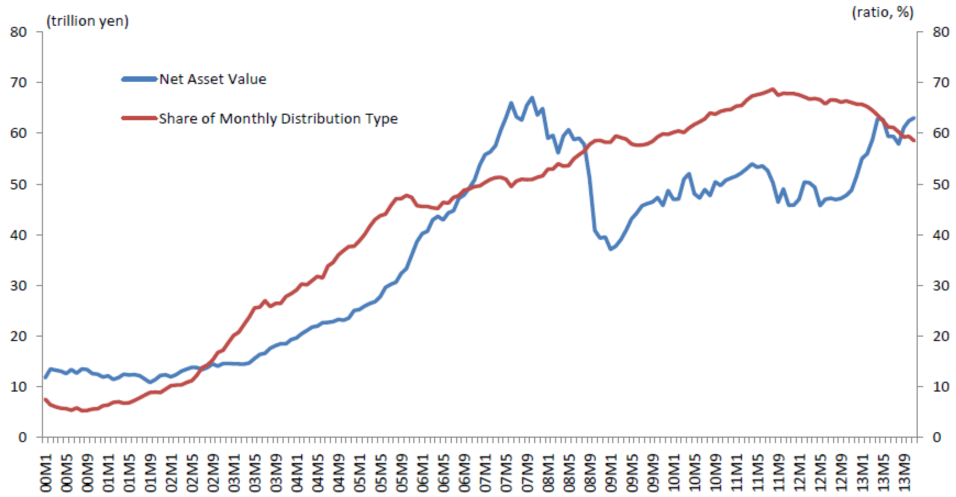
Source: BPM6

Using micro data makes it possible to address the above two issues. First, micro data provide information on individual funds' assets with ultimate holders, solving the third party problem. Second, micro data provide information on individual funds' transactions such as purchases, redemptions, distributions and share prices, assessing how investors behave in relation to market movements – for example, whether investors buy shares when prices increase, ie, pro-cyclical, or whether investors buy shares when prices decline, ie, counter-cyclical. In fact, analyzing micro data reveals that Japan's MFs investing in foreign securities are largely a monthly distributing type, selling their assets pro-cyclically and posing a financial stability risk as explained in detail in the next section.

3. A Unique Type of Mutual Funds in Japan: Monthly Distributing Funds (Background)

There exists a very unique type of MFs in Japan which in recent years have paid out a considerable portion of distributions from the principal, but not from a typical source of income gains (that is, interest and dividends) and capital gains.[1] This type of fund investment strategy has been commonly observed in increasingly popular monthly distributing MFs whose main characteristics are as follows: 1) their assets are predominantly concentrated in foreign-currency denominated bonds to aim for higher returns under the super-low interest rate environment in Japan's domestic market; and 2) distributions are pre-determined and paid out every month (eg, 1% return per month = 12% return per year). Monthly distributions are perceived by investors as substitutes for interest income generated from bank deposits under high-interest rate environment in the past, especially the 1980s, and thus used as supplements to non-labor income and pension payouts, particularly for the elderly, covering living expenses.[2] This type of MFs has perfectly fulfilled investment needs by the elderly and its assets have naturally been increasing given the fast aging population in Japan. Nonetheless, this type of MFs is intrinsically embedded with a financial stability risk as explained below.

NAV of Mutual Funds and Share of Monthly Distributing Type



Note: Publicly offered mutual funds.
Source: Investment Trust Association, Japan

[1] As for terms used in this paper, distributions from income gains refer to investment income that comprises interest (income on debt) and dividends (income on equity) while distributions from capital gains refer to payments distributed from capital gains.

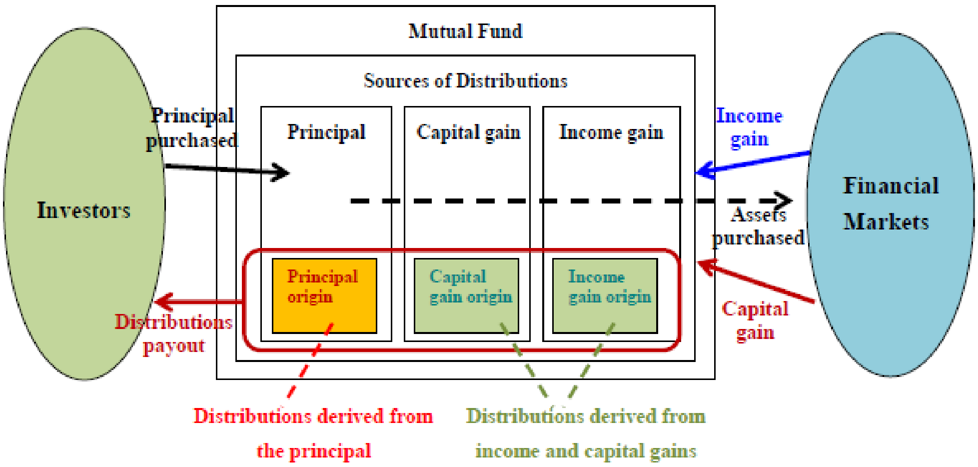
[2] As general observations, the elderly who depend on pension payouts relative to the younger generation prefers monthly distributing MFs more than the younger generation, and the former owns more MFs in asset value than the latter. In tandem with the rapidly aging population in Japan, monthly distribution type MFs have become increasingly popular in society as a whole. In fact, the share of monthly distributing MFs rapidly increased from about 10% of the net asset value of non-MMF MFs in 2000 to about 70% in 2011.

(Sources of Distributions)

MFs are collective investment schemes that raise funds by issuing shares or units to investors and invest the proceeds predominantly in financial assets and in nonfinancial assets. While many types of MF (e.g., open-end or closed-end, active or passive, global or dedicated) exist, the role of MFs as investment vehicles or conduits is universal across fund types in that MFs raise funds from investors, invest the proceeds mainly in securities, and distribute payments to investors.

The mechanism of distributions from the principal can be understood by noting how MFs can pay out distributions from three different sources in Japan: income gains, capital gains, and (part of) the principal. On one hand, "typical" distributions come from income gains and capital gains, which are generated from financial assets – investment returns flowing into the MF sector from the financial market are offset by distributions flowing out of the MF sector. On the other hand, "peculiar" distributions come from the principal where MFs are required to sell their financial assets to generate proceeds which can be distributed to investors. In this case, while no investment returns are flowing in, the MF sector pays out distributions, depleting the principal.

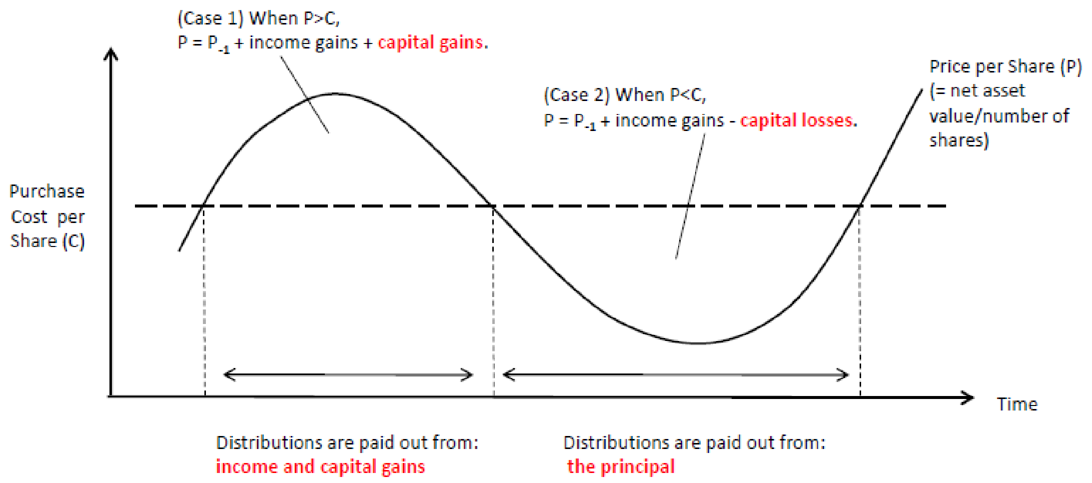
Sources of Distributions



(Estimation Method of Distributions from the Principal)

Conditions under which distributions from the principal come about, conceptually, depend on the relationship between the price per share (= net asset value/number of shares; hereafter, the share price) and the average purchase cost per share (= principal/number of shares; hereafter, the average cost). The underlying concept is to consider distributions as "typical" in the sense that the MF pays out distributions when generating "money" (e.g., income gains and capital gains) represented by the case – case 1 in the diagram below – when the share price is above the average cost; and, in contrast, to consider distributions as "peculiar" in a sense that the MF pays out distributions even when losing "money" (e.g., capital losses) represented by the case – case 2 in the diagram below – when the share price is below the average cost.[3,4] If the amount of total distributions which are divided between "typical" and "peculiar" is pre-determined, the less income and capital gains a MF generate (ie, a MF performs poorly in the financial market), the more distributions from the principal are paid out – the larger the share of "peculiar" distributions.

Concept of Distributions from the Principal (Simplified Illustration)



(Risk of Monthly Distributing Mutual Funds)

Analyzing micro data reveals that Japan's MFs investing in foreign securities are largely a monthly distributing funds type which commits to pay out a pre-determined amount of distributions every month irrespective of funds performance. On one hand, as

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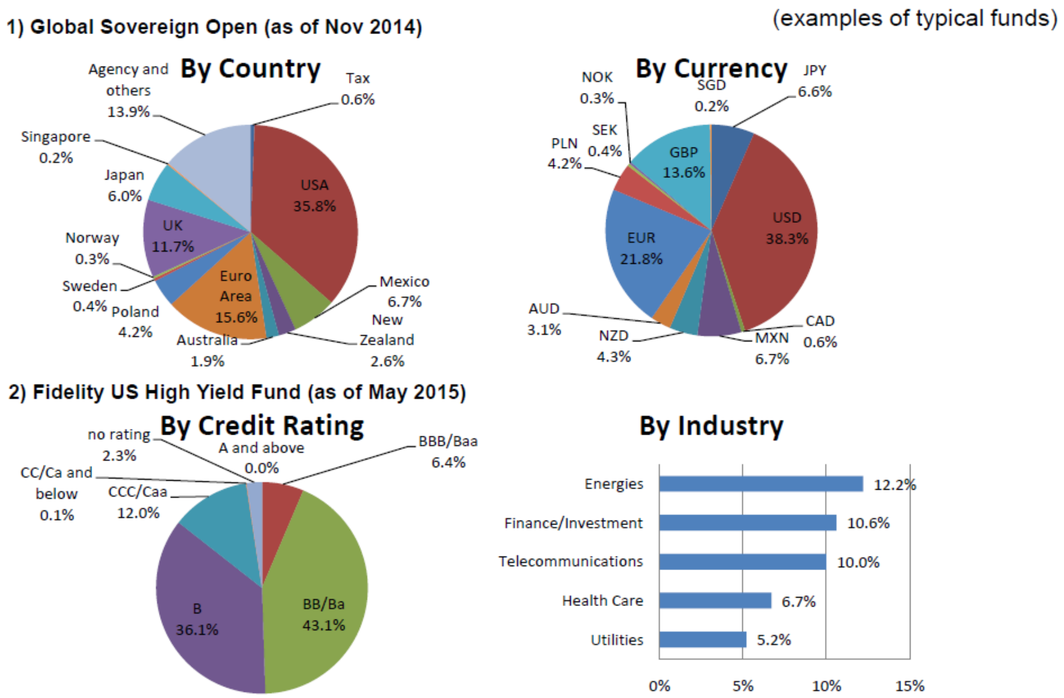
[3] This estimation method makes use of the average purchase cost <u>at the individual mutual fund level</u>. In fact, it is rather common <u>at the individual investor level</u> which taxable income is determined by the relationship between the share price and the average cost. For example, when investors redeem shares, if the share price is above the average cost, the difference between the proceeds from redemption and the principal (= average purchase cost times number of shares) will be taxed. On the contrary, if the share price is below the average cost, the proceeds from redemption are smaller than the principal, and thus no proceeds will be taxed because investors "lost their money" from the investment.

[4] Note that those simplified illustrations do not take into account an impact of distributions payout which reduces the share price by the same magnitude—the share price, calculated as net asset value divided by number of shares, declines after the distribution is paid out. Refer to Osawa (2015) for details.

mentioned earlier, this type of MFs would perfectly fulfill investment needs by the elderly whose income gains generated from their financial assets have declined under zero-interest rate environment in Japan. On the other hand, when fund performance deteriorates, fund asset managers are forced to sell assets to generate cash which is used to pay out distributions if income gains and capital gains are not sufficient to cover pre-determined distributions, redistributing the principal to investors (withdrawal of capital). That is, when funds perform poorly, in addition to investors' "intentional" sale of assets, fire sale ("unintentional" sale from an investors' perspective) by fund asset managers to generate cash for distributions operates as an accelerator for cross-border portfolio investment flows fluctuations. In fact, the collapse of low grade securities markets in the US and Europe in 2008, coupled with concurrent Japanese yen's sharp appreciation against US dollar and euro contributing to sharp NAV declines in yen term, triggered the fire sale, resulting in a substantial reversal of Japan's cross-border portfolio investment outflows. Note that as assets for monthly distributing MFs are concentrated in foreign securities (mainly bonds and investment fund shares) denominated in foreign currencies, fire sale assets of monthly distributing MFs which are approximated by distributions from the principal are considered as mostly cross-border portfolio investment (see examples of typical funds for their asset compositions below).

Disclosed Information on Asset Composition

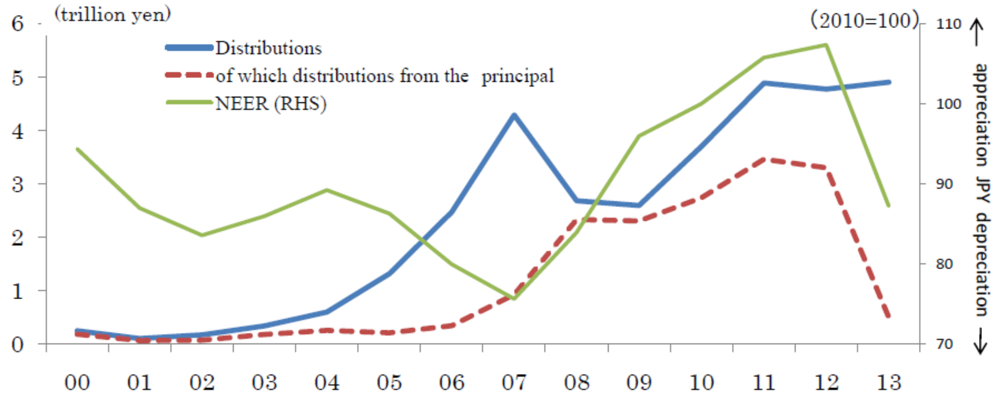


Source: Individual Funds' Financial Statements

(Estimation of Fire Sale Following GFC)

Analyzing monthly micro data of about 5,000 individual (publicly offered) MFs shows that the magnitude of fire sale is in recent years estimated at 3-4 trillion yen at an annualized rate (or 37.5-50 billion US dollars). Noting that most fire sale assets are denominated in foreign currencies, principally US dollars, analyzing an impact of exchange rate fluctuations also indicates that an appreciation of 10 Japanese yen against US dollar is estimated to increase the fire sale of cross-border portfolio investment flows by about 0.5 trillion yen at an annualized rate (or 6 billion US dollars).[5]

Fire Sale of Assets and Exchange Rate

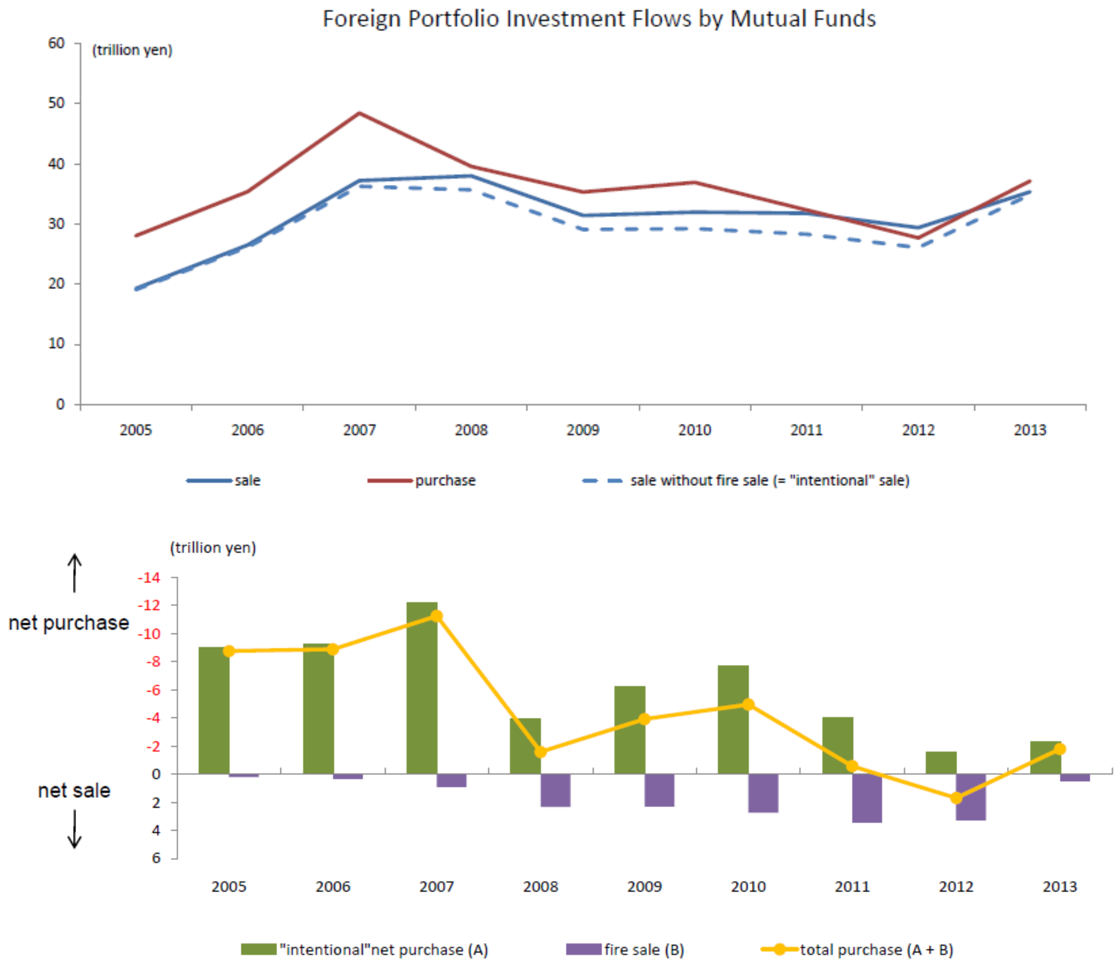


Note: Distributions from the principal are calculated from over 5,000 individual funds and aggregated. NEER = Nominal Effective Exchange Rate. Almost all distributions from the principal come from monthly distributing MFs whose assets are predominantly concentrated in foreign securities denominated in foreign currencies.
Source: Osawa (2015), BIS

With respect to relative size of the fire sale to cross-border portfolio investment flows in BOP statistics, the size of the fire sale is about 10% of sale in level terms – without the fire sale, the level of sale would have been smaller by that amount, making net purchase larger and overseas' securities markets less volatile. In terms of net purchase/sale, the size of the fire sale is equivalent to "intentional" net purchase (=net purchase without the fire sale, ie, the amount of net purchase that would have been purchased without the fire sale) and sometimes even larger. This increasing role of individual investors via MFs presents a significant change in cross-border portfolio investment flows where institutional investors such as banks and life insurance companies have traditionally played the dominant role.

[5] Those estimates are based on OLS regression results from distributions from the principal as a dependant variable and JPY/USD exchange rate as an independent variable, controlling for equity prices and bond prices.

Relative Size of Fire Sale to BOP



Note: Negative sign of net purchase indicates net acquisition of foreign assets.
Total Portfolio investment (BPM5) = equity + long-term debt securities (including investment fund shares) + short-term debt securities.
Total purchase appears as a BOP official statistic.
Source: BPM5, Osawa (2015)

4. Concluding Remarks

This paper uses micro data for financial stability analyses, presenting a unique example of monthly distributing mutual funds in Japan which pay out a pre-determined amount of distributions regardless of fund performance and thus contain a mechanism of pro-cyclical fire sale of foreign assets although in general no financial stability risk is embedded with mutual funds due to no leveraging. The analysis indicates that the fire sale sharply increased following a sharp appreciation of Japanese yen in the aftermath of the Global Financial Crisis, which significantly reduced net asset value of mutual funds, to generate cash for distributions, destabilizing foreign securities markets.

Going forward, although the fire sale has sharply declined following yen's sharp reversal of its course since late 2012, the stock of assets in monthly distributing mutual funds remains substantially high and rising against the background of the rising elderly population, posing a significant risk to securities markets in advanced and emerging market economics. In addition, in East Asia besides Japan, this type of monthly distributing funds is widely sold in countries such as South Korea and Taiwan which also experience an aging population, and could potentially increase in other countries which run current account surplus and thus hold foreign financial assets. Since this type of mutual funds could contribute to a wide swing of cross-border portfolio investment flows to the US and Europe in tandem with foreign exchange and securities markets fluctuations, assessing financial stability risks would greatly benefit from individual fund-level micro data of mutual funds.

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Discussion of session 4 on
"Entity-level credit information transformed into knowledge about macro stability threats"[1]

Maciej Piechocki, BearingPoint

[1] The views expressed are those of the author and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

Discussion on Session 4: Entity-level credit information transformed into knowledge about macro stability threats

Dr. Maciej Piechocki
Warsaw
December 2015

BearingPoint.

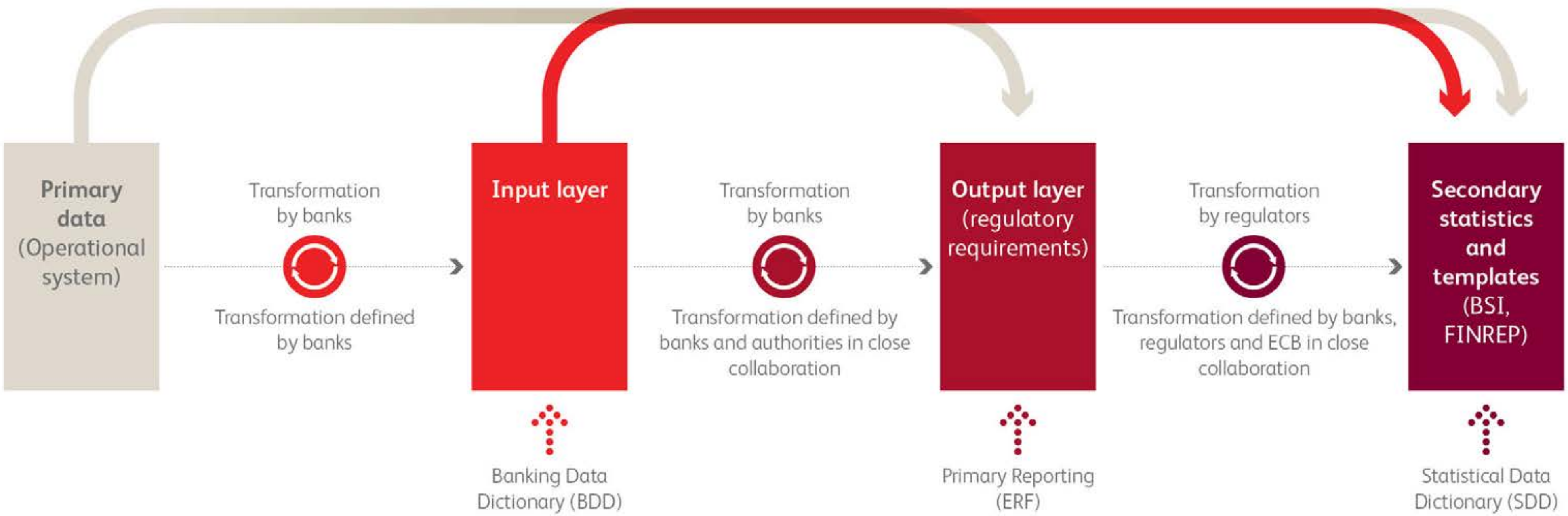
Overview of papers

Entity-level information requirements, approach, covered market and research results

	Kenny et al.	Osawa	Nehrebecka	Wosko	Cadete de Matos
Information requirement	• EMIR	• Public disclosure	• Public disclosure • Prudential reporting • Legal reporting	• n/a	• CCR data
Approach	• Network analysis	• OLS regression	• Logistic regression	• Panel regression	• Various methods
Market	• Irish CDS	• Japanese monthly distributing mutual funds (MFS)	• Polish non-financial corporations	• Polish credit market	• Portuguese economy
Results	• Interconnected-ness • Concentration	• No systemic risk • Pro-cyclical fire sales of foreign assets	• PD estimates	• Credit determinants	• Better economic analysis • Quality control

Value chain of entity level (credit) information

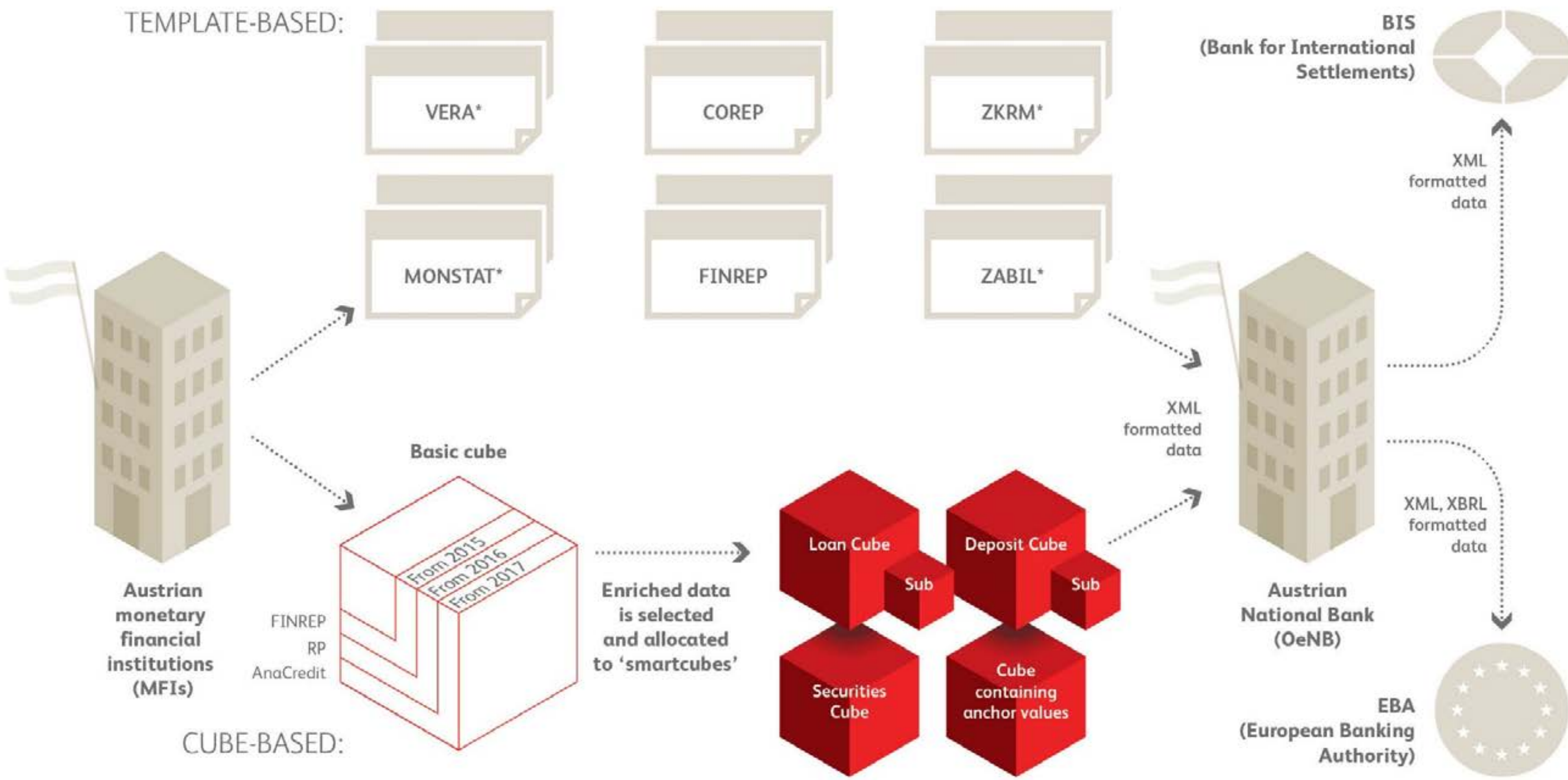
Manging data models along the flow of information from ECB perspective



Source: BearingPoint Institute

Austrian implementation of entity level credit information flow

Cube-based credit information orientation



* Austrian frameworks, rather than European frameworks

Source: BearingPoint Institute

Discussion

Thank you!

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Reforming regulatory reporting – from templates to cubes[1]

Maciej Piechocki and Tim Dabringhausen,
BearingPoint

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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 or the central banks and other institutions represented at the meeting.

Reforming regulatory reporting – from templates to cubes

Maciej Piechocki, Tim Dabringhausen

(BearingPoint)

Contents

Introduction

Since many of the world's biggest economies were brought to the brink by the shocking collapse of Lehman Brothers in 2008, the focus has been on addressing the cracks in the global financial architecture. Some of the deepest fissures were caused by gaps in data. Not being able to identify the scale of exposure to Lehman Brothers or its affiliated network, traders panicked and pulled out of positions that may well have been sound. Lehman Brothers wasn't an isolated case. All of a sudden, not being able to identify counterparty risk turned a bad situation into a catastrophic one. The crisis exposed the need for high quality, comparable and timely data on the global financial network. Since then, policymakers, supervisory authorities and standard-setters in Europe have been collaborating to greater harmonise and standardise regulatory reporting for banks and insurance companies. Urgent debate is needed on how the world's financial services industry could be better and less onerously supervised via a smarter approach to regulatory reporting.

In Vienna, ambitious changes to the collection and interrogation of bank data by Austria's central bank, the Oesterreichische Nationalbank (OeNB), are causing quite a stir. The solution adopted by the country's forward-thinking central bank and banking sector represents a new approach to regulatory reporting, leaving formatted templates to the annals of history. The new methodology creates a software platform that bridges the gap between the IT systems of the OeNB and the banks. This allows critical information to be extracted from the sector at will by the central bank without increasing the administrative burden for the data providers. It marks a significant shift in regulatory and statistical reporting, away from the archaic system of form-filling, to a future framework better able to cope with the growing demands of supervisors, including ad hoc requests that fall outside the regulatory reporting cycle.

The template-based approach to regulatory reporting

Regulatory reporting today is still focused on reporting templates, a leftover from the old times of paper-based reporting. Templates can be characterised alongside three main dimensions: Purpose (prudential vs. statistical), level (supranational vs. national) and frequency (regular vs. ad-hoc). Template data is mostly aggregated and validated as such, the structure of the templates is rather sticky and costly to change. Furthermore, lacking cross-time and cross-entity comparability is limiting the potential to analyse template data appropriately.

Still, the adoption of the CRR/CRD-IV package in 2014 earmarked another heavy increase in the number and complexity of templates to be reported for prudential purposes on an European level and regular basis. Since then, all European Economic Area (EEA) banks are committed to report layers upon layers of harmonised reporting templates in a digital language called XBRL. The European Central Bank (ECB), which took over the supervision of significant credit institutions under the Single Supervisory Mechanism (SSM) in November 2014, requires euro area banks to submit additional reporting templates for statistical purposes on a regular basis. The European Banking Authority (EBA) requires significant credit institutions to report ad-hoc reports for a wide array of exercises, of which the stress test is the most prominent example. On top of the European reporting burden, national competent authorities (NCAs) are adding their very own reporting requirements.

European insurers are also affected by the pan-European template reporting requirements of the EU's insurance and pension's regulator, the European Insurance and Occupational Pensions Authority (EIOPA). EIOPA is currently preparing for the implementation of Pillar 3 of the Solvency II regime, where regulatory reporting is even more complex than the submissions required by the EBA. Asking for large numbers of so-called quantitative reporting templates (QRTs) will set a new benchmark in the volume of data that can be collected using outdated methodologies and technologies. And similar to EBA, EIOPA is conducting its own stress tests. The EIOPA exercise took six months to complete; the regulator issued nine sets of questions, each with their own reporting template.

The different reporting frameworks described are often based on the very same primary data. Dr Johannes Turner, Director, Directorate General of Statistics, OeNB outlined the fact at the Euro Finance Week conference in November 2014: "You take a simple, plain vanilla loan and you have to report it five times," he said. "Different departments within the bank will be required to provide the same data to the regulator at different times".[1] To put it differently. The plain vanilla loan is used for prudential and statistical reports, for supranational and national reports, as well as for regular and ad hoc reports. Is that really efficient?

The cube-based approach to regulatory reporting

So we come to the radical solution being adopted in Austria, where the regulator and the regulated joined forces to turn the tables on the template-driven model and use new technologies to create a new regulatory value chain. The initiative is based on greater harmonisation 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 buffer company, called Austrian Reporting Services GmbH (AuRep), which is co-owned by seven of the largest Austrian banking groups, representing 87% of the market. This allows cost-sharing of compliance as well as standardisation of data collection. AuRep runs on a common software 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.[2]

Austria's new framework has the potential to succeed in clearing the information bottleneck. It represents a paradigm shift in banking supervision and statistical data remittance, finally putting an end to the delays associated with requests and

1 Digitalisation, standardisation and harmonisation of regulatory reporting in Europe: Risk Management Konferenz II', Euro Finance Week, web, conference discussion, Dr Johannes Turner, 18/11/14, programme, PDF, http://bit.ly/1zlsGmn.

2 Micro-data: the Austrian concept with more granularity as a lesson learned from the financial crises, IFC Bulletin, no. 37, pages 168-70, Session H: Links between Micro and Macro-Data I, Bank for International Settlements, Basel, Switzerland, PDF, Johannes Turner, Erich Hille and Günther Sedlacek, 01/14.

formatting, and allowing greater reconciliation between numbers collected for various purposes. The Austrian model is a data-input approach – each regulated entity prepares its data in a standard format in a series of "data cubes" as prescribed by the national central bank OeNB defined by business type, such as loans, securities or deposits. AuRep acts as a buffer between the supervisor and the banks. The data cubes AuRep receives is in a standard format, so a change in required data needs a single coordinated update to all members. Ad hoc data requests do not require the completion of multiple templates but can be gathered from the granular data uploaded to AuRep, which eventually forms the supervisor's dataset.[3] The advantages of standardised data cubes are obvious. The granular information can be used for multiple purposes, the analysis of disaggregated data is unlimited and simply extensible via new data attributes. Furthermore, harmonised data input layers can deliver consistent and comparable data sets.

The Austrian approach is coming at exactly the right time. With the ECB being tasked with dealing with prudential and statistical data of the euro area banking sector there is a strong need for consistency, innovation and smarter way of approaching regulatory reporting. Dr Johannes Turner, Director of the statistical department at OeNB, said that the Austrian model "ensures more consistent, higher quality data", whilst "reducing the amount of checking we have to do."[4] The big win for the banks is that they are not burdened with the problem of completing templates on many different topics. In a sign that Mario Draghi is aware of the limitations of the template approach, he introduced the seventh ECB Statistics conference in 2014 saying: "Data integration on the side of the ECB and the other authorities only comes at the end of a data-production process, the first input of which is in the internal systems of the banks."[5] Ongoing ECB projects can be seen as the counterpart of Draghi's statements. Analytical Credit Datasets (AnaCredit), a granular loan-by-loan reporting requirement, is targeted for 2018. And the Bank's Integrated Reporting Dictionary (B.I.R.D.) is going to take the data input approach to the next level.

Amongst supervisors there seems to be a general acknowledgment that better insight is needed, although there is not yet universal agreement about how this information should be gathered. Patrick Hoedjes, Head of Oversight and Operations at EIOPA, agreed that transparency was "far from where it should be". He said: "We still don't know where we would be if another Lehman Brothers happened. That has to be a key objective for 2020, and better data will help towards that."[6] For many regulators, the data input approach offers a way to increase consistency and quality of data as well as transparency, which is very much on their post-crisis agenda. Some regulators go even further. In her concluding speech at the ECB Conference on Statistics in 2014, Danièle Nouy, Chair of the Supervisory Board of the SSM, said: "Integration, harmonisation and standardisation are necessary conditions, although

3 Details from Austrian Reporting Services GmbH (AuRep) website under construction: http://www.aurep.at/

4 Exclusive interview of Johannes Turner with the BearingPoint Institute for the article "Regulatory reporting: are we headed for real-time?", Bearing Point Institute Report, Issue 6.

5 Towards the banking union: opportunities and challenges for statistics, European Central Bank, Frankfurt am Main, Germany, web, speech transcript, Mario Draghi at 7th ECB Statistics Conference, Frankfurt am Main, Germany, 15/10/14.

6 Exclusive interview of Patrick Hoedjes with the BearingPoint Institute for the article "Regulatory reporting: are we headed for real-time?", Bearing Point Institute Report, Issue 6.

not sufficient for achieving a fully satisfactory degree of transparency for the banking system. We also need to properly disseminate and communicate the data. In that sense, creating a common repository ("European Hub") for publicly available data could be a relatively simple task with a very important and positive impact.' Ms Nouy also addressed the central preoccupation of regulators, policymakers and society; to help prevent future financial crises – or at least make them less likely. She highlighted the benefits that data input could bring: "I cannot promise that the ECB can once and for all eliminate the risk of another financial crisis. But the ECB is equipped to minimise this risk, and statistics play a crucial role here. Remember that the inability to correctly measure and analyse the risks associated [with] banking activity was one of the reasons [for] the current financial crisis. Developing and communicating accurate and timely statistics is essential for avoiding the repetition of this failure in the future."[7]

However, for this model to work, buy-in must go beyond the central bankers. Wide cooperation would be needed from the market. Incentives, including liberation from a labour- and time-intensive process of repeated reformatting of data points seem clear. However, discussions with industry bodies in the banking and insurance sector and their comments at the Euro Finance Week conference in 2014 suggest that, whilst momentum for change is gathering, the mood is still cautious. Speaking at the conference, Adam Farkas, Executive Director, European Banking Authority (EBA), said the Austrian model was producing "nice" data, but cautioned that there was still more work to be done before regulators embraced this approach with confidence. "The compromise is there and the incentive is there but there is no detailed, instructive prescription to an individual bank as to how it should report." He added that that the large-scale move to digital to produce granular data had to be driven by the banks. "Market players do not like regulators telling them what IT solutions to use.[8] Also at the Euro Finance Week conference, Robert Priester, Deputy Chief Executive of the EBF, said that European banks are very interested in tackling the problems of an out-of-date and cumbersome reporting methodology, which "is not working in the current state of IT systems." He suggested that this made the Austrian model worth exploring: "Within the EBF it has produced a very prominent echo," he said, but remained vague about his support. "We all agree on data integration," he added. "The question is how to do that."[9]

Conclusion

It is clear the tectonic plates that have been shifting under the regulatory reporting landscape in Europe have not yet settled. Only twenty years ago, banks and insurance companies were obliged to report once a year, using paper forms with a six-month remittance period. In just a short time, the changes have been enormous. As demands for regulatory reports have risen, templates have increased from a

[7] Concluding remarks', European Central Bank, Frankfurt am Main, Germany, web, speech transcript, Danièle Nouy at 7th ECB Statistics Conference, Frankfurt am Main, Germany, 15/10/14. Frankfurt am Main, Germany, 15/10/14.

[8] Digitalisation, standardisation and harmonisation of regulatory reporting in Europe: Risk Management Konferenz II', Euro Finance Week, web, conference discussion, Adam Farkas.

[9] Digitalisation, standardisation and harmonisation of regulatory reporting in Europe: Risk Management Konferenz II', Euro Finance Week, web, conference discussion, Robert Priester.

handful to hundreds at a time. The document-orientated approach does not satisfy the requirements for relevance at the shorter end, and will hamper the drive for more up-to-date regulatory feeds. Old habits die hard; considerable investments have been poured into the current model over the past few years. Like running a second-hand car, there is a point in time when maintenance costs overtake residual values and the first serious fault can be a signal for buying a brand new vehicle. The current regulatory reporting approach is making it harder to respond effectively with the tight data quality and frequency required to meet the goal of more stringent supervision: to prevent another global financial crisis.

As policymakers and supervisors seek a more timely risk assessment on an entity-by-entity as well as an on systemic level, they turn up the dial on reporting frequency. Time-to-report has been shortened from months to weeks. Against the imperative to build an up-to-date and accurate regulatory picture to assess financial sector risks, a move away from aggregated template data to disaggregated cube data would be more beneficial. Going forward, regulators and industry must agree on a way to reduce the reporting burden for the industry whilst improving the transparency of the data in question. With the ECB now looking into the data input approach to manage the mammoth task of supervising the Eurozone's most important banks, it could be that the regulatory value chain in all member countries is ready to explore new and easier terrain.

Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Opening remarks of session 5 on *"The experience of emerging market statistical institutions in combining micro- and macro-level data: different approaches, a common goal"*[1]

Mashairo Higo, Bank of Japan

[1] The views expressed are those of the author and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

The Experience of Emerging Market's Statistical Institutions in Combining Micro and Macro Level Data: Session 5 Brief Introduction

15 December 2015
Irving Fisher Committee Workshop
in Warsaw

Masahiro Higo
Research and Statistics Department
Bank of Japan

The views expressed are those of the presenter and not necessarily those of the Bank of Japan

1. Five Presentations in Session 5

1. Residential prices and Default risk of Mortgage Loans

   --- (i)Chile and (ii)Poland paper

2. Exchange Rate Risk of FX denominated Liabilities in Non-Financial Firms

   --- (iii)Turkey paper

3. Financial Statistics Developments: Integrating Micro and Macro

   --- (iv)Indonesia and (v)Malaysia paper

2. Points of interest in this session

(1) What type of micro data are essential for analyzing the financial stability?

--- Importance of micro information of debtors (households and non-financial firms) are emphasized

--- What is the role of micro information of lenders (financial institutions) ?

--- How about micro information of markets (residential prices, transaction volumes) or that of regulations?

(2) How can micro databases (e.g. credit registers) contribute to the improvement of these statistics?

(3) Something else necessary (coordination or cooperation…)?

Thanks for your attention!

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IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

A micro-powered model of mortgage default risk for full recourse economies, with an application to the case of Chile[1]

Diego Avanzini, Juan Francisco Martínez and Víctor Pérez,
Central Bank of Chile

[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 or the central banks and other institutions represented at the meeting.

A micro-powered model of mortgage default risk for full recourse economies, with an application to the case of Chile*

Diego Avanzini† — Central Bank of Chile

Juan Francisco Martínez — Central Bank of Chile

Víctor Pérez

Central Bank of Chile

October 21, 2015

Abstract

This paper develops a customized model of mortgage loans default for a full recourse economy. We combine the more usual analysis for nonrecourse economies, adding a non-pecuniary cost for defaulting in order to account for possible loss of utility due to the full-recourse framework. This model applies to economies such as Spain, Australia, and Chile, where defaulters can be prosecuted until their debts are completely settled. Under the proposed model, we obtain an analytical expression involving default determinants for mortgage loans, both micro and macro. As a case study, we estimate

*This paper has been prepared for the Workshop on Housing, Santiago, April 25, 2014, at the Central Bank of Chile. The views and conclusions presented in this paper are exclusively those of the authors and do not necessarily reflect the position of the Central Bank of Chile or of the Board members. We are grateful to Natalia Gallardo for helping us and contributing in a preliminary stage of this work. All errors are our own.

†Corresponding author: davanzini@bcentral.cl, Statistical Division, Central Bank of Chile.

this relationship for the Chilean economy using information from the Chilean Survey of Household Finance (EFH). As stated by our micro-macro model, we find that household financial conditions and their interactions with systemic determinants account for an important part of the cross sectional probability of mortgage default.

Keywords: Default, Mortgage loan, Survey data, Full recourse economy, Rare events, Credit market

JEL Classification Number: C35, D53, E44, G21

1 Introduction

The recent financial crisis has tested the academics and regulators in their ability to anticipate possible sources of instability. Some of the lessons that can be learnt from the latest financial crisis is that policy models and their estimates should take into account factors that might have been at some point overlooked. The recent experience suggests the existence of a mortgage channel that acts as an accelerator or amplifier element of financial instability. This is why, for central banks and policy makers, it is crucial to understand the mechanisms at place, and to use richer sources of data to measure them. Hence, in this work we contribute to the existing literature by presenting a theoretical model that incorporates both micro and macro financial determinants and their interactions for a full recourse economy. We apply the framework to the Chilean economy as a case study, and test it empirically using using a rich source of micro-data coming from the Chilean Survey of Household Finance.[1]

It is widely accepted in the current economic literature, that –in aggregate terms– a mortgagor facing a negative equity is prone to default. In this case, when the value of debt is higher than the value of the collateral, there are incentives to optimally decide not to repay, since it is cheaper to give up the property and to stop repaying. This mechanism is in the heart of various recent crisis related papers such as those of Fostel and Geanakoplos (2008) and Goodhart et al. (2011). Other influential papers that model a collateral financial economy are Kiyotaky and Moore (1997) and Bernanke et al. (1999), but instead of households, these works model firms dynamics under the presence of a credit market affected by asymmetric information. In their settings, the risk premium depends on the firms' probabilities of default, which in turn are related to the value of net worth.

The model that inspires our treatment of the default phenomenon is developed in Geanakoplos and Zame (2013).[2] They abstract from the explicit modeling of asymmetric information,

[1] From now on "EFH", for its name in Spanish ("Encuesta Financiera de Hogares"). The survey is conducted by the Central Bank of Chile (BCCh) since 2007.

[2] Note that this is a published version of a working paper that was first issued in 1997.

but allow for an equilibrium with endogenous default. To do this, they base their model – as all the theoretical literature in this field– on a *non-recourse* credit regulation policy. Non-recourse regulatory frameworks state that the lender gets the collateral only after the occurrence of a default and it is not allowed to prosecute other payments or compensations from the debtor. In this way, modelers avoid the imposition of deadweight losses associated to other punishments in case of default.[3]

However, when modeling the determinants of mortgage default for economies such as Australia, Chile, and Spain, we need to introduce the case of *full recourse* regulation. Under this type of regulation, agents can be prosecuted until their debts are completely settled. This implies that the incentives to repay should be enhanced, since in a *full recourse* framework, the incentive to default due to negative equity is counteracted by the fact that if the collateral is not sufficient to cover the promises, the creditor has the right of going after other assets of the debtor. There is also a reputational effect given that the prosecuted debtors are publicly listed. All these issues motivate us to develop a modeling alternative that adapts the seminal framework of Geanakoplos and Zame (2013).

Economic intuition indicates that our model should incorporate a mechanism that additionally discourages mortgagors from defaulting. This is consistent with the idea that mortgagors do not always default when they face negative equity on their homes as in Harrison et al. (2004) or Ellul et al. (2010). In fact, Foster and Van Order (1984) and Bhutta et al. (2010) find that many borrowers with negative equity do not default; and, conversely, default is often associated with shocks, such as unemployment. Also, the cost of continuing to repay a mortgage also depends on the agent's idiosyncratic discount factor and thus on his liquidity position, as Elmer and Seelig (1999), Gerardi et al. (2007), and Bajari et al. (2010) explain.

Our model formulation closely follows part of the Goodhart et al. (2011) work, which

[3] As Geanakoplos and Zame (2013) state, the only seizure of collateral "[...] avoids the moral and ethical issues of imposing penalties in the event of bad luck." Although, they recognize that in practice, the seizure of collateral implies deadweight losses on its own.

is a recent application based in the Geanakoplos and Zame (2013, and the earlier work dated 1997) model. Yet, in order to modify the mortgage default incentives, we add a non-pecuniary cost that arises as a reputational loss because of the burden of being enforced to repay the debt and other possible losses of utility (e.g. being blacklisted from the credit market or being banned for future credit opportunities). Natural references that we consult to address this type of default cost are those of Shubik and Wilson (1977) and Dubey et al. (2005). Together with Geanakoplos and Zame (2013), these works lie within the general equilibrium literature. Our contribution consists in combining both frameworks to generate a full recourse economy, such as that of Spain, Australia and Chile.

To test our framework, we apply it to the Chilean case. The literature that models default decisions in the Chilean economy is rather brief. One of the recent investigations appears in Alfaro and Gallardo (2012). These authors estimate an empirical characterization using the EFH 2007 survey. They find that income and income-related variables are the only significant and robust factors that explain default for both types of debt (consumer and mortgage). Additionally, demographic variables can help to further explain default probabilities.

Empirical evidence suggests that there is some rich information hidden away in aggregated (or macro) data. Thus, the use of micro-data seems a promising research avenue. That is why, instead of using financial aggregates of credit and macro-financial conditions to determine default dynamics through time, we follow Alfaro and Gallardo (2012) in the sense that we use micro-information coming from the EHF survey. As compared to the latter, beyond contributing with a theoretical modeling framework, in this work we are able to profit from the additional information that the EFH survey has gathered through the years since it was launched in 2007.

The main objective of this work is to improve the identification and estimation of default determinants in the mortgage market. Our results can contribute to support credit policy measures and also enhance the analysis and application of mortgage banking stress tests. In particular, we apply this methodology to the Chilean economy, but it may be relevant to other countries, such those already mentioned.

In recent years, theoretical advances and economic necessity have stimulated the study of the default decision specially on mortgage loans. Since Kau et al. (1994) and Capozza et al. (1997), theoretical models and empirical testing have being integrated in the search for a better understanding of the phenomenon. Following those efforts we elaborate on the theoretical modeling of mortgage default and estimate the resulting model using microdata from households in Chile.

The rest of the work is organized as follows. Section 2 introduces the theoretical model. Section 3 highlights the role of the determinants as they emerge from the model. In Section 4 we describe the empirical methodology as well as the dataset we use for the estimations. All the results are presented in Section 5. Some final remarks are in Section 6. The Appendix contains derivations and proofs from the model, a supporting glossary, and some data description.

2 A theoretical model of the determinants of default

To provide a general view of the mortgage default mechanism at play, in this section we introduce and describe a partial equilibrium model that motivates our empirical estimations. We describe the economy, agents, financial structure, transactions and its timing.

Our model considers a two-period setup. The beginning ($t = 0$) is deterministic, but the second period ($t = 1$) is stochastic. In the latter, there are s possible states of nature that occur with probability π_s.[4] To help notation, we also define $S = \{0, s\}$, a $t-$uple that groups both periods and consider the possible states at the second period.

The economy is composed by one representative household. There are two goods traded in this economy: a consumption commodity and housing. We also have two types of financial assets: one short-term (intra-period) unsecured loan and one long-term (inter-period)

[4] Later we will specify that state variables are in our case represented by commodity endowments and liquidity conditions (i.e. interest rates and monetary endowments).

collateralized loan.

The household is endowed with a perishable commodity that consumes and sells, and money. The endowment is deterministic in the first period, and depends on the realized state of nature in the second period. The agent also consumes housing in both periods that has to be purchased. There are two differences between commodities and housing. On the one hand, commodities are perishable (they only provide utility in the period they are available) while durable goods (house) purchased at the initial period ($t = 0$) also give utility at the final one ($t = 1$). On the other hand, housing also serves as collateral when contracting a long term loan.

2.1 Financial intermediation

The financial intermediation in this model is assumed to be exogenous and it is treated in a stylized manner. However, it can be thought of as a representative bank (or banking system) that lends short-term to the representative household,[5] as well as an inter-period collateralized mortgage loan. The latter is only available at $t = 0$. An exogenous amount of liquidity is pumped into the system and it is reflected in the short- and long-term interest rates (r_S and $\bar{r}$, respectively).[6] Nominal flows of the economy are depicted in Figure 1.

2.2 Timing

At the initial period ($t = 0$) short-term liquidity borrowing plus long-term mortgage borrowing from the representative household occur. Provided the financing, transactions in commodity and mortgage markets take place. The representative agent sells part of his endowment of the consumption commodity and uses the revenues to repay the short-term loan obligations. Under the current setup, short-term obligations arise as a consequence of

[5] To help the focus of the analysis and without loss of generality, this type of loan is assumed to be default-free.

[6] It can be thought of as the monetary authority that injects certain amount of resources in the money market, influencing the short-term rates (e.g. through M_S) and long-term interest rates (e.g. through $\bar{M}$).

the assumption of a cash-in-advance financial economy. The agent also purchases housing, which is financed with a collateralized long-term mortgage loan. Finally, consumption of housing and commodity takes place.

During the second period ($t = 1$) the nature realizes and reveals s, which mainly affects endowments –including monetary– and monetary supply, as we observed before. At this period, the intra-period transactions work in a similar manner than at the beginning. However, there are slight, but significant differences. First, it is easy to see that the long-term interest rate is already fixed (e.g. because the long-term money market does not open at every period). Second, the mortgage loan is settled by the representative household, given by his delivery (or default) decision. At this period, he uses the short-term money market to repay the long-term loans and finances his housing consumption.

2.3 Economy and budget set

The economy is composed by a positive **endowment of** the perishable **commodity**, e_{S1}; positive **monetary endowment** m_S; **preferences** U; **financial assets** consisting of long and short-term loans at rates $\bar{r}$ and r_S, respectively. We assume that in this economy preferences are monotonic and utility is quasi-concave.

Given a set of securities (i.e. short and long-term loans) Λ; commodity price p_{S1}; housing price p_{S2}; rate of return of the short and long-term credit market r_S and $\bar{r}$, respectively; the mortgagor with commodity endowment e_{S1} makes consumption plans, credit demand, sales of commodity, and deliveries against promises.[7] Following Geanakoplos and Zame (2013), in the case of mortgages, optimal deliveries will be always the minimum of promises (i.e. credit demand) and the value of the collateral. Thus, we define the budget set for the representative household as $B(p_1, p_2, r_S, \bar{r}, e_{S1}, \Lambda)$ to be the set of plans $(\mu, \bar{\mu}, q_{S1}, b_{S2})$, where μ stands for the short term borrowing, $\bar{\mu}$ is the mortgage borrowing, q_{S1} represents the commodity sales

[7] Our notation for prices, quantities and monetary expenditures contains a subindex with two components. The first one is the period (or state at $t = 1$), while the second term indicates the type of good, 1 for commodities and 2 for housing.

and b_{S2} stands for housing expenditure.

We have that at the initial date ($t = 0$), the agent is subject to three budget constraints. First, the short term loans must not exceed the revenues from commodity sales. Second, the housing expenditure must be lower than or equal to its long and short term credits and monetary endowment. Finally, the third constraint considers an element of mortgage credit regulation. There is a fixed portion of collateral (i.e. ϕ) required for a mortgage loan.[8]

Formally, we have that, at $t = 0$:

$$\begin{aligned} \mu_0 &\leq p_{01} q_{01} \\ b_{02} &\leq \frac{\mu_0}{1 + r_0} + \frac{\bar{\mu}}{1 + \bar{r}} + m_0 \\ \frac{\bar{\mu}}{1 + \bar{r}} &\leq \phi b_{02} \end{aligned}$$

Conversely, at the final date ($t = 1$), the agent is subject to two budget constraints. The first constraint reflects the fact that the short term loans must not exceed the revenues from commodity sales. The second budget constraint depends on the state of nature that is realized. Thus, under a good state of nature (i.e. $s \in S_G$, where no default is exerted), the constraint states that the repayment of the mortgage loans plus the new housing consumption of the household (i.e. a type of housing top-up) must not exceed the agent's short-term borrowing and monetary endowment. Under a bad state of nature (i.e. $s \in S_B$, there is default), the constraint accounts for the fact that there is no mortgage repayment.

Formally, at $t = 1$, the constraints are:

$$\begin{aligned} \mu_S &\leq p_{s1} q_{s1} \\ b_{s2} + \bar{\mu} &\leq \frac{\mu_s}{1 + r_s} + m_s \qquad \forall s \in S_G \\ b_{s2} &\leq \frac{\mu_s}{1 + r_s} + m_s \qquad \forall s \in S_B \end{aligned}$$

[8] Without loss of generality, we assume that this constraint is always binding in equilibrium.

2.4 Preferences

At the beginning of the time ($t = 0$), the representative household maximizes his expected utility subject to the budget constraints previously described. The agent's utility in our case has the particularity that default incentives are mitigated by seizing the collateral of the mortgagor.[9] However, to adequate the problem to a *full recourse* economy, we also introduce a non-pecuniary default penalty proportional to the defaulted amount, similar to Shubik and Wilson (1977) and Dubey et al. (2005). Thus –subject to his budget set–, the agent solves the following program:

$$\begin{aligned} \max_{\mu_s,\bar{\mu},b_{s2},q_{s1}} U &= u\left(e_{01} - q_{01}\right) + u\left(\frac{b_{02}}{p_{02}}\right) + \sum_{s\in S} \pi_s \left\{u\left(e_{s1} - q_{s1}\right)\right\} + \\ & + \sum_{s\in S_G} \pi_s \left\{u\left(\frac{b_{02}}{p_{02}} + \frac{b_{s2}}{p_{s2}}\right)\right\} + \sum_{s\in S_B} \pi_s \left\{u\left(\frac{b_{s2}}{p_{s2}}\right)\right\} - \\ & - \lambda \sum_{s\in S} \pi_s \max\left\{\left(1 - \frac{b_{02}p_{s2}}{p_{02}\bar{\mu}}\right), 0\right\} \end{aligned}$$

That is, the agent optimizes his utility function, by solving his plan of short and long-term borrowing, housing expenditure (in monetary terms) and commodity sales (quantity), subject to his budget constraints. At the first period ($t = 0$), the agent obtains utility from consuming the commodity that remains from his sales and the housing units that he purchases. At the final period ($t = 1$), the representative household faces the two possible sets of states of nature, good or bad. If a good state realizes, there is no default. Thus, the agent enjoys from consuming his initial date housing consumption plus the additional housing he buys in the final period. Conversely, if the household faces a bad state of nature, he (optimally) defaults.[10] In such cases, the (non-modelled) banking sector seizes the collateral, so the agent cannot benefit from consuming the initial period housing and he is subject to

[9] We interpret this as an exogenous commercial banking sector that is compensated by receiving the collateral. In turn, it sells it back into the market to cash-in.

[10] As we previously mentioned, the optimal delivery is the minimum between the current value of collateral and the promises (i.e. $\min\{\bar{\mu}, (b_{02}p_{s2}/p_{02})\}$).

a default penalty (linearly) proportional to the defaulted amount. It has to be noted that in this model, the agent is not expelled from the market. He is still allowed to obtain short term credit.[11]

2.5 Equilibrium

This section provides a brief note on equilibrium. From the problem formulation, we have that this economy is composed only by the representative household. Here we assume that he behaves in a competitive manner, so takes prices as given.

The competitive collateral equilibrium (CCE) in this economy consists of a set of commodity prices (p_{S1}), security prices (interest rates $r_S, \bar{r}$) and consumption plans ($\mu, \bar{\mu}, q_{S1}, b_{S2}$), such that short-term commodity market clears, durable housing market clears, security markets clear, plans are budget feasible and consumers optimize.

There are important particularities to be highlighted in this type of economy. On the one hand –in this partial equilibrium model–, we abstract from a housing pricing amplification mechanism first described by Fisher (1933) and, more recently, by Goodhart et al. (2011). In these works, if a bad state is attained and there is mortgage default, the representative household will have to give-up the collateral and the housing goes back to the market. In such a situation, the housing market clearing condition incorporates that there is a decrease in prices that further increase default incentives, given that collateral losses value, and the debt face value remains. This spiral-type mechanism is called debt-deflation.

Another issue to be considerer concerns to rational expectations. In this work we also abstract from explicitly modelling the financial (banking) sector. Thus, we do not need to consider the rational expectations of the lending activity. Nevertheless, in cases where the banking sector appears (e.g. Goodhart et al., 2011), and to incorporate the default possibility under rational expectations, the effective return on the mortgage will be the ratio between: (i) the minimum between the collateral value at $t = 1$ and the mortgage promise, $\bar{\mu}$; and (ii)

[11] The agent's program first order conditions appear in the Appendix.

the initial mortgage extension (credit supply). That is, a bank should rationally anticipate the optimal household delivery and account for this into the risk premium.

Theorem 1 Existence: *Assuming rational expectations, a well-behaved (e.g. normally distributed) state probability space, monotonic preferences, quasi-concave utility (quasi-concavity is assumed to be maintained in the presence of linear penalties) and convex budget sets, and provided that all the markets clear, this economy admits a competitive equilibrium.*

Proof. It appears in Geanakoplos and Zame (2013). ■

3 Determinants of mortgage default

Proposition 2 Existence of full-recourse determinants of mortgage default: *From the household optimization problem solution, and assuming without loss of generality that there are only two possible states of nature (the good G, where there is full delivery, and the bad B, where there is default) we can obtain an equation that represents the mortgage default determinants. Furthermore, the default depends on idiosyncratic and systemic factors as well as their interactions. The explicit equation is given by:*

$$1 - \frac{b_{02}p_{B2}}{\bar{\mu}p_{02}} = \omega_0 + \omega_1\bar{\mu}u'\left(\frac{b_{02}}{p_{02}}\right) + \omega_2\bar{\mu}u'\left(\frac{b_{02}}{p_{02}} + \frac{b_{G2}}{p_{G2}}\right) + \omega_3\bar{\mu}u'\left(e_{01} - q_{01}\right) \tag{1}$$

where

$$\begin{aligned}
\omega_0 &= 1 - \frac{\lambda^{\alpha}\pi_B p_{B2}}{p_{02}(1+\bar{r})\phi} \\
\omega_1 &= -\frac{1}{p_{02}\lambda\pi_B\left(1+\bar{r}\right)\phi} \\
\omega_2 &= \frac{\pi_G\left(\phi p_{02}\left(1+\bar{r}\right) - p_{G2}\right)}{p_{G2}p_{02}\lambda\pi_B\left(1+\bar{r}\right)\phi} \\
\omega_3 &= -\frac{\left(1+r_0\right)\left(1-\phi\right)}{p_{01}\lambda\pi_B\left(1+\bar{r}\right)\phi}
\end{aligned}$$

Proof. See the Appendix. ■

Notice that the left hand side of equation (1) corresponds to the expected default frequency on the mortgage loans (i.e. the complement of the expected repayment). The right hand side is composed by systemic and idiosyncratic factors, and their interactions. All of them constitute the determinants of mortgage default.

Remark 3 Systemic factors: *Notice that* ω_0*, the first term at the RHS of equation (1) accounts for the banking regulation and financing standards faced by the household. This is a* systemic *factor that affects households independently from their idiosyncracies (i.e. it is exogenous to them). It is easy to see that the default frequency decreases with: (i) a higher default penalty, (ii) a lower LTV (*ϕ*), (iii) a higher interest rate, and (iv) a decrease in housing prices. Our interpretation is consistent with Jaffee and Stiglitz (1990) that the higher the screening, the lower the default incentives. On the other hand, a tighter regulation provides lower incentives to default, as in OECD (2011). Additionally, the terms* ω_1*,* ω_2 *and* ω_3 *depend only on exogenous variables or parameters. Thus, they also work as exogenous systemic factors that interact with agent's idiosyncracies.*

Remark 4 Systemic and idiosyncratic interaction – housing and mortgage demand in the first period: *The second term at the RHS of equation (1) shows a systemic factor interacted with credit demand and marginal utility of housing at* $t = 0$*. Given that* ω_1 *is always negative, we interpret that the higher the marginal utility of housing consumption and mortgage demand, the lower the incentives to default. Alternatively, given that we assume that preferences are quasi-concave, the higher the preference for housing consumption, the higher the expected mortgage default.*

Remark 5 Systemic and idiosyncratic interaction – housing and mortgage demand in the second period: *The third term at the RHS of equation (1) also contains the systemic factor interacted with the marginal utility, but in this case it is in the good state at* $t = 1$*. The systemic factor* ω_2 *in this case has an ambiguous sign. It is easy to see that if prices are in* *a growing phase*[12] *(i.e.* $p_{02} < p_{G2}$*) and credit supply standards are sufficiently relaxed (i.e.* $\phi(1+\bar{r}) > 1$*), then the dynamics of mortgage default and housing demand work in the same direction than in the second term of (1).*[13] *To sum up, under the specified conditions, higher mortgage or housing demands are associated to greater expected defaults.*

Remark 6 Systemic and idiosyncratic interaction - income: *The fourth term at the RHS of equation (1) works in a similar fashion with regard to the systemic component. There is a negative relationship between tighter (short-term) credit standards and mortgage default probabilities. The effect is proportional to the ratio between the housing and commodity current prices.*[14] *This result is conditioned on the marginal utility of consumption. Assuming risk aversion (e.g. logarithmic utilities), we have that –for a given mortgage credit standard and prices ratio– the higher the commodity endowment, the lower the mortgage default frequency. In this case, we interpret endowments as the availability of resources. Thus, it expresses the importance of housing income in this context. Our conjecture is that the combination of systemic credit standards and household income (or a related variable) is key to determine mortgage default frequency.*

From the findings that our theoretical model provides, we conjecture that mortgage default determinants are associated to credit cost and/or regulation standards and its interaction with idiosyncratic factors, such as the demand for housing and income. At this point, it is important to notice the interaction that we found. This will be key in our empirical specification which will be based on our theoretical model results.

4 Estimation Methodology and Data

In this section we briefly describe the problems that we face to obtain unbiased and efficient estimators, and the characteristics of the data used in the estimations.

[12] This ensures that the good state is attained.

[13] This is straightforward if we notice that $\omega_2 = \omega_1 p_{G2} \pi_G$.

[14] This is easy to see if we notice that $\omega_3 = \omega_1 (p_{02}/p_{01})(1+r_0)(1+\phi)$.

4.1 Estimation Methodology

In this work we explain the default decision of households on their mortgage loans based on idiosyncratic and systemic variables. For doing this, we use logistic regressions to estimate the behavior of a discrete variable representing the fact that some households in our sample have defaulted their mortgages.

Our data on mortgage delinquency present two important features we need to account for in the estimation. First, defaulting a loan (specially mortgages) is not an usual event. Futhermore, it can be considered as a rare event when compared with the occurrence of the contrary. Thus, if we take into account the whole population of outstanding mortgage loans in an economy, delinquency is highly underrepresented in any sample. However, our sample captures an important mass of delinquent loans in order to better appreciate its behavior. This means that the sample is intentionally biased to account for the phenomenon. This is known in econometrics as *choice-based* or *endogenous stratified* sampling. This sampling method is often supplemented with known or estimated prior knowledge of the population fractions of the rare event (as in our case).

Second, popular statistical procedures including the logistic regression, can sharply underestimate the probability of rare events. As King and Zeng (2002) point out, that logit coefficients are biased in small samples is well documented in the literature, but that in rare events data the biases in probabilities can be substantively meaningful is less known and understood. In particular, finite sample, rare event data have at least three features we should account for: (i) increasing the size of the sample does not alleviate the bias, because the rare events do not increase their share of the sample more quickly than the growth rate of the sample; (ii) the bias of the coefficients estimated using logistic regression when rare events are present is known to underestimate the probability of the rare event; (iii) the computation of probabilities of events in logit analysis is suboptimal in finite samples of rare events data, leading to errors in the same direction as biases in the coefficients.

To deal with these features together, we follow the developments of King et al. (2000) and King and Zeng (2001, 2002). Assume that we have a dataset of $i = 1, ..., n$ observations for which we have gathered information on the variable Y_i and a set of $k-1$ variables recorded in $\mathbf{x}_i$. The variable Y_i is a dicothomous variable that represents an underlying continuous variable Y_i^* following $Y_i = 1$ if $Y_i^* > 0$ and $Yi = 0$ if $Y_i^* \leq 0$. Y_i follows a Bernoulli distribution, while Y_i^* follows a Logistic distribution. The behavior of Y_i^* can be adequately inferred from the maximum likelihood estimation of the behavior of Y_i.

We assume that the *ones* ($Y_i = 1$) are the rare outcome, representing those households that hold a delinquent mortgage loan. The *prior population information* refers to the fraction of ones in the population, τ, while the *observed fraction of ones in the sample* refers to the sampling probability, $\overline{y}$.

To compensate for differences in the sample ($\overline{y}$) and population (τ) fractions of ones induced by choice-based sampling we use a weighting procedure. The procedure maximizes the weighted log-likelihood:

$$\begin{aligned} \ln L_w(\boldsymbol{\beta}|\mathbf{y}) &= w_1 \sum_{\{Y_i=1\}} \ln(\pi_i) + w_0 \sum_{\{Y_i=0\}} \ln(1-\pi_i) \\ &= -\sum_{i=1}^{n} w_i \ln\left(1 + \exp\left[(1-2Y_i)\,\mathbf{x}_i\boldsymbol{\beta}\right]\right) \end{aligned} \tag{2}$$

where the weights are $w_1 = \tau/\overline{y}$ and $w_0 = (1-\tau)/(1-\overline{y})$, and where

$$w_i = w_1 Y_i + w_0(1 - Y_i)$$

The resulting $\hat{\boldsymbol{\beta}}$ is the *weighted exogenous sampling maximum-likelihood estimator,* due to Manski and Lerman (1977). One of the advantages of this method is that weighting can outperform other approaches (e.g. prior correction) when both a large sample is available and the functional form is misspecified (see Xie and Manski, 1988). However, weighting is asymptotically less efficient in small samples (see Scott and Wild, 1986; Amemiya and

Vuong, 1987).

When information about τ is available, we can remedy these problems using an analytical approximation to the bias based on McCullagh and Nelder (1989). The bias in $\hat{\boldsymbol{\beta}}$ can be estimated by the following weighted least-squares expression:

$$bias\left(\hat{\boldsymbol{\beta}}\right) = \left(\mathbf{X}'\mathbf{W}\mathbf{X}\right)^{-1}\mathbf{X}'\mathbf{W}\boldsymbol{\xi}$$

where $\boldsymbol{\xi}_i = 0.5Q_{ii}[(1+w_1)\hat{\pi}_i - w_1]$, Q_{ii} are the diagonal elements of $\mathbf{Q} = \mathbf{X}(\mathbf{X}'\mathbf{W}\mathbf{X})^{-1}\mathbf{X}'$, and $W = diag\{\hat{\pi}_i(1-\hat{\pi}_i)w_i\}$. The bias-corrected estimate is then

$$\tilde{\boldsymbol{\beta}} = \hat{\boldsymbol{\beta}} - bias\left(\hat{\boldsymbol{\beta}}\right).$$

Notice that this correction affects the constant term directly, but also the other coefficients primarily as a consequence (King and Zeng, 2001).

The variance of the approximately unbiased estimate of $\boldsymbol{\beta}$, $\tilde{\boldsymbol{\beta}}$, is approximated by a multiple of the usual variance matrix,

$$V\left(\tilde{\boldsymbol{\beta}}\right) = \left(\frac{n}{n+k}\right)^2 V\left(\hat{\boldsymbol{\beta}}\right).$$

A key point is that since $(n/(n+k))^2 < 1$, $V\left(\tilde{\boldsymbol{\beta}}\right) < V\left(\hat{\boldsymbol{\beta}}\right)$. Thus, reducing the bias also reduces the variance.

4.2 Data Description

The primary source of information for our estimations is the Chilean Survey of Household Finance (EFH). The EFH is an initiative of the Central Bank of Chile to collect information about the household's finance including socioeconomic characteristics, information about assets holdings, and detailed information on the debts of each household member. We use the five available waves of the EFH: the first wave (2007) collected information from 3828 urban households at the national level; the second (2008), third (2009), and fourth (2010) waves accounted for 1154, 1190, and 2037 urban households in the Metropolitan Region of Chile, respectively; finally, the fifth wave (2011-12) collected information from 4059 urban households at the national level.

For each wave, higher income households have been oversampled in order to obtain a better insight of the indebtedness. In Table 1 we show the percentage of households per income stratum.[15]

Table 2 shows information about mortgage holdings and delinquency as it comes from the EFH. However, to correct the bias induced by rare events, we also incorporate some prior information coming from the delinquency reported by the banks to the Superintendency of Banks and Financial Institutions (SBIF, for its name in Spanish) every month. Ideally we would use the number of delinquent loans versus the total number of outstanding loans. However, that information is not available. Instead, we use the amounts of loans. Thus, the prior information for us is given by the average ratio of the amount of nonperforming mortgage loans to the total amount of outstanding mortgage loans in the Chilean financial system, during the months each wave of the EFH was collected. Although imperfect, this measure is a good approximation given the almost even distribution of the amount of credits in delinquency in each wave of the EFH (see the Appendix for charts showing the distribution for each year). Notice that while the oversampling of defaulted loans is similar in the EFH, the delinquency rate (as reported by the SBIF) changes over time following the impact of the global crisis in Chile.

The EFH collects information on various aspects of the credits, but specific variables for our estimations must be constructed. For each mortgage loan, we constructed the loan-to-value ratio (LTV) for both initial loan amount and current outstanding debt. While most of the analysis uses the initial LTV (eg. Kau et al., 1994; Harrison et al., 2004; Bajari et al., 2010, 2012; Bhutta et al., 2010; Campbell and Cocco, 2010; Elul et al., 2010; Paniza Bontas,

[15] Stratum 1: percentiles 1-50; Stratum 2: percentiles 51-80; Stratum 3: percentiles 81-100.

2010; Hatchondo et al., 2012), we are more prone to use the current LTV (as in Capozza et al., 1997, 1998; Ambrose and Capone, 1998; Wong et al., 2004). Our perspective is that the current LTV better reflects the financial burden for the household and is the appropiate measure for the household to include in his optimization problem to evaluate the default decision. The initial LTV is useful when the loan is in its first stages of payment, or when we want to evaluate the risk involved at the time of granting the loan. However, for long-term credits such as mortgages, the changing nature of the economic context and the household financial balancesheet hinder the usefulness of the initial LTV. Nevertheless, in our analysis we tested the role of both measures, as shown in the next section.

In Table 3 we present information on the quartiles of the current and initial LTV, and the monthly installment. The median mortgage loan in our sample was granted to cover the 85% of the home value, and the current due amount represents the 45% of the current home value. The median monthly installment is about $185,000 (around US$ 350). Also notice that the median term of the credit is 20 years, while the median age of the credit (the time period elapsed from the granting of the mortgage) is 6 years. As it can be seen, most of the credits are granted for a term of around 20 years, while in more advanced economies the usual term is around 30 years.

We make a final note on the situation of renegotiated mortgages to have some insight on the behavior of those mortgagors that might be observed as defaulting but have renegotiated the loans to avoid default. In our complete sample (12,268 households) we have that 15.9% of them have an outstanding mortgage loan. Of them, the 19.5% have renegotiated the conditions of their loans at some point. Table 4 shows default situation of mortgagors that have renegotiated their loans. It is important to notice that there is a difference between households that are defaulting and those that are paying their debts after renegotiating a mortgage: the main motivation to renegotiate for defaulters was "to decrease the mortgage payment by increasing the term"; for those who kept paying their loan after renegotiation, the main motivation was "a decrease in the interest rate".[16]

5 Results

In this section we present estimation results using the method described in the previous section.[17] There are two sets of estimations in the following tables. In Table 5, each idiosyncratic and systemic variable enters directly in the regressions to explain the decision of defaulting. In Table 6, there are interactions between these variables included as regressors in the estimation, as suggested by our theoretical model.

In Table 5, we show four different models that differ in the inclusion of financial idiosyncratic variables and systemic variables. The set of demographic variables remain the same for all estimated models. Notice that the sign, magnitude, and significance of the coefficients accompanying the latter set of variables is stable through model specifications. Income is an important determinant of the probability of default, and it enters the regressions with the expected negative sign. Contrary to popular intuition, the number of persons in the household impacts positively in the probability of default. This result may be associated with the fact that in most cases at hand, a more densely populated household is not directly associated with higher household total income (for example, because the increased number of members of the household is due to the presence of children).

Regarding the financial variables, we find that suffering a negative shock in the recent past significantly increases the probability of defaulting a mortgage loan.[18] Households that renegotiated the conditions of their loans also are more likely to default them. Having rejected credit applications appears not to be significant to explain default behavior.

[16] The distinction of motivations is based on an specific question for mortgagors that have renegotiated their loans conditions, as collected by the EFH.

[17] We have performed a complete set of estimations including a wide range of variables that were included in previous empirical analysis of mortgage default. We also tried single step and two step estimations to correct for possible endogeneity in the decision of getting a loan and then defaulting, as in Alfaro and Gallardo (2012). We did not find any technical or empirical reason to keep the track of the two step estimation procedure. However, all the additional results are available from the authors upon request.

[18] The EFH collects information on a specific question that inquires about the occurrence of an event that significantly lowered the income o increased the expenditure and that was not planned.

We included three variables capturing systemic impact on household default behavior. The current loan to value (CLTV) implies that a bigger CLTV increases the probability of default all other things equal. Our results indicate that a higher amount due (higher long-term financial burden) may impact positively the decision of defaulting (as in Elul et al., 2010). On the other hand, higher price houses (usually associated with higher amounts of loans) lessen the probability of default. The LTV of origination does not have major impact on the decision of default. This result supports our argument that CLTV is the relevant information for the household, specially if the relatively more defaulted loans are the older ones. The systemic variables as a whole tell us that bigger mortgage loans are less likely to default. These credits have being predominantly granted since 2005, accompanying important aggregate phenomena of the Chilean economy: a sustained high growth period (even during the global crisis), and a real estate boom. These two aspects require more detailed analysis in terms of the risk-taking decision of the financial system and the aggregate push-pull effect of commodity prices and other macro determinants, all of them far beyond the scope of this paper.[19]

The second set of results is presented in Table 6. Idiosyncratic demographic and financial variables, as well as systemic variables, play a similar role to that of the results in Table 5. The novel results come from the interaction between systemic and idiosyncratic variables, as our theoretical model suggested. We find that the interaction between income and current loan to value positively impact the chances of making default, as well as the interaction between the price of the home at the origination moment and the fact that the household suffered an unexpected negative shock. In the first case, even when the income has a negative effect on the default probability, the CLTV dominates in the overall. In the second case, the effect of the negative shock dominates the scene. These results emphasize that shocks affecting income (expenditure) or the remaining (long term) financial burden are key aspects when analyzing default probabilities. For example, sustained high unemployment rates may

[19] Our general equilibrium framework incorporates these two levels of analysis together with the partial equilibrium we are presenting in this paper.

impact income level configuring at the same time an unexpected shock that aggravates the financial burden.

As we have analyzed above –and in contrast to Alfaro Gallardo (2012), which also analyze the Chilean mortgage market–, the current LTV (CLTV) as a systemic factor is statistically and economically significant, as well as the house price at origination. This suggests that both idiosyncratic and systemic factors (and its interactions) are simultaneously determining the mortgage defaults.

6 Final Remarks

In this paper we propose a theoretical framework to model mortgage default in full recourse economies. In such framework, it is possible to derive an analytical expression for the household's default decision that involves idiosyncratic and systemic factors, and their combinations.

To empirically test this framework, we take into account two important issues of the type of phenomenon we are studying: first, its occurrence is rare; and second, the sampling framework favored the collection of data on default cases but contributes to worsen the statistical properties of estimators. Overall, traditional logistic regression provides biased and inefficient estimators. We overcome this problem adopting appropiate adjustments suggested by the literature.

Following our theoretical default description and the empirical strategy, we estimate the default decision determinants for the representative Chilean household, using information from the EFH survey.

According to our theoretical model, we find empirically that systemic and idiosyncratic factors are statistically important to determine the default decision. Moreover, the systemic and idiosyncratic interactions play a key role in determining default probability.

Our results suggest that aggregated macrofinancial variables –such as prices and loan to value ratios– and its interaction with microeconomic information, can contribute to explain an important portion of mortgage risks. This in turn implies that, when assessing the quality of a mortgage, or any other credit portfolio, the use of microeconomic or demographic information is not enough. Accordingly, financial regulators and supervisors should invest in developing aggregated measures that can act as early warning indicators, as well as incorporating market trends information into the analysis of risks. Furthermore, this constitutes another rationale that reinforces the idea that monetary and banking authorities should inform the market about this type of financial developments in a consistent and integrated report, that uses macro and micro financial information. Financial stability reports appear as natural channel to issue this information.[20].

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8 Appendix

8.1 Glossary

Non-performing loans: A loan is nonperforming when payments of interest and/or principal are past due by 90 days or more, or interest payments equal to 90 days or more have been capitalized, refinanced, or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons —such as a debtor filing for bankruptcy— to doubt that payments will be made in full. After a loan is classified as nonperforming, it (and, possibly, replacement loan(s)) should remain classified as such until written off or payments of interest and/or principal are received (IMF, 2005).

Default: it essentially means a debtor has not paid a debt which he or she is required to have paid. Debt service default occurs when the borrower has not made a scheduled payment of interest or principal.

Reputational Effects of Default: A loan becomes *delinquent* the first day after the borrower misses a payment. The *delinquency* will continue until all payments are made to *bring the loan current*. Loan servicers report all delinquencies of at least 90 days to the SBIF and other credit bureaus (e.g. SINACOFI, DICOM). This information is used by the financial market agents to evaluate risk and grant credit. In particular, being in listed in DICOM implies that the debtor also may have trouble getting a job, signing up for utilities or leasing, getting home owner's insurance, getting a cellphone plan, or getting approval to rent an apartment (credit checks usually are required for renters).

8.2 First order conditions for the household problem

$$\frac{\partial L^\alpha}{\partial q_{01}^\alpha} : - U^{\alpha\prime}\left(e_{01}^\alpha - q_{01}^\alpha\right) - \eta_{01}^\alpha p_{01} = 0 \tag{3}$$

$$\frac{\partial L^\alpha}{\partial q_{11}^\alpha} : - \pi_G U^{\alpha\prime}\left(e_{11}^\alpha - q_{11}^\alpha\right) - \eta_{11}^\alpha p_{11} = 0 \tag{4}$$

$$\frac{\partial L^\alpha}{\partial q_{21}^\alpha} : - \pi_B U^{\alpha\prime}\left(e_{21}^\alpha - q_{21}^\alpha\right) - \eta_{21}^\alpha p_{21} = 0 \tag{5}$$

$$\frac{\partial L^\alpha}{\partial b_{02}^\alpha} :\ U^{\alpha\prime}\left(\frac{b_{02}^\alpha}{p_{02}}\right)\frac{1}{p_{02}} + \pi_G U^{\alpha\prime}\left(\frac{b_{02}^\alpha}{p_{02}} + \frac{b_{G2}^\alpha}{p_{G2}}\right)\frac{1}{p_{02}} + \eta_{02}^\alpha - \phi\eta_\phi^\alpha + \frac{\lambda^\alpha \pi_B p_{B2}}{\bar{\mu} p_{02}} = 0 \tag{6}$$

$$\frac{\partial L^\alpha}{\partial b_{G2}^\alpha} :\ \pi_G U^{\alpha\prime}\left(\frac{b_{02}^\alpha}{p_{02}} + \frac{b_{G2}^\alpha}{p_{G2}}\right)\frac{1}{p_{G2}} + \eta_{G2}^\alpha = 0 \tag{7}$$

$$\frac{\partial L^\alpha}{\partial b_{B2}^\alpha} :\ \pi_B U^{\alpha\prime}\left(\frac{b_{B2}^\alpha}{p_{B2}}\right)\frac{1}{p_{B2}} + \eta_{B2}^\alpha = 0 \tag{8}$$

$$\frac{\partial L^\alpha}{\partial \mu_0^\alpha} :\ \eta_{01}^\alpha - \frac{\eta_{02}^\alpha}{1+r_0} = 0 \tag{9}$$

$$\frac{\partial L^\alpha}{\partial \mu_1^\alpha} :\ \eta_{11}^\alpha - \frac{\eta_{G2}^\alpha}{1+r_1} = 0 \tag{10}$$

$$\frac{\partial L^\alpha}{\partial \mu_2^\alpha} :\ \eta_{21}^\alpha - \frac{\eta_{B2}^\alpha}{1+r_2} = 0 \tag{11}$$

$$\frac{\partial L^\alpha}{\partial \bar{\mu}^\alpha} :\ -\frac{\eta_{02}^\alpha}{1+\bar{r}} + \eta_{G2}^\alpha + \frac{\eta_\phi^\alpha}{1+\bar{r}} - \frac{\lambda^\alpha \pi_B p_{B2} b_{02}^\alpha}{\bar{\mu}^2 p_{02}} = 0 \tag{12}$$

$$\frac{\partial L^\alpha}{\partial \eta_{01}^\alpha} :\ \mu_0^\alpha - p_{01} q_{01}^\alpha = 0 \tag{13}$$

$$\frac{\partial L^\alpha}{\partial \eta_{02}^\alpha} :\ b_{02}^\alpha - \frac{\mu_0^\alpha}{1+r_0} - \frac{\bar{\mu}^\alpha}{1+\bar{r}} - m_0^\alpha = 0 \tag{14}$$

$$\frac{\partial L^\alpha}{\partial \eta_\phi^\alpha} :\ \frac{\bar{\mu}^\alpha}{1+\bar{r}} - \phi b_{02}^\alpha = 0 \tag{15}$$

$$\frac{\partial L^\alpha}{\partial \eta_{11}^\alpha} :\ \mu_1^\alpha - p_{11} q_{11}^\alpha = 0 \tag{16}$$

$$\frac{\partial L^\alpha}{\partial \eta_{21}^\alpha} :\ \mu_2^\alpha - p_{21} q_{21}^\alpha = 0 \tag{17}$$

$$\frac{\partial L^\alpha}{\partial \eta_{G2}^\alpha} :\ b_{G2}^\alpha + \bar{\mu}^\alpha - \frac{\mu_1^\alpha}{1+r_1} - m_1^\alpha = 0 \tag{18}$$

$$\frac{\partial L^\alpha}{\partial \eta_{B2}^\alpha} :\ b_{B2}^\alpha - \frac{\mu_2^\alpha}{1+r_2} - m_2^\alpha = 0 \tag{19}$$

8.3 Proof of Proposition 1

From (5),

$$U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)\frac{1}{p_{02}}+\pi_1 U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)\frac{1}{p_{02}}-\phi\eta_{\phi}^{\alpha}+\frac{\lambda^{\alpha}\pi_2 p_{B2}}{\bar{\mu}p_{02}}=-\eta_{02}^{\alpha}$$

From (2), we have that $\frac{-U^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right)}{p_{01}}=\eta_{01}^{\alpha}$, from (7) $\eta_{01}^{\alpha}(1+r_0)=\eta_{02}^{\alpha}$. Combining these results,

$$\frac{U^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right)}{p_{01}}(1+r_0)=U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)\frac{1}{p_{02}}+\pi_1 U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)\frac{1}{p_{02}}-\phi\eta_{\phi}^{\alpha}$$

$$\frac{-U^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right)}{p_{01}\phi}(1+r_0)+\frac{1}{p_{02}\phi}\left[U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)+\pi_1 U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)+\frac{\lambda^{\alpha}\pi_2 p_{B2}}{\bar{\mu}}\right]=\eta_{\phi}^{\alpha}$$

On the other hand, using (6),$-\pi_1 U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)\frac{1}{p_{G2}}=\eta_{G2}^{\alpha}$, we can replace this expression with (5) in (11) and it yields,

$$\frac{-1}{p_{02}(1-\phi)}\left[U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)+\pi_1 U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)+\frac{\lambda^{\alpha}\pi_2 p_{B2}}{\bar{\mu}}\right]+\frac{\lambda^{\alpha}\pi_2 p_{B2}b_{02}^{\alpha}(1+\bar{r})}{\bar{\mu}^2 p_{02}(1-\phi)}+$$
$$\pi_1(1+\bar{r})U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)\frac{1}{p_{G2}(1-\phi)}=\eta_{\phi}^{\alpha}$$

Equating for η_{ϕ}^{α}, we have,

$$\frac{-U^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right)}{p_{01}\phi}(1+r_0)=\frac{-1}{p_{02}(1-\phi)\phi}\left[U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)+\pi_1 U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)+\frac{\lambda^{\alpha}\pi_2 p_{B2}}{\bar{\mu}}\right]+$$
$$\frac{\lambda^{\alpha}\pi_2 p_{B2}b_{02}^{\alpha}(1+\bar{r})}{\bar{\mu}^2 p_{02}(1-\phi)}+\pi_1(1+\bar{r})U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)\frac{1}{p_{G2}(1-\phi)}$$

$$\frac{-U^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right)}{p_{01}}(1+r_0) = \frac{1}{p_{02}(1-\phi)}\left[-U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)+\frac{\pi_1(\phi p_{02}(1+\bar{\mu})-p_{G2})}{p_{G2}}U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)-\frac{\lambda^{\alpha}\pi_2 p_{B2}}{\bar{\mu}}\right]$$
$$\frac{\lambda^{\alpha}\pi_2 p_{B2} b_{02}^{\alpha}(1+\bar{r})\phi}{\bar{\mu}^2 p_{02}(1-\phi)}$$

$$\frac{-b_{02}^{\alpha}p_{B2}}{\bar{\mu}p_{02}} = \frac{\bar{\mu}}{p_{02}\lambda^{\alpha}\pi_2(1+\bar{r})\phi}\left[-U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)+\frac{\pi_1(\phi p_{02}(1+\bar{\mu})-p_{G2})}{p_{G2}}U^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)-\frac{\lambda^{\alpha}\pi_2 p_{B2}}{\bar{\mu}}\right]+$$
$$\frac{-U^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right)}{p_{01}}\frac{(1+r_0)(1-\phi)\bar{\mu}}{\lambda^{\alpha}\pi_2(1+\bar{r})\phi}$$

Adding 1 and regrouping, we have:

$$1-\frac{b_{02}^{\alpha}p_{B2}}{\bar{\mu}^{\alpha}p_{02}} = \omega_0+\omega_1\bar{\mu}^{\alpha}u^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}\right)+\omega_2\bar{\mu}^{\alpha}u^{\alpha\prime}\left(\frac{b_{02}^{\alpha}}{p_{02}}+\frac{b_{G2}^{\alpha}}{p_{G2}}\right)+\omega_3\bar{\mu}^{\alpha}u^{\alpha\prime}\left(e_{01}^{\alpha}-q_{01}^{\alpha}\right) \tag{20}$$

Where, $\omega_0 = 1-\frac{\lambda^{\alpha}\pi_B p_{B2}}{p_{02}(1+\bar{r})\phi}$, $\omega_1 = \frac{-1}{p_{02}\lambda^{\alpha}\pi_B(1+\bar{r})\phi}$, $\omega_2 = \frac{\pi_G(\phi p_{02}(1+\bar{r})-p_{G2})}{p_{G2}p_{02}\lambda^{\alpha}\pi_B(1+\bar{r})\phi}$, $\omega_3 = \frac{-(1+r_0)(1-\phi)}{p_{01}\lambda^{\alpha}\pi_B(1+\bar{r})\phi}$

Q.E.D

8.4 Tables and Figures

Table 1: Distribution of Households by Income Group (%)

	2007	**2008**	**2009**	**2010**	**2011**	**Total**
Stratum 1	26.38	31.28	25.88	29.46	30.45	28.65
Stratum 2	24.97	29.03	31.09	29.7	29.1	28.1
Stratum 3	48.64	39.69	43.03	40.84	40.45	43.25

Table 2: Mortgage Loans and Delinquency (%)

	2007	**2008**	**2009**	**2010**	**2011**	**Total**
Mortgage holders	16.77	13.17	13.70	18.85	15.00	15.90
Defaulted mortgages	8.26	13.82	9.2	8.07	8.87	8.92
Delinquent mortgages (SBIF)	0.97	1.29	1.95	2.01	1.70	1.58

Table 3: Distribution of Mortgage Characteristics

	p25	**p50**	**p75**
Current Loan to Value	24.6 %	45.1 %	67.9 %
Initial Loan to Value	63.6 %	85.0 %	100.0 %
Monthly Intallment	$ 95,000	$ 185,000	$ 320,000
Term of Credit (in years)	19	20	20
Age of Debt (in years)	3	6	11

Table 4: Default and Renegotiation in the Sample

	Did not renegotiated	**RENEGOTIATED**	**Total**
Paying	74.5 %	16.6 %	91.1 %
DEFAULTED	6.0 %	2.9 %	8.9 %
Total	80.5 %	19.5 %	100 %

Note: Percentages are calculated over the complete group of mortgagors in the sample.

Table 5: Estimation Results 1: No interactions

Dep. Var.: Mortgage Default Dummy	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Idiosyncratic - Demographic Variables				
Number of persons in house	0.211***	0.235***	0.214**	0.213**
	(0.0715)	(0.0826)	(0.0844)	(0.0856)
Income (in logs)	-0.827***	-0.563***	-0.734***	-0.524***
	(0.133)	(0.153)	(0.155)	(0.162)
Primary Education	0.348	0.0446	0.215	0.109
	(0.333)	(0.424)	(0.440)	(0.466)
Tertiary Education	-0.633***	-0.417	-0.554*	-0.397
	(0.241)	(0.291)	(0.308)	(0.309)
Gender	-0.285	-0.214	-0.285	-0.301
	(0.199)	(0.229)	(0.244)	(0.242)
Age 18-35	-0.0218	-0.155	0.0266	0.105
	(0.260)	(0.295)	(0.306)	(0.308)
Age 55-99	-0.699	-0.0802	-0.0578	-0.0759
	(0.603)	(0.675)	(0.696)	(0.683)
Idiosyncratic - Finance Variables				
Negative Shock	1.745***	1.715***	1.668***	1.683***
	(0.207)	(0.245)	(0.255)	(0.256)
Credit Applications Rejected	0.276			
	(0.398)			
Renegotiation	1.352***	1.052***	1.016***	1.073***
	(0.244)	(0.309)	(0.332)	(0.336)
Systemic Variables				
Current Loan to Value		0.253**		
		(0.117)		
Initial House Price (in logs)		-0.416***		-0.450***
		(0.113)		(0.152)
Initial Loan to Value			0.0407	-0.0835
			(0.0249)	(0.0794)
Constant	6.125***	9.095***	4.663**	9.413***
	(1.761)	(2.302)	(2.074)	(2.631)
Observations	1,894	1,446	1,301	1,337

Note: Robust standard errors in parentheses. Significance: *** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimation Results 2: Including Interactions

Dep. Var.: Mortgage Default Dummy	**Model 1**	**Model 2**
Idiosyncratic - Demographic Variables		
Number of persons in house	0.237***	0.231***
	(0.0820)	(0.0819)
Income (in logs)	-0.578***	-0.582***
	(0.150)	(0.149)
Primary Education	0.0564	0.0804
	(0.421)	(0.414)
Tertiary Education	-0.423	-0.425
	(0.290)	(0.290)
Gender	-0.260	-0.247
	(0.228)	(0.227)
Age 18-35	-0.189	-0.195
	(0.298)	(0.298)
Age 55-99	-0.0714	-0.0950
	(0.675)	(0.675)
Idiosyncratic - Finance Variables		
Negative Shock	1.678***	
	(0.245)	
Credit Applications Rejected	0.687	0.677
	(0.437)	(0.439)
Renegotiation	1.319***	1.325***
	(0.277)	(0.276)
Systemic Variables		
Initial House Price (in logs)	-0.417***	-0.443***
	(0.112)	(0.111)
Interaction Variables		
Income and current loan to value	0.0199**	0.0195**
	(0.00810)	(0.00814)
Initial House Price and Negative shock		0.102***
		(0.0147)
Constant	9.326***	9.817***
	(2.265)	(2.243)
Observations	1,446	1,446

Note: Robust standard errors in parentheses. Significance: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

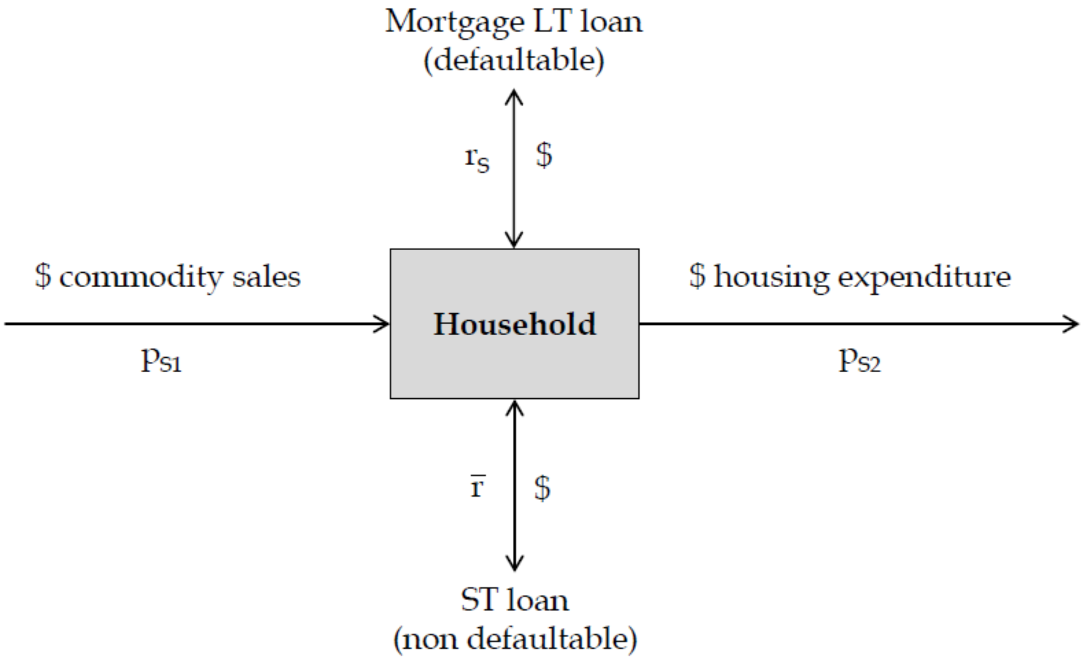

Figure 1: Nominal flows

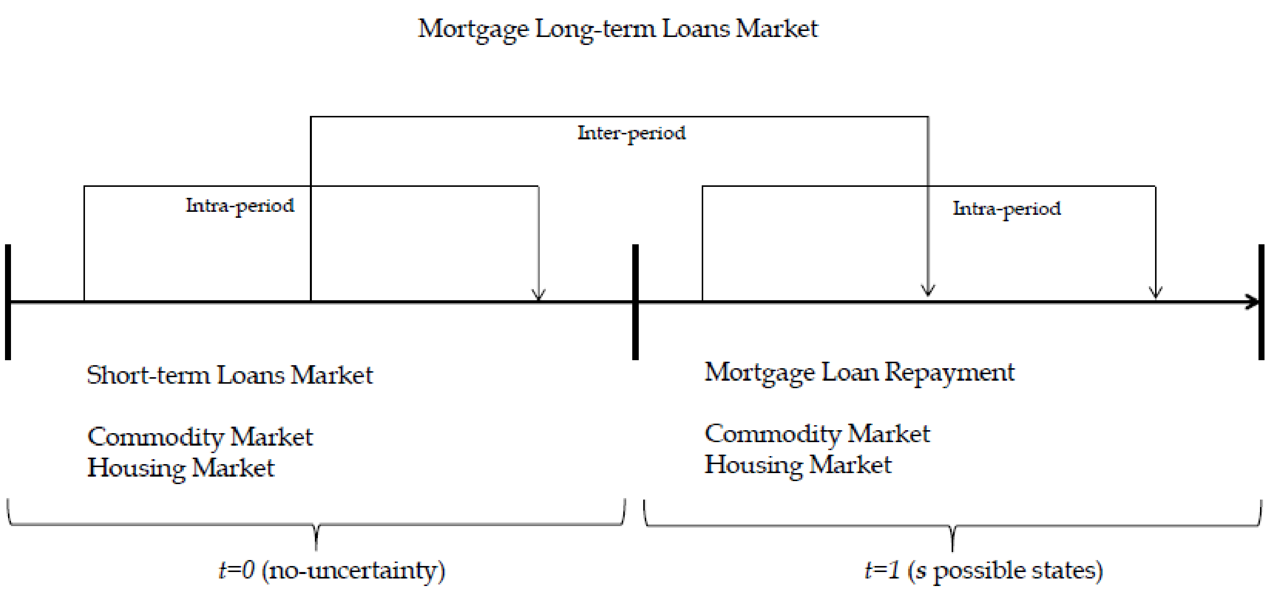

Figure 2: Timing of markets and transactions.

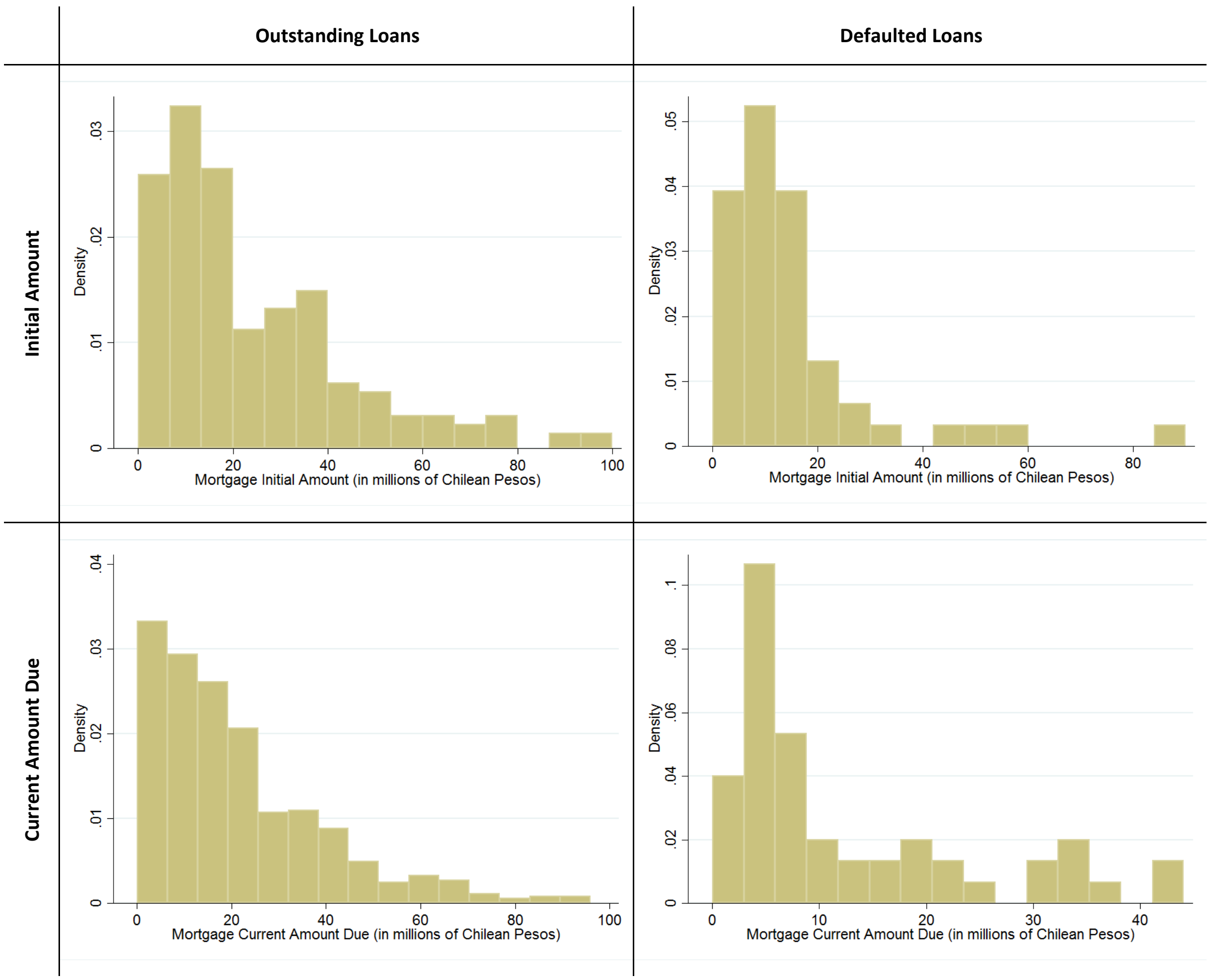

Figure 3: Distribution of the amount of mortgage loans, 2007

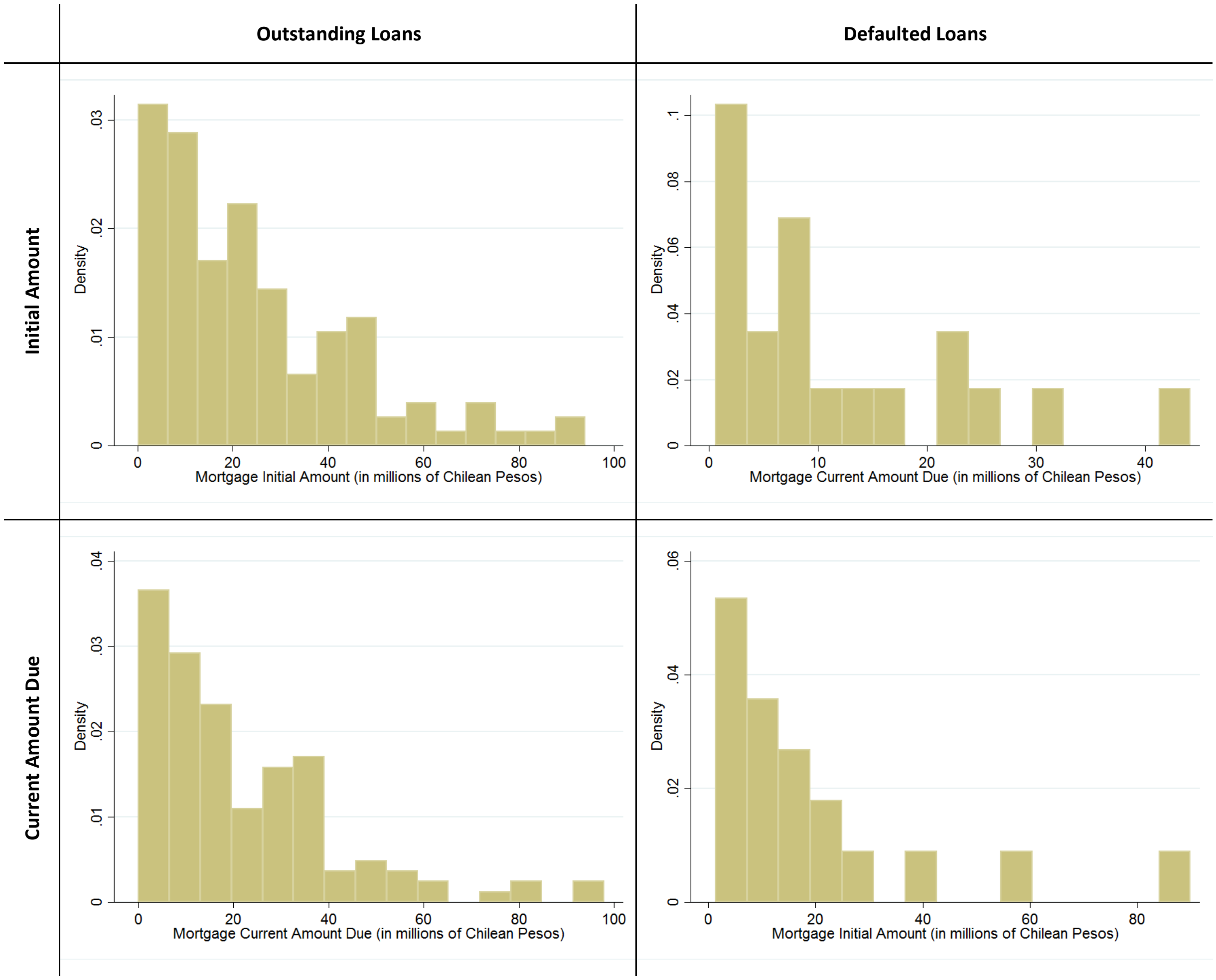

Figure 4: Distribution of the amount of mortgage loans, 2008

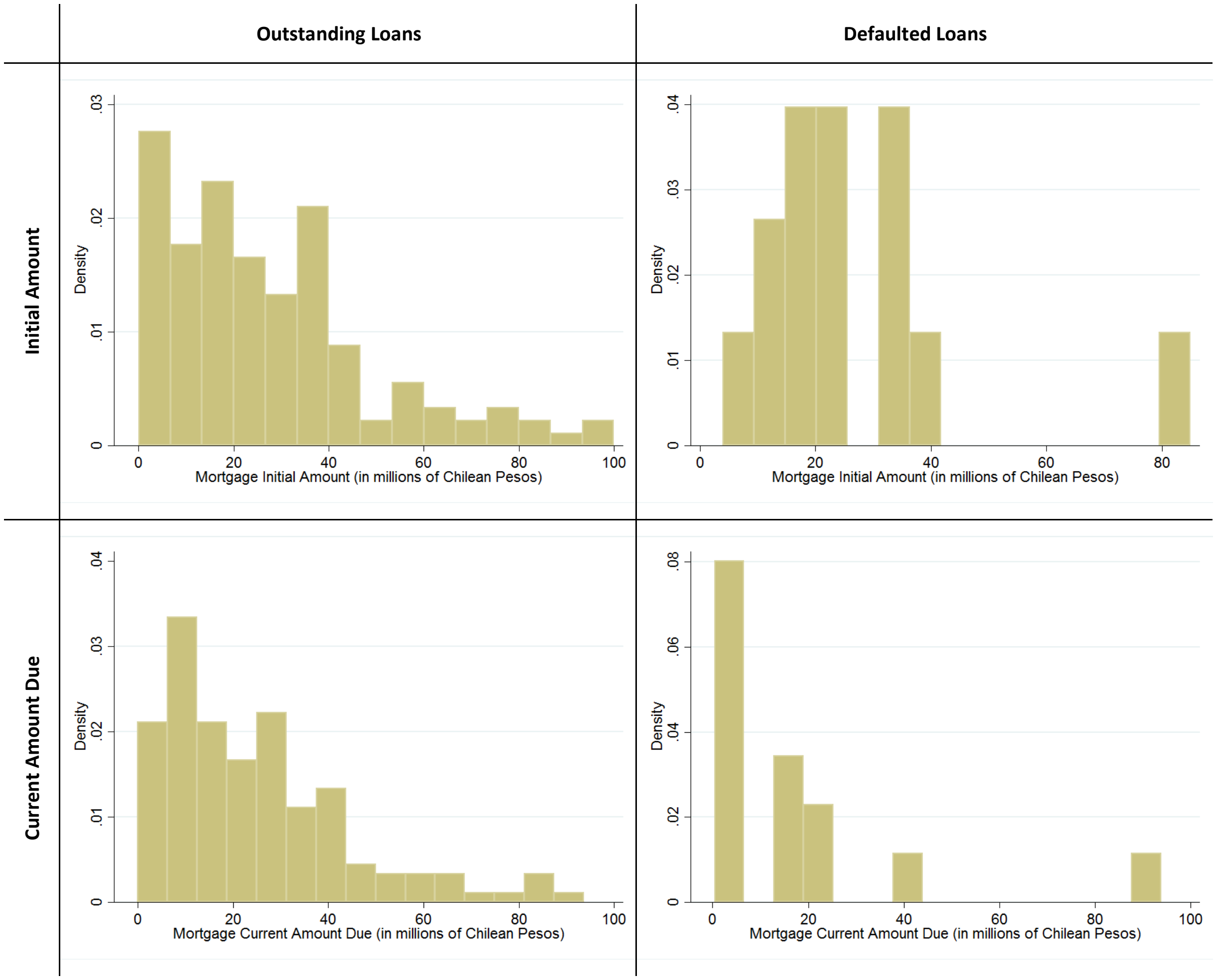

Figure 5: Distribution of the amount of mortgage loans, 2009

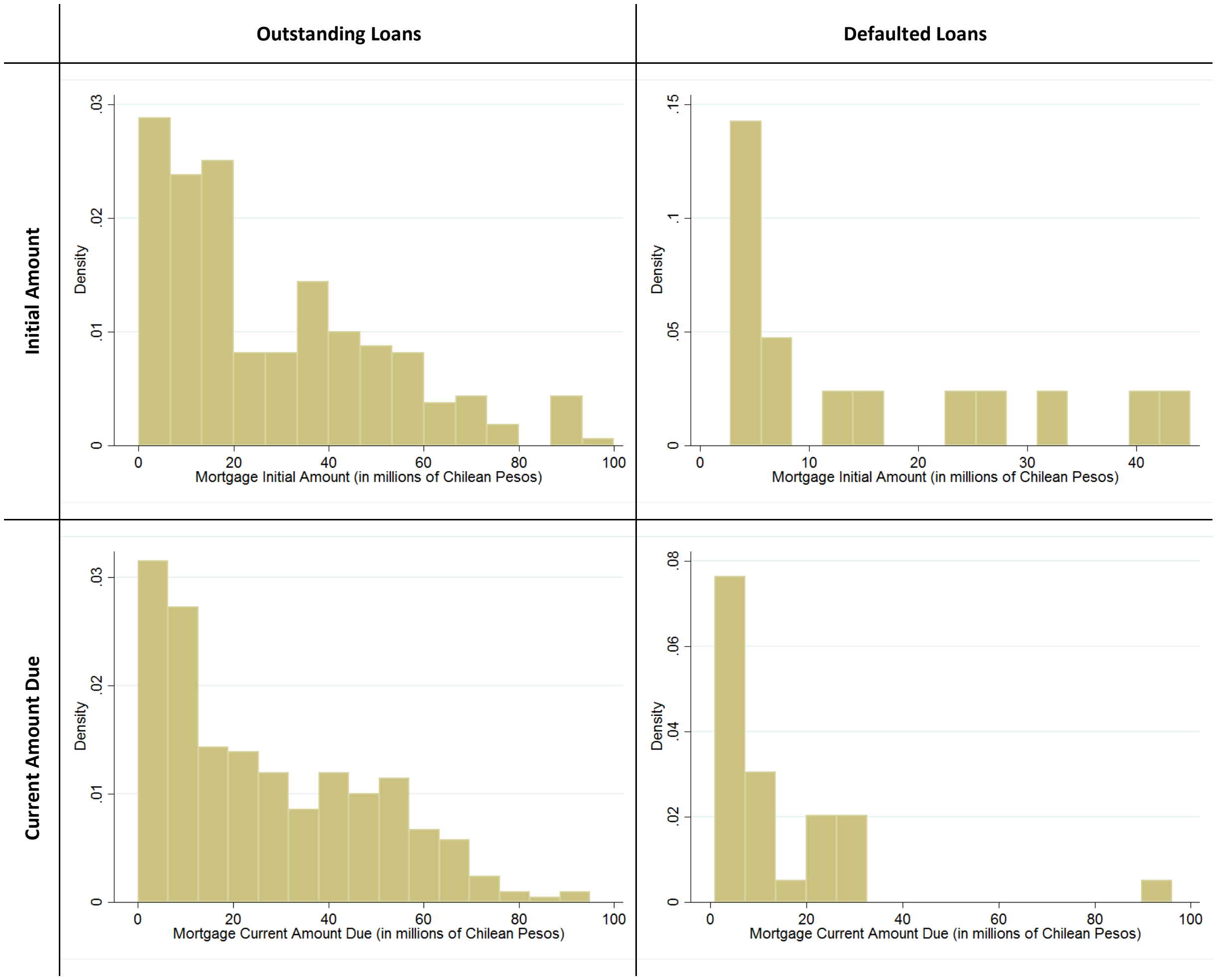

Figure 6: Distribution of the amount of mortgage loans, 2010

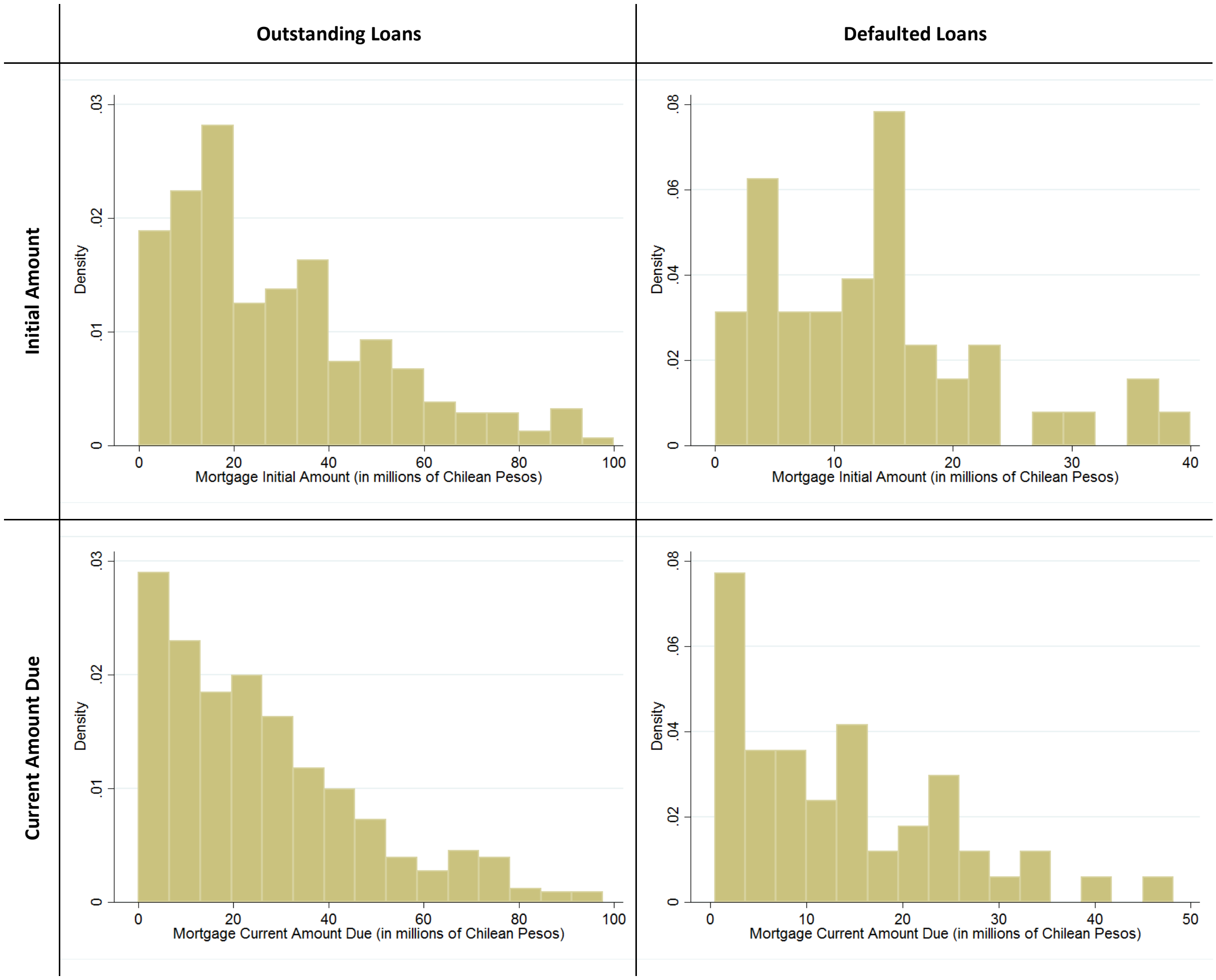

Figure 7: Distribution of the amount of mortgage loans, 2011-12

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Warsaw, Poland, 14-15 December 2015

On the dynamics of the primary housing market and the forecasting of house prices[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 or the central banks and other institutions represented at the meeting.

On the dynamics of the primary housing market and the forecasting of house prices

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November 2015

Abstract

This paper discusses and explains the dynamics of the primary housing market, focusing on housing supply, demand, price and the growth rate of construction costs. The attention is placed on the primary housing market because it can create excessive supply, which can cause distress to the economy.

Due to multiplier effects, even small changes in fundamental factors, such as minor changes in the interest rate, result in demand shocks. Positive demand shifts cannot be easily satisfied as supply is rigid in the short run. This usually makes house prices grow and developers increase their production, which will be delivered to the market with a time lag. Housing developers have marketing tools to heat up the market for a prolonged period of time. Rising prices can lead to further demand increases as housing is a consumer and investment good. When demand moves back to its long-run level, the economy is left with excessive supply, falling prices and bad mortgages.

The simple four-equation model presented in this article is able to replicate the dynamics of the Warsaw primary housing market. Out-of-sample forecasting proves that the model replicates historical data in an appropriate way and the model is applied to forecast house prices, demand, supply and construction costs over two years on a quarterly basis.

JEL classification: E32, E44, E37, R21, R31
Key words: Housing market cycles, disequilibrium demand and supply forecast

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The paper presents the personal opinions of the authors and does not necessarily reflect the official position of Narodowy Bank Polski or the Warsaw School of Economics.

1. Introduction and motivation

A home plays an enormous role in the life of every household as a capital good that generates consumer services and an investment good that is a source of income for the future (see DiPasquale, 1992, Henderson and Ioannides, 1983 and Łaszek, 2013). The decisions of households that buy housing on the primary market depend on incomes, interest rates and prices, while the decisions of developers who produce it depend on prices and costs. An analysis of the housing market is very important because the housing market serves a social function and can increase the wealth of the home owner. However, during boom-bust episodes it can negatively affect financial stability. A permanent feature of the housing market is its cyclical character, which can be explained by the low elasticity of supply. The financial system and consumer behaviour have a pro-cyclical effect on demand. Ciarlone (2012) claims that housing booms in Eastern Europe were mainly caused by regulations and the lack of housing in comparison to the basic needs of households, not just by speculation.

The market is imperfect, there is a long construction process and the market players behave irrationally. Another problem is the information asymmetry, which means that during transactions one side is better informed than the other. Problems with reliable and complete information are in many cases a result of brokers' and developers' marketing activities in mass media[4], so the buyer can see a distorted picture of the market. However, developers face positive and negative consequences of this market intransparency. They can obtain higher returns, selling homes at high prices to uninformed clients. However, it is difficult for them to plan future production when signals from the market are misleading. While demand is analysed in various articles, the supply side is less often studied, and models of the market that could be used to make forecasts for the primary housing market are not well developed. While there is a rich literature on the forecasting of house prices (see Rahal, 2014 for a detailed review), those models do not forecast the demand, supply and construction costs explicitly. In order to provide proper policy advice about the housing market, it is not enough to know how prices will evolve, but also what will drive them. Thus, supply, demand and construction costs need to be analysed and forecasted, too. Some macroeconomic models take the housing market into account, but it usually plays a minor role. Researchers that try to incorporate housing in DSGE (dynamic stochastic general equilibrium) models need to simplify the housing market, and the supply side is usually not captured or it is ad-hoc, included just to close the model. Those models do not account for accelerator effects and frictions in the housing market, speculative behaviour and finally the time to build. As Iacovelli (2010) explains, DSGE models aim to explain how housing affects consumption or how monetary policy affects the housing market. This is a great and important task, but it is also crucial to go more into the details of the housing market, such as the number of newly constructed dwellings. If DSGE models contained a fully developed housing market, they would be too complicated to be solved with state-of-the-art mathematical tools. This is

[4] Soo (2013) constructed a sentiment indicator from the tone of local housing news from 20 largest cities in the US during the 2000-2011 period. His sentiment indicator is able to predict house price booms and busts with a significant lead, which shows that mass media have a big impact on consumer behaviour and affect housing demand.

understandable, as their aim is to model the whole economy and explain inflation. However, if one wants to model house price dynamics, it is necessary to understand the connections between the demand and supply side. The model introduced in this paper presents a detailed explanation of the relationships between demand, supply, costs and prices, and is useful in an analysis of the impact of changes in income or mortgage rates on house prices.

It is important to stress that the model focuses on newly constructed housing and not the whole housing stock. Adjustments of the housing stock through migration, the construction of new housing and its depreciation or destruction happen only in the long run. The division of a housing unit into two or the conversion of commercial real estate into housing is very costly, happens only on a very small scale and takes a lot of time. In the short term, increased housing needs can be satisfied only with new construction, and through rising prices, rising demand leads to construction booms. These booms end quite often in excessive debt accumulation and sometimes in banking crises that are accompanied by an economic slowdown (see the case of the US, Spain and Ireland discussed in André, 2010, André, 2011 and Cerutti et al., 2015).

The aim of this paper is to forecast house prices, construction costs, demand and supply, thus the whole housing market. A housing model is set up that is based on the Augustyniak et al. (2014a) model and the dynamics of the primary housing market are explained with a simple four-equation model of housing supply, demand, price and construction costs. The model replicates historical data well, and it is applied to predict the future value of house prices, demand, supply and costs in the next two years on a quarterly basis. The economy has a direct impact on the housing market, while the effects of the housing market feed through the labour market and the banking sector with a certain delay to the economy and might be non-linear. Therefore, the whole economy is taken as given and the official NBP NECMOD[5] forecast is used (see NBP 2014b).

The paper is organized as follows. A brief overview of the Polish housing market is presented in chapter 2. The dynamic model of the market is introduced in chapter 3, while its empirical analysis and the out-of-sample forecasting tests are performed in chapter 4. The forecast of house prices for the next two years is presented in chapter 5, while chapter 6 concludes the paper.

2. A short overview of the Polish housing market

After the Second World War, the housing stock in Poland was to a large degree destroyed and the socialistic system never managed to satisfy the needs of households. Since the change to the market economy, the primary market has become very important in Poland, as it contributes to growth of the housing stock and helps to satisfy the growing need of households to possess an apartment. The transformation changed significantly the size and investor structure of construction in Poland. The share of the private sector grew, while the share of housing cooperatives, company and communal housing fell. This was possible due to

5 NECMOD is the structural macroeconometric model of the Polish economy

changes in the law, but also due to the emergence of banks that issued housing loans on a large scale.

Since the beginning of the 1990s, together with the withdrawal of the state from pursuing housing construction and its gradual withdrawal from funding too, a new form of housing developers has emerged. These companies realized investments at the risk of future homeowners and with the funds provided by them (prepayments), supplemented sometimes with loans. The investments were often risky for the clients and very profitable for the developers. The risk associated with this form of activity was an important factor that limited construction demand. In 2012 a law to protect buyers of developer housing was introduced.

The transformation of the production sphere had a positive impact on the housing construction sector in the long term, eliminating large state enterprises and expensive, poor quality production based on prefabricated technology. However, the changes in the basic proportions of the housing market, such as the private source of funding, changes in the price-to-income ratio of newly-built apartments, inflation and unemployment, and the collapse in the availability of credit affected housing demand, causing changes in construction size.

In the long term, the whole economy and the developer sector adopted to the new needs, and consequently new projects were begun on a larger scale. First of all, developers and new technologies appeared. The market structures of housing construction developed, especially in the largest cities in Poland, and its financing was privatized, which was a consequence of the withdrawal of the state from successive programmes subsidizing housing construction. The first programme that subsidized the owner-occupied housing segment, *Family on its own* (RnS[6]), was introduced in 2006. It operated in a pro-cyclical manner, strengthening the excessive increase in prices, bordering on a price bubble, and was abandoned in 2012. In 2014 the *Housing for the young* (MdM[7]) programme was introduced. The main change in the MdM programme was that households could not buy a subsidized flat from the secondary market until late 2015. The RnS programme cut the interest rate by half for the first eight years of the loan duration. The MDM programme is a down-payment subsidy, up to 30% of the loan value. It decreases the loan instalments and thus makes mortgage financed housing more affordable. Both subsidy schemes do directly or indirectly decrease the interest rate that the owner has to pay, but they can only be used for mortgage-financed housing purchases. According to NBP (2013, 2015) both programmes increased the demand for loans and also had a positive impact on house prices.

The structure of the investment sector of developer firms changed with Poland's accession to the European Union and the credit boom in the years 2005-2008. The EU accession in 2004 resulted in an inflow of foreign capital, while the easy access to foreign finance, stable inflation and growing income caused strong demand for housing. The market concentration of developers in the largest cities was growing. Developers bought land banks that are large enough to build housing

6 RnS – (Rodzina na Swoim; Family on its own) – the government programme intended to support the housing sector through subsidies to interest rates on housing loans. The programme was introduced in 2006 and closed at the end of 2012.

7 MDM – (Mieszkanie dla Młodych; Housing for the young) – the government-subsidized programme intended to support housing construction through subsidies for housing loans, entered into force at the beginning of 2014.

for six years without the need to buy more land. Governmental procedures were introduced that speed up the preparation of land for investment. As a consequence, the limited access to development land has been eased. The years 2005–2008 were characterized by a boom on the mortgage market and the beginnings of the creation of standards and regulations of this market. From the beginning of the outbreak of the global financial crisis to 2013, important financial supervision regulations were introduced which restricted access to credit (Recommendation S, Recommendation T, and Recommendation J).

The years 2002-2014 left many housing issues unresolved, mainly in the sphere of social housing (after the expiry of the Social Building Society TBS[8] programme) and rental housing, but also mortgage lending, remained a problem. Twenty five years after the transformation, the state has not settled the issue of the rental market and social housing for the poorest, and the demand for owner-occupied housing from the primary market is still large. The rental market is tiny, mostly restricted to the largest cities and in many cases is found in the grey-zone (see Augustyniak et al., 2013). The dominant share of owner-occupied housing was obtained by the current owner in socialistic times, and there is little trade of those dwellings. As the empirical analysis in NBP (2015) shows, even controlling for the GDP per capita differences, CEE countries lack around 50 housing units per 1000 inhabitants to meet the EU average, which is around 340 housing units per 1000 inhabitants. This excessive demand can be satisfied only with new construction.

3. Explanation of housing demand and supply dynamics

The transactions in the housing market are those of newly constructed housing and sales of housing from the existing stock. A detailed analysis of the relationship between these two markets can be found in Augustyniak et al. (2014a). The relationship at the city level for Poland was investigated empirically by Leszczyński and Olszewski (2014). Because supply from the existing housing stock is rigid in the short and medium term, any excessive demand translates very quickly into excessive demand for new construction (see Augustyniak et al. 2014b).

There are other approaches to the analysis of housing cycles, some of them are presented below. Capozza and Helsley (1990) present a theoretical dynamic model of a growing urban area, in which land has been converted from agricultural to urban use. Developers maximize their profits by selecting the optimal time to convert land from agricultural to urban use and build houses. It is assumed that a city has potentially infinite borders, so it can expand outward from a city centre (business centre) to which all residents must commute. A city has an exogenous function of housing rents, fixed lot and house sizes and the authors decompose theoretically price rents into their components. Capozza and Helsley also introduced uncertainty and claimed that uncertainty, and the irreversibility of development,

[8] TBS (Towarzystwa Budownictw Socjalnego; Social Building Society) – a company operating under the Act of 26 October 1995 on certain forms of subsidizing housing construction, the subject of which was housing construction and maintenance based on rental, provision of management and administration services and conducting business related to housing construction and accompanying infrastructure. The TBS offer was planned to be addressed to non-affluent families eligible for a loan subsidy from the National Housing Fund (KFM).

slow down the development process and could cause an increase in the value of land if the boundary of the urban area is exogenous.

Abraham and Hendershott (1996) describe and empirically verify metropolitan real price changes. They divide the determinants of real house price appreciation into two groups: one that accounts for the deviations from the equilibrium price and another that explains changes in the equilibrium price. This approach helps to explain cross sectional variation in real housing price changes in 30 US cities over the period 1977-1992.

Mishkin (1995) stressed an important fact that there are different channels through which mortgage financing affects the housing market ('banking lending' and 'balance sheet' channels). Changes in monetary policy affect the availability of households debt and asset prices.

3.1 Housing demand

Housing cycles are driven by excessive increases in housing demand, thus the analysis starts by explaining the dynamics of housing demand. Throughout the paper housing is bought with the use of a mortgage, thus the cost the household has to pay every month is the loan instalment. Households use their income for the loan repayment[9] and the consumption of other goods. In order to obtain housing demand that is in line with empirical observations, the imputed rent has to enter the utility function. This means that when house prices rise, the imputed rent rises too. Without this fact, rising prices would make households decrease housing consumption and increase the consumption of other goods. In reality, amidst rising prices households give up as much consumption of other goods as possible to increase housing consumption. Similarly as in Bajari et al. (2013), the imputed rent $k * p * H$ is the size of the apartment *H*, multiplied by its price *p* and by a rent-to-price rate *k*. The utility function can be written as follows:

$$U(C,H) = (\theta C^{\mu} + (1-\theta)A^{\gamma}(kpH)^{\mu})^{\frac{1}{\mu}}$$

where the parameter μ denotes the elasticity of substitution between consumption and housing, ε = 1 / (1-μ) and the parameter θ denotes the share of utility resulting from consumption of other goods. According to Henderson and Ioannides, 1983 and Łaszek, 2013 housing is bought for consumption and investment purposes. To capture the latter purpose, the appreciation of housing $A = \frac{p_t}{p_{t-1}}$ is included in the utility function. Consumers form extrapolative expectations and rising prices make housing a more desirable good (see Dunsky and Follain, 1997, Somerville et al., 2010, Lambertini et al., 2012, Hott, 2012, Salzman and Zwinkels, 2013).

In order to find the optimal amount of housing, the consumers' utility is maximized under the following budget constraint: $b = rpH + C$.Under fixed loan instalments, the cost of housing borne by the consumer in a given period is the price per square metre of housing *p* multiplied by the mortgage rate *r* and the house size in sq. metres *H*. The price of the consumer good is normalized to 1.

[9] Prudential regulations set a maximum limit of the monthly loan service to the income, to curb excessive housing demand.

Solving this problem yields the following optimal substitution of consumption of housing and other goods

$$\theta C^{\mu-1} rp = (1-\theta) A^{\gamma} (kp)^{\mu} H^{\mu-1}$$

Substituting this condition in the budget constraint, leads to the optimal choice of consumption goods and housing:

$$C^* = \frac{b}{1 + rp\left(\frac{\theta}{1-\theta}\frac{rp}{A^{\gamma}(kp)^{\mu}}\right)^{\frac{1}{\mu-1}}}$$

$$H^* = \frac{b}{rp + \left(\frac{1-\theta}{\theta}\frac{A^{\gamma}(kp)^{\mu}}{rp}\right)^{\frac{1}{\mu-1}}}$$

The housing demand equation tells us that housing rises with increases in income and also when interest rates fall. High prices have the usual negative effect on demand, but if they rise fast in a given period, they increase housing demand. The rationale for this phenomenon is that consumers are worried about even faster rising prices and anticipate housing purchases or hope to sell the house later at a higher price. Augustyniak et al. (2014b) show how a simultaneous growth in income, decline in mortgage rates and increase in house prices leads to increased housing demand.

3.2 Supply of housing from real estate developers

Housing supply is a crucial factor in the housing boom, but unlike the demand side it has received little attention in the literature. There are studies on the supply of housing such as Muth (1960), Smith (1976), DiPasquale (1999), Epple, Gordon and Sieg (2010), but most of the studies do not go into empirical details about producers' decisions concerning at which point in time to start the development process and at what scale. A notable exception is the article by Bulan et al., 2009, who study irreversible investment decisions in Canada. The biggest obstacle to the empirical analysis of housing supply at the company level or even the city level is the lack of data on individual developers and their cost functions. The costs of a developer at each stage of the construction process are described in detail in Augustyniak et al. (2014b). Taking into account the factual development process, the average housing supply function is analysed.

Although the housing production function can be written as a Cobb-Douglas function, most empirical works are not based on micro-foundations, but rather run ad-hoc regressions. A good starting point for the analysis is the housing production function developed by Smith (1976), which is replicated here in detail. Smith makes two important assumptions, which bring his model close to reality and help to understand the developer market. Firstly, house producers have a constant returns to scale production function, thus they can produce any amount of housing if they increase their production capacity. Secondly, developers create a good which is not homogenous, but is of varying quality. This quality depends on the land L and materials K that are used and buyers pay a price P for the quality Q. The market price of housing $P*$ is the product of the house quality and its price. Housing of a given quality is produced with the following production function *Q=Q(L,K)*. For simplicity the price of land is denoted *R* and the price of capital is the numeraire. In order to maximize profits, the developer has to choose the optimal amount of land and capital and his profits at a given location can be described as follows:

$$\pi = PDQ - KD - R$$

The focus is on profits that are obtained from a unit of land, where *D* is the density of housing units put on a piece of land *(D=1/L)*. The production function per unit of land can be written as *q(D,K)* and the following Lagrangean is set up to solve the problem:

$$\mathcal{L} = PQD - KD - R - \mu(q(D,K) - Q)$$

Taking first derivatives of the Lagrangean in respect to *D, Q* an *K* and solving the system results in two first order optimality conditions:

$$PQ = K - D(q_D/q_K)$$

$$P = 1/q_K$$

In equilibrium, developers choose such a type of housing that the marginal cost of increased density equals the market price P* and the marginal cost of increased quality of a dwelling equals the price of quality (see Smith 1976, p. 394). In the long run the profits of the developers should be zero and all profits should go to the land owners. From this it follows that the price of land is given as *R=PQD-KD*. Smith shows that from this equation it follows that land prices and housing quality are positively related. This theoretical finding is in line with empirical observations, as better locations usually offer housing of higher quality[10]. No reasonable developer would pay for good land and construct poor quality housing.

In fact the urban housing development process is more complex and allows the developer to make certain adjustments. As shown in Augustyniak et al. (2014b), the developer faces a virtual and a real supply curve. In short, the developer can increase his production without increasing costs, as he uses outsourcing of construction services. Moreover, he uses the pre-payments of clients, which is basically an interest free source of funding and buys most of the production factor just in time. This makes him assume that he can expand his production and make significant profits. However, in reality there are many housing producers, due to which construction, material and land costs increase, thus the factual supply curve has the well-known shape that each productive firm faces. Moreover, housing is a heterogeneous good and allows the developer to use a price discriminating strategy, by which he sells each apartment to the highest bidder and raises his profits (see Łaszek and Olszewski, 2014) for more details.

For the analysis of housing dynamics at the city level it is enough to understand that developers are profit maximizers who choose the optimal amount of land and

10 Grimes and Aitken (2010) discuss whether one can assume that construction costs are proportional to land costs, but our observations and also data presented in the detailed analysis of housing construction costs presented in NBP (2014a) indicates that this assumption is backed empirically. If house demand rises, developers need to buy more land, which becomes more expensive. At the same time the demand for workers and construction material increases, thus total construction costs rise. Such an approach is used by Glaeser and Gyourko (2006) and Glaeser, Gyourko and Saiz (2008).

housing quality. Developers form extrapolated expectations (see Wheaton et al., 2001 and Hendershott et al., 2002), thus they increase their production if their short-term profits increase and if they assume that house prices will rise further.

4. Estimation of the housing demand and supply dynamics

The estimation of the housing market bases on the above presented micro-founded model and the work of Mayer and Somerville (2010), Steiner (2010) and Augustyniak et al (2014b). The time-series that are available for most countries do not allow us to estimate the previously presented micro-models directly. The housing demand equation cannot be transformed into a log-linear equation and non-linear estimation methods would need to be used. There are some parameters that would be estimated jointly and there is no auxiliary data to disentangle the parameters. A reasonable approach is to rewrite the model with log-linear equations, which correspond to the initial micro-funded equations. As in Mayer and Somerville (2000), log-linear models of supply and demand that describe the number of housing units placed and sold on the market are estimated.

For the empirical analysis, quarterly data for the Warsaw primary housing market is applied and to cope with short-term shocks the four-quarters moving average is used. It is Poland's biggest market, with the highest number of transactions. The Warsaw market has higher price levels, but behaves in a very similar way as the markets in other Polish cities do (see Baldowska et al., 2013 and NBP, 2015). Conclusions from the Warsaw market are therefore applicable to the markets of the other large cities. The house prices (P_t) originate from the NBP database BaRN. The number of housing units sold and placed on the market (HD_t, HS_t) comes from REAS data[11]. Sekocenbud[12] is the source of the construction costs (PC_t). The Central Statistical Office (GUS) provides data on income in the private sector ($Income_t$) and the mortgage rate ($Intrate_t$) is calculated from NBP data. The supply, demand, price, income and construction costs time series are in logarithms. Because the REAS data starts only in 2007 Q1, it is extended with the dynamics of GUS data on completed housing, lagged by 8 quarters. It takes around two years between the date at which the pre-sale contract is sold and the moment that the housing unit is completed. The demand, supply and construction costs equations were estimated on quarterly data for 2005 Q1-2014 Q3. Due to limitations in available data, the price equation was estimated for 2007 Q1-2014 Q3. Each equation was estimated jointly using the OLS regression, correcting for heteroskedasticity and autocorrelation. The recursive regression test for each regression showed that the regression coefficients are robust.

The first equation describes the aggregated housing demand (HD_t):

$$HD_t = \alpha 1 + \alpha 2 * P_t + \alpha 3 * D(P_t) + \alpha 4 * Intrate_t + \alpha 5 * Income_t + \epsilon_t \qquad (1)$$

Here Pt is the log house price, $D(P_t)$ is the rate of house price growth. The interest rate $(Intrate_t)$ and income in log terms $(Income_t)$account for the changing

[11] REAS is a consulting company providing services related to the housing market.

[12] Secocenbud is a source of information concerning prices in the building industry

economic situation. The empirical results (see table 1) show that there is a positive relation between aggregated demand and income and a negative one in the case of prices and interest rates. As expected, the appreciation has a positive effect on housing demand.

The next step is the estimation of the supply in the primary housing market. Wheaton et al. (2001) and Hendershott et al. (2002) state that housing producers base their decisions on past information. The housing supply is the number of dwellings put on the market in a given quarter and is estimated with the following equation

$$HS_t = \beta 1 + \beta 2 * D(P_{t-4}) + \beta 3 * D(PC_{t-4}) + \beta 4 * Intrate_{t-4} + \epsilon_t \qquad (2)$$

The constant $\beta 1$ captures the autonomous production, a particular number of housing units that will be produced regardless of current prices or costs (see Augustyniak et al., 2012). Based on empirical observation, the lagged price (lagged by one year) is included *($D(P_{t-4})$)*. Producers of dwellings react directly to price increases and start new constructions, but those dwellings will be delivered to the market in the form of pre-sale contracts one year later. Higher construction costs lagged by one year $D(PC_{t-4})$ and lagged interest rates $D(Intrate_{t-4})$, lower the developers' willingness to begin new projects. The interest rates inform developers about consumers' financial affordability, which determines their ability to buy housing. Higher interest rates also cause higher alternative costs of investments in real estate.

The price adjustment mechanism is estimated in equation 3. The house price dynamics depend mainly on their lagged levels, so $D(P_t)$ depends on its past realizations $D(P_{t-1})$. Moreover, as in Tse, Ho and Ganesan (1999) prices react with a one quarter lag to the supply and demand mismatch[13] $(HS_{t-1} - HD_{t-1})$. Excessive demand makes prices rise, while they start to fall under excessive supply.

$$D(P_t) = \vartheta 1 + \vartheta 2 * D(P_{t-1}) + \vartheta 3 * (HS_{t-1} - HD_{t-1}) + \epsilon_t \qquad (3)$$

Asymmetric price adjustment reactions were tested for, but it turned out that the price increase in response to excessive demand is as strong as the price decrease in response to excessive supply. One could expect prices to decline faster than they rise, which would help developers to reduce the stock of unsold housing and make the market move back to its equilibrium. However, developers lower their price expectations slowly, looking to find a buyer that will be willing to purchase the dwelling for the high price. When dwellings are financed with credit, the loan agreement would refrain housing producers from reducing prices below a certain level. Purchasers could negotiate the price, but they have very little negotiation power and not enough information about the number of unsold housing units in a given location. Housing producers are not interested in lowering the price and amidst oversupply they still place new dwellings on the market. To some extent this is the result of projects which are under way and cannot be stopped (see Grenadier, 1996, Łaszek and Olszewski, 2014).

[13] Indeed this is the same as the adjustment of the stock of unsold housing, which evolves as Stockt= Stockt-1+HSt-HDt, thus its change ΔStockt equals HSt-HDt.

The construction cost dynamics $D(PC_t)$, which affect the start of new construction are estimated in equation 4. The growth of costs depends strongly on its past realization $D(PC_{t-1})$. Moreover, construction costs grow with house supply increases ($D(HS_{t-1})$), as more input goods are needed and their costs increase.

$$D(\mathrm{PC_t}) = \rho 1 + \rho 2 * \mathrm{D(PC_{t-1})} + \rho 3 * \mathrm{D(HS_{t-1})} + \epsilon_t \quad (4)$$

The four equations presented above, describe the dynamics on the housing market. The empirical results indicate that constantly low interest rates or increasing incomes lead to a demand boom, which in turn causes price increases and a supply boom. When incomes and nominal housing prices rise at the same pace, relative house prices remain stable, and the housing boom can last for a long time. It can be stopped only by a huge shock (for example the sub-prime crisis in the US), which forced banks to constrain the disbursement of mortgages.

Table 1. Regression results of the determinants of aggregate supply, demand, prices and production costs.

	LHD_t	**LHS_t**	**$D(LP_t)$**	**$D(LPC_t)$**
LP_t	**-0.894 *** ** (0.189)			
$D(LP_t)$	**7.714 *** ** (1.465)			
$D(LP_{t-1})$			**0.835*** ** 0.089	
$D(LP_{t-4})$		**9.922 *** ** (1.966)		
$Intrate_t$	**-13.301 ** ** (6.065)			
$Intrate_{t-4}$		**-12.770 * ** (6.670)		
$LIncome_t$	**1.164 *** ** (0.339)			
$D(LPC_{t-1})$				**0.977 *** ** (0.103)
$D(LPC_{t-4})$		**-14.377 *** ** (2.033)		
$D(LHS_{t-1})$				**0.022 *** ** (0.007)
$LHS_{t-1} – LHD_{t-1}$			**-0.022 * ** (0.012)	
C	**6.925 *** ** (2.365)	**8.857 *** ** (0.382)	0.001 (0.003)	0.0003 (0.001)
Adj. R^2	0.82	0.71	0.69	0.89

*Newey-West standard errors HAC in brackets, ***, **, * significant at: 1%, 5% or 10%.*
HD_t, HS_t -the number of housing units sold / placed on the market
$\mathrm{PC_t}$ - construction costs
$Income_t$ - income in the private sector
$Intrate_t$ - mortgage rate
Symbols: L - logarithms, (t-i) - lagged variables, D – first differences.

5. Analysis of deviations from the equilibrium

In this subsection the empirical values are compared with observed demand, supply, prices and the construction costs data. Factors which most likely caused the small differences between those values are discussed.

From 2004 to 2006, demand for new apartments rose, caused by mortgage availability, increasing wages and expectations of price increases. From 2007, fewer households could afford to buy dwellings, which were getting more expensive. The model predicts the demand decline in 2009 quite well, but due to the global crisis and prudential constraints on mortgages disbursed to households, demand decreased faster than suggested by the model. In contrast, from 2010 Q3 till the end of 2012 the empirical demand was observed to be greater than the estimated demand, which most likely was a result of the government subsidy scheme *Family on their own,* which aimed at subsidizing mortgages. The programme ended at the beginning of 2013 and during 2013 there was no subsidy programme. Buyers delayed their purchase decisions, waiting for the implementation of the new *Housing for the young* scheme that came into force in 2014. This fact explains why demand in 2013 was lower than the model demand and shows that housing policy works. From the beginning of the analysed period the supply increased, but from 2007 it started to decrease. In 2009 the global financial crisis and the increasing risk aversion contributed to a dramatic decline in the construction of housing units. Even when the supply recovered, the increase in the number of housing offers was not as strong as the model predicts. This was probably caused by developers' difficulty with selling dwellings and their problems with financing new investments. Since 2012, the model supply has been very close to the empirical supply.

The empirical price and construction cost increases were close to their theoretical values and periodical deviations were random. Price adjustments usually occur with a 1 quarter delay to differences between demand and supply. Likewise, production costs tend to adjust to changes in production level with a 1 quarter lag.

Figure 1-4. Theoretical and empirical values of demand, supply, prices and construction costs, Warsaw primary housing market

Figure 5. Housing demand

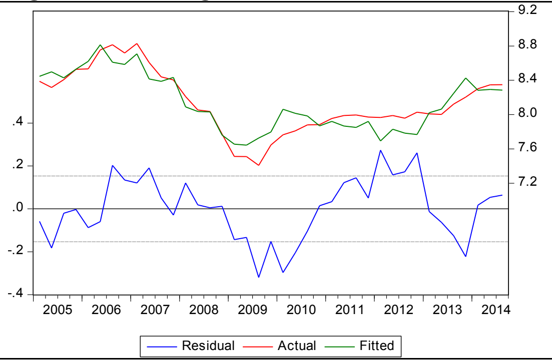


Figure 6. Housing supply

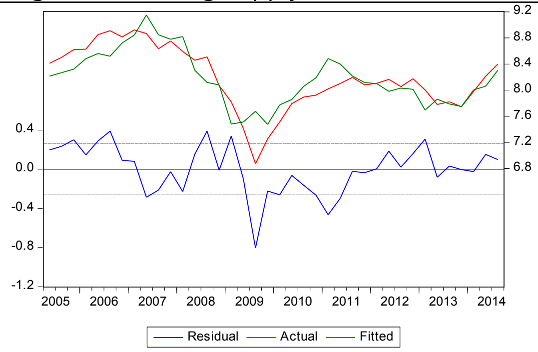


Figure 7. House price dynamics

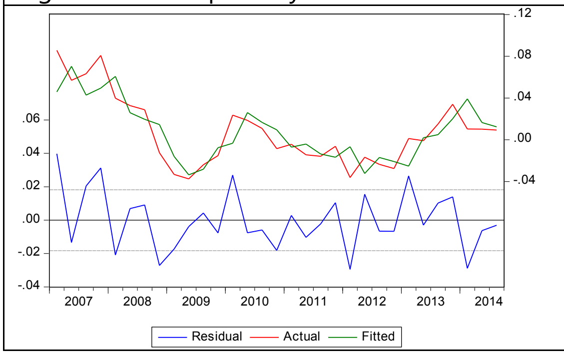
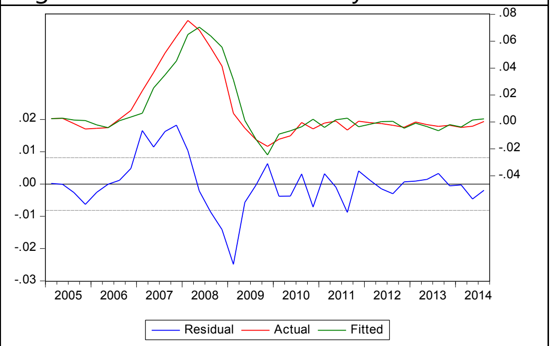


Figure 8. Construction cost dynamics



6. Forecasting of house prices

To forecast house prices the housing cycle model is used, which is based on four endogenous variables (demand, supply, costs and prices) and two exogenous variables (mortgage rates and income). The historical data used in the analysis comes from the NBP database BaRN, REAS, GUS, and Sekocenbud, as described in chapter 4. The equations are recursive, which allows future values to be calculated basing on their past realizations. The two exogenous variables (the interest rate and economic growth) stem from the NECMOD projection (see Budnik et al., 2009) and are published in the Inflation Report of the NBP (2014b). The income is assumed to grow at the same pace as GDP growth. Interest rates are always set constant over the forecast period, thus the mortgage rate is also constant. The housing forecast covers the next 2 years on a quarterly basis until the end of 2016. The forecast results were transformed from logs to normal numbers and are presented in Figure 5. The demand and supply measured in housing units is on the left axis, while prices and construction costs per sq. meter in PLN are presented on the right axis. The root mean squared error of the forecast (RMSE), calculated on past forecast errors is presented in table 2. It should be highlighted that the accuracy of the four equations is tested for, while the literature review by Rahal (2014) indicates that only the accuracy of the price forecast is measured.

Figure 5. Forecast of housing demand, supply, house prices and construction costs (dashed line).

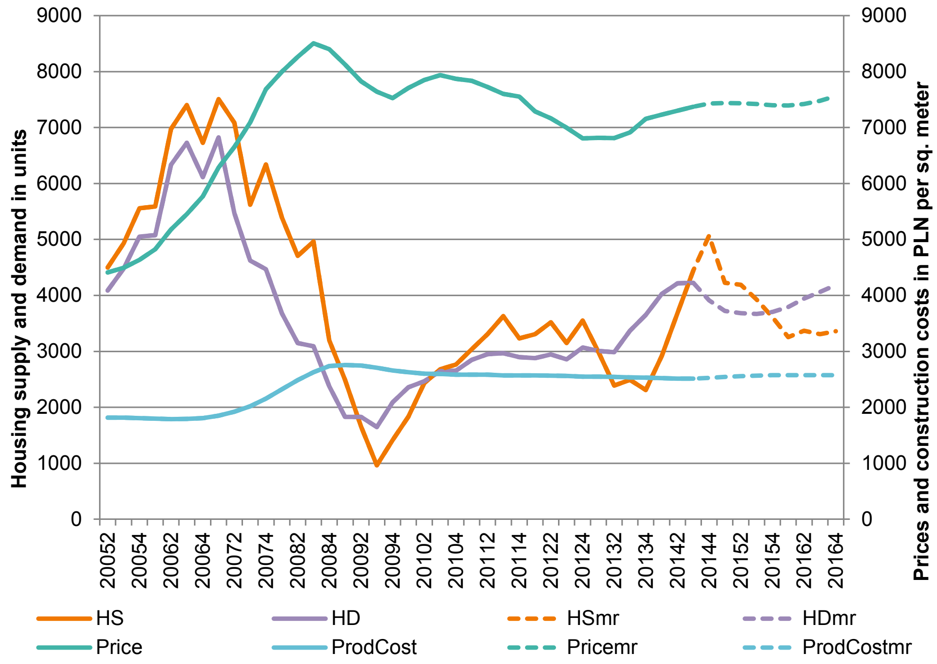


Table 2 Root mean squared error (RMSE) of the forecast, based on out-of-sample forecasting.

Forecast horizon	HS	HD	P	PC
1	991.8	668.7	125.9	20.5
2	982.8	854.1	260.2	53.9
3	937.4	915.7	432.7	101.4
4	840.4	926.6	673.3	162.3
5	751.0	922.8	920.3	234.7
6	604.0	772.5	1159.6	313.4
7	635.4	676.5	1395.6	396.2
8	695.9	605.1	1610.6	481.1

The observed values are presented as solid lines and the dashed lines show the predictions. Prices should first decline and then increase slightly, while costs should be relatively stable in the future. Supply should rise for a short period and then decrease sharply. Demand should fall in the next quarters and increase gradually from the middle of 2015. As stated earlier, housing policy has a strong effect and changes in the housing subsidy scheme can have a significant impact on demand. Also, potential changes in interest rates will change the demand and supply of housing. The forecast should be understood only as an academic analysis and an indicator that tells in which direction the housing market will evolve. It should not be used to make investment decisions, because external interest rate shocks, large capital flows or unexpected changes in housing policy can affect the market.

7. Conclusions

The four equations model describes the main drivers of housing demand and supply in the primary housing market in Warsaw. Housing demand is mainly driven by rises in income and interest rate declines. Contrary to what would be expected, the appreciation of housing boosts its demand. Housing supply rises if increases in prices are higher than increases in construction costs.

The four-equation model replicates the real dynamics of the housing market well, which is confirmed by the results of the out-of-sample forecasting exercise. This model can be used to forecast the behaviour of the housing market for the next two years on a quarterly basis. As it can be easily replicated, the model should be useful for policy makers, central banks and regulators to test how changes in mortgage rates or income affect prices, demand and supply in the primary housing market.

The model focuses only on the primary market, thus further research should incorporate the secondary market. The inclusion of the rental market could be another improvement of the model, but at this stage the aim is to provide a quite simple model that provides an understanding of where housing booms and bust come from.

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Micro evidence on foreign exchange liabilities and the exchange rate risk in non-financial firms in Turkey: a descriptive analysis[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 or the central banks and other institutions represented at the meeting.

Micro Evidence on Foreign Exchange Liabilities and the Exchange Rate Risk in Non-Financial Firms in Turkey: A Descriptive Analysis

Timur Hülagü[a] Cihan Yalçın[b]

Abstract

In Turkey, households are not allowed to hold foreign currency (FX) debt and open position in the financial sector is limited by regulation. However, non-financial firms can hold foreign currency (FX) denominated debt under some restrictions. This study tends to explore the related risks for holding FX debt within a micro perspective by using a firm level dataset. We find that firms in the dataset, which account for a significant amount of economic activity in Turkey, adopt some internal mechanisms to avoid the currency risk. First of all, firms with small size and high currency risk have reduced their liability dollarization ratios and extended the maturity of FX debt in recent years. In addition, findings suggest that firms with limited export revenues and having higher FX denominated debt obtain higher FX profits, which compensate a significant amount of their FX financial expenditures. Meanwhile, FX pricing of domestic sales in some sectors, which are not classified under export revenues, implies a lower currency risk of firms than perceived.

Content

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Micro Evidence on Foreign Exchange Liabilities and the Exchange Rate Risk in Non-Financial Firms in Turkey: A Descriptive Analysis*

1. Introduction

Limited availability of Turkish lira-denominated funds with long-term maturity in the financial system and the high course of "external finance premium" in Turkey have driven firms to borrow in foreign currency (FX) particularly starting late 1990s.[1] The ratios of FX-denominated debt to total liabilities (liability dollarization) of particularly large and exporter firms have increased over time even though there has been a decline in overall liability dollarization after introduction of flexible exchange rate regime in early 2000s (Alp, 2013).[2]

As a result of the liability dollarization, total FX-denominated debts of non-financial firms in Turkey are above their FX-denominated assets. The FX net short positions (macro position) of these firms reached USD 178.5 billion by the end of 2014.[3] Such a currency mismatch may raise concerns about the balance sheets effects due to volatility in capital flows and exchange rates. These in return may cause a decline in firms' profitability in the first stage and eventually deterioration in investment appetite. However, such a mismatch may also ease the financial constraints of firms by serving the facility of borrowing in FX at longer maturity and allow these firms to grow at higher rates in normal times. In fact, Alp and Yalçın (2015) and Karamollaoğlu and Yalçın (2015) estimate a robust positive association between liability dollarization of non-financial firms and their activity (total sales and exports) in Turkey.

This study provides some micro indicators produced from the balance sheets, income statements and FX liabilities of more than 9 thousand non-financial firms which are available in Central Bank of the Republic of Turkey Sectoral Company Accounts (the CBRT Company Accounts) and Banks Association of Turkey Risk Centre (BAT) databases. In view of these data, we show that most firms do not borrow in FX and a significant portion of FX borrowers are naturally hedged. However, firms without or limited export revenues borrow in FX, which constitute to one third of the total FX debt of all firms in the dataset. Nevertheless, results reveal

* This version of the paper is largely a translation of CBRT Research Notes in Economics released in August 2014.

1 The average firm profitability (potential to generate internal resources) in Turkey is lower than that in similar countries (Özmen et al. 2012). This restricts the firms' ability to invest by exploiting their internal resources, and resulting in the need to borrow in order to grow. The average indebtedness rate of the Turkish corporate sector is observed to be high (the total debts to total liabilities ratio is above 50 percent) (Özlü and Yalçın, 2012).

2 The liability dollarization ratio of the private sector in Turkey (including households) is below the ratios of many emerging economies (particularly Central and Eastern Europe countries) (Zettelmeyer et al. 2010). Individuals or households in Turkey are not allowed to borrow in FX, which secures low levels of total private sector liability dollarization compared to that of non-financial firms, and warrants hedging for the households against the exchange rate risk.

3 Note that this net short position is only about USD 6 billion for short term liabilities. That is, macro data suggest that non-financial firms are largely hedged in short term.

that these firms obtain a higher average net FX profits than other firms and they are more inclined towards holding cash. Moreover, at the sectoral level, most of the sectors with relatively higher debt dollarization ratios seem to have activities not classified as exports but generating revenues through FX-linked pricing in the domestic market. As evidenced by the current dataset, the currency risk of non-financial firms in Turkey might be lower than what macro aggregates imply.[4]

In the following section of the study, we provide a short discussion on the data used in the analysis. The third section reveals statistical indicators that may contribute to the risk analysis of non-financial firms in Turkey. Accordingly, indicators are generated considering whether the firms possess natural hedge or not as well as the size of their FX-denominated debt. Evaluations on firms without FX-denominated revenues (or not appeared on their balance sheets, though being available) and having large amounts of FX-denominated debts are given particular importance. The conclusion section presents a summary of findings and general assessments.

2. Data and Indicators

The CBRT Company Accounts is the most comprehensive database regarding financial data of non-financial firms in Turkey. It includes information on balance sheet and income statement items, sub-sectoral activity, establishment date, number of employees, provinces operated in and the legal status. About a half of the firms operate in the manufacturing industry. It mostly includes small and medium-sized enterprises, yet covers almost all large firms operating in Turkey. Our estimations suggest that, basing on data of 2011, these firms hold 58.2 percent of total sales, 72.5 percent of exports and 40 percent of FX-denominated debts at the end of 2013. Around 75 percent of employment with 10 or more employees in the manufacturing industry is fulfilled by firms included in this dataset. In fact, these firms cover a significant portion of aggregate economic activity. The dataset does not constitute a sample with regard to sampling standards, yet firms included in the dataset are of great weight in total activities, which renders the representative power of this analysis high.

Table 1 displays the percentage distribution of firms based on whether firms have FX-denominated debt by their export ratio (export/sales) tranches or not. As about 45 percent tranche of firms does not have exports revenues, firms are divided into export ratio tranches of 10 percent starting from 50 percent. In the analysed period, it is seen that having FX-denominated debt is common among firms ranking high in export ratio tranches. However, there has been a decline in the share of firms having FX debt across export share ratio tranches over time. For example, 85 percent of the firms in the highest tranche held some FX-denominated debt in 2002, whereas it declined to 76 percent in 2013. On the other hand, the percentage of firms with FX-denominated debt is lower among firms in the lower export ratio tranches. This ratio decreased faster in these firms than those ranking among high export ratio tranches in the 2002-2013. However, the ratio of holding FX-denominated debt by firms without exports displayed a limited rise in this period.

[4] Data regarding the firms' balance sheets and income statements are available up to 2012 while FX-denominated debts are available up to 2013, and the charts and evaluations below are based thereon.

Distribution of Firms Based on Liability Dollarization and Export Ratios (%)							Table1
		Export Ratio Tranches					
	Non-exporting	(0, 50]	(50, 60]	(60, 70]	(70, 80]	(80, 90]	(90,100]
				2002			
Dollarization > 0	27.5	50.1	63.7	71.6	80.4	84.1	85.3
Dollarization = 0	72.5	49.9	36.3	28.4	19.6	15.9	14.7
Number of Firms	2133	2055	838	838	838	838	837
				2013			
Dollarization > 0	29.8	35.0	36.2	49.5	62.8	73.5	76.3
Dollarization = 0	70.2	65.0	63.8	50.5	37.2	26.5	23.7
Number of Firms	4055	571	925	925	925	925	925
				Difference (2013-2002)			
Dollarization > 0	2.3	-15.1	-27.5	-22.1	-17.6	-10.6	-9.0

Source: CBRT Sectoral Balance sheets

For a facilitated follow-up of the variables used in the analysis, definitions and explanations thereof are exhibited in Table 2.

Variables and Definitions Used in the Analysis — Table 2

Variable	Definition	Source
Liability Dollarization Ratio	FX Cash Debt/Total Cash Liabilities (%)	BAT
FX Debt-Exports Ratio (Exchange Rate Risk Ratio)	FX Cash Debt/Exports	BAT and CBRT Balance sheets
Maturity Structure of FX Liability	Long-term FX Cash Liabilities/Total FX Cash Liabilities (%)	BAT
Net Profit Margin	After-Tax Net Profit-Loss/ Sales (%)	CBRT Sectoral Balance Sheets
Net FX Transactions Profit Margin	Net FX Transactions Profit / Sales (%)	CBRT Company Accounts
FX-denominated Financial Expenditure Margin	Dollarization Ratio*Financial Expenditures/ Sales (%)	BAT and CBRT Balance sheets
Net FX Transactions Profit-FX-Denominated Financial Expenditures Ratio (Coverage Ratio)	Net FX Transactions Profit /(Dollarization Ratio*Financial Expenditures) (%)	BAT and CBRT Sectoral Balance sheets
Current Ratio	Current Assets / Short term Liabilities (%)	CBRT Company Accounts
Cash Ratio	(Liquid Assets + Real Estates) / Short term Liabilities (%)	CBRT Company Accounts
Asset Profitability	Net Profit of the Period / Total Assets (%)	CBRT Company Accounts

3. Liability Dollarization and Exchange Rate Risk of Firms: Statistical Observations

3.1. Exchange Rate Risk Indicators and Evaluations on Time Series

As underlined in the introduction section, non-financial firms have liability dollarization in Turkey, yet the related ratio declined remarkably following the crisis in 2001. The average maturity of FX-denominated debts got extended in this period. The comprehensive reforms introduced after the 2001 crisis have been effective in these two developments. Adoption of the flexible exchange rate regime, regulations associated with policy independence of the Central Bank of Turkey, enforcement of fiscal discipline and providing the banking sector with a strong capital structure are among these reforms, which contributed to strong disinflation and de-dollarization processes.[5]

Following the enforcement of the flexible exchange rate regime in 2002 in Turkey, firms with limited FX-denominated revenues began to hold lower FX-denominated liabilities compared to their total liabilities in order to hedge against exchange rate fluctuations, and thus the fragilities of firms regarding the exchange rate risk posted a decline to some extent (Özmen and Yalçın, 2007; Alp and Yalçın, 2015). In other words, the flexible exchange rate regime is believed to stimulate the firms' motives for hedging the exchange rate risk.[6] In fact, as a result of improvements in the financial position of firms between 2001 and 2008, Alp and Yalçın (2015) estimates that the adverse effect of the exchange rate shock in the 2008-2009 crisis on firms' balance sheets and growth performances proved to be more limited than that of the crisis in 2001, despite an apparent fall in the external demand in 2009.

In this study, the ratio of FX-denominated debt to exports is used as the main criterion to evaluate the exchange rate riskiness of firms. The literature contains studies suggesting that exporter firms can borrow in FX to eliminate their financial constraints and therefore can compensate for the negative effects of exchange rate shocks as long as there is no excessive borrowing (Claessens et al. 2000; Claessens et al. 2012; Bougheas et al. 2012). In this respect, we use the mentioned variable in the analysis as it reflects the operational hedging capacity of firms against the currency risk. A high FX-denominated debt to exports ratio implies that FX-denominated revenues fall short of offsetting FX-denominated debts, thus lacking of "natural hedging" mechanism against exchange rate shocks. The average of FX-denominated debt to exports ratio is considered as the exchange rate risk indicator and firms are classified into 3 groups (risk groups) based on this ratio.[7]

In the first group, the firms with no exports and with FX-denominated debt exceeding 5 percent of their gross sales are referred as 'high-risk'. In the second

5 Eichengreen and Hausmann (1999) associate the way to evade dollarization with the enforcement of reforms to enhance the capabilities of policy-making authorities in independence, transparency, reliability.

6 In a cross country analysis, Kamil (2012) shows that upon the adoption of flexible exchange rate regime following fixed and/or administered regimes, firms lower their shares of FX liabilities, use the export revenues more systematically and hold FX-denominated assets more than normal, thus lower their FX short positions.

7 As the dataset does not include 2013 export data, those belonging to 2012 are used.

group, firms with positive export revenues but their FX debts exceeding three times of their exports are called 'medium-risk'. In the third group, firms having FX debts less than three times of their exports as well as those without exports and their FX-denominated debts being equal to or less than 5 percent of sales are classified as 'low-risk'.[8]

In order to evaluate the possible risks caused by the FX-denominated debts of firms, some statistical analyses are carried out for the period of 2006-2013. Firstly, the distribution of firm numbers and their FX debts for the year of 2013 by risk groups and firm scales are shown in Chart 1 and Chart 2, respectively.[9] Firms that are referred to as high-risk have a limited share in terms of numbers (13 percent), yet the sum of FX debts of these firms are estimated to hold around one thirds of total FX-denominated debts. Moreover, about a half of the FX debts of firms in the high-risk group belong to SMEs, while most of these have long maturities as displayed in Chart 8 below.[10] As expected, total FX debts of small scale firms is relatively low. However, these firms are mostly included in the high-risk group.

Chart 1. Distribution of Firms by Risk Group and Scale (2013)

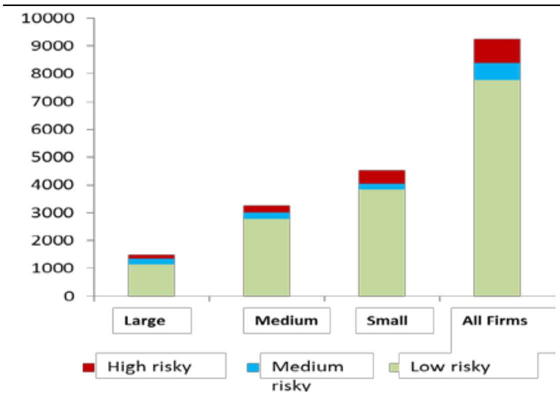
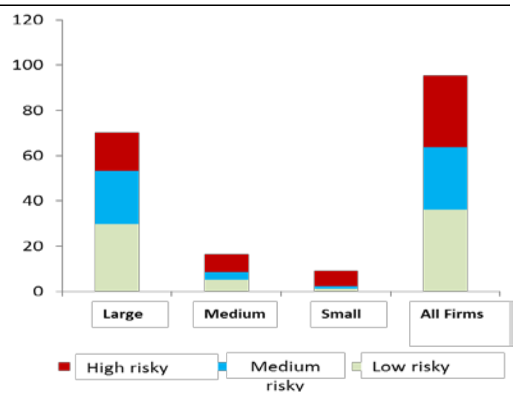


Chart 2. Distribution of FX Debt by Risk Group and Scale (Billion $, 2013)



Source: CBRT Company Accounts and BAT Risk Center Data

8 Regarding the medium-risky group, it is assumed that the average maturities of firms' FX liabilities is three years, thus firms' exports for three years correspond to their FX debts and when this ratio is larger than 3, firms bear more risk. On the other hand, not having export revenues but having FX-denominated debt larger than 5 percent of sales is picked as a risk factor by authors.

9 Firms are scaled according to the "asset size "criterion for construction firms and holding companies that display great differences in net sales among years, while for firms in the rest of sectors, the "net sales" criterion applies. According to the net sales criterion, firms having net sales below Euro 10 million in 2012 are classified as small scale, those having net sales from Euro 10 million to Euro 50 million are medium size, while those having net sales above Euro 50 million are large scale. According to the asset size criterion, firms with total assets less than Euro 10 million in 2012 are small scale, those with total assets between Euro 10 million and Euro 43 million are medium scale, and firms with total assets larger than Euro 43 million are large scale.

10 Özmen and Yalçın (2007) suggests that also due to the flexible exchange rate regime enforced after the crisis in 2001, dollarization ratios of firms exposed to the exchange rate risk, particularly the SMEs witnessed sizeable declines.

Secondly, to evaluate the exchange rate risk of firms, the course of sales-weighted liability dollarization and FX-denominated debt-export ratios by firm scales are exhibited in Chart 3 and Chart 4, respectively. In the period of 2006-2013, the sales-weighted liability dollarization ratio receded from 55.1 percent to 44.3 percent. Particularly following the reforms, the decline in the ratio of firms' average liability dollarization ratio has decelerated in recent years due to large firms. Furthermore, liability dollarization ratios of medium and small scale firms continued to fall after the crisis in 2009. The fall in the liability dollarization ratios of these firms is attributed to the enhanced access to Turkish lira denominated loans following the crisis in 2009 and their avoidance from the exchange rate risk.[11]

On the other hand, FX-denominated debt to export ratios by scales showed a rise in the period of 2006-2009. Taking the average of all firms reveals that FX-denominated debts were two times of exports in 2006, but this rate showed an inrease and reached eight folds in 2012 (Chart 4). This signals some deterioration in the exchange rate riskiness of firms particularly in the period of 2006-2009. Nevertheless, this rate exhibited a flat course for medium and small scale firms after 2009. This finding suggests that following the crisis in 2009, due to various supply and demand-side factors as well, these firms acted more cautiously in taking exchange rate risk compared to the period of 2006-2009.[12]

Chart 3. Average Liability Dollarization Ratios by Scales (%)

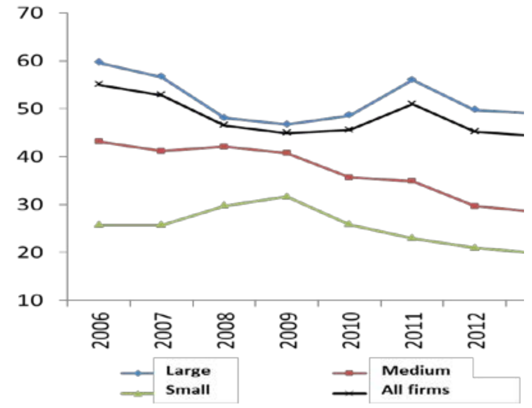
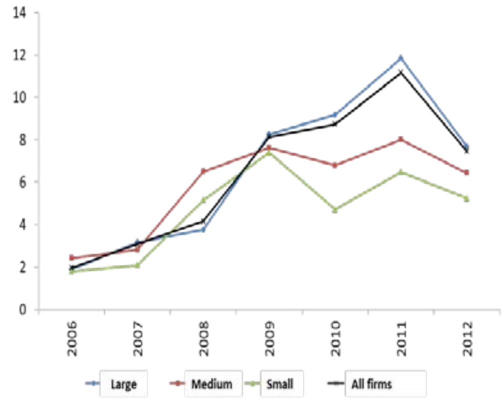


Chart 4. FX Debt-to-Exports Ratio by Scales



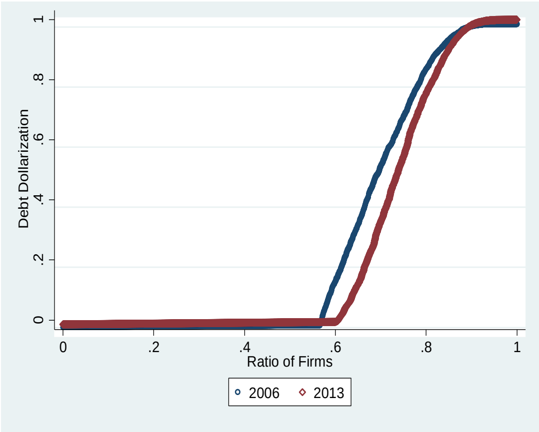
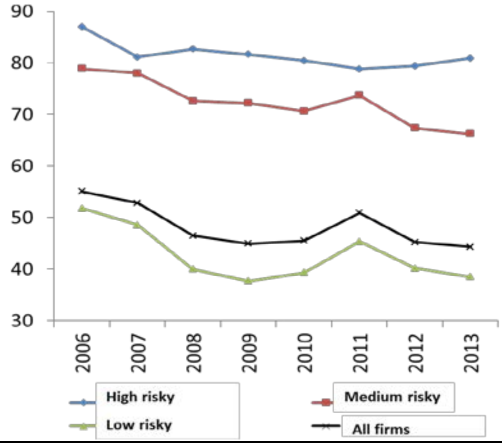
Source: CBRT Company Accounts and BAT Risk Center Data

Chart 5 shows firms' liability dollarization ratios for 2006 and 2013. It reveals that in terms of percentage fewer firms had FX debts in 2013 than in 2006 and the number of firms with higher liability dollarization ratios was smaller. Average sales-weighted liability dollarization ratios by risk groups are shown in Chart 6. As anticipated, liability dollarization ratios increase with riskiness. Because of having FX

11 However, as also underlined above, the amendment to the exchange rate regime in 2009 facilitated the firms' access to FX financing. The amendment to Decree No.32 in made in 2009 allowed firms with no FX revenues to borrow FX loans from resident banks provided that the loan is not below USD 5 million and maturity is longer than 1 year?.

12 The highest 1 percentile of FX-denominated liability-export ratios is considered as outliers and thus excluded in these figures.

debts, high-risk firms without natural hedge become vulnerable to the depreciation of domestic currency.

Chart 5. Average Liability Dollarization Ratios by Firms	Chart 6. Average Liability Dollarization Ratios by Risk Groups (%)
	

Source: CBRT Company Accounts and BAT Risk Center Data

Thirdly, the maturity of the FX debt is often considered as a variable in assessing the currency risk in the related literature. To this end, Chart 7 and Chart 8 show the maturity of the FX debt (long-term FX debt to total FX debt ratio) by firm scale and risk groups, respectively. Accordingly, the share of long-term FX debt (with an original maturity of more than one year) in total FX debt increased in the analysed period. Although there is a monotonic relationship between firm scale and maturity length at the start of the given period, small-scale firms have been able to borrow more loans with longer maturity in recent years. As a result, the share of long-term FX debt was up 30 points between 2006 and 2013 to 64.5 percent for these firms. This evidence suggests that small-scale firms that are expected to be more financially-fragile are increasingly able to borrow more long-term loans in time, limiting the adverse impact of any short-term exchange rate volatility on these firms.

FX debts are mostly long-term for the firms in high-risk group and the share of their long-term debts is calculated to have increased from 76.1 percent in 2006 to 86.4 percent in 2013. However, the maturity of FX debts is shorter for firms in the low-risk group (Chart 8). These findings show that firms are largely immune to any short-term exchange rate volatility, and thus the negative effects on the FX debt service can be restrained to a great extent. On the other hand, the maturity of FX debts somewhat shortened between 2011 and 2013 due to large firms and low-risk firms. Since this shortening is seen in firms with assumingly less currency risk, it is considered as a factor alleviating concerns. And this is consistent with the increasing prominence of modernization-maintenance investments that could be completed in a shorter period thanks to the slowdown in fixed capital investments (CBRT, 2014).

Despite the decline in the liability dollarization ratio and the increase in the FX debt maturity, firms' profit margins might fall after exchange rate shocks because of the sustained net FX short position of firms. In fact, when the Turkish lira depreciated in 2008 and 2011, the net profit margins of firms susceptible to currency risk (net profit/sales) decreased (Chart 9). One of the reasons behind falling profit margins in times of exchange rate shocks is the rise in financial expenditures. These periods are also marked by rising borrowing costs of domestic currency denominated credit. Therefore, a surge in financial expenditures can be the result of not only an exchange rate shock-driven appreciation of an FX denominated debt service in terms of the domestic currency but also an increase in the costs of domestic currency debts. The profit margins of high-risky firms are calculated to be lower and more volatile than other firm groups (Chart 9).

The abovementioned currency risk susceptibility indicators are calculated based on firms' export data. It is important to take into account two major factors that interact in opposite directions in order to evaluate currency risk. Firstly, the export data in the income statements tables of firms do not contain domestic sales priced in FX. This suggests that firms' currency risks may be evaluated higher by the above indicators than what they actually are. For instance, prices of products relying mostly on imported inputs (construction, energy, chemical and oil products) are generally quoted in FX in the domestic market but the accounting of sales might be in domestic currency. Similarly, services such as hotel room, etc. in the upper segments of the tourism industry are frequently quoted in FX but are not booked under export in the financial tables as the balance sheets are quoted in domestic currency. Therefore, depending solely on indicators based on official export data would be misleading in analysing the currency risk of firms producing or selling such products or services. Secondly, the direct use of imported inputs or the widespread use of inputs quoted in FX in the domestic market might cause the above currency risk indicators to misperceive this risk as lower than they actually imply.

Chart 7. FX Debt Maturity by Scales (%)

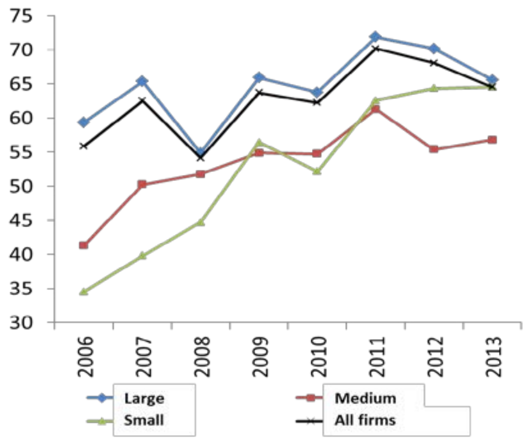
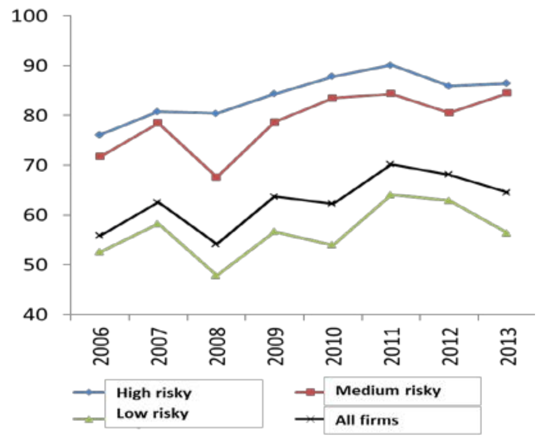


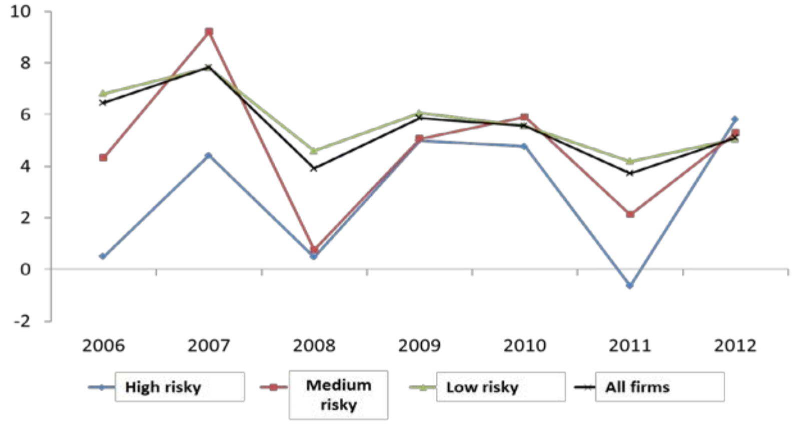
Chart 8. FX Debt Maturity by Risk Group (%)



Source: CBRT Company Accounts and BAT Risk Center Data

To this end, the currency risk analysis has been enriched by generating new currency risk indicators. First of all, we use FX profits and losses from the firm's income statement, which mostly rise from trade credits or debts and revaluation of FX-denominated liabilities and assets. Secondly, we included the financial expenses reflecting costs of both domestic currency debts and FX debts, again from the income statement.[13]

Chart 9. Net Profit Margins by Risk Groups (%)



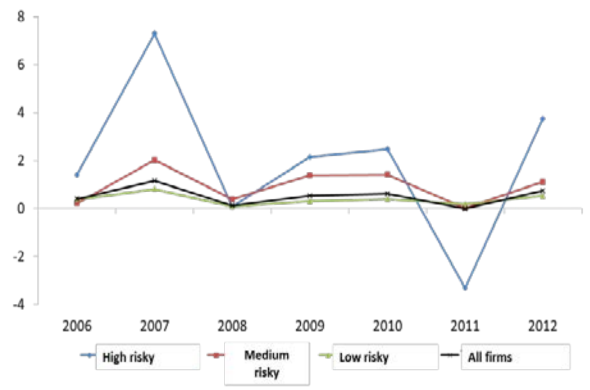
Source: CBRT Company Accounts and BAT Risk Center Data

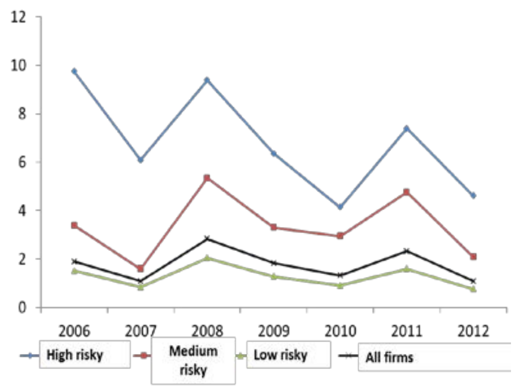
Chart 10 shows the course of average sales-weighted net FX margins (net FX profit/gross sales) over time by risk groups. On average, firms made net FX profits during 2006-2012 while the Turkish lira depreciations caused the net FX profits to fall in 2008 and 2011. Although high-risk firms made net FX losses in 2011, which, however, were more than offset by the net FX profits in the remaining years. In fact, on average, FX margins are calculated to be 1.82, 0.97 and 0.39 percent for high-risk, medium-risk and low-risk firms, respectively, during 2006-2012. Accordingly, average FX margins seem to be higher in high-risk firms than other risk groups despite the exchange rate volatility during the analysed period.

Chart 11, on the other hand, shows the course of average sales-weighted FX financial expense margins (debt dollarization ratio*financial expenses/gross sales) on the basis of risk groups over the period. Seemingly, financial expense margins increase with firm riskiness. For instance, the FX financial expense margins of high-risk firms are measured to be 5.3 points higher than low-risk firms based on periodic averages. Yet, the FX financial expense margins of high-risk firms have declined dramatically in recent years. For instance, the average FX financial expense margins of high-risk firms went down from 9.7 percent in 2006 to 4.6 percent in 2012. Although the financial expense margins of high-risk and medium-risk firms are high, the contribution to average financial expense margins from all firms is found to be minimal (0.5 points). The fall in financial expense margins despite rising debt ratios of high-risk firms in this period indicates that cheaper financial sources became increasingly more available, which is a positive development regarding the riskiness of firms.

13 The estimation for the financing expense of the FX debt is obtained by multiplying the total financing expense by the liability dollarization ratio.

Chart 10. Net FX Margins by Risk Groups (%)	Chart 11. FX Financial Expense Margins by Risk Groups (%)





Source: CBRT Company Accounts and BAT Risk Center Data

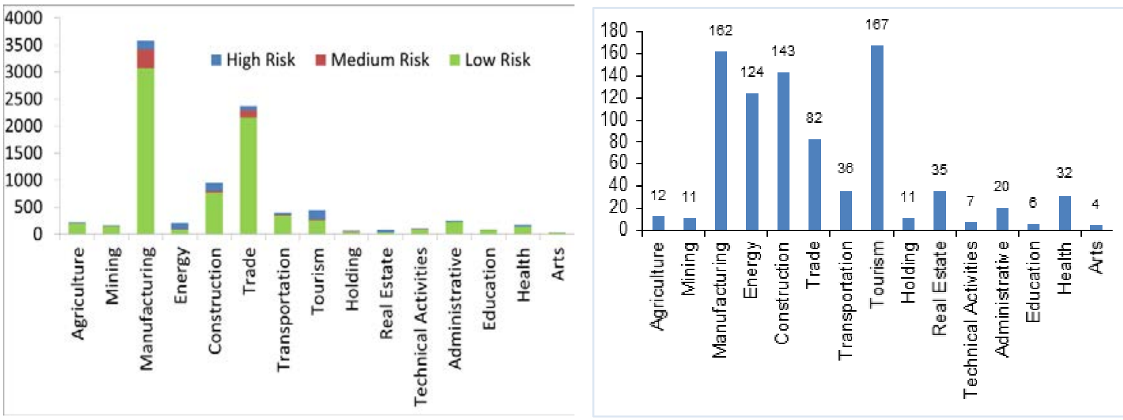
In our estimations, it is found that firms with high FX debt and therefore large FX financial expenses make more net FX profits as a result of the appreciation of domestic currency. In fact, there is a positive correlation between the dollarization rate weighted financial expenses and net FX profits (0.29). This correlation is notably higher in high-risk firms (0.89). These findings suggest that high-risk firms were inclined toward balancing off their FX debt related financial expenses by possessing FX assets and making exchange rate-driven net FX profits through purchases of goods and services. This view is also supported by the information that 53.8 percent of high-risk firms in 2013 had net FX profits which were higher than the half of their financial expenses. However, normally deemed positive, this mechanism is considered to be ineffective in times of significant exchange rate depreciations. In fact, during the exchange rate shocks of 2008 and 2011, the net FX profits of high-risk firms dropped markedly while their financial expenses increased, thus worsening their profitability.

3.2. Currency Risk Assessments at Sectoral Level

The number of firms by risk groups and sectors are shown in Chart 12. Accordingly, high-risk firms operate mostly in tourism, manufacturing, energy, construction and trade sectors. At the sectoral level, net FX profits of sectors with high FX debts appear to be higher, too (Chart 13). Prices in the energy sector are quoted on a par with international energy prices, and therefore the currency risk is closely related to the price adjustments in the sector. For instance, natural gas distributors basically determine prices in accordance with exchange rate movements and thus the currency risk is largely contained. However, there are also products and services whose prices are administered by the government and therefore exchange rate movements are not automatically reflected in this sector. Meanwhile, in the construction sector, prices of raw materials are mostly quoted in FX, which causes final prices to be linked to FX to a certain degree. Moreover, as large construction firms operate with partners and affiliates abroad, which are usually financed by the headquarters, but cannot integrate their international revenues into their local balance sheets because of their separate legal status, their currency risk might be lower than it actually is. Likewise, the rise in tourism revenues and the common FX-denomination of prices, particularly in hotels, are considered to have restricted the currency risk attributed to the tourism activity. On the other hand, many exporters with net FX short position often consider their final goods and raw materials inventories as collateral to their currency risks (CBRT, 2014).

Chart 12: Risk Groups of Firms at Sectoral Level (2013)

a. Firm Number by Risk Groups | b. Numbers of High Risky Firms



Source: CBRT Company Accounts and BAT Risk Center Data

For a detailed analysis of the currency risk of firms, in addition to the above risk groups, the ratio of net FX profits to the FX debt-weighted financial expenses (the coverage ratio) has been calculated. A lower ratio indicates that firms might be subject to some FX debt-driven fragility. Accordingly, the average of the coverage ratio in high-risk firms is higher than 50 percent while it exceeds this average for firms operating in sectors such as energy, transport, professional activity, tourism, healthcare and culture (Chart 14). In this context, high-risky firms whose coverage ratios below 50 percent have been analysed more in detail. Based on the data from balance sheets of 2012, there are 396 firms in total that can be classified under the “highest-risk group” in 2013, most of which are operating in manufacturing (80), tourism (74), construction (68), trade (49) and energy (40). The coverage ratios calculated for the highest-risk firms support the analysis above. In other words, there is a positive correlation between the dollarization ratios of firms and their coverage ratios. Looking at the highest-risk firms, these results imply that firms tend to avoid the currency risk at sectoral level, too.

Table 3 shows average figures for the total asset-weighted average current, cash and profitability ratios of highest-risk firms and FX debt amounts. Accordingly, the liquidity ratios of highest-risk firms seem close to those of low-risk firms. However, the profitability ratio of this group is lower than in other groups. Moreover, the average FX debt is 31.9 million USD for highest-risk firms, almost all of which is long-term.

Chart 15 shows the number of highest-risk firms and the course of their average FX debt in time. In line with the Turkish lira depreciation in 2009 and 2011, an increasing number of firms shifted toward the highest-risk group in 2009 and 2011, but despite the exchange rate rise depreciation in 2013, the number of highest-risk firms decreased. Meanwhile, their average FX debt increased notably in 2013.

Chart 13: FX Debt and Net FX Profits at Sectoral Level (Million TL, 2012)

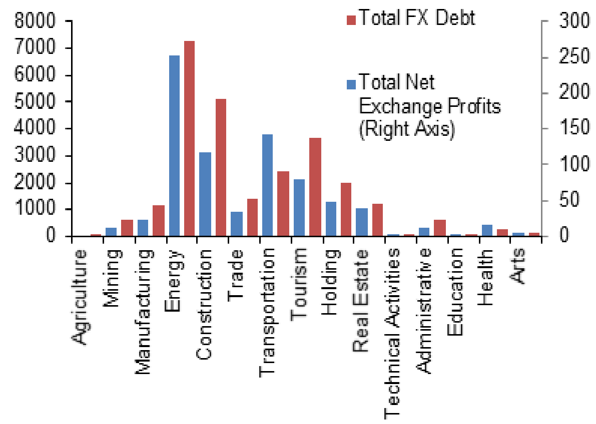
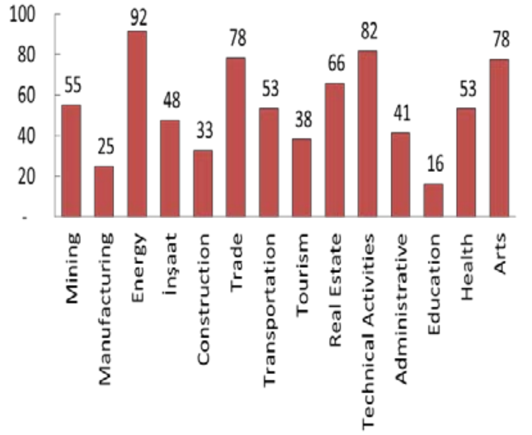


Chart 14: Sectoral Net FX Profits/Financial Expense Ratio of High-Risk Firms (2012)



Source: CBRT Company Accounts and BAT Risk Center Data

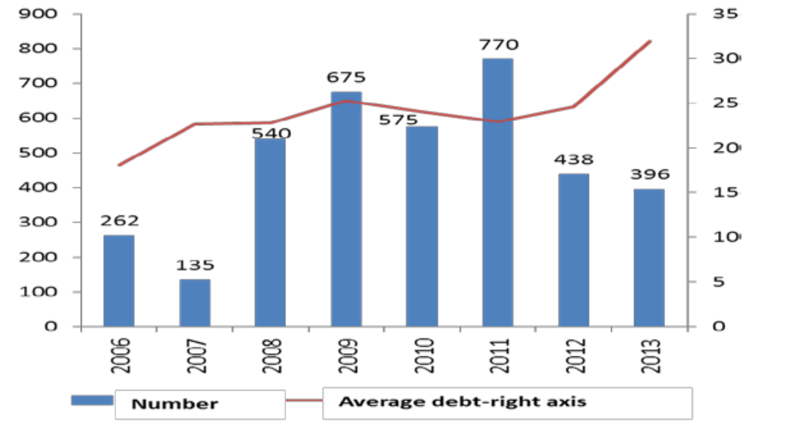
Liquidity Indicators and Profitability by Risk Groups

Table 3

	Current Ratio (2012)	Cash Ratio (2012)	Asset Profitability (%, 2012)	FX Debt (Arithmetic mean, 2013, Million $)
Highest-risky	3.33	1.24	2.04	31.9
High-risky	2.68	0.89	3.30	30.7
Medium-risky	1.92	0.54	3.79	38.5
Low-risky	3.62	1.48	4.27	6.5

Source: CBRT Company Accounts and BAT Risk Center Data

Chart 16. The Number of the Highest-Risky Firms and Average FX Debt (Million $)



Source: CBRT Company Accounts and BAT Risk Center Data

4. Conclusion and Assessments

In this study, by using a firm level dataset of non-financial firms in Turkey, we show that 87 percent of firms in the dataset either do not borrow in FX or are naturally hedged with export revenues. However, firms without or limited export revenues borrow significantly in FX, which constitute to one third of the total FX debt of all firms in the dataset. From the first impression, these firms are vulnerable to currency risk. However, a closer look at the data reveals that firms in this so-called 'high-risk' group and with high FX debt obtain a higher average net FX profits than other firms. We find that high-risk firms with a lower net FX profits-to-FX financial expenses ratio are more inclined towards holding cash. Moreover, at the sectoral level, most of the sectors with relatively higher debt dollarization ratios seem to have activities not classified as exports but generating revenues through FX-linked pricing in the domestic market. As evidenced by the current dataset, the currency risk of non-financial firms in Turkey might be lower than what macro aggregates imply.

The findings above show that the currency risk of non-financial firms can be better estimated through a firm-level analysis. For instance, firms take into consideration the position of their owners when they assess their currency risks. In addition, firms tend to take into account not only the current period but also the period ahead with regard to their currency risks. In fact, although firms with a net FX short position made losses in recent years when the Turkish lira depreciated significantly, they made profits out of exchange rate movements in the long run. Thus, we believe that negative effects of exchange rate level changes or its volatility are more pronounced on investment and production decisions of firms rather than on their balance sheets.

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Indonesia financial system statistics: a combination of micro and macro data[1]

Andy Johan Prasetyo, Astri Octiana Lana and Irfan Sampe,
Bank of Indonesia

[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 or the central banks and other institutions represented at the meeting.

Indonesia Financial System Statistics

A combination of Micro and Macro Data

Andy Johan Prasetyo, Astri Octiana Lana, Irfan Sampe

Abstract

Bank Indonesia has a new responsibility in regulation on macroprudencial policy which focuses on the stability of the financial system. Thus, formulating policies for the financial stability in Bank Indonesia has to be supported by a trustworthy current, reliable, accurate, timely and accessible statistics. On the other hand, the new Bank Indonesia Act gives a mandate that Bank Indonesia must always adhere to the principles of accountability and transparency in implementing its authorities and others. Therefore, its publications need to be complemented by macro-prudential and financial stability statistics.

Statistics Department publicized Indonesia Financial System Statistics (SSKI) on May 2014 for internal purposes initially and June 2015 as external publication. SSKI consists of sectors refers to definition of financial system in line with SNA 2008. The publication mainly consists of indicators and data reflected soundness of financial system in Indonesia arranged in coordination with other Departments in Bank Indonesia and other Institutions.

Keywords: New Responsibility, Macroprudential Policy, SSKI

Table of Content

Introduction

Background

Since January 2014, the bank supervisory function is no longer done by Bank Indonesia. Bank Indonesia has a new responsibility in regulation on macroprudencial policy which focuses on the soundness and stability of the financial system. Bank Indonesia has to maintain the resilience of the financial system to prevent and mitigate systemic risks, encourage a balanced intermediation for the economy, and improve the efficiency of the financial system in order to maintain the stability of the financial system. Formulating policies for the financial stability in Bank Indonesia has to be supported by a trustworthy current, reliable, accurate, timely and accessible statistics. Timely and accurate data are keys to the preparation of macroprudential policy recommendations and decisions by the Board of Bank Indonesia, as well as to monitor policy decisions in terms of their impact on, or transmission to, the economy.

On the other hand, the new Bank Indonesia Act gives a mandate that Bank Indonesia must always adhere to the principles of accountability and transparency in implementing its authorities and others. The accountability and transparency are intended to increase all stakeholders participation in overseeing every policy taken by the Bank Indonesia. In the concern of take steps towards transparency further, Bank Indonesia periodically publicized various publications related to its functions. Hence, due to Bank Indonesia's role in maintaining financial system stability, its publications need to be complemented by macro-prudential and financial stability statistics. As the beginning step, Bank Indonesia publicized Indonesia Financial System Statistics for internal purposes on September 2014 and followed by SSKI publication for external purposes less than a year later.

Aims

SSKI publicized for several purposes, internally and externally.
Internally:

- Supporting analyses and assessments to policy department for its surveillance function and formulating macroprudential policy

Externally:

- To educate and bringout public awareness in overseeing a new mandate for Bank Indonesia as macropudential authority
- To provide financial statistics in Bank Indonesia web page since Indonesia Banking Statistics removed to Financial Service Authority due to its function in Banking Supervisory authority

Indonesia Financial System Statistics (SSKI) Framework

SSKI arranged to support financial stability mandate, as a part of tools for transparency to external stakeholders and even more to complement data supporting in analysing and assessing soundness of financial system in term of internal purposes. As stated in the beginning, one of the aims of SSKI is to determine financial stability in Indonesia. Therefore, data/ indicators published should portray a conditions of financial system. Public also could oversee macroprudential policy effect by looking at indicators in this publication. Based on its purposes, SSKI data structure should be derived refers to definition of financial system framework and classification as stated in SNA 2008.

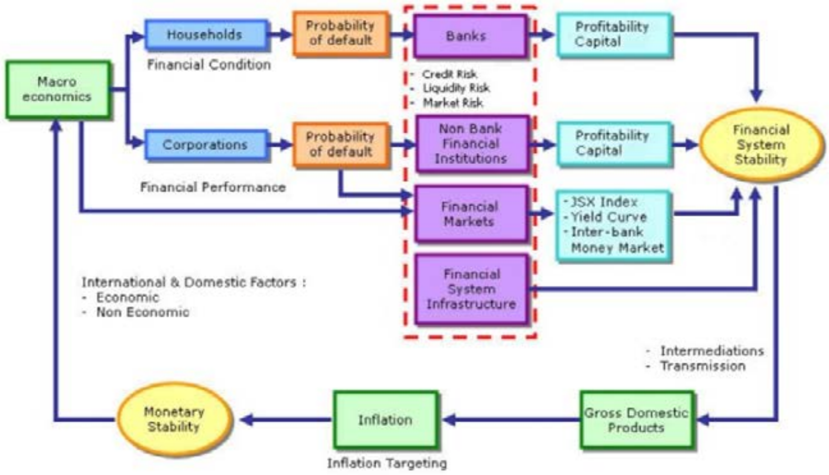
Financial System Stability (FSS) does not in fact have any standard international definition. Instead, multiple definitions are in use essentially stating that a financial system becomes unstable when economic activity is hindered and the system is endangering the economy itself. The following are examples of definitions quoted from various sources:

FSS is a condition represented by a strong financial system capable of withstanding economic shocks, one that is able to ensure intermediary function, settlement of payments and diversification of risk.

FSS is a condition in which the economic mechanisms of price formation, funds allocation and risk management operate properly in support of economic growth.

As stated in Bank Indonesia Regulation No. 16/11/PBI/2014 concerning Macroprudential Regulation and Supervisory, FSS is a condition in which national financial system functioning effectively, efficient, and capable to withstand internal and external shock, therefore funding sources or financing can be allocated to contribute the growth and economic stability. Furthermore, in the regulation also stated that Financial System is a system consisting of financial institutions, financial markets, financial infrastructure, non-financial companies and households which interacting each others in term of funding and financing to the economy.

The definitions also in line with the Financial Soundness Indicators (FSI) guideline by the IMF stated "A financial system consists of institutionalunitsand markets that interact, typically in a complex manner, for the purpose of mobilizing funds forinvestment and providing facilities, including paymentsystems, for the financing of commercial activity". In additional, classification of institutional sectors as in SNA 2008 consists of non-financial corporations sector, financial corporations sector, and general government sector. Intitutionals sectors interaction and linkage can be simply summarized as Picture 1.



Picture 1. Financial System Linkage

SSKI structured by myriad tables reflects soundness of Indonesia Financial System. It devided into 24 tables and breakdown into 1 table for macroeconomic indicators, 3 tables to portray soundness in Banking System, 6 tables to determine soundness in Other Financial Corporations, 1 table for money market indicators, 1 table for capital market indicators, 4 tables for Government and Real Sector Indicators, Property, Non Financial Corporations, and Households respectively, 5 tables for market infrastructure, and 2 tables for financial inclusive and SME's respectively.

SSKI Structure

Banking System

Banking system in this publication is defined under banking or similar regulatory legislation for supervisory purposes. It is financial institutions whose principal activity is to take deposits and on-lend or otherwise invest these funds on their account. It defined as those units that engage in financial intermediation as a principal activity, channels funds from lenders to borrowers by intermediating between them trough their own account.

The 3 tables in the SSKI which reflect the soundness of banking system are 1) Table 3. Banking Sector Indicators (using definition based on supervisory framework in Indonesia), 2) Table 4. Financial Soundness Indicators (based on FSI Guidelines by the IMF), and 3) Locational Banking Statistics (based on LBS Guidelines by the BIS). In Table 3, it mainly consists of:

- Portfolio Assets Composition
- Capital (CAR, Regulatory Tier 1 to Risk Weighted Assets, and Regulatory Tier 1 to Total Regulatory Capital)
- Rentability Indicators
- Liquidity Indicators
- Market Indicators
- Credit Risk Indicators

In Table 4, refers to FSI Guidelines by the IMF. All indicators in this table refer to its publication submitted to IMF quarterly. This is also implemented to Table 5 which is reflect all dimensions as publicized in the LBS publication submitted to BIS quarterly (DGI G-20 recommendation #11). It portrays transactions which measure claims and liabilities, including inter-office positions, of banking offices resident in the respective reporting countries[1]. The LBS is an impressive data due to its information can determine banks' risk exposures indirectly (due to LBS concept using intermediate counterpart).

Monthly Banking Report is the main source data for Banking System. Indicators publicized for SSKI accounted in coordination with other department in Bank Indonesia, in particular Macroprudential Department and Financial System Surveillance Department, also Financial Service Authority (OJK).

Other Financial Corporations (OFC)

OFC are those financial corporations that principally engaged in financial services including financial intermediation. It includes insurance corporations, financing institutions, pension funds, venture capital, Credit Guarantee Corporations, Pawn Shops, and Infrastructure Financing Company. Using this table can give information to public to monitor potential risk from this sectors. It also provide information on the size of OFC's assets to total Financial sectors assets to gain a sense of its systemic importance. Data and indicators to portray the soundness of those sectors also accounted in coordination with OJK as the authority for OFC supervisory and regulations.

Money Market Indicators

Money market is important to monitor because it plays a role in the banking intermediation mechanism and it affects the central bank's ability to manage banking sector liquidity and short-term interest rates. Data and indicators in the SSKI consist of domestic interbank money market which is devided into Rupiah and Foreign Currency market, Repo transactions, foreign interbank money market, and interest rate in money market. Source for these data and indicators is Daily Banking Report and Bank Indonesia - Scripless Securities Settlement System (BI-SSSS).

Capital Market Indicators

It arranged to portray the development of stock markets. It consists of stock trading snapshot such as Jakarta Composite Index, Number of listed issuers, IPO transactions, Market Capitalization, and Trading Highlight (o/w corporate and government bond transactions). It also includes price earning ratio breakdown by sectors. Data and indicators compiled in coordination with Indonesian Stock Exchange.

Government Sector

The table portray central government debt performance, that are consists of Debt Performance Indicators Including Debt to GDP, Debt to Revenue, Debt in

[1] Refers to LBS Guidelines by BIS

Foreign Exchange to GDP, External Debt to GDP, External Debt to Reserve Asset Position, Refixing Rate and also Average Time to Maturity . In this chapter, also informed about Government Debt Composition breakdown into Loan Agreement and Government Bond devided into debt source (resident/ non resident) and currency decomposition (Domestic and Foreign Currency). Data and indicators compiled in coordination with Ministry of Finance.

Non Financial Corporations (NFC)

Non Financial Corporations defined as institutional units that are principally engaged in the production of market goods and non-financial services (*SNA, 2008*). This chapter portray the soundness of NFC in Indonesia which is consists of Leverage Ratio, Liquidity Ratio, Solvability, Turn Over Ratio, Profitability and also NPL from Banking Loans. Mainly data collected from financial statement of companies listed in Indonesia Stock Exchange (IDX) due to limitation of data for non listed companies. Indicators devided into several sectors based on sectoral structured in IDX due to specific behaviour for each sector.

Households (HHs)

The households sector consists of all resident households defined as a group of persons who share the same living accommodation, who pool some, or all, of their income and wealth and who consume certain types of goods and services collectively, mainly housing and food (*SNA, 2008*). It mainly consists of HHs Repayment Capacity indicators that are NPL, Credit Growth from Banking and Financing Institution. It also complemented by indicators resulting from Survey conducted by Bank Indonesia that are Real Sales Index, Consumer Confidence Index, Current Economic Condition Index, Consumer Expectation Index, Consumer Financial Conditions, and also HHs Income Allocation.

Property Sectors

This chapter portray the development of property market in Indonesia. It mainly consists of Loans to Property Sector from Banking Sector and its quality processed using Monthly Banking Report. Subsequently, this table also complemented by indicators resulting from Residential Property Survey for primary house conducted by Bank Indonesia that are Property Price Index and also structure of consumer financing for property.

Market Infrastructure

Central banks have a role for safety and efficiency of payment and settlement systems. These aims should reflect in payment system tables in SSKI. Thus, it immensely adopted various issues published by the Committee on Payment and Market Infastructures (CPMI) which has guideline to oversee this functions. As stated by the CPMI "Central banks is to be the guardian of public confidence in money, and this confidence depends crucially on the ability of economic agents to transmit money and financial instruments smoothly and securely through payment and settlement systems. The systems must therefore be strong and reliable, available even when the markets around them are in crisis and never themselves the source of such crisis".

Table 18. Media Used as a Means of Payment by Banks and Non Banks consists of transferable balances held at the central bank, Transferable balances held at other banks, Notes and coin in circulation outside banks, Narrow money supply, Outstanding value on e-money storages, and also Transferable deposits in foreign currencies. Table 19. Money In Circulation consists of outflow/ inflow transactions, banknotes and coins issued by denomination, and also several indicators that are Currency Substitution Ratio, Cash Position to Monthly Outflow (average), etc. Subsequently, Table 20. Institutions offering payment services to non-banks consists of Number of Institutions offering payment services and its volume of transactions, Number of Bank and Non Bank E-Money Operators and also Amount of Floating Funds.

Furthermore, Table 21. Card-Based Means of Payment (APMK), Electronic Money (UE) and Supporting Facilities mainly consists of Card-Based Means of Payment transactions, Electronic money transaction, etc. Table 22. The Bank Indonesia Real Time Gross Settlement (RTGS) System and National Clearing System (SKNBI) mainly consists of RTGS and SKNBI participants, and its transactions volume and value. It also complemented by several indicators that are Turnover Ratio and Throughput Guidelines.

Financial Inclusion

This table portray the financial inclusive development in Indonesia. Mainly data/ indicators in this chapter adopted from The Global Findex indicators which is measure the use of financial services, which is distinct from access to financial services. It devided into 3 aims, (i) to portray the access to financial services; (ii) to portray the usage of financial services; and (iii) to portray the quality of the products and the service delivery. Thus, those aims are reflected to indicators such as Ratio of bank deposits/Third Party Deposits in Banking System to GDP, Ratio of the number of bank branches per 1000 km2, Ratio of the number of deposit (DPK) accounts per 1000 adults, etc.

MSMEs Indicators

This chapter portray the development of MSME in Indonesia. It mainly consists of Bank Loans to MSMEs and its quality.

Compilation Phases

SSKI compiled through several stages before publicized to the public initially, that were:

- Brainstorming with other departments in Bank Indonesia, in particular Macroprudential Department and also related institutions
- In depth discussion with economists and academists
- Highlevel meeting involved the chair of related departmens in Bank Indonesia and also related institutions

The main agenda of those stages was to get insight from the experts related to the concept of SSKI (indicators, structures, etc).

Subsequently, after SSKI publicized regularly since mid of 2014, Focus Group Discussion with data contributor helds periodically to ensure the quality of the data before its publicized in accordance with Advanced Release Calendar. The main agenda is to ensure the data robustness compiled in the draft publication.

The Challenges of Producing SSKI

The challenges facing Statistics Department are significant. Keeping up the coverage and quality of data has been constrained by:

1. The complexity of data collection

   Because of the wide range of data sources/ indicators that need to be drawn upon to determine the soundness for each sectors in financial system, compiling the full range of data described as in framework is become a complex task.

2. Numerous data with various time lag

   The main drawback to compile these various data is differences of time lag which then makes it difficult when forming the structure of the publication.

3. A dynamic macroprudential indicators

   SSKI is different from other statistics publicized by Bank Indonesia due to its function to publish the indicators that can reflect the soundness of each sector in financial system. Indicators presented mainly refer to the macroprudential Department and Financial Stability Department in assessing and supervise the soundness of financial system, which are very dynamic following the results of the study or the recent assessment.

4. Manually processed

   Cannot be denied that manually processed is very tricky and has many weaknesses, including human error so that the data compiled to be not robust. In the near term, Statistics Department will begin the automation process for SSKI.

5. Coordination with various institutions

   Coordination will be very difficult to do if the other institutions do not have the same vision or less understand the purposes of this publication.

The Development Path of SSKI

In the year of 2014, SSKI publicized only for internal purposes.

1. Quarter I-2014 and Quarter II-2014 (only consists 21 tables)
    - Central Government Table only consists of Financial Report
    - Non Financial Corporation (NFC) Table only consists of indicators of NFC Go Public LQ-45
    - Banking System Tables only consist of Financial Soundness Indicators and Locational Banking Statistics
    - Other Financial Corporations (OFC) Tables only consist of Insurance, Finance Company, and Pension Fund

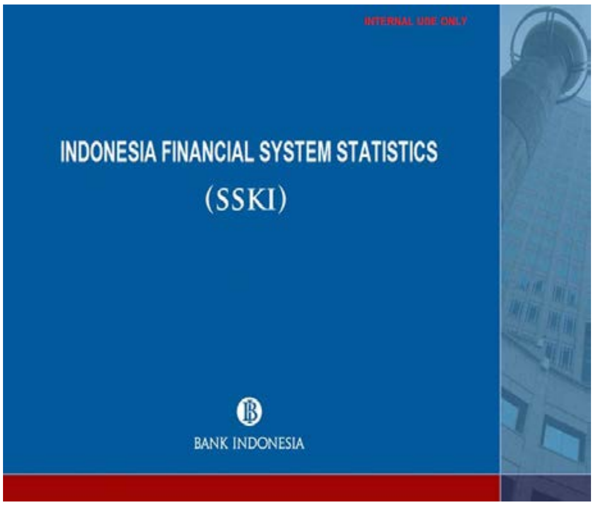


TABLE OF CONTENT

2. Quarter III-2014 and Quarter IV-2014 (consist of 21 tables)
    - Additional table for banking system
    - NFC Table consist of all listed companies
    - Additional tables for Financial Infrastructures (Settlement Media used by Bank and Non Bank, Payment Services to Non-Banks) and merged other 3 tables

TABLE OF CONTENT

In the year 2015, SSKI publicized for internal and external purposes

1. Quarter I-2015

   Internal publication consists of 23 tables

   - Additional table for OFC that is Indicators of Pawn Shop
   - Additional table for Government Sector that is Government Debt Indicators
   - Complementary Indicators for Household

   Meanwhile, external publication consists of 18 tables

   - Not include OFC Indicators
   - Not include Money Changer (Non Bank)

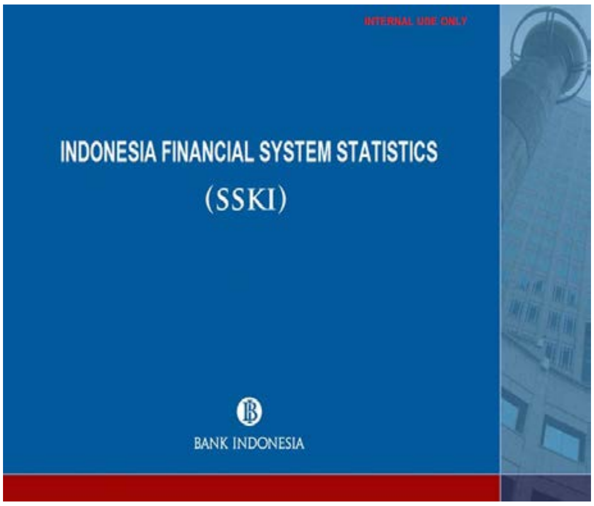


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TABLE OF CONTENT

2. Quarter II-2015

Internal publication consists of 26 tables

- Additional table for OFC that is Indicators of Venture Capital, Indicators of Credit Guarantee Corporation, and Indicators of Infrastructure Finance Company

Meanwhile, external publication consists of 24 tables

- Not include Indicators of Pawn Shop
- Not include Government Financial Report

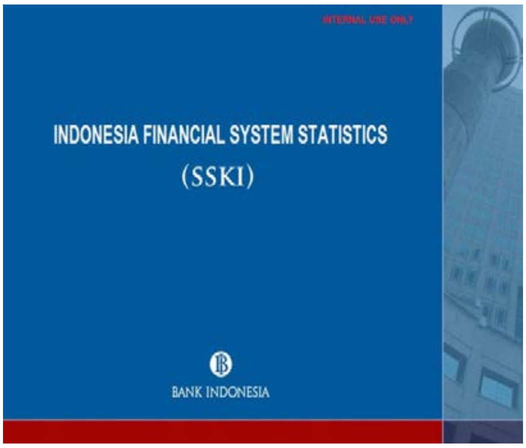


TABLE OF CONTENT

TABLE OF CONTENT

After SSKI publicized externally on Mid 2015, Statistics Department plan to assess possibility in providing SSKI for regional dimensions while keep on extending the coverage of existing SSKI.

SSKI can be accessed on Bank Indonesia Web Page with the following link: http://www.bi.go.id/id/statistik/sski/default.aspx.

Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Malaysia's experience in managing credit registers: integrating micro databases for macro analysis[1]

Nur Fazila Mat Salleh, Central Bank of Malaysia

[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 or the central banks and other institutions represented at the meeting.

Malaysia's Experience in Managing the Credit Registers: Integrating Micro Databases for Macro Analysis

IFC Workshop
Combining micro and macro statistical data for financial stability analysis. Experience, opportunities and challenges

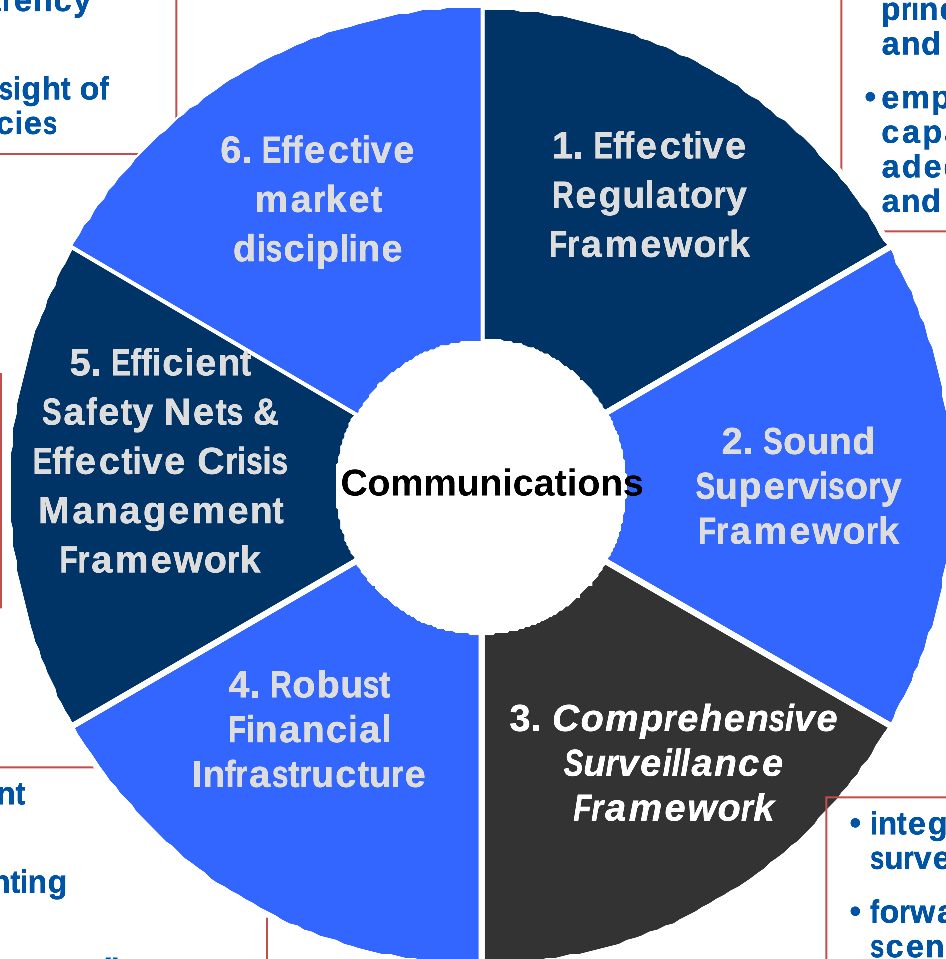
Warsaw, 14-15 December 2015

Nur Fazila Mat Salleh
Statistical Services Department

Presentation Outline

1. Financial Stability Framework
2. Credit Reporting in Malaysia
   - Enabling legislation
   - Private credit bureaus and public credit registry
3. Operations of Central Credit Reference Information System (CCRIS)
4. Relationship with Private Credit Bureau
5. Moving towards Integrated Statistical System (ISS)
6. Challenges

Core Components of Financial Stability in Malaysia



- consumer education
- enhanced transparency and disclosure
- strengthened oversight of credit rating agencies

- appropriate balance between principle-based regulations and prescriptive rules
- emphasis on governance, capacity to manage risks, adequate financial buffers, and consumer protection

- lender of last resort
- deposit and insurance protection
- priority ranking for deposits

- consolidated and risk-based supervision
- supported by home/host supervisory cooperation

- stable and efficient payment system
- effective legal and accounting framework
- sound institutional arrangements (inter-agency cooperation, CCRIS, AKPK, CDRC)

- integrated macro and micro surveillance
- forward looking, supported by scenario analyses and stress testing

Organisational Structure based on Components of Financial Stability Framework

Micro-Surveillance

Financial Conglomerate Supervision
- *Conglomerate Banking Group*

Banking Supervision
- *Foreign Banks*
- *Stand alone Islamic Banks*
- *Stand alone Investment Banks*
- *Development Finance FIs*

Insurance & Takaful Supervision
- *Life, General*
- *Takaful*
- *Reinsurers*

Supervisory Practices Unit
- *Ensure consistency of supervisory practices*
- *Provide guidance and support on RBSF*

Macro-surveillance

Financial Surveillance
- *Macro-prudential analysis & policy*
    - *Financial/ non-financial sectors*
    - *Financial markets*
    - *Non BNM regulated entities*
- *Crisis management arrangements*

Regulation

Prudential Financial Policy

Consumer & Market Conduct

Payments System Policy

Risk Specialists : Credit, Market, Operational, Technology, Actuarial
- *Provide technical advice and support to line departments*
- *Conduct horizontal risk assessments and evaluation on risk practices*

Credit Information to Facilitate Financial Surveillance

1 Credit information in CCRIS

- Delinquencies
- Outstanding amount
- Facility type
- Loan applications, approvals & rejections
- Demographic information

2 Credit information from capital market

- Private debt securities (PDS) outstanding
- PDS holders

3 Credit information from external market

- External loans
- External PDS

To facilitate assessment of

Business sector

- Systemic impact of selected large borrowers' exposure to the banking system
- Migration of financing from commercial papers to banking system
- Exposures of banking system to property-related sector

Household sector

- Default trend analysis of selected loan portfolios (by purpose / by location / by age)
- Impaired loans analysis
- Analysis on borrowers with multiple housing loans

Credit Information Industry Supported by Enhanced Regulatory Framework

1. Enforcement of Central Bank of Malaysia Act 2009 and Financial Services Act 2013
   - The central bank is allowed to collect credit-related information from participating financial institutions (PFIs) and disclose such information to the PFIs and credit reporting agencies, provided that the data subject has provided consent
   - Duty of participating financial institutions to submit timely and accurate credit information to the central bank
   - Secrecy requirement to maintain confidentiality of information

2. Enactment of Credit Reporting Agencies Act and Personal Data Protection Act 2010
   - Legal framework as a platform to facilitate the sharing of credit information while still protecting borrowers' right to privacy

Central Bank of Malaysia Act 2009

… supporting the operation of public credit registry

Section 47 enables Bank Negara Malaysia:

1. To collect credit information (including information relating to rejection of any cheque by reason of insufficient fund in the account)

2. To disclose the credit information collected to:
   - Financial institution for the purpose of assessing credit-worthiness of its existing and potential customers or to assess the eligibility of the customer to maintain or open a current account;
   - Borrower for the purpose of verifying the accuracy of the credit information; and
   - Registered credit reporting agency for the purpose of providing credit reporting or credit assessment services.

3. This section also protects the Central Bank against any legal action.

Credit Reporting Agencies Act 2010[1/]

... mainly to protect the rights of consumers

Coverage	Credit information relating to both natural persons and other entities, such as corporations, partnerships, cooperatives and other organisations
Regulation of Credit Reporting Agencies (CRAs)	• A registrar is appointed by the Minister of Finance to regulate CRAs • CRAs are required to be registered to undertake credit reporting business • The registrar also responsible for resolving complaints and disputes between credit customers and CRAs
Preserving privacy	• CRAs required to notify customers that information are being collected • CRAs are also required to obtain the consent of the consumers on disclosures of information to third parties
Consumer rights	• Access own information held by the CRAs • Shall not be charged for correcting any information that is inaccurate, incomplete or misleading
Accuracy and security of information	• CRAs are required to take reasonable steps to ensure that information held are accurate, complete, not misleading and up-to-date • CRAs also obligated to put in place the necessary safeguards (e.g. systems, procedures and processes) to ensure the security and safety of information
Enforcement information	Penalties ranging between RM50,000 to RM1 million or a six months to three years imprisonment or both, depending on the severity of the offence

[1/] The Act was officially enforced on 15 Jan 2014.

Credit Reporting in Malaysia

… presence of both private and public credit bureaus

Public Credit Registry

- Non-profit and owned by Bank Negara Malaysia
- Participation of licensed banking institutions is mandated by law
- Collects information on credit facilities and dishonoured cheques
- Provides basic credit reports to members on reciprocal basis as well as to the public
- Governed by Central Bank of Malaysia Act 2009

Governance of Credit Registry's Operations by Bank Negara Malaysia

Financial Surveillance Department	Statistical Services Department	LINK[1/] and Regional Office
• Policy formulation • Business Development	• Data reporting & quality management • System administration • Training & education	• Manage general inquiries and public complaints in relation to the credit registry

[1/] Refers to centralised point of contact to facilitate a rapid and effective response for members of the public in matters related to the financial sector

Credit Reporting in Malaysia

… presence of both private and public credit bureaus

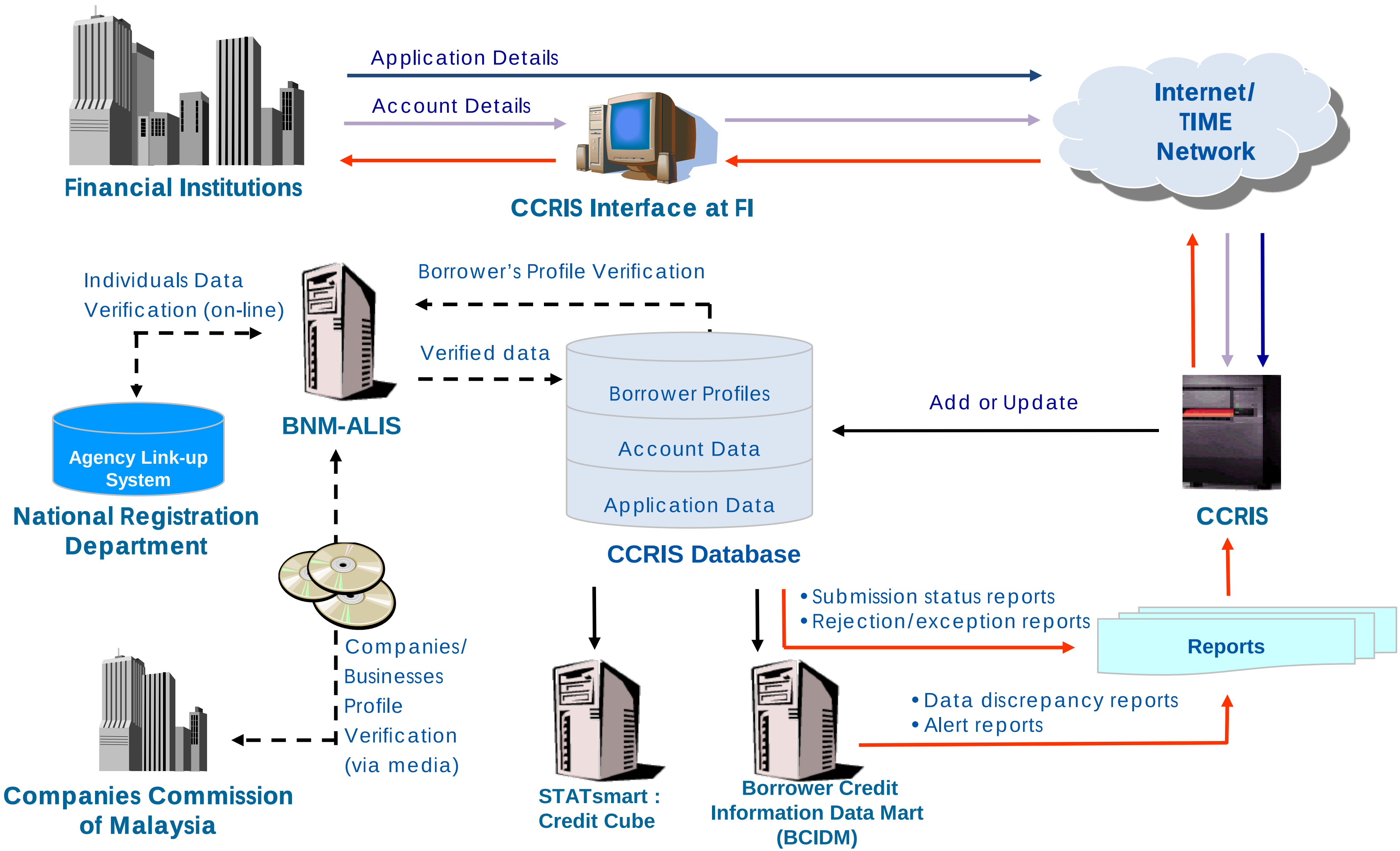
Private Credit Bureaus (PCB)

- Privately-owned and profit-oriented
- Mainly rely on public information as main source
- No access to borrowing information of banks unless consented by borrowers
- 7 bureaus currently operating
- Governed by Credit Reporting Agencies Act 2010
- Regulated by Registrar Office of Credit Reporting Agencies under Ministry of Finance

PCBs	Services Offered
PCB 1	▪ One stop centre for financial institutions and other credit grantors to retrieve credit information and ratings for credit evaluation purposes ▪ Platform for SMEs to build their track record and credit standings to facilitate faster processing of their credit applications
PCB 2	▪ Collates factual information on legal proceedings against individuals and businesses as well as other information from public sources and captured into an electronic media for easy, fast and accurate retrieval
PCB 3	▪ Registration of vehicle/equipment ownership claims to protect and safeguard the interest of all members ▪ Prevent double financing of vehicles/equipment ▪ Provide leading information for credit evaluation and monitoring
PCB 4, 5, 6 and 7	▪ Provide business report which includes detailed information on companies, litigation check, credit information, financial information and analysis, clientele, business operations, industry analysis and credit risk rating

Overview of Central Credit Reference Information System (CCRIS)

… a real-time online credit information system operated by BNM



Credit Application / Account Information Flow

… detailed information on borrowers and credit transactions

FI makes decision based on CCRIS credit report and other info

Application Update

- Status of Application (Approved/Rejected/ Cancelled)
- Approval Date
- Amount Approved
- Reason for Rejection

Reporting to CCRIS:

Stage 1: Credit application received
Stage 2: Credit decision made, where:

- Rejected, Cancelled, Withdrawn by Customer before FI Decision – FI updates status and process ends here.
- Approved – FI continues to submit data 1- 6.

Credit Application

- FI Name
- Name of Applicant
- ID Number
- Date of Birth/Registration
- Nationality
- Application Ref. No.
- Amount Applied
- Application Date

Financial Institution (FI)

Customer submits loan application to FI

Borrower's Details

- Name of Borrower
- ID Number
- Date of Birth/Registration
- Marital Status
- Nationality/Country of Operation
- Resident/Non-Resident
- Corporate Status
- Industrial Sector
- Address
- Telephone Number
- Employment Details

1

Loan Information

- Account Number
- Approved Limit
- Approval Date
- Facility Type
- Purpose of Loan
- Financing Concept
- Repayment Term
- Interest/Rebate Rate
- Type of Pricing
- Maturity Date

2

Account Position

- Outstanding Balance
- Months in Arrears
- Installments in Arrears
- Amount Undrawn
- Account Status
- Loan Sold to Secondary Market under SBBA
- Amount Disbursed
- Amount Repaid

3

Account Collateral

- Collateral Reference Number
- Collateral Type
- Collateral Value
- Collateral Details

4

Legal Action

- Latest Legal Status
- Date of Latest Legal Status

5

Provision

- Impaired Loan Tagging
- Month in Arrears
- Principal Outstanding
- Interest/Income Outstanding
- Other Charges
- Individual Impairment Provision
- Impaired Loan Written-back/Written-off

6

Credit Reports from CCRIS

…provides positive and negative information on borrowers

CCRIS collates data collected & returns credit reports to financial institutions on demand, real-time

Types of credit reports:

1. Summary Credit Report – aggregate overall credit exposure of the customer including financial guarantees, if any

2. Detailed Credit Report – details on each loan account (e.g. credit limit, outstanding amount, conduct of accounts, legal action)

3. Customer Supplementary Report – historical employment, addresses, telephone numbers

4. Motor Vehicle Report – info on the source of financing of specific vehicles

Dissemination and Communications

… various channels and diverse users

1. Reports

- Standard reports
- Filterable by common dimensions
- View data at granular level based on access rights

2. Analytical tools

- Users granted access to Business intelligence tools such as SAS and Business Objects to facilitate generation of data by different dimensions
- Able to view to transactional details

3. Publications

- Statistics collected are published in:
  - BNM's periodic reports such as the Annual Report
  - Reports of international agencies such as IMF and World Bank

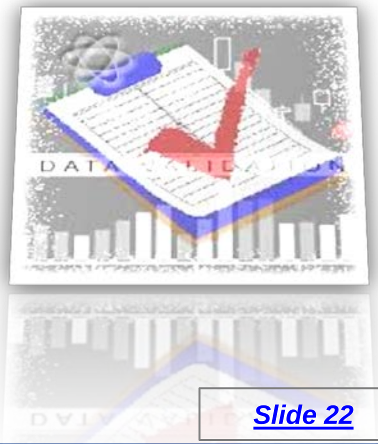
Data Quality Management Framework

…ensure creditability of information for credit reference

Borrowers profile – data from financial institutions are verified against the official sources:

- Individuals – National Registration Department
- Businesses and Companies – Companies Commission of Malaysia

Data validation – during loading and processing, only data which pass validation will be loaded into the database. Rejected records are returned to the financial institutions for rectification and resubmission.



Data verification – a data quality assurance framework to check possible data inaccuracies in data provided by the financial institutions e.g. cross-checking with other financial data and trend analysis.

Slide 22

Relationship with Private Credit Bureau

…as a source of credit information

1. Access to credit registry's information given based on careful consideration and is on case-to-case basis.

2. For approved applications, private credit bureaus are required to demonstrate sufficient measures are in place to ensure that the information will be:
   a) properly and accurately recorded, maintained, collated, synthesised and/or processed;
   b) protected against loss and/or damage; and
   c) protected against unauthorised access, use, modification or disclosure.

3. After all conditions are met, the private credit bureau will sign an agreement with Bank Negara Malaysia which, among others, detailed the responsibilities of the private credit bureau and enabling Bank Negara Malaysia to revoke access in the event of any breach of any terms in the agreement.

4. Currently, three private credit bureaus have access to credit information from Bank Negara Malaysia's credit registry.

Slide 23

Moving Towards Integrated Solution… Integrated Statistical System (ISS)

Objective

Effective and efficient data management to meet the Bank's business needs and desired outcomes

Deliverables

1. Enterprise data governance (EDG) policies and processes to instill discipline in data management Bank-wide
2. An integrated statistical system with agile IT infrastructure for end-to-end data management from data submission, storage to dissemination

Benefits

1. More efficient data management Bank-wide
2. Easy and fast access to timely, credible and relevant data
3. Reduced reporting burden by eliminating data duplication
4. Ease of IT maintenance and support

Statistical Information and Interlinkages

External Sector Flows and Stock

1. Non-resident Counter Party Profile
2. Investment Information
3. External Assets and Liabilities Position

Financial Assets and Liabilities

1. Securities
2. Loans
3. Deposits
4. Assets / Liabilities

Macroeconomics

1. Real
2. External
3. Financial
4. Fiscal

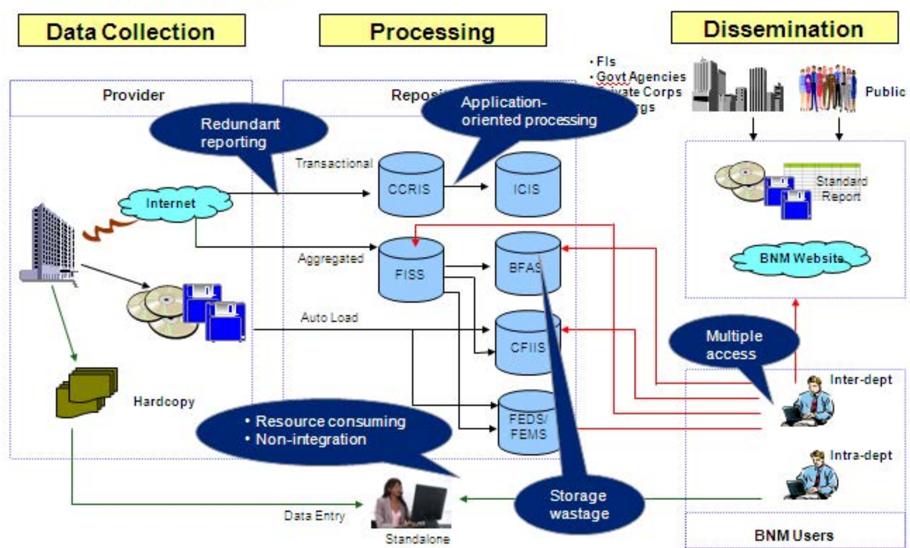
Credit Information

1. Application Details
2. Loan Details
3. Account Position
4. Provision
5. Account Collateral
6. Legal Action

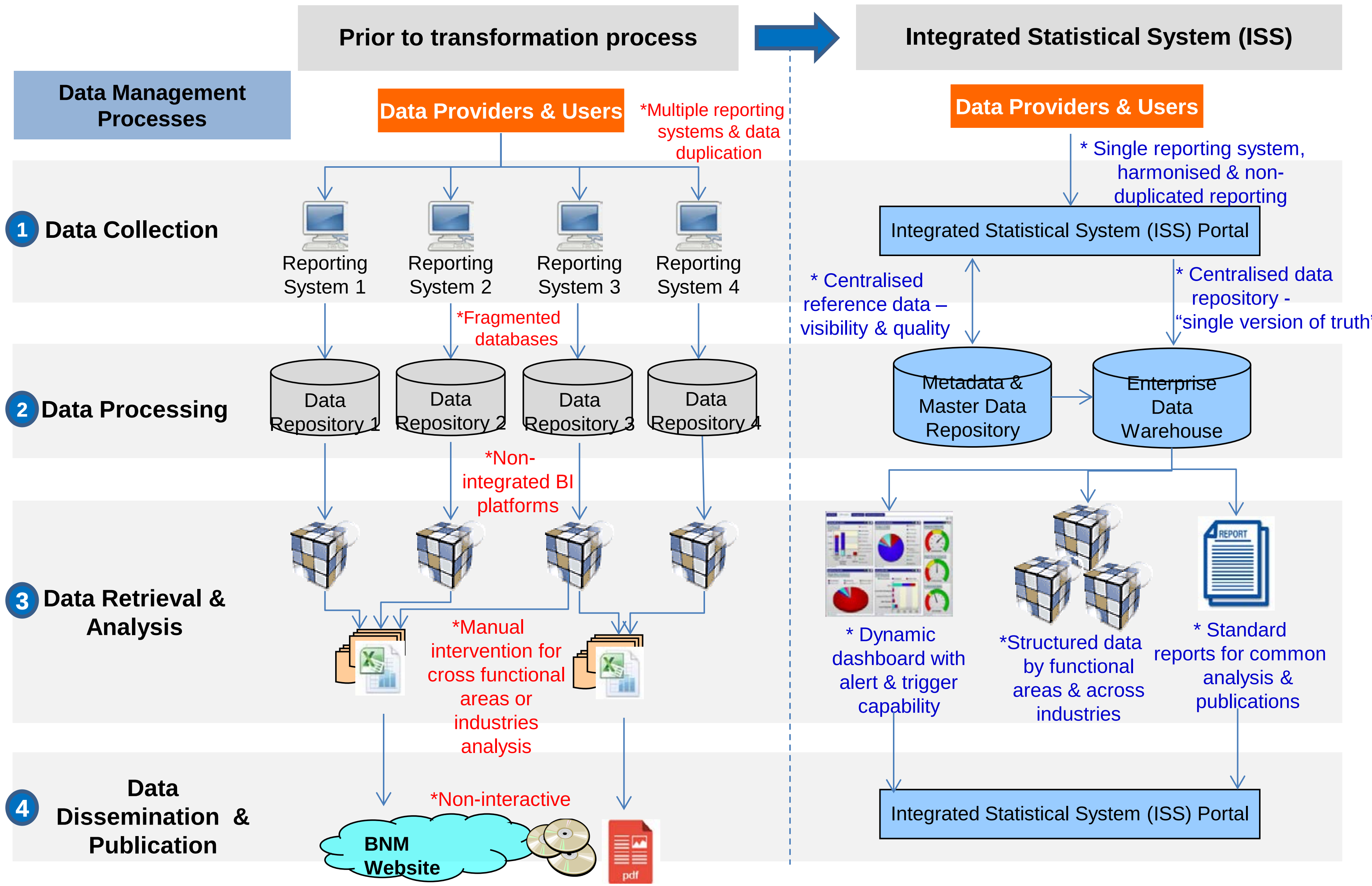
Entity Profiles

1. Name
2. ID/Registration No.
3. Nationality/Country of Operation
4. Resident/Non-Resident
5. Corporate Status
6. Industrial Sector

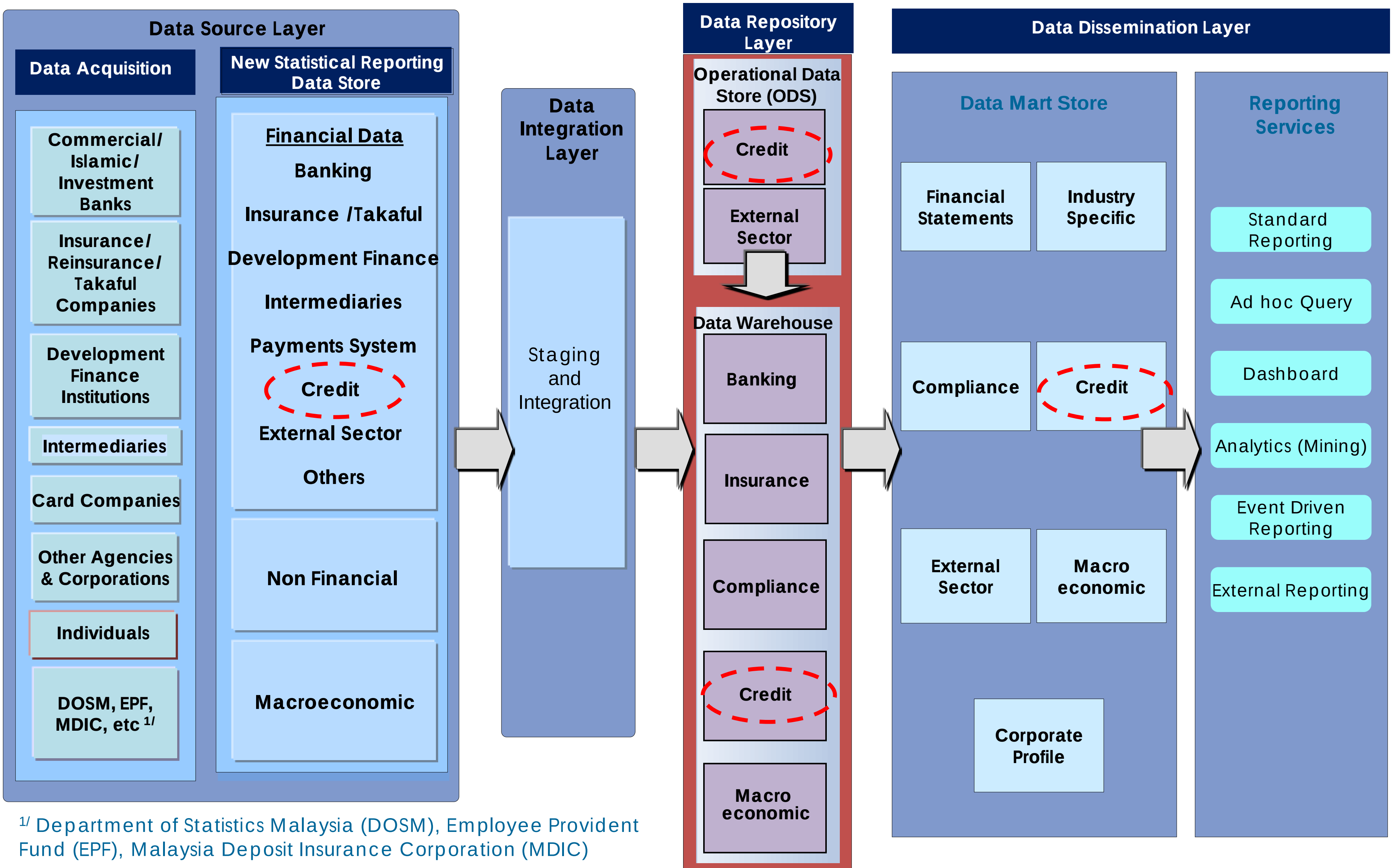
Current Process



Moving towards integrated solution… Integrated Statistical System (ISS)



Moving towards integrated solution… Integrated Statistical System (ISS)



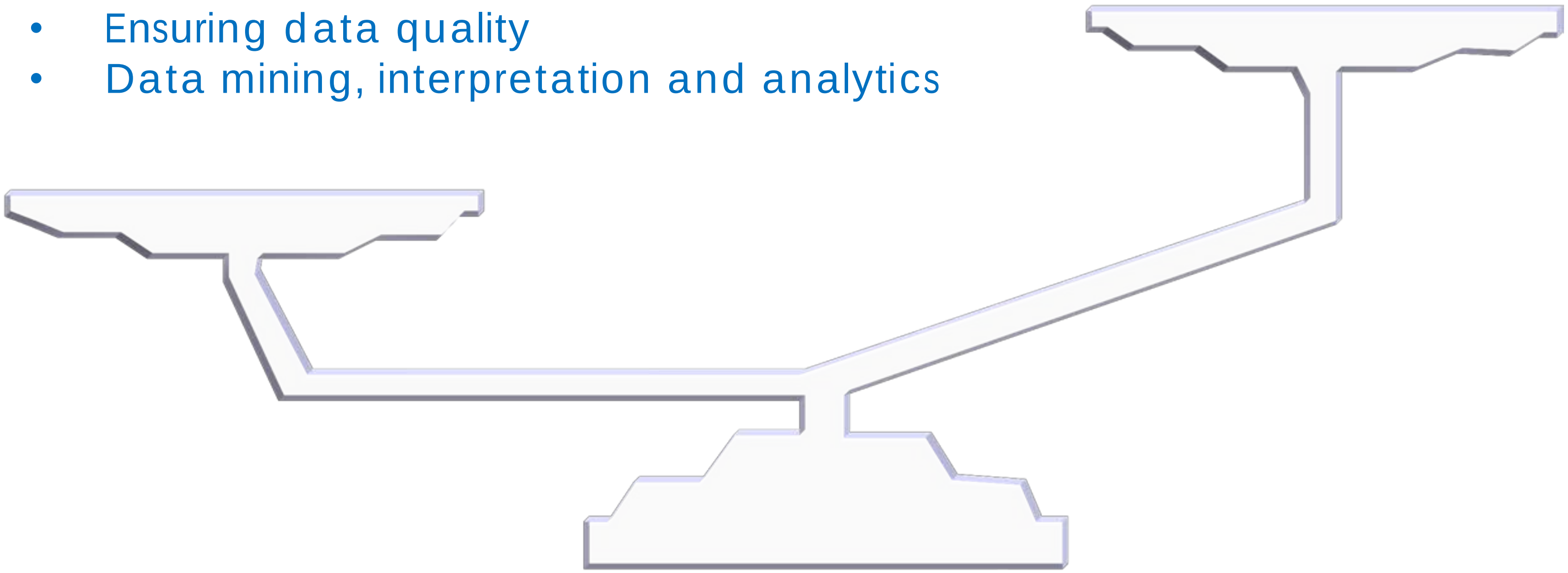
[1/] Department of Statistics Malaysia (DOSM), Employee Provident Fund (EPF), Malaysia Deposit Insurance Corporation (MDIC)

ISS Implementation Phases

Phase 1 (2011-2014)	Phase 2 (2015-2017)	Phase 3 (2016-2018)
1. Standard Platform for Data Submission to BNM by All Reporting Entities		
❑ **Statistics on:** ▪ Banking Institutions ▪ Payment System Operators ▪ Devt Financial Institutions	❑ **Statistics on:** ▪ External sector statistics ▪ Macro-economic data (from government agencies) ▪ Basel (capital adequacy)	❑ **Statistics on:** ▪ Insurance Companies, Takaful Operators and Intermediaries ▪ Credit ▪ Non Financial data
2. End-to-end IT infrastructure for all components of ISS 3. Centralised data repository and migration of historical banking, payments and development finance data 4. Statistical information portal for banking, payments and development finance data 5. Enhancements and interfaces from/to legacy statistical systems	2. Migration of external sector, macroeconomic and Basel data 3. Statistical information portal for external sector, macroeconomic and Basel data 4. Interfaces from/to legacy statistical systems	2. Migration of historical insurance, takaful, intermediaries and credit data 3. Statistical information portal for insurance, takaful, intermediaries, and credit data 4. Develop business continuity plan and set up recovery environment 5. Decommission of legacy statistical systems

Challenges

1. **Infrastructure readiness**
   - Institutions may be at varying stages of infrastructure development
   - Large initial outlay
2. **Buy-in of relevant stakeholders**
   - Some agencies may be reluctant to share "sensitive" information
   - Legal framework may be necessary to facilitate sharing of information
3. **Technical resources**
   - Ensuring data quality
   - Data mining, interpretation and analytics



Useful Websites

Central Bank of Malaysia

http://www.bnm.gov.my

Credit Registry

http://creditbureau.bnm.gov.my

Consumer Education Program

http://www.bankinginfo.com.my/

Thank you

Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Discussion of session 5 on *"The experience of emerging market statistical institutions in combining micro and macro level data: different approaches, a common goal"*[1]

Laura Vajanne, Bank of Finland

[1] The views expressed are those of the author and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

Laura Vajanne

Bank of Finland

Discussion: The experience of emerging markets

IFC Workshop

Warsaw 14-15 December 2015

Session 5: *The experience of emerging markets' statistical institutions in **combining micro and macro level data**: different approaches - common goal*

- ***Diego Avanzini***, Central Bank of Chile,
  *"A micro-powered model of **mortgage default risk** for full recourse economies, with an application to the case of Chile"*

- ***Krzysztof Olszewski***, Joanna Waszczuk, Jacek Łaszek, Hanna Augustyniak, Robert Leszczyński, Narodowy Bank Polski,
  *"On the dynamics of **the primary housing market** and the forecasting of **house prices"***

- **Cihan Yalçın** and Timur Hülagü,Central Bank of the Republic of Turkey, *"Micro Evidence on **Foreign Exchange Liabilities and the Exchange Rate Risk** in Non-Financial Firms in Turkey: A Descriptive Analysis*

- ***Andy Johan Prasetyo***, Astri Octiana Lana, Irfan Sampe, Bank of Indonesia, *"Indonesia Financial System Statistics: **A combination Micro and Macro Data***

- ***Nur Fazila Mat Salleh***, Central Bank of Malaysia,
  *"**Malaysia's Experience in Managing Credit Registers: Integrating Micro Databases for Macro Analysis"***

Statistical requirements for financial stability and macroprudential policy

- The need for a new set of policy instruments i.e. **macroprudential tools** for addressing financial stability is one of the main lessons of the global financial crisis.

- Emerging countries are already experienced in macroprudential policies, primarily because they have also experienced **more pronounced business and financial cycles.**

- Pro-cyclicality is often due to the greater exposures to international capital flow volatility, commodity price shocks, and other risks, and external and internal transmission channels that operate more adversely.

Statistical requirements for financial stability and macroprudential policy

- For proper macroprudential policymaking, we need right and enough information. Aggregative data might not be enough, because aggregation can hide important information. Therefore, **micro level data and its linkages with macro-level data are required.**

- The papers presented in this session are investigating the importance of micro information of debtors and lenders and how micro databases (e.g. credit registers) contribute to the improvement of these statistics.

- The research results show that macroprudential policy decision making can be supported by enhancing the analysis and applications of financial markets with the help of micro level data.

Some conclusions and comments

- The questions asked in the research papers are well directed because macroprudential tools are mostly adressit **at risks originating from the financial sector.**
- Large movements in the real estate market not only magnify fluctuations in the real economy but also destabilize the financial system. Therefore, it is important to monitor and analyse real estate market trends.

  – ***Diego Avanzini*** showed in his presentation that aggregated macro financial variables such as prices and loan to value ratios and its interaction with microeconomic information can contribute explaining an important portion of mortgage risks.

  – The model presented by ***Krzysztof Olszewski*** proves to be useful for policy makers, central banks and regulators to test how changes in mortgage rates or income affect prices, demand and supply in the primary housing

Some conclusions and comments

- Foreign currency loans are used in many emerging countries to complete or compensate the supply of domestic loans. But loans in foreign currencies might give rise to a huge risk for financial stability.

  – **Cihan Yalçın's** presentation shows that the currency risk of non-financial firms can be better estimated through a firm-level analysis.

Some conclusions and comments

- **Andy Johan Prasetyo** in this presentation discussed the new responsibility in macroprudential policies of the Bank of Indonesia. Bank Indonesia has recently started regulation in the field of macroprudential policy which focuses on the soundness and stability of the financial system.
  - Formulating policies for the financial stability Bank Indonesia has to be supported by timely and accessible statistics. Timely and accurate data are keys to the preparation of macroprudential policy recommendations and decisions by the Board of Bank Indonesia, as well as to monitor policy decisions in terms of their impact on or transmission to the economy.

- **Nur Fazila Mat Salleh's** presentation comprehensively described Malaysia's experience in managing credit registers and how to integrate micro databases for macro analysis.

Some conclusions and comments

- Analyzing risks arising from financial instabilities is essential for central banks but is complicated by the limited suitability of aggregated data for this purpose.
- The microdata underlying corresponding aggregates, however, often lack sufficient quality, as they are gathered for purposes other than microanalyses, are derived from a large number of sources and based on a wide range of data-gathering techniques and formats, or they simply fail to provide the right information.
- Therefore, the use of micro level data puts different request also for data producers and compilers like central banks and supervisors.
- Especially, tighter **coordination and cooperation** are crucial, within the central bank itself and with other competent authorities at the national and international level to be able to get the best out of the existing micro data bases.
- Also the limitations of **data sharing** between the competent organisations need to be reduced or removed.

Some conclusions and comments

Questions to all speakers:

- What are the most pronounced risks considering financial stability in your countries?

- What kind of macroprudential tools could be used to mitigate these risks?

Irving Fisher Committee on
Central Bank Statistics
BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Insights from matched firm-bond level data – Market of issuance and credit quality[1]

Alberto Fuertes and Jose Maria Serena, Bank of Spain

[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 or the central banks and other institutions represented at the meeting.

Insights from matched firm-bond level data: Market of issuance and credit quality

Alberto Fuertes (Banco de España) and Jose Maria Serena (Banco de España)[1]

Abstract

Matching firm-level and bond-level information is useful to investigate the real and financial risks of firms' financing patterns. In this paper we describe the construction of a database with these features. We gather all the bonds issued in the period 2000-2014 which are guaranteed by emerging economies firms; and we match them with firm-level data. Using this data, we describe how firm-specific features affect the market in which they issue international bonds. Typically, firms with less ability to comply with demanding securities regulation and fewer gains from doing so –due to their informational asymmetries or credit risks- will prefer issuing in the Eurobond market or the US institutional market.

Key words: bond markets, market-depth, securities regulation, debt choice.

JEL classification: F34; F36; G15; G30

[1] We are very grateful to Branimir Gruic for helpful discussions on debt securities data. The author's views need not coincide with those of Banco de España or the Eurosystem. Corresponding author: alberto.fuertes@bde.es.

1. Introduction

The post-crisis international financial markets are defined by the transition towards market-based financing. Emerging economies firms are obtaining substantial amounts of funding from international bond markets, and they are managing to do so at long maturities (Shin (2013)). This easy access to debt-markets is attributed to global financial conditions (Lo Duca et al. (2014), Ayala et al. (2015), Feyen et al. (2015)). Among the lenders, non-bank institutions have stepped into the provision of credit, in a context of low returns on traditional assets. Overall, the process is deemed to pose significant risks for international financial stability: borrowers could be raising too much debt; lenders could be underestimating the risk.

Many interesting insights of the process have been highlighted using international data on debt securities, and more specifically the International Debt Securities compiled by the BIS. For instance, how firms often use affiliates incorporated overseas to accede international debt markets (Shin (2013), McCauley, Upper and Villar (2013)). Recent developments suggest as well a growing reliance on international bond funding in local currency (Gruic and Wooldridge (2013));

Overall, the trends identified with the international debt statistics open a number of relevant questions. Addressing some of them requires, to an important extent, complementing aggregate statistics with micro-level data.

The credit risks of firms borrowing in markets are one of these aspects. To investigate the issue, we have constructed a database matching firm-level and deal-specific information for all emerging economies firms active in international markets during the period 2000-2014, in line with parallel work. A distinctive feature of our database is that it is built around the firms guarantying the debt-securities, which need not be the issuer companies. Debt-guarantors are the entities which would be liable in case of distress. The database contains information on firms' financial accounts, corporate structure, and non-financial information; and on the type of debt-securities issued. Overall, there is information for 1,584 firms, which issue a total of 3,944 securities, for a total amount of 1.2 USD trillion. The database covers unlisted firms, firms listed in local exchanges, and firms cross-listed in the US.

Using the dataset, we investigate if firm-specific factors matter for the choice of international market of issuance: global, US institutional (Rule 144A), and Eurobond markets. These markets differ in relevant dimensions, being one their different regulation; this implies they differ in how demanding is the disclosure of financial information. Issuing a global bond requires complying with US regulation –if a tranche of the bond is placed in the US. Comparatively, the regulation of the US 144A bond market is lighter. Firms can issue in the Eurobond market without the need of complying with burdensome disclosure of financial information. While complying with regulation has a benefit –the sales of the bond in the secondary market are unrestricted, and thus liquidity is enhanced-, it imposes costs on the issuer; these costs are mostly firm-specific. Accordingly, theory predicts that firms borrowing in less regulated markets, such as Eurobond markets, have less ability to absorb high flotation costs, exhibit more informational asymmetries, and exhibit lower credit quality –compared to issuers of Global bonds. Univariate analysis and results of multinomial models of choice confirm the first two hypotheses, and give mixed support for the third one. After the global financial crisis, firms' propensity to issue debts in US 144A and Eurobond markets has increased. Overall, issuance in less regulated debt-markets signals more uncertainty on borrowers' credit quality.

Our paper is related to substantial parallel work matching bond and firm-level data to zoom into the broader implications of funding patterns. Along the same lines, Bruno and Shin (2015) match firm and bond-level data to investigate the connection between bond issuances and firms' hoarding of cash. Besides, similar data has been used to gauge the evolution of financial vulnerabilities for firms active in international bond markets, which underscores a trend towards worsening of financial conditions (Fuertes and Serena (2014) and IMF (2015)).

The rest of the paper is structured as follows. Section 2 describes the construction of a micro-level dataset relevant for financial stability analysis. Section 3 presents our empirical exercise. In section 4 we discuss the main conclusions.

2. Constructing a Database to Investigate Credit Risks of Firms' Active in International Bond Markets

2.1. Main features

We use Bloomberg to construct a dataset matching firm-level data with information of debt-securities issued in international debt markets in the period 2000-2014, and guaranteed by emerging economies firms. Our focus is on 36 countries of four emerging economies regions: Emerging Asia, Latin America, Emerging Europe, and Africa and Middle East[2].

The database has three defining features. First, it is built around the firms guaranteeing the debt-securities, instead of the issuer entities. This allows mimicking properly the risk-analysis carried out by international investors, when deciding to invest in a given debt-security. Second, the debt-securities information contains foreign bonds, issued in the global bond market, US 144A bond market, and Eurobond market. Thus, it is not limited to public offerings of bonds, and encompasses private placements. Finally, we match bond-level data with firm-specific information, and cover more than 80% of the total amount issued; the coverage is, overall, good, albeit relatively poorer in 2006 and 2007.

Overall, these three features make our database comprehensive and consistent: it contains 3,944 debt-securities, issued by 1,584 firms in the period 2000-2014, which make up a total amount of 1.2 USD trillion.

2.2. Monitoring credit-risks of firms guaranteeing debt-securities

The exercise of investigating the risks that investors assume by investing debt-securities issued in international debt markets is extremely challenging. A reason is that the organizational structures of firms have become very complex. They expand well beyond their domestic boundaries, posing important challenges for the analysis of financial risks (see, for instance, Avdjiev et al. (2015), and references therein).

Thus, we follow previous work in tracking firms' activities on a consolidated basis. Since our interest is gauging the credit risks of investing in a bond, we delve into the actual financial dependence between affiliates with respect to their parent companies. We do so because, while some affiliates are fully-supported, others are fully-independent; and some other might receive explicit guarantees for specific financial operations.

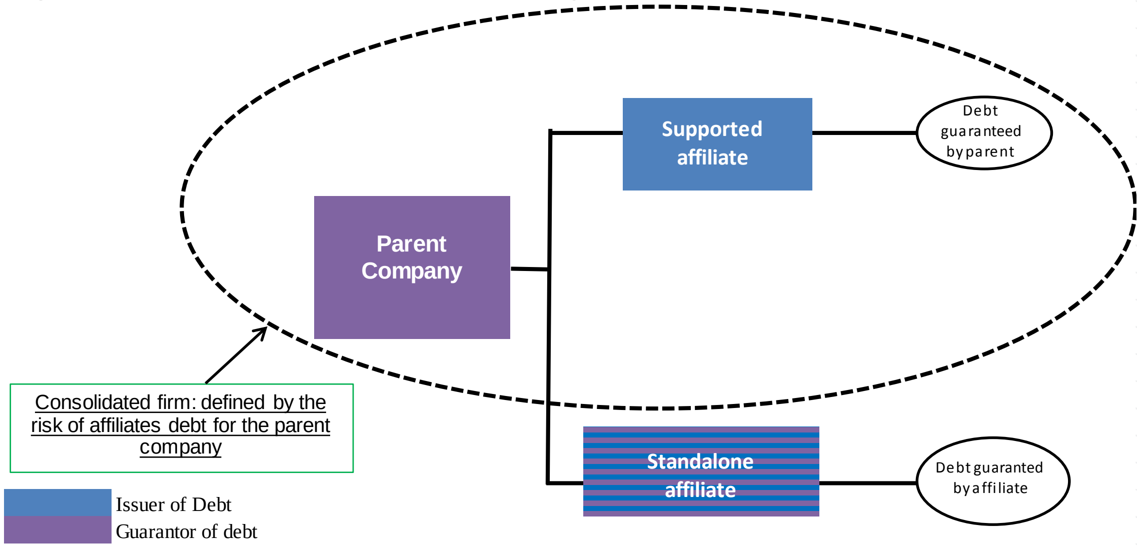
Accordingly, we make a distinction between supported and standalone affiliates. If an affiliate issues debt with guarantees from its parent company, we treat it as part of a consolidated entity; we interpret the issuer is transferring upstream its risk to the guarantor. This criterion applies to all issuer-entities -non-financial affiliates and offshore/onshore financial vehicles-. If, alternatively, an entity issues debt without explicit guarantee of another company, we treat the affiliate on a individual basis. Most probably, this affiliate will be non-financial, fully-independent from its parent company[3].

[2] Latin America includes Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, and Venezuela; Emerging Europe includes Bulgaria, Belarus, Bosnia, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Turkey, Ukraine; Africa & Middle East includes Egypt, Morocco, Nigeria, Saudi Arabia, South Africa, UAE. Emerging Asia includes India, Indonesia, Malaysia, Philippines, Thailand, South Korea.

[3] There are two options: it can be an emerging economy firm, and be in our sample; alternatively, it can be an advanced economy firm, and be excluded from it.

Figure 1 provides an example of how our criterion works. It shows a company with two affiliates - these entities can be incorporated domestically or overseas-. We assume investors assess the risks of investing in their bonds analyzing the guarantor-company. We consider the supported affiliate as part of a non-financial conglomerate, and match its bonds with the parent company balance-sheet. The case of the standalone company is, in contrast, financially independent -the debt-securities it issues do not receive any explicit guarantee-. Thus, we consider investors perform the risk-analysis using its financial accounts; accordingly, we treat it as a different company.

Figure 1. Non-financial corporations and their guarantees on debt issued by affiliates



Source: own elaboration.

The reason why we use this criterion is that we want to mimic the risk-analysis carried out by international investors; we assume investors price the risk of investing in a bond analyzing the soundness of the firm guaranteeing it: legally, it is the entity liable in case of distress.

Although we are the first to use this criterion, its interests had already been suggested (Esho, Lam, and Sharpe (2001)). Due to the problems to match systematically the debt-security with the underlying firm-level data, previous research had opted to use a more conservative approach and focus only on observations in which debt-issuers and debt-guarantors coincide.

2.3. Firms guarantees on affiliates' debt securities: identification of upstream transfers of risks

Implementing this criterion requires identifying transfers of risk from debt-issuers to debt-guarantors. But, how can such upstream transfers of risk be identified, in practice? Our main input is the fundamental company ticker underlying each debt-security. This ticker identifies the firm guaranteeing the debt-security; it need not coincide with the issuer-firm, or with the ultimate parent company of the issuer-firm. The country of incorporation of the debt-guarantor firm is equivalent to the country-risk of the debt-security. This is an ISO code constructed using four factors listed in order of importance: management location, country of primary listing, country of revenue, and reporting currency of the issuer. In practical terms, the primary listing status and managerial location are key to determine the holder of the risk, while the reporting currency is the least important factor. As a robustness check, we have cross-checked our conclusion using firms' financial reports.

Using this method, we identify two types of upstream transfers of risk. Firstly, transfers of risk of financial vehicles; these entities are used to tap international markets and are often referred to as "offshore vehicles" since most are incorporated overseas (see Shin (2013), Avdjiev et a. (2015), and references therein). Table 1 lists some recent deals in which emerging economies firms have tapped international markets through offshore financial vehicles. They include debt securities issuances by Petrobras Global Finance, Lukoil International Finance BV, or AngloGold Ashanti Holdings PLC, among others. A way of confirming that there is a transfer of risk is comparing the country of risk of these securities with the country of the ultimate parent company. In these cases they do coincide. This reflects that these entities are always explicitly guaranteed by their parent companies, and so it is the debt they issue. The debt is guaranteed by emerging economies firms. Entities issuing these debt securities are, though, incorporated in advanced economies such as Netherlands, Luxembourg, or Ireland. Thus, these deals would not be included in analyses of debt-issued by emerging economies firms, since these financial vehicles are domiciled in advanced economies.

Table.1. International debt securities issuances by offshore financial vehicles

Company Name	Parent Company	Country of Incorporation	Country of Risk	Country of Ultimate Parent Company	CUSIP	Amount (US bn)
Petrobras Global Finance BV	PETROBRAS - PETROLEO BRAS-PR	Netherlands	Brazil	Brazil	71647NAF6	3.5
Lukoil International Finance BV	LUKOIL OAO	Netherlands	Russia	Russia	EJ6431419	1.5
Gazprom Neft OAO Via GPN Capital SA	GAZPROM NEFT OAO-CLS	Luxemburg	Russia	Russia	EJ9515473	1.5
Russian Railways via RZD Capital PLC	RUSSIAN RAILWAYS JSC	Ireland	Russia	Russia	EJ6158582	1.308
AngloGold Ashanti Holdings PLC	ANGLOGOLD ASHANTI LTD	Isle of Man	South Africa	South Africa	03512TAD3	1.25
Metalloinvest Finance Ltd	METALLOINVEST HOLDING CO OAO	Ireland	Russia	Russia	EJ8456547	1
SABIC Capital II BV	SAUDI BASIC INDUSTRIES CORP	Netherland	Saudi Arabia	Saudi Arabia	EJ8456547	1

Source: Bloomberg, own elaboration.

Secondly, non-financial affiliates can also transfer upstream risk to their parent companies. This happens when their debt is guaranteed by its parent companies. Albeit less frequent, this is not rare. Table 2 lists a number of debt securities issuances in which the risk of non-financial affiliates debt issuances is transferred to parent companies. There are relevant examples. For instance, JBS Investment GmbH is an Austrian affiliate of a Brazilian company, whose debt is guaranteed by its parent company, JBS S.A; therefore the risks are transferred upstream to Brazil. Rolta LLC is a US affiliate of an Indian firm, Rolta India, which guarantees its debt; similarly, the risk is transferred to its parent.

Table.2. International debt securities issuances of affiliates and guaranteed by parent companies

Company Name	Parent Company	Country of Incorporation	Country of Risk	Country of Ultimate Parent Company	CUSIP	Amount (US bn)
JBS Investment GmbH	JBS SA	Austria	Brazil	Brazil	46611DAA3	1
OAS Investments GmbH	CMP Participacoes	Austria	Brazil	Brazil	67089RAA1	0.875
PT Portugal SGPS SA	Telemar Patcipacoes (OI SA)	Portugal	Brazil	Brazil	EJ2496895	0.491
Sappi Papier Holdings GmbH	Sappi Ltd.	Austria	South Africa	South Africa	803071AC3	0.4
Rolta LLC	Rolta India Ltd.	United States	India	India	775793AA0	0.2

Source: Bloomberg, own elaboration.

This method is important as well to treat standalone affiliates. In emerging economies there are affiliates of foreign firms which do not receive financial support from their parent companies. They shall be considered as standalone entities, since their debt issuances are not guaranteed by their parent companies. An example is given by Kansas City Southern Lines, a US-headquartered company, which has a standalone affiliate in Mexico. The affiliate is Kansas City Southern de México, which obtains financing without the guarantees of its parent company[4]. Thus, investors will weigh the interest

[4] The number of these foreign-owned, independent affiliates, operating in emerging economies is not large in the case of non-financial corporations. Though, there are other examples. For instance, in Mexico Concesionaria Mexiquense SA, an independent subsidiary of Obrascón Huarte Lain, S.A, a Spanish company; SatMex, the Mexican telecommunication company, was acquired by the French firm Eutelsat in 2014, but its country of risk remains Mexican.

of acquiring its bonds delving into the soundness of the Mexican affiliate. Accordingly, we treat these affiliates as emerging economies' firms -even if they are owned by foreign companies, as happens in this example.[5] The financial risks of their activities lay in emerging economies. Besides, the bond shall be matched with the financial information of the affiliate.

Interestingly, emerging economies' firms have also standalone affiliates outside their jurisdictions. Table 3 lists some bonds issued by them. Most of these standalone affiliates are large and well-known companies: Jaguar Land Rover, Pilgrims' Pride, Novelis, among others. Novelis is a US–nonfinancial affiliate of Hindalco, an Indian company. Pilgrim Pride is a US–nonfinancial affiliate of JBS, the Brazilian food producer. The debt-securities issued by these foreign-owned affiliates are not guaranteed by their parent companies; the telltale sign there is not a risk transfer is that the country of risk assigned to these securities is equivalent to the country of incorporation of the subsidiary (and different to the ultimate parent company country). The controlling interest of these affiliates -in India and Brazil, respectively- does not guarantee their foreign-owned affiliates' debt-securities. These entities are not considered in our analysis, since are incorporated in advanced economies.

Table 3. International debt securities issuances of affiliates not guaranteed by parent companies

Company Name	Parent Company	Country of Incorporation	Country of Risk	Country of Ultimate Parent Company	CUSIP	Amount (US bn)
Jaguar Land Rover Automotive PLC	Tata Motors Ltd.	United Kingdom	United Kingdom	India	EK0498676	0.65
Novelis Inc.	Hindalco Industries	United States	United States	India	67000XAL0	1.1
Rain CII Carbon LLC /CII Carbon Corp.	Rain Industries Ltd.	United States	United States	India	EJ4718106	0.4
Moy Park Bondco PLC	Marfrig Global Food	United Kingdom	United Kingdom	Brazil	EK2879899	0.33
Springs Industries Inc.	Cia de Tecidos do Norte de Minas	United States	United States	Brazil	851783AB6	0.47
Pilgrim's Pride Corp.	JBS SA	United States	United States	Brazil	72147KAB4	0.49

Source: Bloomberg, own elaboration.

We look at firms' financial reports and credit agencies' rating opinions and find support for our decision of treating these entities as standalone entities. Jaguar Land Rover Automotive PLC (JLR) is an interesting example, since it is very active in international debt markets. It is incorporated in United Kingdom as a subsidiary of Tata Motors, an Indian firm. JLR subscribes liabilities, which are not guaranteed by Tata Motors. Accordingly, it does not transfer its risk upstream. When deciding to price the risk of acquiring JLR debt-securities, international investors will look at JLR financial information. Consistently, we treat JLR as an UK company. Since our analysis focuses on emerging economies firms, it is not in our sample. Similar insights are obtained from external credit agencies decisions: Fitch rates JLR on a standalone basis, highlighting there is no parent support.[6]

3. Analyzing credit risks in international bond markets: Does lack of harmonization in securities regulation segments firms?

3.1. How lack of harmonization in regulation can segment international bond markets

This dataset is useful to investigate the credit risks of firms active in international bond markets. We conjecture that it is a key factor behind their choice of international market of issuance. As a corollary, we expect the credit quality of firms to differ substantially across markets. We describe the underlying theory behind the hypothesis.

[5] These affiliates are integrated with their parent companies in some relevant dimensions, such as revenues or profits, but not in terms of financial stability risks: they retain the risk.

[6]From JLR debt-securities offerings JLR announced the 23th of April 2015 a 10-year 400 £ million senior note offering, stating that these securities "*will be guaranteed (the "Guarantees") on a senior unsecured basis by Jaguar Land Rover Limited and Jaguar Land Rover Holdings Limited.*"Interestingly, the announcement was welcomed by both the CFO of Jaguar Land Rover and Tata Motors. This suggests that, beyond legal risk-fencing, there could be a reputational or informal support.

The starting point is that, conditional on their decision to tap foreign investors, firms have several options: issuing foreign bonds, targeting the US institutional investors, issuing in the Eurobond market, or issuing Global bonds. International bonds are those in which the issuer is not domiciled in the jurisdiction, and the issuer is subject to a non-local regulation (BIS-ECB-IMF (2015))[7]. But firms can choose among many options. First, they can issue foreign bonds –Yankees, Samurai, Bulldogs, etc- are bonds issued in a foreign local market; at least since 2000, they are rarely issued by emerging economies firms. As an alternative, they can target the US institutional investors by issuing private placements with Rule 144A rights; these bonds can be sold in the secondary market among institutional investors (qualified institutional buyers, QIBs). Besides, firms can issue Eurobonds; this is an offshore market, whose main financial centers are Luxembourg, Ireland, or London. Finally, firms can issue Global bonds, which are simultaneous issuance in at least two markets. Global bonds are fully fungible –which enhances liquidity-; since they often involve a placement in the US domestic market, they are fully subject to the SEC regulation.

Theory suggests that firm-specific factors are relevant in firms' choices. The markets described differ in several dimensions, being a relevant one their different regulation: it is more demanding in some markets than in others. Complying with the regulation required to issue a global bond is more demanding than the required to issue a bond with 144A rights; issuing these bonds is, finally, more costly than issuing a Eurobond. Complying with regulation enhances bond liquidity. However, it is costly since requires disclosing publicly financial information. Providing such information is costly, but these costs are firm-specific. Theory suggests that firms with less ability to comply with regulation, suffering more informational asymmetries, and exhibiting higher credit risks, will resort to less regulated bond markets. In a nutshell, complying with regulation is less burdensome for firms which are larger, or are already compliant –due to, for instance, being already cross-listed in an US exchange. Overall, the stringency of regulation leads to an increase in the flotation costs in Global bond markets. The benefits of issuing in a regulated bond market are lower for firms with higher credit risks. Typically, these bonds are placed among a larger base of investors; thus, due to coordination problems, in an event of distress, the recovery value of the firm will be lower. Similarly, firms with more severe informational asymmetries are more amenable to financing in less regulated markets; here, borrowers can informally gauge the interest of bond investors, and customize bonds to incorporate options and enhancing its value (for further details, see Denis and Mihov (2003), Fuertes and Serena, mimeo).

The importance of the firm-specific costs of complying with regulation has been widely study in the literature. Existing research has compared Yankee (US foreign) and US144 bonds (Chaplinsky and Ramchand (2004), Fenn (2001), Esho et al. (2001), Gomes and Phillips (2012)); Yankee and Eurobonds (Miller and Puthenpurackal (2001)); or the choice between Yankee, US144A, and Eurobonds (Gao (2011)). In this article we expand the analysis to investigate the choice between Global, US144A, and Eurobonds; foreign bonds have lost ground in the period 2000-2014, at least for emerging economies, and thus we left them aside. Table 4 shows the number of bonds issued in each market, during this period. Eurobonds represent the bulk of total issuances. Bonds issued in the US institutional market rank as the second in importance, and grew markedly in 2014. The number of Global bonds is comparatively lower. Foreign bonds have become infrequent over these years.

[7] For instance, a Mexican firm issuing a bond in the US; in contrast, a firm domiciled in the US issuing a debt security in the US, is carrying out a US domestic placement. The popular distinction between domestic and international debt markets reflects the relationship between the residence of debt issuer and the market of issuance location. Following this convention, domestic debt issuances are placements by resident issuers in their home-countries.

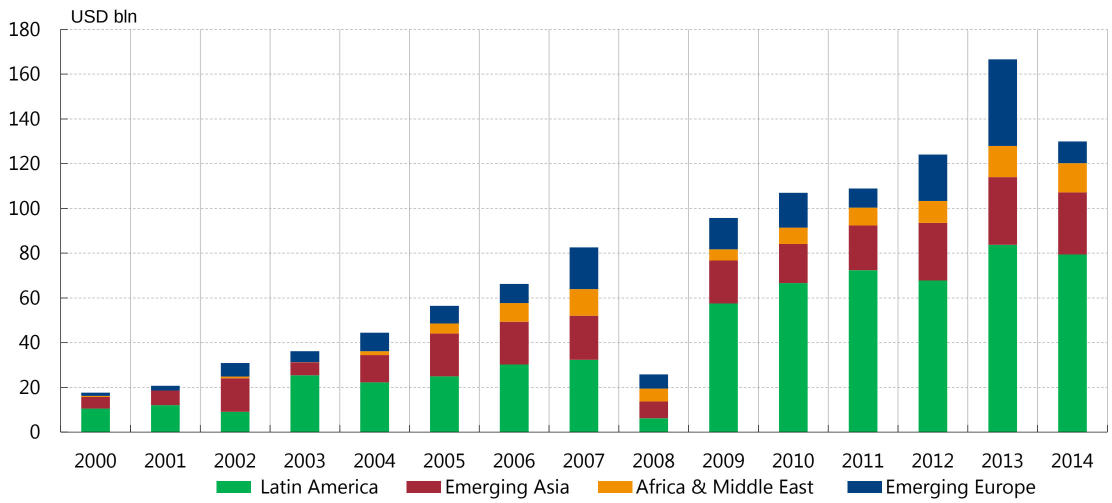
Table 4. Number of deals per year. Breakdown by market of issuance

	Total	Global Bond Markets	Foreign Bond Markets	US 144A Bond Market	EuroBond Market
2000	163	8	11	43	101
2001	179	6	4	31	138
2002	168	14	4	34	116
2003	175	20	4	51	100
2004	293	16	7	43	227
2005	434	20	7	60	347
2006	593	27	5	36	525
2007	386	15	4	15	352
2008	104	3	5	7	89
2009	196	17	4	39	136
2010	233	15	1	38	179
2011	206	17	10	22	157
2012	247	20	3	30	194
2013	327	29	7	45	246
2014	240	22	1	105	112
Total	3944	249	77	599	3019

Note: Foreign Bond Market include Samurai, Shogun, Yankee; and US Domestic placements of foreign affiliates of emerging economies firms which are guaranteed by their parent companies.

Chart 1 displays the total amount raised by firms of each region, and breaks it down by year. Latin-American firms have guaranteed debt-securities for an amount of more than 600 USD bn; Emerging Asian firms are second in importance, and have guaranteed 250 USD bn, while Emerging Europe and Africa & Middle East stand as third and fourth, with a total of 250 and 171 USD bn.

Chart 1. Debt-guaranteed by emerging economies firms. Breakdown by region.



Source: Bloomberg, own elaboration.
Note: breakdown by country of risk (nationality of the firm guaranteeing the debt-security).

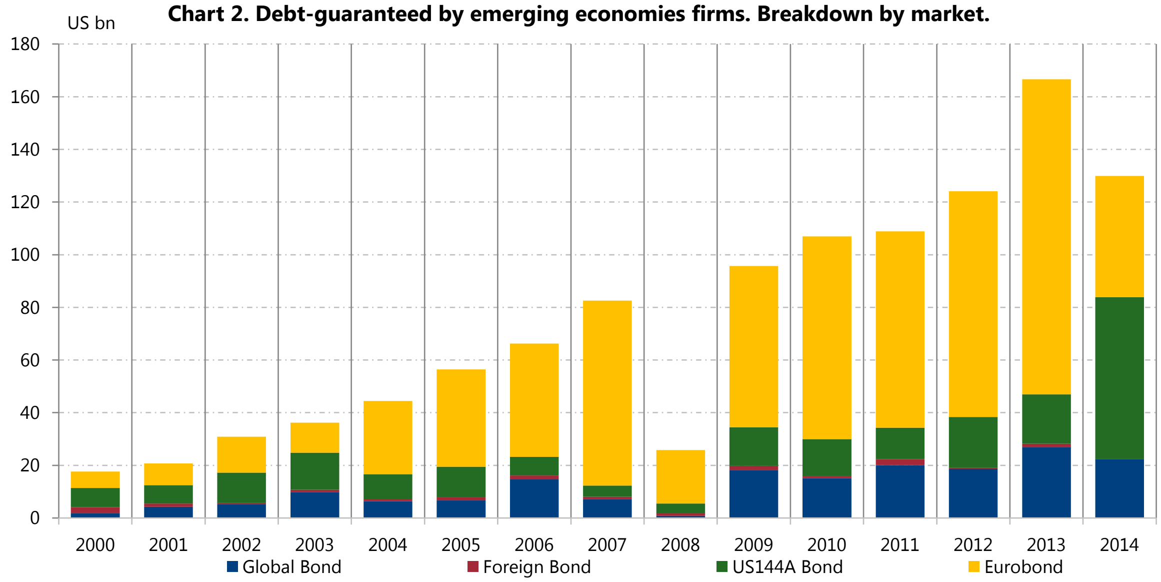
3.2. Firm-year database

To carry out the analysis, we construct a firm-year database. This is important since some firms have medium term note (MTN) programs. This allows them issuing through shelf-registration; firms file a prospectus describing in general terms firms' funding plans, and define the specific conditions when carrying out bond issuances -in some cases through reverse enquiry (at demand of the investor). Overall, these firms tend to issue many bonds of small amounts; this makes convenient to carry out analyses on a year basis. Otherwise there is a risk of overestimating the number of bonds issued, and underestimating its average size. Similar methodological decisions have been taken in previous research (Esho et al. (2001)).

Thus, for each firm, we map all the debt-securities issued in a given year into a single observation. If a firm issues only once, the annual observation coincides with the deal-level observation described in the previous sub-section. But if a firm issues several times in a given year, we need construct a single observation.

Once we have constructed a firm-level database, we classify firms according to the market in which they issue. We classify firms in three main groups: firms able to issue Global bonds, firms issuing in the US institutional (US144A) market, and firms issuing Eurobonds. We remove firms which switch between US institutional and the Eurobond market. Chart 2 shows the volume issued in each market. The volume issued in the Eurobond represents the bulk of the total; the amount issued in the US institutional market ranks second in importance; finally, the amount issued in the Global bond market is the smallest. These differences remain constant over time. Though, in 2014 there is a contraction in the relative importance of the Eurobond, and an increase in the US institutional market.

Chart 2. Debt-guaranteed by emerging economies firms. Breakdown by market.



Source: Bloomberg, own elaboration.

3.3. Identification method and summary of statistics

We use different variables to identify firms' ability to cope with flotation costs, asymmetries of information, and credit risks. They can be classified in two groups: firm-information; and variables related to the type of financial contracts that firms subscribe. We refer to them as financial contract characteristics. They include measures of the type of bonds issued, and are a valuable source of information of firms' credit quality, which reflects how lenders assess their risk.

We start describing the firm-information. We interpret that firms can comply more easily with the regulation required to issue a Global bond if they are larger, already file their financial accounts with a US GAAP or IFRS, and are cross-listed in the US through ADR. We consider that firms suffer more informational asymmetries if they have lower ratios of net fixed assets to total assets, their financial information is not familiar to international investors (for instance, report with a local GAAP), or have less coverage by international analysts (again, cross-listed in the US is a good proxy); informational asymmetries can also be signaled by rapid recent growth (average growth in firms' assets in the last five years).

Table 5. Firm-level variables. Descriptive statistics (median values).

	Firms with Access to Global Market	Firms Issuing only on US144A Market	Firms Issuing only on Eurobond Market
A. Firm-information			
Total Assets ($ mm)	11,620	4,295	936
Fixed Assets to Total Assets	0.58	0.46	0.38
Altman Score	1.93	1.82	1.92
Leverage	2.46	2.58	2.35
Return on Assets (%)	4.38	3.19	3.39
Current Ratio	1.34	1.29	1.36
Interest Coverage Ratio	3.47	2.88	2.55
Asset growth (5 years)	16.50	18.00	22.80
Local GAAP (%)	6%	20%	27%
US ADR (%)	48%	25%	13%
B.Financial contract characteristics			
Amount Issued ($ mm)	650	300	55
Maturity (years)	9.38	6.69	5.00
Sinking Fund (%)	4%	18%	6%
Convertible Rights (%)	6%	6%	29%
Call option (%)	32%	38%	15%
Put option (%)	3%	4%	35%
Rating (%)	86%	76%	34%
Bond Holder Rights (%)	9%	23%	33%

Source: Bloomberg, own elaboration.

As proxy of credit risk, we use the Altman score. We use as well firm-year variables constructed using the type of bonds which firms issue. The total amount issued is a proxy of ability to cope with regulatory costs –since flotation costs are typically mostly fixed, the relative cost decreases-. The average maturity of bonds indicates informational asymmetries; typically, investors will be willing to lend at longer tenors to more trustworthy firms. We construct a dummy variable indicating if the firm has issued at least a bond with rating: credit ratings indicate arms' length finance; they increase transparency only for firms with low informational asymmetries, otherwise a more direct engagement by lenders is required –and bonds are not rated. Finally, we construct dummies indicating if firms embed options to enhance the value of the bond for investors: sinking funds, put options, or convertible rights[8]. They all indicate that there is uncertainty surrounding a firms' value: attaching a sinking fund to a bond is conceptually similar to posting collateral, and signals credit risks; put options give bondholders the right to sell back the bond; and convertible rights allow lenders to convert bonds into equity, this way allowing them to gain equity-like returns.

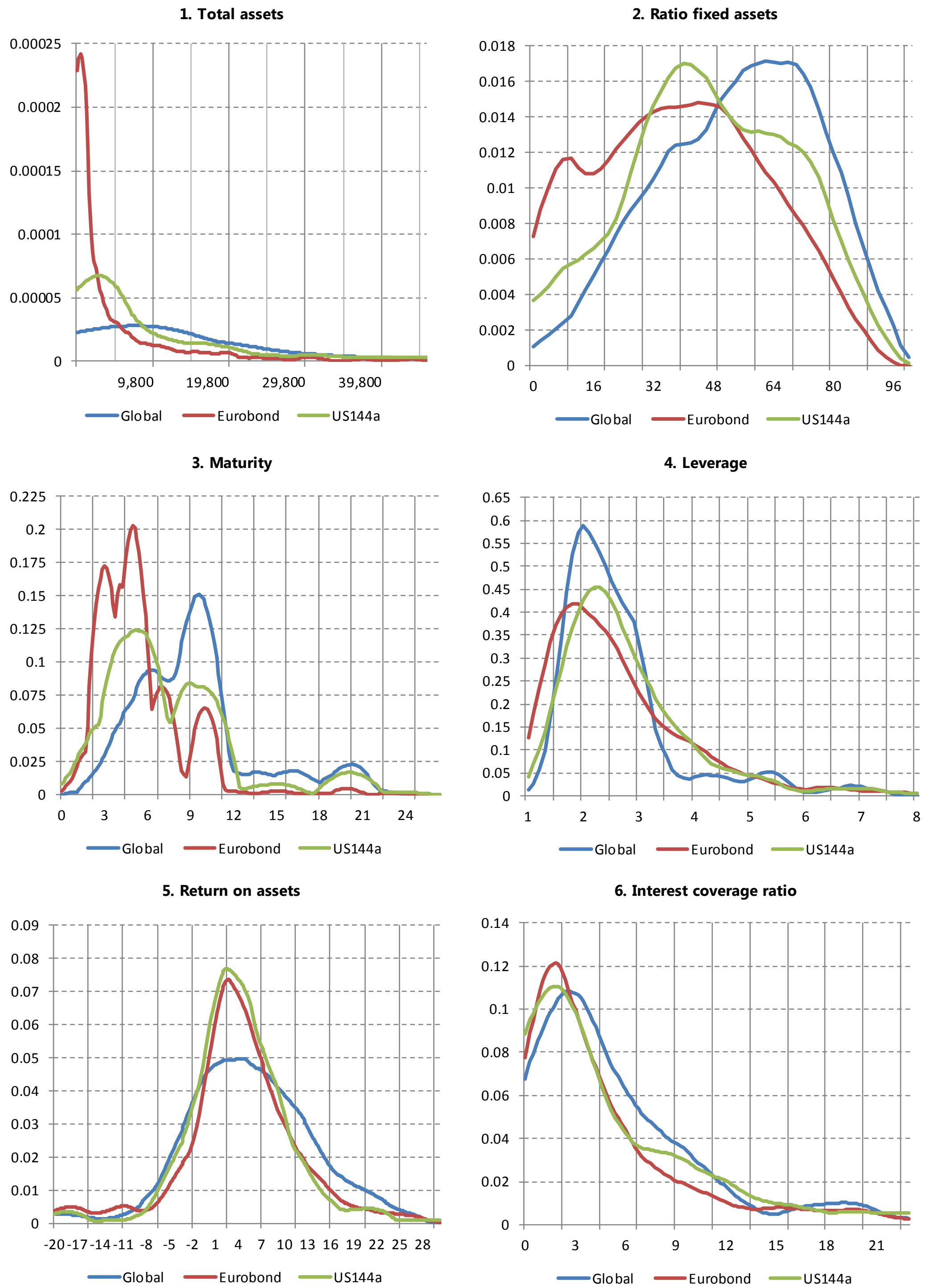
Table 5 shows descriptive statistics for firms active in each market. All variables shown are firm-specific. Typically, firms with access to the Global bond market are larger, and have less costs of complying with regulation: they rarely file their financial accounts with a local GAAP, and 48% of these firms are cross-listed in the US through ADR. They exhibit less informational asymmetries: on the top of the signals given by the two latter two variables, they have higher ratios of net fixed assets to total assets, issue at longer maturities, and rarely enhance bond holder rights. Most global bonds have a public rating. Interestingly, firms issuing in the US144A market rank second in all the variables. This is consistent with the predictions of theory, which suggests a ranking between the markets.

[8] Dummies take values 1 of all bonds contain the corresponding embedded option (sinking fund, convertible rights, put options). Bond holder rights take value 1 if all bonds include at least one of the embedded options. The proportion of firms issuing with call options is shown for comparison purposes –it is not a signal of informational asymmetries.

3.4. Empirical evidence

Chart 3 plots the density function of a number of variables for different types of firms: firms with access to global bond market; firms issuing debt only in the Eurobond market and firms issuing debt only in the US144A market.

Chart 3. Kernel density function estimation



Source: Bloomberg and own calculations.
Note: Global: firms with access to Global market. Eurobond: Firms only issuing Eurobonds. US144a: Firms only issuing US144a bonds. Charts show estimated kernel density functions for different periods. We use the "Epanechnikov" kernel function and the "optimal" window width (the one that minimizes the mean integrated square error). Robustness checks using different kernel functions and window widths show similar qualitative results. To control for the potential influence of outliers, we exclude observations in the 1% from upper and lower tails of the distribution.

Visual inspection suggests that firms with access to global bond markets are larger, have a better ratio of fixed assets to total assess and issue at longer maturities. These firms also have better interest coverage ratios and larger ROA. Firms issuing only in the Eurobond market are smaller and have lower ratio of fixed assets than those in the US144A market. Issuers of Global bonds tend to be more profitable (higher ROA), and have a better interest coverage ratio; while its median leverage its very similar, the distribution suggests tail risks are stronger in firms issuing in US 144A or Eurobond markets. In unreported results, we use tests for stochastic dominance which confirm that the distributions are different, and in accordance with theoretical predictions.

To investigate if these variables determine firms' choices, we estimate a multinomial logit model. The results –not reported- support that low ability to cope with the costs of complying with regulation, and informational asymmetries, make firms less likely to issue in the global bond market. Firms issuing in the Eurobond market are, compared to firms issuing in the US144 market, less likely to be cross-listed in the US through ADR, and are comparatively more opaque; this suggests they exhibit higher asymmetries of information, and might find binding the requirements of the Rule 144A[9]. To gauge the importance of the results, in table 6 we report the average marginal effects computed with the estimated parameters, of one standard deviation in the continuous variables, and one unit change in the binary variables.

Table 6. Average Marginal Effects

	Global	US 144A	Eurobond
Total Assets	3.15%	1.60%	-4.74%
	0.05	0.29	0.01
Term	2.24%	1.30%	-3.54%
	0.00	0.22	0.01
Local GAAP	-5.35%	3.26%	2.09%
	0.00	0.26	0.49
ADR	4.37%	1.23%	-5.61%
	0.00	0.60	0.03
MOVE Index	1.22%	1.89%	-3.11%
	0.20	0.11	0.02
Rated Security	7.19%	13.78%	-20.97%
	0.00	0.00	0.00
Bond Holder Right	-5.25%	5.54%	-0.29%
	0.01	0.10	0.94
Market Based	-4.07%	1.83%	2.24%
	0.02	0.44	0.42
Fixed Assets to Total Assets	0.65%	-0.09%	-0.57%
	0.48	0.94	0.66
Altman score <1.21	2.09%	8.51%	-10.60%
	0.33	0.01	0.00
Baseline Values	8.05%	14.67%	77.28%

Note: marginal effects computed on binary changes in categorical variables; and one-standard deviation in continuous variables.p-values of the test change is 0 reported below the marginal effects. We compute the Altman score for private companies; in the analysis we use a dummy taking value 1 if it is in the distress zone (below 1.23). Market based is a dummy taking value 1 for years after 2009 (post-crisis period). MOVE index shows the average value of the index in the 20 days before the issuace.

An increase in total assets increases the chances of issuing in the global bond market (+3 pp), relative, in particular, to the Eurobond market (-4.7 pp). Firms cross listed in the US, and reporting with US GAAP or equivalent, are 4 and 5 pp more likely to issue in the Global bond market. We find as well that if firms do not rated their bonds, the chances that they issue in the Eurobond market increases substantially (+20 pp), relative to the other two markets (where chances of issuing in the Global and US144A markets decrease in 7 and 13 pp , respectively).

[9] This is consistent with anecdotal evidence among firms issuing corporate infrastructure bonds (see Ehlers,T., F. Packer, and E. Remolona (2014))

After the crisis, the chances of issuing in the Global market have decreased (-4 pp), relative to the US144A or Eurobond market. Finally, it is worth mentioning that having an Altman score in the distress zone (i.e., below 1.23, the threshold suggested) increases the chances of issuing in the Eurobond market.

Overall, results suggest that firms issuing global bonds can cope better with demanding regulatory requirements, and are less opaque. Firms issuing in the Eurobond are set apart from issuers in US institutional market by their lack of US footprint, and opacity; though, the Altman score suggests their balance-sheets are sounder.

4. Conclusions

The transition towards market-based finance is one of the current defining features of the global financial system. The new statistics on debt securities have highlighted a number of features of the process, and opening relevant questions.

In this paper we have used matched firm-bond level data to investigate a specific issue: the credit risks of firms borrowing in international bond markets. We find that there is a bifurcation bifurcation in bond markets by credit quality. Larger and less opaque firms issue in the Global bond market. Issuers in the US 144A are comparatively smaller and less likely to prepare their financial accounts with accounting principles different from IFRS or US GAAP. Compared to the latter, issuers in the Eurobond market have less US footprint, and more opaque. This is underscored by the low proportion of these firms which are cross-listed with ADR in the US. The low proportion of firms which rates their bonds underscores these firms are less amenable to arms' length financing, suggesting higher informational asymmetries.

Overall, the analysis underscores the interest in using microeconomic data to zoom into topics of specific interest. Matching firm data with information on their funding patterns is helpful to understand real-side implications of financing patterns.

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Shadow banking: Some considerations for measurement purposes[1]

Anna Maria Agresti, European Central Bank

[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 or the central banks and other institutions represented at the meeting.

Shadow banking: Some considerations for measurements purposes.

Anna Maria Agresti[1]

Abstract

There in an increasing interest in shadow banking and in the way it can be measured and monitored. This requires a better understanding of the information available at both the micro- and at the macro-level, taking as an example the "macro-mapping" exercise as recommended by the Financial Stability Board. While there are still several open issues in the development of a framework for shadow banking and its definition, some general methodological considerations might be made on the use of macro data for measurement purpose.

This paper provides an overview of important aspects that need to be taken into account in addressing measurements issues for the shadow banking focusing on the use of aggregate data. The paper is structured as follow. First, it presents the macro approach and advantages and the limitations in using aggregate data for shadow banking purposes. Second, in sections two and three it sets out how the determination of a perimeter of the shadow banking is strongly related from a micro prospective to a better understanding of the regulatory and the accounting framework. It also highlights how these aspects might pose additional challenges in using aggregate data for measurement purposes

The paper concludes, in section four, by explaining how the usage of granular data and supervisory data might reduce some information gaps between the micro and macro approach.

Section 1: Macro measurement framework, availability of data and future challenges.

1. The size of the shadow banking system and its relative riskiness varies depending on the defined perimeter[2], whereby the identification of an appropriate definition and its implementation in an appropriate framework and within a defined perimeter are substantial and sensitive issues. The perimeter of shadow banking as broadly defined[3], *credit intermediation performed outside the traditional banking system*, needs to be addressed under a dual prospective: the macro and micro one. The macro prospective is mostly utilised for

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2 There are several definitions of shadow banking. For a summary table see *The Deloitte Shadow Banking Index: Shedding light on banking's shadows*, page 15 (www.deloitte.com/us/shadowbanking).

3 FSB definition. *Financial Stability Board (2011a), Shadow Banking: Scoping the Issues. A Background Note of the Financial Stability Board, 12 April.*

monitoring and macro-prudential policy purposes. For a quantitative assessment of the perimeter and risk indicators for shadow banking, some relevant work has been undertaken at international and European level[4] making use of the aggregate statistical data from National Accounts[5]. From the micro prospective, shadow banking analysis implies to identify and analyse the risk characteristics of entities and activities that are de facto outside both the regulatory banking perimeter and out of scope of any supervisory requirements.

2. The FSB's broad definition of the shadow banking system refers to "*the system of credit intermediation that involves entities and activities outside the regular banking system*". More precisely, according to the FSB, "*this implies that credit intermediation takes place in an environment where prudential regulatory standards and supervisory oversight are either not applied or are applied to a materially lesser or different degree than is the case for regular banks engaged in similar activities*" . In its 2013 shadow banking monitoring report, the FSB made a first attempt to narrow down the broad measure filtering out "non-bank financial activities that have no direct relation to credit intermediation (e.g. equity investment funds) or that are already prudentially consolidated into banking groups". In particular, the FSB excluded (i) OFIs that are consolidated into (domestic) banking groups; (ii) securitisation without credit risk transfer from the banking system (retained securitisation mainly used to create collateral for central banks' refinancing operations); and (iii) equity funds as they do not contribute directly to credit intermediation.

3. Based on the FSB broad definition of the shadow banking system[6], a first broad proxy for the perimeter of shadow banking has been constructed at European level by adding the European System of Accounts (ESA 2010) sector comprising "non-monetary financial intermediaries other than insurance corporations and pension funds" (basically OFIs) to "MMFs". Accordingly, this metric provides for an assessment of the broad scale and trends of the shadow banking system, and enables to focus on more specific types of shadow banking entities, in so far as data are also available for the more granular classifications. The European Systemic Risk Board's Joint ATC-ASC Expert Group on Shadow Banking (JEGS)[7] has further elaborated on the FSB[8] framework proposing risk indicators constructed for the subsector of OFIs[9]. Based on these risk

[4] See work of ESRB's Joint ATC-ASC Expert Group on Shadow Banking (JEGS) and FSB. At the European level, the JEGS whose mandate also comprises the development of a monitoring framework for the European shadow banking system. The expert group delegated this work to the Task Force on Risk Metrics made up of members of the expert group. This report presents the status quo of the on-going development of the approach and first results for the European Union. The ESRB's Joint ATC-ASC Expert Group on Shadow Banking (JEGS) was constituted in autumn 2013

[5] ESRB's Joint ATC-ASC Expert Group on Shadow Banking (JEGS) the Task Force relied on financial sector data published by the ECB for the euro area.

[6] The FSB takes a two-step approach in defining the shadow banking system: a wider definition for "casting the net wide" (*the system of credit intermediation that involves entities and activities outside the regular banking system*) and a narrower one for evaluating regulatory options (*focusing on those entities and activities raising systemic concerns owing to maturity/liquidity transformation and/or leverage and/or showing indications of regulatory arbitrage*). See FSB (2011a).

[7] See above note 3.

8 Financial Stability Board http://www.financialstabilityboard.org/

[9] ESRB's Joint ATC-ASC Expert Group on Shadow Banking (JEGS)the Task Force relied on financial sector data published by the ECB for the euro area and, with some limitations, for non-euro area EU countries. "ECB data" (as it will be referred to in this paper) includes monthly or quarterly balance sheet statistics for MFIs (including MMFs), non-MMF investment funds (by investment policy), and FVCs. These monetary statistics are collected in accordance with ECB statistical regulations which provide a harmonised approach to sector and instrument classifications. ECB statistics are also published on insurance corporations and pension funds under a short-term

indicators and also within the parts of the broad measure more directly linked to financial activities, distinctions has been made by the JEGS Task force with respect to the degree of "shadow banking" attributes and risks. Using the risk metrics framework, together with other available information, the Task Force carried out an assessment of the engagement of types of entities in shadow banking risks. However, the Task Force (JEGS) did not undertake any narrowing down to exclude entities consolidated in banking groups, as this micro approach suggested by EBA[10] is still difficult to implement due to the absence of a complete list of entities not consolidated (as it will be clear later), also due to the data gaps, and different regulatory frameworks, as explained below.

4. While the broad definition and macro measure for shadow banking developed by the FSB and also utilised by the ESRB's JEGS, might be a useful proxy for determining the size of shadow banking, there are several shortcomings in using aggregated data from National Accounts (European System of Accounts at European level) [11]. First there is large part of assets in the non-bank financial sector that cannot be classified according to the ESA sub-sectors breakdowns (so called problem of residuals). Second national accounts data are based on residency framework, this implies the exclusion of the cross border component, aspect this that is becoming very relevant in the shadow banking. Third, there are still limitations in the coverage and breakdowns of some types of entities (i.e. other than funds and securitisation vehicles) and in the granularity of data for some instruments (in particular to allow a thorough analysis of liquidity and maturity transformation) in a European context[12]. Fourth, while in the total OFIs sector, Investment fund (IFs) and FVCs are published by the ECB, since December 2009 and December 2010 respectively based on ECB regulations, data on Security and derivative dealers (SDDs), Financial corporations engaged in lending (FCLs), are not yet published. Furthermore, there is a residual part of the OFI sector that is not covered by detailed balance sheet statistics. This "residual" is significant and it is estimated to be 44% of OFIs. While some work has been done in LU in classifying the entities, considering that the largest share in terms of OFIs' assets sub-categories is observed for Specialised Financial Corporations (other OFIs financial intermediaries)[13], additional work needs to be done also in the other member states were large share of residual is observed.

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approach based on the best available (mainly supervisory) national sources. Almost all of these ECB data used are publicly available, in many cases also at the national level, while some are not published. For OFIs other than investment funds and FVCs, only incomplete and unpublished information are collected for securities and derivatives dealers (SDDs) and financial corporations engaged in lending (FCLs). The remaining part of the OFI sector is uncovered by detailed balance sheet statistics

[10] See following section for the development of shadow banking entities consolidated in the banking group .

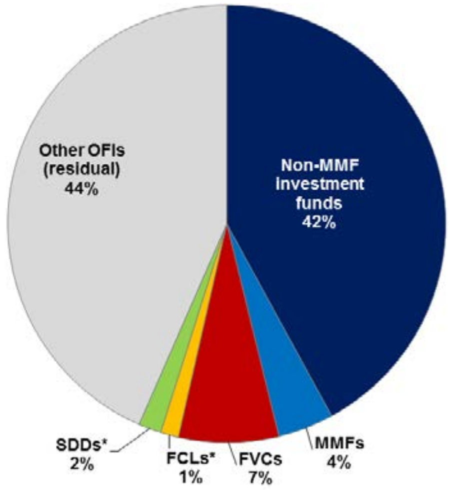
11 The European System of National and Regional Accounts (ESA 2010) is the newest internationally compatible EU accounting framework for a systematic and detailed description of an economy. It will be implemented as from September 2014; from that date onwards the data transmission from Member States to Eurostat will follow ESA 2010 rules. The ESA 2010 was published in the Official Journal as Annex A of Regulation (EU) No 549/2013. The present document contains the complete text of Annex A of Regulation 549/2013 and offers several additional features like an index, hyperlinks and an easy to read two-column layout.

http://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-02-13-269

[12] An assessment of data gaps was also made by the JEGS.

[13] According to ESA 2010, Specialised financial corporations are financial intermediaries, for example: (a) venture and development capital companies; (b) export/import financing companies; or c) financial intermediaries which acquire deposits and/or close substitutes for deposits, or incur loans vis-à-vis monetary financial institutions only; these financial intermediaries cover also central counterparty clearing houses (CCPs) carrying out inter-MFI repurchase agreement transactions

Chart 1: Breakdown of euro area investment funds and OFIs by type, Q1 2015 total assets



Source: ECB

Note: The "residual" represents the part of the euro area OFI sector for which ECB monetary data on balance sheets are not collected. Data for the total OFI sector are sourced from flow of funds statistics. (*) denotes incomplete coverage in the euro area.[14]

5. Another reason, to use aggregate data for the macro assessment only with some caution, is that the statistical breakdown is sector and domestic residency based and not based on a risk framework. National account data are not cross border consolidated, while shadow banking has a relevant component in transferring the risk cross borders and the on-going statistical framework is not adjusted for that.[15] Finally, the framework constructed with the aggregated data still has relevant data gaps for the construction of risk metrics, as concluded by an ESRB assessment[16] of the shadow banking data gaps. According to the ESRB analysis data on some activities particularly on liquidity transformation are still missing. Data covering S.126 (Financial auxiliaries) and S.127 (Captive financial institutions and money lenders), SDDs and FCLs are not publishable for the euro area[17]. Finally, as the regulatory regime plays an important role in

[14] Part of the residual indeed might be now counted in the Specialised financial corporations as some other EU countries like NL where Special Financial Institutions (SFIs) , as part of the Captive financial Institutions and money lenders (S.127) , represent an important feature of the remaining old OFI sector (according to ESA95 named S123).

[15] To this aim, the BIS work on national global consolidation is working on that . Arriving at a proper monitoring and measuring of cross-border exposures of financial and non-financial corporations, including foreign exchange and derivatives exposures, requires the measurement of financial positions and transactions on a globally consolidated basis. This approach would need to complement, and be articulated with, the SNA framework. That necessitates the combination of existing business accounting, supervisory and statistical standards and practices. BIS; Consolidation and corporate groups: an overview of methodological and practical issues *Prepared by a Task Force of the Inter-Agency Group on Economic and Financial Statistics Forthcoming October 2015 https://www.bis.org/ifc/publ/iagrefdoc-oct15.pdf*

[16] ESRB assessment on shadow banking is expected to be published in the 2016.

[17] Under the "short-term approach", that is the basis of data available at the national level, data on Security and derivative dealers (SDDs), and Financial corporations engaged in lending (FCLs), are collected covering for the SDDs only the main asset and liability aggregates and no further additional breakdown is reported to the ECB. With the respect to the FCLs, the data are broadly available the following items: detailed breakdowns for assets (i.e. loans counterpart sector) and liabilities. For the other OFIs (including Financial Holdings Corporations, FHCs) only the total assets/liabilities are collected.

ensuring consistency in the definition and quality of the data, there are still different regimes among the euro area, which imply not harmonized data.

In conclusion, while the use of aggregated data might be useful for macro-prudential policy and for monitoring purposes, there are still some limitations and shortcomings in making use of these data. Furthermore, definition and perimeter of shadow banking will need to take into account to the regulatory framework and consolidation of the entities to be consistent with the micro approach, these will pose additional challenges in the use of aggregated data for measurement purposes, as it will be clear in the next section.

Section 2: Perimeter of shadow banking: the micro measurement

6. The perimeter and the definition of shadow banking involve also a micro dimension, mostly based on the regulatory regimes of the different entities. While from a macro prospective, the FSB and JEGS exercises required a mapping of the aggregated data with the list of entities and activities "*that undertake credit intermediation outside the regular banking system*", from a micro prospective, the mapping of shadow banking implies to identify and specify the criteria according by which a credit institution is defined, and to list which entities and activities are *de facto* outside both the regulatory banking perimeter and out of scope of any supervisory requirements[18]. The aim of this section is to highlight how the available aggregated statistical data might not be fitted for this micro approach.

7. One relevant on-going data initiative on shadow banking at the micro level is the EBA collection of data on banking large exposures to shadow banking. In this regard, EBA noted in its Guidelines[19] that, in the absence of a definition in the CRR of the terms 'shadow banking entities', 'banking activities' and 'regulated framework', for the purposes of the Guidelines, shadow banking entities should be based on the two following criteria, : 1) entities that carry out credit intermediation activities, defined as bank-like activities involving maturity transformation, liquidity transformation, leverage, credit risk transfer or similar activities; and 2) entities that are not within the scope of prudential consolidation[20] nor subject to solo prudential requirements under specified EU legislation (or equivalent third country legal frameworks). Furthermore, EBA also excludes from the scope of the definition entities, which are subject to an appropriate and sufficiently robust prudential framework, considered to be equivalent to that applied in the Union. In particular, the Guidelines make clear that entities carrying out one or more of the activities listed in the *Annex 1 of the CRD shall* [21]be

[18] From a micro-prudential perspective, shadow banks are generally not subject to prudential regulation (or are not subject to the same standards of prudential regulation as core regulated entities such as institutions), do not provide access to deposit guarantee schemes to investors, and do not have access to central bank liquidity. See EBA. Draft EBA Guidelines on limits on exposures to shadow banking entities which carry out banking activities outside a regulated framework under Article 395 para. 2 Regulation (EU) No. 575/2013 https://www.eba.europa.eu/documents/10180/1019894/EBA+CP+2015+06+(CP+on+GL+on+shadow+Banking).pdf

[19] Guidelines are the ones "*Proposing criteria to set limits on EU institutions' exposures to shadow banking entities"*

20 This criterion is is still being debated at the international level mostly due to the different regulatory settings and the data gaps

[21] See Annex 1 of the CRD ,DIRECTIVE 2013/36/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC

http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32013L0036&from=EN

automatically regarded as carrying out credit intermediation activities. The second part of the definition of shadow banking entities for the purposes of the Guidelines exclude certain entities that are subject to an appropriate and sufficiently robust prudential framework. As regards investment funds, notwithstanding the regulatory, EBA proposes that all money market funds (MMFs), regardless of whether they operate under the rules of Directive 2009/65/EC[22], should fall within the scope of the definition of shadow banking entities for the purposes of these Guidelines[23].

8. Further work on shadow banking undertaken by the EBA mostly focuses on the interpretation of the term 'credit institution' in the Capital Requirements Regulation (CRR) and the prudential treatment of those entities established in the Union which carry on credit intermediation but are not 'credit institutions'. A 'credit institution' is defined in the CRR as 'an undertaking the business of which is to take deposits or other repayable funds from the public and to grant credits for its own account'. In the report[24], the EBA observes that there is a degree of variation across EU Member States as to the interpretation of the term 'credit institution' and also observes that there is wide variation between the Member States as to the prudential treatment of entities established in the Union which carry on bank-like activities within the scope of credit intermediation but are not subject to solo prudential requirements under relevant Union measures[25]. Finally, the EBA observes that any future work in relation to the shadow banking sector should take account of the need to ensure that the perimeter of credit institutions is clearly defined. And this is line with the sector classification of the National accounts.

9. The EBA in setting the above tentative definition of shadow banking entities and in linking the shadow banking sector with the perimeter of credit institutions, is initiating a micro framework that might imply some differences with the current macro framework and might pose furthermore challenges to the use of the macro data for the measurement purposes and for comparability of the data. In first instance, the EBA takes the stance that if entities are consolidated in credit institutions, their assets should be excluded from shadow banking, while the aggregate data[26] used for the macro risk assessment (perimeter and indicators) do not distinguish the two components, consolidated and unconsolidated parts. Second, this criterion has not yet been agreed at international level and data gaps show the difficulty in building up the perimeter and risk indicators for the unconsolidated part. Third, regulatory requirements for shadow banking entities prudentially consolidated within banking groups might be different and less stringent than for banks, reason this for potentially not excluding these entities from the shadow banking. Furthermore in order to exclude entities subject to an appropriate and sufficiently robust prudential framework, more comparability between regulatory requirements is required. And in order to overcome the present challenges to ensure more comparability, on-going exercises are in place at the Basel Committee on Banking Supervision (BCBS) and at the European Banking Authority (EBA), which aim at ensuring the consistency of the consolidation perimeter of banks' balance sheets. Both initiatives BCBS and EBA might have implications for

[22] UCITS – Undertakings for the collective investment in transferable securities

[23] The inclusion of the MMF in the shadow banking is similar to the the macro approach of ESRB JEGS and FSB.

24 EBA Report to the European Commission on the perimeter of credit institutionse stablished in the *Member States*

https://www.eba.europa.eu/documents/10180/534414/2014+11+27+-EBA+Report+-+Credit+institutions.pdf

[25] The EBA observes that there may be merit in the Commission conducting or commissioning further analysis of the sector to determine whether it would be appropriate to put forward any Union legislative proposals with respect to some or all such entities

[26] See note 5 on the use of national accounts data.

the macro prospective . Fourth, as there is not yet an agreements on the list of shadow baking entities that are deconsolidated from accounting principle and not captured in the regulatory framework according to the Basel and accounting framework[27], divergences among the jurisdictions makes difficult to use the aggregated data for comparative purposes. In conclusion, while the EBA micro-prudential criteria might pose additional challenges to the measurement of shadow banking with the available macro data, as the aggregate data of OFIs are available without any distinguish of the unconsolidated part and on the regulatory framework among the entities. In this respect, the use of granular data from supervisory sources for shadow banking purposes might reduce the information gap, between the micro and macro approach.

Section 3: The accounting perimeter and the consequences for the shadow banking

10. The definition of the perimeter of shadow banking from a micro prospective, while still being under development, appears in any case to heavily depend on the regulatory setting. In most jurisdictions the starting point for the determination of the regulatory scope of consolidation is the accounting scope; adjustments are then made to accounting scope to arrive at the regulatory scope[28], the link between the two scopes of consolidation is important. Hence, understanding the banking regulatory scope[29], depends to a large extent on having an understanding of the accounting scope. The aim of this section is to investigate whether the application of new IFRSs 10[30] *(Consolidated Financial Statements*) and 12[31] (*Disclosure of Interests in Other Entities*) might imply some potential changes in the perimeter of shadow banking. In particular, this section in exhibiting how the accounting consolidation scope and disclosure information might represent a challenge in measurement of the shadow banking perimeter and how these aspects might not be captured by the aggregate statistics.

11. IFRS 10 (which replaces IAS 27)[32] establishes new principles for the presentation and preparation of consolidated financial statements when an entity controls one or more other entities. The

[27] See next section

[28] As mentioned above, the Basel Committee's work points out there are still differences between the accounting and regulatory perimeter as well as in the definition of some legal commercial entities, and activities should rather be ascribed to the financial institutions performing them, and thus subject to consolidation, rather than as a commercial entity and consequently excluded. Consequently it is worth understanding how these differences might affect the shadow banking measurements.

[29] As it has been underlined by EBA work on the perimeter of shadow banking, this depends also on the way it is defined the perimeter of banking institutions.

[30] IFRS 10 *Consolidated Financial Statements* outlines the requirements for the preparation and presentation of consolidated financial statements, requiring entities to consolidate entities it controls. Control requires exposure or rights to variable returns and the ability to affect those returns through power over an investee.

IFRS 10 was issued in May 2011 and applies to annual periods beginning on or after 1 January 2013.

[31] IFRS 12 *Disclosure of Interests in Other Entities* is a consolidated disclosure standard requiring a wide range of disclosures about an entity's interests in subsidiaries, joint arrangements, associates and unconsolidated 'structured entities'. Disclosures are presented as a series of objectives, with detailed guidance on satisfying those objectives. IFRS 12 was issued in May 2011 and applies to annual periods beginning on or after 1 January 2013.

[32] International Accounting Standards Board (IASB) adopted IAS 27 Consolidated Financial Statements and Accounting for Investments in Subsidiaries, which had originally been issued by the International Accounting Standards Committee in April 1989. IAS 27 replaced most of IAS 3 Consolidated Financial Statements (issued in June 1976).In December 2003, the IASB amended and renamed IAS 27 with a new title—Consolidated and

IFRS 10[33] defines the principle of control and establishes control as the basis for determining which entities are consolidated in the consolidated financial Statements. The IFRS also sets out the accounting requirements for the preparation of consolidated financial statements. New definition of control is based on: "An investor controls an investee when it is exposed, or has rights, to variable returns from its involvement with the investee and has the ability to affect those returns through its power over the investee". In particular, three are the elements of the definition of control (IFRS 10.7),1)power over an investee 2)exposure, or rights, to variable returns from an investee and 3)ability to use power to affect the reporting entity's returns.

12. One important consequence is that, where a bank has a risk exposure (eg reputational risk) but no power to direct the activities of the entity, it is not consolidated for accounting purposes (although separate disclosure requirements exist).While some first impact assessment studies show that some banking groups will not have a significant change in the banking consolidation perimeter, initial concerns started to emerge considering that in general terms, the application of the IFRS 10 might imply a reduction of the accounting perimeter. As matter of fact, the new IFRS 10 principle is only based on control and the ability to control relevant activities and replace the SIC 12 "risks and rewards" approach[34]. This will imply that the deconsolidation of the some entities might reduce the banking accounting perimeter having potential implications on shadow banking[35]. Furthermore, different applications of the IFRs at European level among the Member states might have potential consequence in the in the cross comparability of the banking financial information. [36]

13. According to the IFRS 12, an entity shall decide, in the light of its circumstances, how much detail it provides to satisfy the information needs of users, how much emphasis it places on different aspects of the requirements and how it aggregates the information, also for the unconsolidated entities. The entity shall present the disclosures in a manner that clearly explains to users of financial statements the nature and extent of its interests in those other entities. However, it will be not requested the disclosure of the name of the entity, creating areas of

Separate Financial Statements. The amended IAS 27 also incorporated the guidance contained in two related Interpretations (SIC-12 Consolidation-Special Purpose Entities and SIC-33 Consolidation and Equity Method—Potential Voting Rights and Allocation of Ownership Interests).

[33] Comparing IFRS 10 with the standard that it replaces (IAS 27), it should be noted that: It establishes a single control model which applies to all entities, ie "traditional entities" as well as "structured entities" and it substantially converges with the US GAAP approach to consolidation, in particular because, for structured entities, it is no longer based on risks and rewards but rather on the combined assessment of control and returns.

[34] SIC takes a broder view . It requires and evaluation of every entity for the controlling party.

[35] In this line, is the opinion of Banca Italia, according to which the new IFRS 10 replacing part the IAS 27 and SIC 12 might imply for a reduction the accounting perimeter. See also C. Calandrini *Consolidated Financial statements: fu vera gloria? IFRS 10, the key issues of accounting and disclosure standards.* Bancaria n172013 IFS 10 Rome 2013

[36] Some first analysis in the work of JEGR on the usage of the IFRS and the use of FINREP in the European countries[36], have pointed to some different application among the countries. As matter of fact, the use IAS/IFRS as the basis for prudential reporting provides scope for further alignment of supervisory and financial reporting and ultimately for harmonization of the prudential reporting frameworks within the European Union, such as to avoid divergences and increase clarity in the reporting. The eventual further harmonization might imply some reduction in accounting and regulatory arbitrage among the European countries As in some jurisdiction the regulatory scope might be in line with the accounting scope [36]. Their different applications might have potential consequence in the opacity of the information in the banking financial intermediation and in the in the cross comparability also of the shadow banking activities. Please see the work of the Joint Expert Group on Reconciliation of credit institutions' statistical and supervisory reporting requirements MFI balance sheet and interest rate statistics and EBA guidelines on FINREP and COREP/large exposures, ECB may 2012 JEGR)

https://www.ecb.europa.eu/pub/pdf/other/mfibalancesheetinterestratesstatisticsebsguidelines201203en.pdf differences between the accounting and the Basel recommendations. In nutshell, according to the IFRS 12 it will be possible not to show the list of unconsolidated entities, but only their aggregation according to their industry level or nature of activity, without any specific list of the entities left out of the accounting scope[37].

14. In conclusion, reducing the information disclosures and increasing the entities outside the accounting scope and potentially not captured by regulatory frameworks, might imply some further reduction of information not captured by the available aggregate statistics. While it is still not clear cut how these new standards will in principle affects the current statistical classification, aggregated data will not be able to capture the changes of the allocation of entities between the accounting and regulatory perimeter. In this respect, also a recent ECB survey[38] failed to assess the quantitative difference between the accounting and regulatory perimeter with the aggregated data.

BOX: Differences of accounting and regulatory perimeter: consequences for the shadow banking

According to the on-going work of Basel Committee's Macroprudential Supervision Group (MPG) "Scope of consolidation"[39], it can be observed that there are hundreds of legal entities that are deconsolidated for regulatory capital purposes but not for accounting purposes[40]. Furthermore, there are two key relevant aspects in the Basel Committee's standards on scope of consolidation: (1) the types of entities that are required to be consolidated for regulatory purposes (referred here as the "covered entities"); and (2) the "threshold of consolidation". While Committee's standards list the

[37] Some information can be obtained from Paragraph 16 of the Basel Committee's composition of capital disclosure standards according to which banks are required to disclose the list the legal entities that are included within accounting scope of consolidation but excluded from the regulatory scope of consolidation. http://www.bis.org/publ/bcbs221.pdf. In fact, according to Paragraph 16 of the Basel Committee's composition of capital disclosure standards of Inadequate implementation of public disclosure requirements includes the following requirement: "*banks are required to disclose the list of the legal entities that are included within accounting scope of consolidation but excluded from the regulatory scope of consolidation*. The above disclosure requirements could be likely produce a rich set of granular information that could be used to analyse the differences in the scopes of consolidation for accounting and regulatory purposes. However, it seems that many jurisdictions have not yet implemented the requirements.

[38] WGMFS survey on the Survey questionnaire on Shadow Banking entities: accounting versus regulatory perimeter . Frankfurt 2015

[39] Basel the Macroprudential Supervision Group (MPG) is looking into the divergency of scope of prudential consolidation and the accounting standard sets some relevant conclusions that can help us to understand the issue. In particular See FSB" Strengthening regulation of the shadow banking system "*The BCBS also continues to work on reviewing the scope of consolidation for prudential regulatory purposes with a view to developing guidance for public consultation by end-2015 to ensure that all banks' activities, including interaction with the shadow banking system, are appropriately captured in prudential regimes*.

http://www.financialstabilityboard.org/wp-content/uploads/Overview-of-Progress-in-the-Implementation-of-the-G20-Recommendations-for-Strengthening-Financial-Stability.pdf

[40] The majority of these entities seem to be various types of securitisation vehicles. Whether securitisation vehicles are deconsolidated from the regulatory balance sheet could have a material effect on the consistent application of these other standards across jurisdictions is still under investigation

entities to be consolidated within the regulatory scope[41], at same time the Basel framework endorse the deconsolidation of commercial entities (or *non-financial entities*)[42]. For example, some of the following types of entities were listed, by at least some of the G-SIBs, being excluded from the regulatory scope of consolidation: i) Asset management companies and investment vehicles, including venture capital companies, bank employee pension/investment management. ii) Property management companies (including some that appear to be managing properties that have been repossessed by the bank and others that act as property leasing companies). iii) Trade finance companies and factoring companies. iv) Stockbroking companies and entities providing investment banking services. However, according to the Basel paper while these results might have some implication for the identifying shadow banking entities, as these will be unregulated entities, it is worth mentioning that is missing at moment an exhaustive comparative study of the different entities consolidated according the two perimeters in the EU jurisdictions. Also the work of the Joint Expert Group on Reconciliation of credit institutions' statistical and supervisory reporting requirements (JEGR)[43] is following the differences consolidation perimeter in the European law [44]and the accounting perimeter[45] . However also in this analysis is missing at moment an exhaustive comparative study of the different entities consolidated according the two perimeters.[46] In conclusion the Basel paper show a large variety of entities included in the accounting scope of consolidation and not in the banking

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[41] Entities to be consolidated within the regulatory scope are Banking entities; Securities entities and other financial entities (as entities involved in "financial leasing, issuing credit cards, portfolio management, investment advisory, custodial and safekeeping services and other similar activities that are ancillary to the business of banking").

[42] However, the Macroprudential Supervision Group (MPG) "Scope of consolidation" is still investigating whether some legal commercial entities and activities should rather be treated as a financial institution, and subject to consolidation, rather than as a commercial entity and consequently excluded.

[43] https://www.ecb.europa.eu/pub/pdf/other/mfibalancesheetinterestratesstatisticsebaguidelines201405en.pdf

MFI balance sheet and interest rate statistics, securities holdings and implementing technical standards on supervisory reporting ECB 2014 may.

[44] REGULATION (EU) No 575/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012

[45] As matter of fact, the approach to prudential consolidation foreseen in the CRR is defined in Article 18, 'Methods of prudential consolidation', require that the institutions that have reporting requirements on a consolidated basis shall carry out a full consolidation of all institutions (credit institutions and investments firm) and financial institutions that are its subsidiaries, or subsidiaries of the same (mixed) parent financial holding company. Article 18(2) of the CRR adds that the business of undertakings providing ancillary banking services and asset management companies should also be consolidated

[46] In practice, for capital requirements purposes, parent credit institutions (or parent financial holding companies) consolidate financial institutions, but not insurance undertakings neither non-financial subsidiaries. Consequently, holdings in these unconsolidated undertakings have to be deducted from Common Equity Tier 1 capital, to ensure that the bank is not bolstering its own capital with capital that is also used to support the risks of an insurance subsidiary. Furthermore, supervisory authorities may require information about these subsidiaries when deemed relevant for the purpose of supervising subsidiaries which are credit institutions (CRD Art. 122(1)), in particular in the context of Directive 2002/87/EC on the supplementary supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate. In addition, for prudential purposes and for the calculation of capital requirements, a credit institution may be required to consolidate the business of a subsidiary of an entity which is not itself included in the group consolidation – for example, an investment firm that is a subsidiary of an insurance corporation (not consolidated) within a group headed by a credit institutionFinally, according to the EU law CRD IV (Directive 2013/36/EU of the European Parliament), the regulatory scope of consolidation includes all financial entities that are majority owned or controlled by banks (with the exception of insurance companies) and these ones are subject to the same prudential requirements that apply to banks, whereas non-financial commercial entities will be excluded

regulatory scope. Result this that need to be taken in consideration for the measurement of the shadow banking according to the micro approach.

Section 4: Different use of granular data[47].

15. While the use of aggregated data points to some limitations for the measurement of shadow banking also for micro perspective, the importance and potential usefulness of granular and supervisory data has started to be stressed by the international community. The aim of this section is to present the ongoing work in the area and to pint to more granular data collection also for the monitoring pf shadow banking. Recently the Office Financial Research (OFR) [48] and the FED are undertaking joint projects aiming in understanding the uses of short term funding and related markets (broker –dealers), linking quarterly data with more granular and frequent data sources and increasing coverage of financial activity represented. Furthermore, some central banks[49] have already started to employed granular data on financial vehicle corporations (FVCs), money market funds (MMFs) and investment funds (IFs). This bottom-up approach facilitates the classification of entities engaged in shadow banking activities – any top-down definition inevitably excludes entities that engage in shadow banking and/or includes some that do not. The use of granular data sheds light on categories, such as hedge funds and exchange-traded funds (ETFs), where there is some debate as to whether they undertake these activities. These results show that shadow banking activity does not fit neatly into the broad categories of published statistical data, as also was commented in the above sections[50].

16. An initial exercise has recently also undertaken making use of granular information on securitisations in Italy, as a large database is available on granular data. The Bank of Italy has historically carried out a close oversight on securitisation transactions by means of different instruments and at present, on supervises servicers and the intermediaries involved in the transactions (originators, swap counterparties, liquidity providers, etc.)[51]. The exercise undertaken in Italy consisted in constructing some risk indicators only for the un-retained part.

[47] Granual data are considered here for the purpose of the paper individual data

[48] Pozsar, Z. (2014), 'Shadow banking: The Money View', Office of Financial Research Working Paper, No. 14/4.

[49] As for example Bank of Ireland

https://www.centralbank.ie/publications/Documents/Measuring%20Shadow%20Banking%20in%20Ireland%20using%20Granular%20Data.pdf

50 Brian Godfrey and Brian Golden " Measuring Shadow Banking in Ireland using Granular Data" Bank of Ireland Quarterly Bulletin 04 / October 12

https://www.centralbank.ie/publications/Documents/Measuring%20Shadow%20Banking%20in%20Ireland%20using%20Granular%20Data.pdf

[51] In Italy, the securitization transactions are regulated by the Italian Securitisation Law, enacted in 1999 (L. 130/99)51. The securitization, Italian structures have only some of the typical characteristics of "shadow banking" (namely they generate non-deposit funded credit, but much less leverage, liquidity and maturity transformation), due to some form of regulation. Furthermore, the Italian legal and supervisory framework has discouraged (though not eliminated) the issuing of the most complex structures, like synthetic CDOs, through the Italian SPVs. At present, the Bank of Italy exerts supervision on servicers (banks or financial intermediaries enrolled in the "Special Register ex art. 107 TUB), which have the legislative duty to check the compliance of each single securitisation with the provisions of the Securitisation Law and with the contents of the prospectus. More importantly, Sivs and Conduits are included in the consolidated accounts of the Italian banks when there is a "legal" or a "substantial" control (according to the accounting principle IAS 27).

In particular, in Italy much of the securitization activity following the crisis has been in retained securitizations. Such a securitization[52], which is not traded between market participants, might be unlikely to foster risks to financial stability and for these reasons in general are to be excluded from the narrow perimeter[53]. Results show some remarkable differences between the risk indicators obtained from the total of the FVCs and the ones with granular data: liquidity and maturity indicators points to some lower quality for the un-retained part[54]. In conclusion, granular data might complete and add the information content of the risk assessment made with aggregated data on the shadow banking.

17. Also additional granular data for the OFI sector, as for example the leverage in the investment fund sector coming from the AIFMD data base, will lead to enhanced data availability from this year onwards, which should improve the monitoring and facilitate empirical work in the investment fund sector with a view to monitoring systemic risks. In particular, limits on the use of leverage are in the UCITS Directive and the AIFMD, where asset managers have to report the leverage of the funds they manage. In both cases, while data on leverage in the investment fund sector are not collected and not yet readily in the official statistics, these will be available in the near future also at micro level. Finally also addition micro data available for the SSM, might shed some light on the shadow banking entities consolidated and the related prudential requirements. Further work in this area is very much encouraged.

Conclusions:

Non- bank financial intermediation and shadow banking is a complex phenomenon from both a micro and a macro measurement prospective. From a macro prospective, the use of aggregate data, the lack of focus of regulatory regime and lack of data on assets consolidation in the banking sector might imply some divergences between the micro and macro approach with potential consequences on some differences in risk measurements. From micro prospective the application of accounting standard and the regulatory framework matters for the determination of the relative size of shadow banking, while the current macro data might not be able to capture these aspects. As the two dimensions (micro and macro) and the relative measure of shadow banking might diverge, the paper suggests as a way forward, to integrate the metrics constructed with aggregated statistical data with the one using granular data. These data might help to better use the information content of the macro framework and overcome some of the limitations in using aggregated data that have been here addressed.

[52] See ECB regulaton https://www.ecb.europa.eu/ecb/legal/pdf/en_02013r1075-20131127-en.pdf

[53]In particular, SPV information are collected and provided by SPV divided by each single operation of securitisation. In order to calculate data for the narrow perimeter of FVC, we subtracted from the entire set of securitization those operations whose securities are held completely (self-securitisation) or partly (not permitting derecognition according to IAS 39 principles at individual bank level).

[54] Additional analysis has been undertaken in terms of outstanding amounts, additional information can be obtained from the ratio of retained debt securities issued and the total in terms of flow. Information expressed in terms of flow will indicate the size of securitization which will be traded between market participants at later stage. In term of flows, results show that Interconnection and liquidity transformation are larger for the FVCs in terms of flow for the not-retained part compared to the respective ones constructed using the outstanding amounts

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Reporting of derivatives transactions in Europe – Exploring the potential of EMIR micro data against the challenges of aggregation across six trade repositories[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 or the central banks and other institutions represented at the meeting.

Reporting of derivatives transactions in Europe

Exploring the potential of EMIR micro data against the challenges of aggregation across six trade repositories[1]

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Abstract

Since February 2014, the European Market Infrastructure Regulation (EMIR) requires all counterparties in the European Union (EU) entering into a derivative contract to report its details to one of the six authorised trade repositories (TRs). Over the first year of reporting, the six TRs have received more than 10 billion of data records and thus represent a very rich source of information for regulators in Europe. However, the decentralized and heterogeneous landscape for this reporting obligation poses significant challenges for data analysis and aggregation. This paper elaborates on these challenges, putting particular emphasis on the lack of common standards, the monitoring of data quality and the need to reconcile the data from the different trade repositories. Furthermore, it also compares aggregates derived from EMIR data with those available from other sources such as the semi-annual OTC derivatives survey run by Bank of International Settlements (BIS).

Keywords: derivatives; European Market Infrastructure Regulation (EMIR); trade repositories; harmonisation.

JEL classification:

1 The authors thank to Julius Cerniauskas and Valeria Uliano for the statistical support and comments in preparation of this paper but the authors remain solely responsible for any remaining errors or omissions.

2 The views expressed in this paper are solely those of the authors and do not necessarily reflect the opinion of the European Central Bank.

Contents

1. Introduction

According to European Market Infrastructure Regulation (EMIR), since 12th February 2014 all counterparties located in the European Union (EU)[3] that enter into a derivative contract have to report the details of the contract to one of six trade repositories (TR) authorised under EMIR. These are (i) CME Trade Repository Ltd. (CME), (ii) DTCC Derivatives Repository Ltd. (DDRL), (iii) ICE Trade Vault Europe Ltd. (ICE), (iv) Krajowy Depozyt Papierów Wartościowych S.A. (KDPW), (v) Regis-TR S.A. (Regis-TR), and (vi) UnaVista Limited (UnaVista). As a result, the data are currently scattered among the six TRs, which embraced different technical solutions for storing, providing and representing the data. Moreover, the data are not standardised and suffer from serious drawbacks in terms of quality.

This decentralized and heterogeneous landscape poses significant challenges to more than 50 regulators in Europe accessing, managing and analysing the EMIR data from the six TRs. Moreover, high data confidentiality causes additional difficulty, restricting the exchange of knowledge gained by individual regulators in handling the dataset.

In this paper, we first describe the main features of the EMIR data (Section 2). Drawing on the experience gathered in the Directorate General Statistics of the European Central Bank (ECB), we elaborate on the challenges in handling these data, putting particular emphasis on the lack of common standards and difficulties in the reconciliation of trades reported to the different TRs – a necessity stemming from the double-reporting obligation under EMIR (Section 3). Furthermore, Section 4 focusses on the monitoring of EMIR data quality from the micro data perspective, while Section 5 takes the macro data view and presents the comparison of the aggregated EMIR over-the-counter (OTC) credit derivatives data with similar data collected through the semi-annual surveys conducted by the Bank of International Settlement (BIS). Finally, Section 6 concludes.

2. Overview of EMIR data

EMIR is a far-reaching reform of the derivatives market in Europe and introduces, inter-alia, a reporting obligation to all counterparties located in EU, which trade a derivative contract. The reporting obligation applies to all types of derivatives contracts – both OTC and exchange-traded derivatives (ETD) on all main five derivatives classes (credit, commodity, equity, interest rates and foreign exchange). Trades cleared via Central Clearing Counterparties (CCPs) are also included.

Around 85 data fields are to be reported for each transaction and they are divided into two groups. The first group contains information on the counterparties involved, which usually remain static over life cycle of a transaction. The second group provides details on the characteristics of the contract (e.g. type of derivative,

[3] This paper focusses on the implementation of EMIR in the EU. EMIR is however an EU legal act marked as European Economic Area (EEA) relevant and currently under consideration for incorporation into the EEA Agreement by Iceland, Liechtenstein and Norway.

underlying, prices, amount outstanding), how/on which venue the contract was executed and/or cleared, valuation and collateral, and life-cycle events (e.g. new contract, modification, termination).

The high granularity in principle allows for the derivation of positions and aggregate data. This process is facilitated by some TRs, which compile and provide regulators with reports that contain all outstanding trades at the end of the day (so called "trade state report"). However, as this report is not mandatorily required from TRs, not all of them provide such report. In such a case, TRs only provide reports with transactions carried out (or modified) on a given day (so called "trade activity reports"). This in turn means that outstanding positions can only be derived by accumulating information on all past trades (and their modifications) from the individual trade activity reports generated since the reporting start.

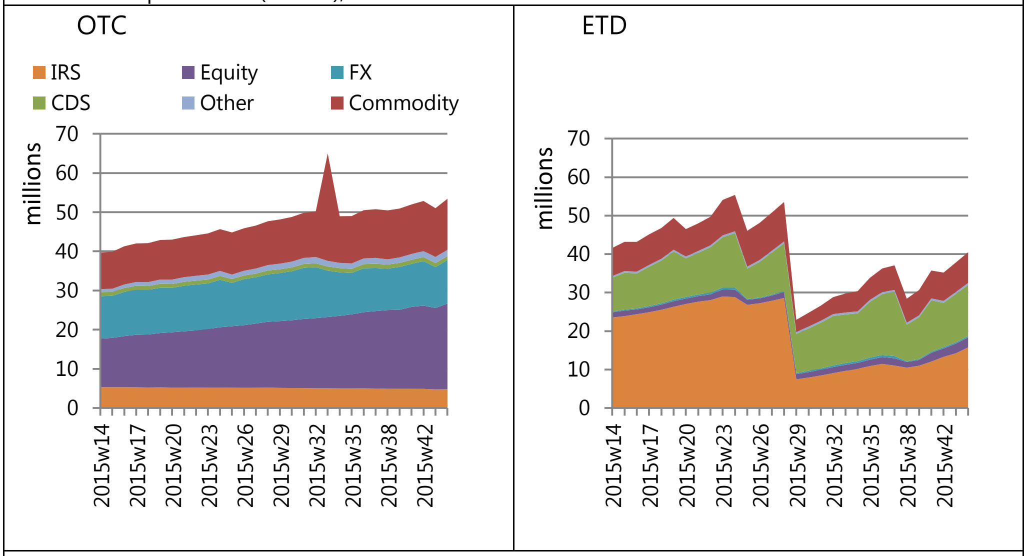
Such a wide-scaled and detailed reporting implies huge data volumes. Over the first year of reporting, almost 10 billion of records were received and processed by the six TRs in Europe according to European Securities and Markets Authority (ESMA), the supervisor of the TRs (ESMA, 2015a). In addition, Figure 1 shows the number of outstanding (open) trades and notional values as obtained from the aggregated EMIR data published on a weekly basis by the six TRs on their websites.

Focussing on the OTC market segment, the number of open trades reaches over 50 million outstanding trades at the end of October 2015. The figures are relatively consistent over time (except for one outlier in OTC commodities in week 33 of 2015). However, this is not the case for notional values, which tend to be very volatile and thus do not seem reliable. They show over EUR 4,000 trillion outstanding in the OTC European market at the end of August 2015, whereas only around EUR 500 trillion are reported in BIS OTC derivatives survey for the global OTC market. The error seems coming from data on FX derivatives in one TR (UnaVista). After removing the transactions from this TR, the total EU OTC market amounts to over EUR 300 trillion, where interest rates derivatives with around 70% represent by far the most important derivative class, followed by FX and equity derivatives (10% each). However, interest rates derivatives tend to be associated with relatively large notional values. Therefore, the distribution among the different asset classes is much more balanced, when considering the number of open trades.

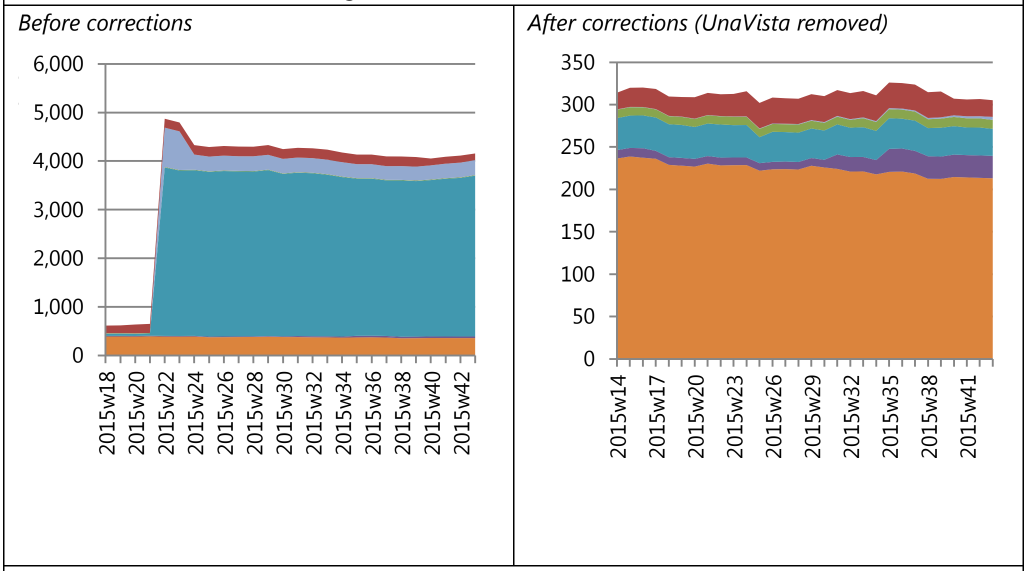
Regarding the ETD market, the time-series constructed from the EMIR public data show a couple of structural breaks and potential outliers. As this impedes for now to draw any conclusions about this market segment, we leave such analysis for further investigations.

Figure 1: Derivatives market in Europe – public aggregates from EMIR data

Number of open trades (million), week 14 to 44 of 2015



OTC market, notional outstanding (EUR trillion), week 18 to 43 of 2015



Note: To avoid double-counting, the figures are calculated as sum of 100% of dual sided and 50% of single-sided trades in each TR (see also Section 5). Notional outstanding before corrections are presented from week 18 to 43 of 2015, given that earlier and later periods contain improbable outliers (sextillion).
Source: Public EMIR data from TRs' websites.

3. Challenge of data scattered across six different TRs

The EMIR legislation and TR supervision do not currently provide a sufficiently detailed and coherent framework to provide regulatory authorities in the EU with standardised high quality data about the derivatives market. Although data quality has been gradually improving, mainly owing to recent steps by ESMA (see Section 4), the heterogeneous landscape in TR data provision and non-standardised data collection pose significant challenges for regulators accessing and analysing the data.

First and foremost, since the EMIR secondary legislation leaves significant room for interpretation of the reported fields, the data are not standardised at the input point, when entered into TRs by reporting agents. In particular, the EMIR reporting relies on concepts such as the Unique Trade Identifier (UTI) and Unique Product Identifier (UPI), which are not yet developed, several reported fields are not accompanied by code-lists (lists of allowed values) and the interpretation of their content raises questions (see ESMA, 2015c). Second, the EMIR framework does not provide any detailed guidance on how the six TRs shall treat, structure and present the collected data. For instance, even the variable names, the number and structure of the data files provided to regulators vary from TR to TR. Moreover, the "trade state report" is not mandatorily required from TRs, though it is a key report for many uses including financial stability. Another level of complexity in EMIR is added by the differences in certain aspects of reporting across EU member states with the remarkable example of the definition of a derivative contract, and consequently what type of transactions should be reported (see e.g. Maxwell, 2014).

A peculiar point in EMIR reporting is the so called 'double reporting obligation', i.e. both counterparties to a derivative transaction have the reporting obligation, if they are located in the EU (while in other jurisdictions one counterparty is usually obliged to report on behalf of both sides to the trade). As a result, trades are frequently reported twice under EMIR (i.e. always when the two counterparts are EU resident), possibly to two different TRs. Hence, any meaningful data aggregation requires the reconciliation of the information between the duplicated trades, which shall in principle rely on the use of a Unique Trade Identifier (UTI), but its definition on a global level is still under development[4]. In the meantime, ESMA put forward temporary guidelines how an interim UTI should be generated (see ESMA, 2015b).

Our results show that the pairing rate is particularly low in case of trades reported to different TRs. Moreover, even if the two legs are paired using an interim UTI, information in the other data fields submitted by the two counterparties very often do not match, which raises the question which of the two to keep in the final database with de-duplicated trades. Even for trades reported to the same TR, there can be significant discrepancies for variables such as execution timestamp, price per contract or notional value.

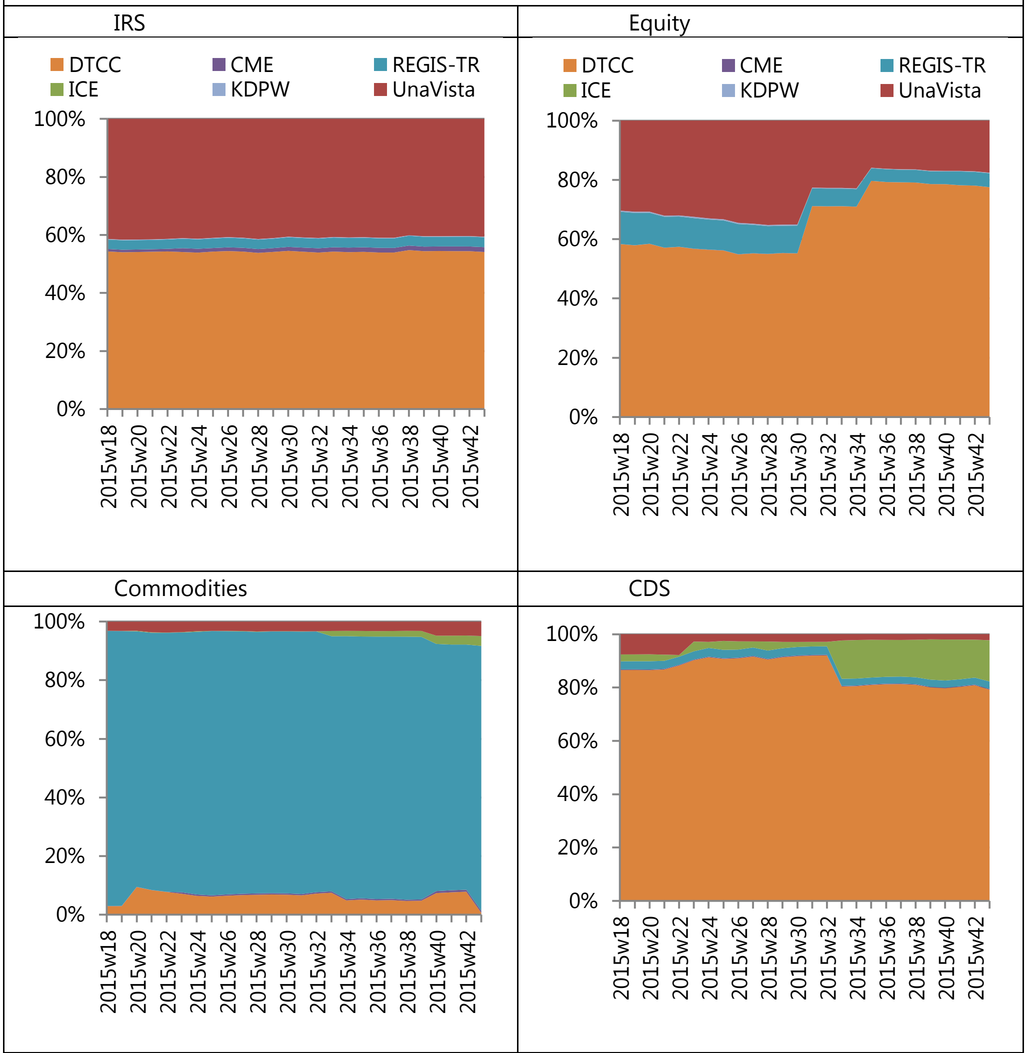
Reconciling and aggregating data across the different TRs may be easier in certain market segments, especially when reporting of a particular asset class is concentrated in one TR. This is the case for OTC credit and equity derivatives, which are reported currently in around 80% (in terms of notional values) to DDRL. Interest rates derivatives are split between DDRL and UnaVista, while commodities are reported mostly to Regis-TR. See Figure 2, which shows the shares of each TR in

[4] The Financial Stability Board (FSB) has asked the Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO) to develop global guidance on harmonisation of data elements that are reported to trade repositories, in particular the UTI and the UPI. It is envisaged that the sub-structure created for this purpose, the CPMI-IOSCO Harmonisation Group, will publish final guidelines on the UTI at the beginning of 2016 (see CPMI-IOSCO 2015a and CPMI-IOSCO 2015b).

terms of notional volumes of outstanding trades on a week by week basis in order to present also the stability of the results over time[5].

Figure 2: Importance of the six TRs in Europe in the OTC market

Notional values as % of total



Note: To avoid double-counting, the figures are calculated as sum of 100% of dual sided and 50% of single-sided trades in each TR (see also Section 5).
Source: Public EMIR data from TRs' websites.

5 With respect to FX derivatives, the reported data indicate that the lion share is covered by UnaVista, however, the figures look unreliable and we do not present it here. The category Other, meaning that the transaction could not have been allocated to any of the above asset classes, is used mostly by UnaVista and to some extent by Regist-TR (also not presented here).

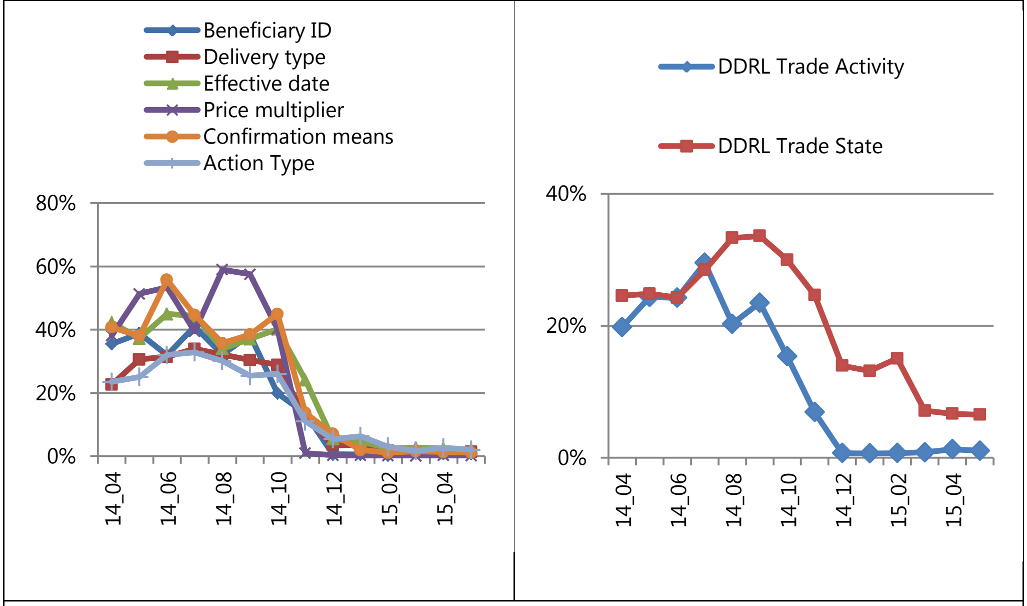
4. Data quality caveats

To monitor the quality of EMIR data, we have developed several checks on the micro-data accessible to the ECB. In particular, we regularly check the number of missing values and the use of the key identifiers such as Legal Entity Identifiers (LEI), interim UTI and International Securities Identification Numbers (ISINs).

The results suggest that the quality of EMIR data was relatively low in the first reporting months, but that the situation has been gradually improving, owing to large extent to ESMA's on-going efforts to improve EMIR data quality. Figure 3 illustrates the significant improvement in the completeness of reported fields in December 2014, after the introduction of ESMA Level 1 validation rules[6]. The number of missing values dropped virtually to zero for the trade activity reports, i.e. reports which contain the current transactions. In the trade state report, which comprises all outstanding trades, part of the dataset remains still with missing values given that the older trades, before the introduction of the validation rules, are not updated.

Figure 3: Data quality checks – percentage of missing values per month

Based on data from four TRs | DDRL – field: Beneficiary ID



Source: EMIR data from four trade repositories available to the ECB.

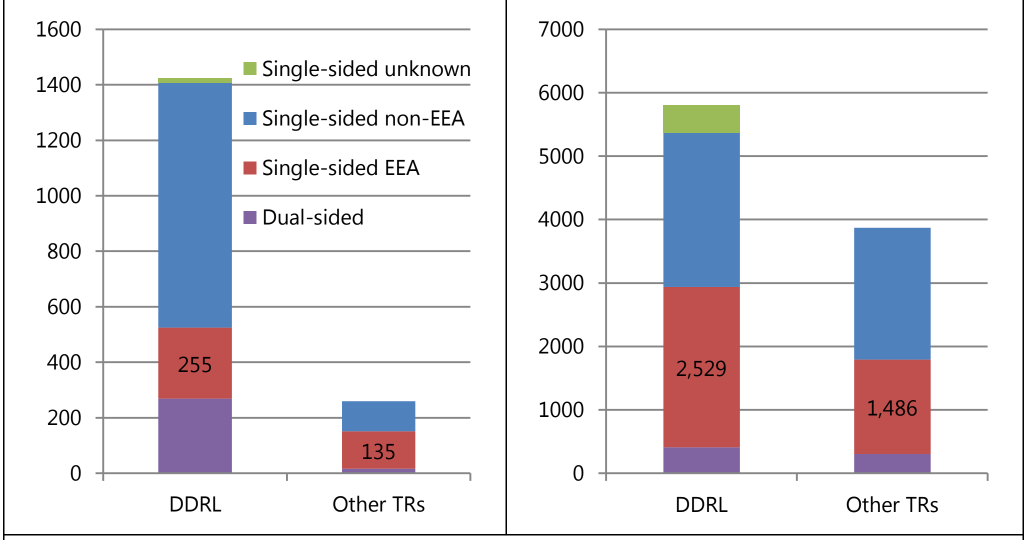
Similarly, as the same UTI is expected to appear only once or twice in the data on outstanding trades on a given date, we monitor the cases of triplicated or more often repeated UTIs and found out that those cases dropped from more than 30,000 in the initial reporting stage to about 1,000 in 2015 (based on data available to the ECB).

[6] ESMA, the supervisor of TRs, aims at improving EMIR data quality through a data quality action plan, which foresees that TR run consistent data validations at the data submitted by reporting agents. The Level 1 validations were put in place in December 2014, while Level 2 validations In November 2015 (see ESMA, 2015a for more details).

However, the reconciliation of the trades reported to different TRs is still one of the most challenging issues. In the EMIR public data, the transactions are divided into the categories of dual-sided and single-sided trades, while the latter is further split into: (i) single-sided non-EEA, (ii) single-sided EEA counterparties and (iii) single-sided unknown (see Table 1). The category "single-sided EEA" contains the trades, where both counterparties are located in EEA and thus shall report the trade, but the transaction cannot be reconciled with any other transaction in the same TR. Assuming correct reporting, the other leg of the trades should be submitted to another TRs under the same category. However, looking at the DDRL example for credit and interest rates derivatives, the combined number of trades in all other TRs is smaller than the single-sided EEA trades in DDRL (see Figure 4). Even if all trades from other trades repositories could be reconciled with the DDRL, still around 47% of trades for credit derivatives in the category "single-sided EEA" and 41% for interest rates would be left unmatched.

Figure 4: Data quality checks – number of trades (thousands), 2015 week 22

CDS: DDRL and other TRs | IRS: DDRL and other TRs



Source: Public EMIR data from TRs' websites.

We also match the reported counterparty identifiers with those in the official LEI database as published by Global LEI Foundation[7] to examine to what extent LEI codes are used in reporting. The match is quite successful for the field of the reporting counterparty (in 97% of trades) but remains significantly lower for the field of the other counterparty (around 75%) as the reporting counterparty may not know the LEI of the other entity. The number of distinct LEIs in the data has been significantly increasing since the reporting start (e.g. doubled for the reporting counterparty within one year from May 2014 to May 2015), as more entities apply for LEI and join the reporting.

[7] This list of valid LEIs can be downloaded from the website of the Global LEI Foundation: https://www.gleif.org/en

5. Comparison of EMIR OTC credit data with BIS CDS survey data on OTC derivatives

Beyond the checks conducted on micro-level, we also compare aggregated EMIR data with those obtained from the established semi-annual OTC derivatives surveys conducted by the Bank of International Settlement (BIS). We focus on OTC credit derivatives, as we expect the data for this asset class to be of somewhat better quality, owing to the high concentration of these data in one TR (DDRL) and to the prior experience of market participants with the voluntary reporting of CDS to this TR since 2008. Due to the double-reporting regime, mentioned before, the transactions are divided into the categories of dual-sided and single-sided trades. We derive from the public EMIR data lower-, middle- and upper-bound estimates for the EU aggregates using different assumptions (see Table 1 for an overview and the underlying assumptions).

Table 1: Types of transactions and estimates for EU aggregates

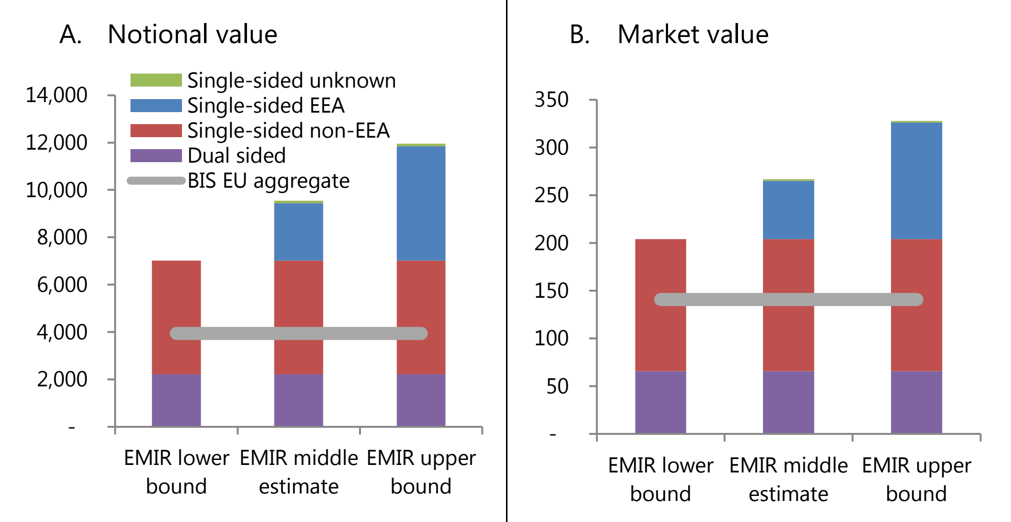
Category	***Explanation***	***Amounts included in the computation of the EU aggregates***		
		Lower bound	***Middle estimate***	***Upper bound***
Dual sided	Both legs of transaction in the same TR	As in the middle estimate	100% - as the amounts refer to one transaction without double-counting	As in the middle estimate
Single-sided non-EEA	Both legs are known: one counterparty belongs to EEA, another to non-EEA	As in the middle estimate	50% - to align the results with BIS methodology, where the transactions between EU and non-EU counterparty are halved	As in the middle estimate
Single-sided EEA	Both counterparties belong to EEA, but the transaction cannot be reconciled with any other transaction in the same TR	0% - disregarded due to doubts about the data quality (since it should be matched in theory)	50% - assuming that the amount is duplicated (another leg is reported but cannot be paired)	100% - assuming that the amount is NOT duplicated (another leg is not reported and for that reason cannot be paired)
Single-sided unknown	One counterparty belongs to EEA, another is unknown and the transaction cannot be reconciled with any other transaction in the same TR	0% - disregarded due to doubts about the data quality (since another counterparty is not known)	50% - assuming one of the two cases above for single-sided transactions	As in the middle estimate

Note: EEA refers to European Economic Area. See also footnote 3.

Looking at the EU aggregated data based on EMIR and the results from the BIS OTC survey (Figure 5), the figures are of similar magnitude, although the BIS figure is somewhat below the lower bound for EMIR data, both in terms of notional and market values. The difference can be partially explained by: (i) geographical coverage (all entities in EMIR, only largest dealers and selected countries in BIS); (ii) product coverage (all credit derivatives in EMIR, only CDS for BIS); and (iii) reporting basis (residency basis for EMIR, consolidated basis for BIS).

Figure 5: Comparison of EMIR OTC credit derivatives data with BIS OTC survey

EUR billion, end-June 2015



Note: EMIR data refer to all OTC credit derivatives, while BIS data to credit-default-swaps (CDS) data only..
Source: Semi-annual BIS OTC derivatives survey and public EMIR data from TRs' websites.

While the higher EMIR coverage with respect to geographical and product coverage (points i and ii) are consistent with the results, these conceptual differences should not have a significant impact on the comparability of the two statistics given the high concentration in the CDS market (i.e. the largest dealers cover most of the CDS trades) and the fact that CDS products constitute the lion share in the credit derivatives asset class. On the other hand, the effect of differences in the reporting basis (point iii) – consolidated reporting for the banking groups in BIS versus inclusion of only EU resident entities under EMIR – is more difficult to quantify without access to the data reported by the overseas subsidiaries of the EU entities.

We perform the exercise of comparison of EMIR data and BIS statistics on a regular basis and results from previous periods are similar to those presented above. It should be mentioned that the long time lag of the BIS publication illustrates the superiority of the EMIR data with respect to the timeliness.

6. Conclusions and way forward

The introduction of the daily reporting obligation for the derivatives market on the transaction-by-transaction basis is a challenging undertaking by the global authorities, due to its enormous scale and complexity of the financial products. We have described some of the biggest challenges faced in Europe in the first stage of the data reporting. In particular, the experience shows that clear and detailed guidance on the fields to be reported to the TRs (e.g. code-lists, formats) and the validation checks run by TRs at the input point can enormously improve the consistency and quality of the collected data. This is the case in Europe, when the continuous clarifications via ESMA's Questions and Answers document (ESMA, 2015b), and in particular the introduction and the enforcement of the validation rules on each reported transaction, help gradually improve the quality.

However, in order to make the dataset suitable for a wide range of analytical studies, further harmonisation of reporting is needed. There are currently two work streams which should greatly contribute to further improvements: i) ESMA's recently updated reporting standards (see ESMA, 2015c) and ii) the CPMI-IOSCO work on the global guidelines on the harmonisation of the derivatives reporting, including the global identifiers such as UTI and UPI (see CPMI-IOSCO 2015a and CPMI-IOSCO 2015b). Moreover, detailed guidance to TRs on the final data provided to authorities is another key step to enable authorities to aggregate and analyse the data across TRs.

Drawing from the European experience will be useful during the process of the global data aggregation, given that the double-reporting obligation resembles the situation at the time of trying to match cross-border trades, where the two counterparties report the transaction to two different TRs. The challenge of the reconciliation of two sides of the trade highlights the importance of fully standardised rules, not only within jurisdictions, but also globally. In this respect one of the most crucial elements is the globally applicable and unique UTI as well as clear rules about its generation. The development of the UPI and harmonization of other data elements are further key steps to obtain data of high quality.

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Closing information gaps at the global level – what micro data can bring[1]

Bruno Tissot, Bank for International Settlements

[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 or the central banks and other institutions represented at the meeting.

Closing information gaps at the global level – what micro data can bring

Bruno Tissot[1]

Abstract

The dual micro/macro dimension of statistics was clearly recognised in the actions undertaken by the global community to have better information in response to the Great Financial Crisis of 2007-09. The Data Gaps Initiative endorsed by the G-20 comprised several recommendations that had, to a varying extent, a micro and macro aspects. Yet the development of these new statistical frameworks has proved challenging. The collection of micro data can bring value from this perspective, by giving access to needed entity-level information, providing distribution information, increasing the quality of macro statistics, enhancing policy making, and expanding the economic knowledge frontier.

Keywords: financial stability; data gaps initiative; micro data; systemic risk; policy making.

JEL classification: C8, D2, E01, E61, F60, G01, G20

Introduction

If anything, the Great Financial Crisis of 2007-09 proved that financial stability issues have both a micro and a macro aspect.[2] At the micro level – that is, at the level of individual entities, transactions or instruments – stress faced in specific areas quickly reverberated in the entire financial system. At the macro level – that is, at the level of the (national and international) economy as a whole, the crisis was preceded a financial boom characterised by rapid credit growth, surging asset prices and accommodative policies which led to the system-wide build-up of fragilities.[3]

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2 This distinction between micro and macro statistics can be, in practice, less simple than it appears. In particular an intermediate category refers to "granular" data, which may not be available at a "pure" micro level but would comprise breakdowns not available in aggregated macro-data. One reason is that very granular data may not be available in the public domain due to general privacy limitations (for instance a bank cannot communicate one's bank account details) as well as to specific confidentiality rules imposed to the authorities that have access to micro data but are imposed by law to avoid their sharing and/or disclosure (for instance the financial supervisor of a bank will typically be able to monitor its detailed activities but will have a legal obligation to keep it confidential).

3 For a short introduction on these mechanisms, see BIS (2014; Chapter IV: Debt and the financial cycle: domestic and global). For an overview of the implications of the crisis for economic analysis and policy, see Carnot et al. (2011).

This micro/macro duality matters not only at the conceptual level; it is also a key element to be considered by statisticians and practitioners in their day-to-day work which aims, especially in central banks, at mobilising data to support research, analysis and policy making. The need, as summarised by Borio (2013), is to have "*good information about the system as a whole and the individual institutions within it – that is, we need to see the forest as well as the trees within it.*"

The dual micro/macro dimension of statistics was indeed clearly recognised in the actions undertaken by the global community to have better information in response to the crisis. In 2009, the International Monetary Fund (IMF) and the Financial Stability Board (FSB) prepared *The Financial Crisis and Information Gaps* report to explore information gaps and provide appropriate proposals for strengthening data collection (International Monetary Fund and Financial Stability Board, 2009). This initial Data Gaps Initiative (DGI-I) endorsed by the G-20 comprised 20 recommendations and focussed on three key statistical domains, ie the build-up of risks in the financial sector, international financial network connections, and vulnerabilities to shocks. Not surprisingly, each of these recommendations had, to a varying extent, a micro and macro aspects.

Yet statisticians are still in an intermediate phase. Certainly, the shortcomings of analysis based solely on micro- or macro-level data have now been recognised. Micro information alone is of little use if it cannot be properly aggregated, analysed and communicated to policy makers; this was indeed the case in the run-up of the last crisis, surprisingly characterised by both the abundance of statistics and the lack of key information at least at the level of the global system. Conversely, the "macro" picture can be misleading, as it may mask micro fragilities that have system-wide implications; again, the last crisis highlighted how quickly the stress faced by individual firms can spillover to others through financial networks.

While the diagnosis is now widely shared, what is still unclear is how to develop new statistical frameworks that can adequately combine micro- and macro-level information. This integration task has proved more complex than initially thought. It remains hindered by the limited availability of reliable and timely statistical data in some domains, particularly at the international level. Moreover, imperfect statistical harmonisation is challenging the collection of comparable, entity-by-entity data among financial institutions, not least across jurisdictions. These are obvious difficulties, and it will take time to address those. To this end, the international community has just decided to launch the second phase of the DGI (DGI-II), which aims at "*implementing the regular collection and dissemination of comparable, timely, integrated, high quality, and standardized statistics for policy use*" over the next five years (International Monetary Fund and Financial Stability Board, 2015). The collection of more granular data was recognised as a key element of this initiative as it will "*help straddle the divide between micro and macro analysis*".

The new data collection exercises undertaken in response to the financial crisis have highlighted five main contributions of micro data. A first is to *collect "pure" micro information* to assess the situation of a specific institution or market; eg the balance sheet composition of a large bank considered as having systemic importance. A second is to have a *sense of the distribution of economic indicators*; to judge, for instance, how aggregated figures for the banking sector may cover a wide range of situations depending on particular sub-groups ("fat tails"). A third contribution is to enhance the *quality of macro statistics*: the idea is to use the richness of micro, granular data sources to enhance the accuracy / details of "traditional" macro statistics. A fourth contribution is *policy assessment*: micro information can be instrumental to track individual responses to public policy decisions and, in turn, the overall impact of these policies. The fifth and last contribution relates to *economic understanding*: micro statistics can trigger a paradigm shift in the knowledge frontier, by highlighting the interest of a different representation of the economy.

What does this implies for the collection of micro data, that is, data that is granular enough to capture the situation of one economic agent within a given institutional sector (one household, one firm etc)? This paper argues that the collection of micro data can be instrumental in fulfilling the objectives highlighted above. It is accordingly structured along five sections, ie access to micro information, distribution information, quality of macro statistics, policy assessment, economic understanding. All these sections describe the (i) value added of mobilising micro data and integrating them in an encompassing macro framework to address a particular objective and (ii) the way this is being implemented in the context of the ongoing international statistical initiatives to ensure a proper mobilisation of micro-type information at the global level. These international initiatives comprise mainly the ones referred to in the DGI as well as the financial regulatory work that is being done in parallel in response to the crisis, especially by the Financial Stability Board (FSB) and the Basel Committee on Banking Supervision (BCBS). Section 7 concludes.

2. Macro-relevant, "pure" micro information

The crisis showed that aggregated data is not enough: one need to take into consideration "pure" micro information that is relevant from a macro perspective. Fragilities can arise at the level of specific institutions (eg Lehman Brothers) or financial market segments or instruments (eg US subprime mortgages) that will have implications for the financial system as a whole. Such micro-level information can have a systemic importance but be masked by "traditional" macro, aggregated indicators. This raises a particular challenge for financial stability purposes, since fragilities may differ significantly across economic agents both at a point in time as a well as over time.[4] From this perspective, aggregated information can prove meaningless and even sometimes misleading if it masks needed information.

Hence, when assessing financial stability fragilities at a macro level, it is often essential to understand what lies behind aggregated numbers and dig into the data in a granular way (Cadete de Matos, 2015). For instance, a country-wide indicator can reflect the homogeneous situation of a group of economic agents or, in contrary, the combination of idiosyncratic positions. Non-linearity effects mean that, on average, the implication of an aggregate number will differ from the picture that one can derive from the sum of individual situations.

Obviously, national financial supervisors are the first in line to require access to institution-level information in their own jurisdictions. At the international level, the collection of micro data for global systemic institutions have been promoted by the FSB and is being conducted with the operational support of the International Data

[4] For these two financial stability dimensions (across the financial system at a point of time; and over time), see Crockett (2000).

Hub (IDH) set by the BIS (see FSB (2011) for the initial overview of this project). This collection is governed by the senior authorities[5] supervising the major financial centres (the Hub Governance Group, HGG), who are sharing institution-level information deemed relevant for the stability of the global financial system. Strict procedures have been set up to ensure accuracy, confidentiality, completeness and timeliness of these statistics. And a particular effort has been made to coordinate banks' compliance with reporting guidelines so as to achieve international comparability.

Actual data have started to be collected for a subset of the *global systemically important banks* (G-SIBs) that have been characterised as of "systemic importance" by the FSB and the BCBS.[6] They encompass a variety of micro indicators – based on banks' assets (exposures), liabilities (funding) and off-balance figures (contingent positions) – aiming at assessing interlinkages among the institutions surveyed as well as with their key counterparties ("network effects") and the concentration of these institutions in specific sectors and markets ("size effects"), with various frequencies (eg weekly, monthly and quarterly).

In terms of analytics, the value of different combinations of these micro data will depend on circumstances, eg the need for a specific monitoring of a single institution or of the exposures of a number of them to a given counterparty or risk factor, etc. Making sense of the data and presenting them in a synthetic way is therefore quite challenging: it requires the developing of ad hoc analytical tools and metrics to capture "micro specific" situations that are of system-wide relevance. For instance, the purpose is not to simply consolidate the micro data collected and analyse the aggregated situation of all G-SIBs taken together; it is rather to filter the (large) amount of data available and extract the specific information deemed important for macro financial stability analyses at a specific point of time.

The set-up of the Hub was organised in the context of the DGI-I recommendations #8 and #9 along three phases. Phase I, started in 2013, involved the collection of simple I-I ("*Institution-to-Institution*") bilateral data to measure the G-SIBs' exposures to their major counterparts; for instance, the claims of Deutsche Bank on BNP Paribas. It also comprised I-A ("*Institution-to-Aggregate*") data to assess the concentration of G-SIBs to specific sectors and markets; for instance the claims of Deutsche Bank on Russian residents. These latter I-A data are in fact the institution-level data underlying the consolidated international banking statistics (IBS) collected by the BIS: for instance the data reported for Deutsche Bank in the example above will be a subset of the IBS data published on the claims of all German banks vis-à-vis Russian residents. The data collected by the IDH have progressively become more detailed in parallel with the implementation of the enhancements of the IBS in the context of the DGI-I (recommendation #11). In particular, greater detailed information has been made available in terms of instrument and counterparty sector breakdowns. Phase II, launched in 2014, focused on I-I liabilities, ie information on the largest funding providers (bank and non-banks) of a bank like Deutsche Bank, as well as on

[5] Hub data are shared among national supervisors and macro-prudential authorities of the jurisdictions participating in the granular data collection. A number of IFIs also will receive special information derived from it.

[6] For the framework related to the Basel Committee's methodology for assessing and identifying (G-SIBs) see BCCS (2013). For the actual list of G-SIBs, see FSB (2015). This list is updated on a regular basis as part of the review of the largest 75 banks identified by the BCBS, and can differ somewhat from the list of institutions actually reporting data to the Hub.

its funding structure (eg use of wholesale funding). With the decision to start the implementation of Phase III at end-2015, additional I-A information will be provided for the consolidated balance sheet of each G-SIBs, with detailed breakdowns by counterparty country, sector, instrument, currency and maturity.

3. Distribution information – a new data dimension

As analysed above in the case of G-SIBs, there are clear cases for which it is essential to collect detailed, institution-by-institution data to support economic analyses and macro policies. But often there is no such need (and it may not be very easy from an operational perspective either…). What instead matters is how average macro indicators reflect the particular "micro" situation of individual entities; attention will thus focus on the distribution of these indicators for the population being considered. For instance, to assess the relative importance of the subgroup of banks that have a very low capital ratio – compared to the average measured for the banking sector as a whole – and that are thus more vulnerable to episodes of financial stress. Another example is when household debt is low on average but concentrated on a very limited type of borrowers (cf the US subprime market).

However, "traditional" macro indicators usually provide little information on how general aggregates are distributed. They have basically three main characteristics: a country of residence (US), a point in time (2014), and a specific indicator value (average capital ratio of banks). The objective is therefore to add a fourth dimension (eg by providing ranges or quartile information) to assess the distribution of the indicator. The aim is to be able to explore the heterogeneity hidden behind aggregate numbers and in particular to analyse the tails of distributions.

A number of recommendations of the DGI-I have been indeed focussing on the development of distribution information. A case in point was the general recommendation (DGI-I #16) for "*statistical experts to seek to compile distributional information alongside aggregate figures, wherever this is relevant…* [and in particular]… *to link national accounts data with distributional information*". The new, second phase of the DGI is focussing more specifically on income, consumption, saving, and wealth, for the household sector (recommendation DGI-II #9). Work on distribution information is also required in other areas, in particular to ensure the regular collection of concentration and distribution measures for financial soundness indicators (FSIs; see International Monetary Fund (2006)). The objective is to complement the overall assessment of the financial sector risks through aggregate measures by taking into consideration the risks posed by institutions that are at the tail of the distribution and that can cause system-wide disturbances (DGI-II #3).

This work is clearly important for policy purposes. Distributional data have for long been a useful input to help to better calibrate policies. For instance, the allocation of debt and wealth among households can affect the monetary transmission mechanism. Moreover, the need for distribution information is likely to become even more pressing in the post-crisis period, for instance reflecting greater attention paid to policy redistribution effects in a low interest rates environment. Cases in point are monetary policy issues related to the impact of the newly developed unconventional tools as well as the effects of low interest rates on the distribution of wealth and income. Another growing area of interest is related to the new impetus put on financial stability analyses and policies. The way assets and incomes are distributed within a population is indeed a key element to consider when assessing the "macro" impact of a financial shock (eg house price correction, increase in interest rates). And the increased use of macro prudential tools, which are often targeted at specific groups of economic agents (eg "speculative" investors), markets/sectors (eg housing) and instruments (eg mortgages), will in itself call for more distribution information.[7]

Obviously, access to micro data is instrumental to facilitate the production of distribution information, which can be easily derived from granular information obtained through surveys,[8] administrative databases,[9] or even web-based indicators ("big data").[10] The task is however not straightforward, as it requires a good understanding of the links between the "macro" (often national accounts-based) world and "micro", granular databases. One challenge relates to the type of micro data that can be mobilised in these integration exercises, as they may not be consistent between the micro and the macro levels. Another is that the distribution of the variable of interest may be quite different even for relatively comparable indicators. For instance, low-income households are often characterised by a relatively high home ownership rate, so that they differ from the group of low-housing wealth households, as argued by La Cava (2015). As a result household wealth distribution may differ significantly from their income distribution. The bottom line is that distribution information is a new data dimension that makes data analysis richer… but also more complex.

4. Micro data for better macro statistics

There is a growing consensus to recognise the benefits of collecting micro data as a way to improve macro statistics. Attention has in particular focussed on the development of "integrated sectoral financial accounts" which complete the traditional system of national accounts (SNA) framework by presenting information on financial flows and positions and on a sectoral basis (Tissot, forthcoming). An important feature is that the financial assets and liabilities of a specific sector are broken down by main instruments and counterparty sectors. This constitutes the so-called *from-whom-to-whom* tables, which provide information on who is financing whom, in what amount and with which type of financial instrument.[11] In particular,

7 For a review of macro prudential policies and related data implications, see Gadanecz and Jayaram (2015).

8 See IFC (2009).

9 The term "administrative" comprise a variety of aspects. Administrative datasets can be publicly available from public or private sources (eg balance sheet data for listed companies or even regulatory reports when they are made publicly available in some countries). They can be derived from private sources (eg banks' loan registers) and made available to specific authorities under strict confidentiality rules. Or they can be "pure" administrative data collected by the authorities themselves in their conduct of public policies (eg social security registers).

10 For the various dimensions of what is understood as "big data", see Irving Fisher Committee on Central Bank Statistics (2015).

11 The SNA's three-dimensional "from-whom-to-whom" tables presentation is sometimes referred to as a "flow of funds matrix"; see European Commission, International Monetary Fund, Organisation for Economic Cooperation and Development, United Nations and World Bank (2009).

recommendation #15 of the first DGI Initiative invited international organisations to "*develop a strategy to promote the compilation and dissemination of the balance sheet approach (BSA), flow of funds, and sectoral data more generally*".

Micro data sources can play an important role to support the compilation of financial accounts (Cadete de Matos, 2015). These accounts requires a wealth of information, for instance a breakdown of flows and positions by borrowing as well as lending sectors as well as a decomposition by type of instruments, ideally including information on original and/or remaining maturity. In theory, this information can be derived from granular "administrative" datasets, which typically include databases maintained by financial institutions or by public authorities, including public credit registries on individual loans data, security-by-security databases, central balance sheet databases etc.[12] An important feature of these datasets is that they have a large sample size and relatively high quality information. Moreover, the information can be mobilised in a flexible way so as to compute a wide range of different indicators, even more so when they can be combined to other datasets through a common identifier. Furthermore, these data sources have generally a good coverage of the relevant economic agents and may have a relatively low collecting cost for statisticians, for instance when their collection is the by-product of an administrative operation (eg inscription to a public register).

But a key challenge is to integrate in a structured, consistent way all the various data available at granular level into a comprehensive macro framework. Financial transactions are usually not registered in line with the SNA standards because they were not initially thought to be part of the national accounts framework: concepts (eg risk indicators), reporting entities (for instance within consolidated financial group), valuations (eg accounting treatments) etc. do not automatically coincide. A second, and related, challenge is the fact that financial data come from heterogeneous sources: for instance information on debt instruments can be derived from a security-by-security database, while other information can come from credit registers, regulatory authorities, etc; these elements can in particular undermine international comparisons. Micro data's inherent complexity can also lead to sizeable delays in the production of the statistics, as they require substantial investment costs (eg IT, algorithmic methods, human resources, skill mix) and can raise important quality issues; indeed, a number of countries have experienced significant difficulties as they embarked on the collection of, for instance, large-scale exhaustive security-by-security databases. A third challenge is the lack of data. In particular, financial information on households and non-financial corporates can be scare, esp. when declined by instruments; not surprisingly, recommendation #15 stated that "*data on nonbank financial institutions should be a particular priority*". Yet a last issue is related to legal and confidentiality aspects. Data at the level of individual institutional units can be very sensitive and are usually protected by stringent rules. So far, this has been a key obstacle for the sharing of micro data among statisticians esp. those in charge of compiling financial accounts. Important efforts are ongoing to address these issues by revisiting the implementation of confidentiality rules and using anonymization / cryptographic techniques.

For sure, micro is not necessarily a synonym of completeness. There are alternative ways to enhance macro statistics without necessarily relying on the

12 Cf the "administrative records revolution" (Guiso (2015)), with the possibility of a "new age" of combining various, large administrative records.

collection of a huge amount of exhaustive and granular information. For instance, one can limit the collection of micro data to a selected group of units and instruments and "extrapolated" to the wider economy by using sampling techniques. Surveys are interesting in this context because they can be less costly to collect – compared to setting an exhaustive micro-data collection exercise– and can nevertheless be useful for distributional analysis, as seen above. They can also provide information that is difficult to find elsewhere, such as time use information, self-report assessments, and subjective expectations (Bover, 2015). But they have also a number of drawbacks, especially in terms of timeliness, comprehensiveness, updating (being typically not conducted every year, and the data collected may vary from one survey to another) and accuracy.[13] Moreover survey data tend to provide information that is not fully consistent with national accounts aggregates due to the concepts, definitions and statistical practices employed; similarly surveys may not be consistent among themselves, a good example being the traditional consumption and wealth survey which have different household samples.

Nevertheless, a number of initiatives have tried to enhance this integration and ensure that the granular data collected are consistent or "matched" with the macro framework (La Cava (2015)). Statistical matching can facilitate the consistency of the granular information collected (with the national accounts-based framework, over time, and internationally), its complementarity (allowing both "top-down" and "bottom-up" types of analysis) and its adaptability. Other avenues can be explored too. One is to link survey data and administrative datasets, for instance credit registers and loan application surveys (Jiménez et al (2014)). Attention has also focussed on developing panel databases derived from administrative data sets or diaries, with the same households sampled over time (instead of cross-sectional surveys with different households sampled for each period). The objective is to build longitudinal panel data sets that are sufficiently rich at the micro level, available in a timely manner, and regularly updated over time.

5. Designing and assessing policies

Micro data offers new opportunities to support macroeconomic analyses and guide policy decisions. They are obviously indispensable for the monitoring task of micro prudential authorities conducted at the level of individual institutions. Granular data is also required for the implementation of specific policy actions targeted at specific market segments or instruments. For instance, the design, calibration and implementation of macroprudential tools (eg loan-to-value limits, debt servicing limits) require close monitoring of available data. Almost by definition, granular data are needed to properly assess the effectiveness of such targeted policies and mitigate possible unintended consequences over time (eg agent behaviours in response to these policies, overall impact on the economy). Lastly, data are needed to decide when, and how, to reverse previous policy decisions.

Micro data certainly present several benefits from this perspective. First, they are rich enough to be used for various policy purposes, ie macro- and microprudential,

[13] For instance surveys can suffer from bias, measurement errors, and representativeness problems (Meyer et al (2015)).

fiscal, structural and monetary policies, so that they can be used by multiple users.[14] Second, data sources that are granular enough can be combined to take into consideration multiple dimensions. And another benefit is the flexibility allowed by micro data, as new information requests can be addressed more easily without having to organise another ad hoc statistical collection exercise. This, at least in the longer run, should also reduce the reporting costs and burden on economic agents.

Reflecting the above, micro data have played an increasing role to support policy making since the Great Financial Crisis. Two main forces were at stake. The first has been the development of policy tools that need to be applied at a granular level. An obvious example is the growing variety of macroprudential measures adopted, focussing on specific instruments (eg underwriting standards for mortgages, explicit loan-to-value limits, debt servicing ratios), creditor sectors (eg capital buffers for banks), and borrowers (eg taxation, structural measures addressed to specific market segments). Another example relates to monetary policy: the assessment of (granular) credit risk is instrumental in determining the quality and conditions of assets that can be used as collateral in monetary policy operations, and which have been in increasing demand in the aftermath of the crisis with the development of quantitative easing policies. Lastly, a number of fiscal policy actions have been taken in a granular way to prevent financial fragilities, for instance to dampen targeted buoyant asset markets.

The second force has been the reworking of the designing of public policies so as to better factor in the crisis' lessons. This is particularly the case in the area of financial regulation, with the active involvement of the various standard-setting bodies hosted by the BIS in Basel. Almost all new regulatory initiatives are now supported by some kind of granular data collections, something that was almost inexistent less than ten years ago.[15] Quantitative impact studies (QIS) have now become a central element of these new indicator-based frameworks developed to, among other tasks, draw the lessons of previous policies, assess the ex-ante impact of new measures, identify additional areas of weakness, and clarify the functioning of regulation by measuring feedback effects, behavioural responses and unintended consequences. Moreover, they facilitate the assessment of the cross-impact of the various regulatory requirements introduced in parallel: for instance, by shedding light on how banks' leverage ratio would evolve in response to change in their capital ratio requirements. The BCBS has been leading ahead in this evolution, and has developed in recent years a large number of regular monitoring reports on various items such as capital regulation, liquidity rules, the selection and measurement of G-SIBs (Basel Committee on Banking Supervision, 2015)[16]. Its work is now underpinned by an extensive quantitative framework for the collection and analysis of institution-level data (Ingves, 2013). Other Basel-based groups such as the International Data Hub,

[14] For an analysis of how the understanding of the impact of monetary policy requires an appreciation of heterogeneity across households, see for instance Sufi (2015).

[15] Although a number of QIS exercises were launched in the early 2000s with regard to the Basel II capital framework. The number and complexity of such exercises have however expanded markedly after the crisis.

[16] Especially related to the semi-annual monitoring of the impact of *Basel III: A global regulatory framework for more resilient banks and banking systems*, *Basel III leverage ratio framework and disclosure requirements*, *Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools* and *Basel III: The Net Stable Funding Ratio on a sample of banks*. See www.bis.org/bcbs/qis.

the FSB and the International Association of Insurance Supervisors (IAIS) are also increasingly participating in this new way of steering and implementing policy.

As a result of these two forces – development of micro policy tools and of indicator-based policy designing – micro data are being increasingly used for setting up policies, ensuring their effective implementation, monitoring their impact, and revising them afterwards in case of need. This trend is, obviously, raising significant challenges for public statisticians, as it requires the build-up of well-defined survey processes, IT systems and fully automated workflows to ensure in particular a certain degree of replicability and sufficient data quality checking.

6. A new knowledge frontier

Micro data offers new possibility in economic thinking. The access to granular information provides perspectives for aggregating data in different ways and thereby to analyse economic issues from another, possibly radically different angle. A case in point relates to analyses focussing on the global financial system as a whole (Heath (2015)), which cannot be solely analysed through aggregated, country-based statistics. Indeed, the Great Financial Crisis of 2007–09 showed the importance of collecting information on global, group-level balance sheets for properly assessing firms' economic behaviour and their potential financial stresses. A growing part of corporates' domestic activities is now governed by parent companies located abroad, rather than by the (resident) reporting institutional units. Symmetrically, residents' actions are increasingly influencing the actions of other "controlled" agents located in other sectors and/or countries.[17]

Given that the controlling and controlled units forming a corporate group usually belong to different economies and different sectors, the aggregation of group-level information cannot be consistent with traditional residency based framework of the System of National Accounts (2008 SNA; see European Commission et al (2009)). This framework records assets and liabilities of the economic units that are resident in a specific economic territory, information that is progressively losing its relevance with globalisation.[18] What is needed is to capture the claims and liabilities of groups' affiliates that can have an important impact at the level of the parent company, since it is accountable for the business of all the entities under its control and is ultimately bearing the related risks. That requires consolidated group-level, risk-based data, an approach which is often described as "nationality-based":[19] the information of the various institutional units belonging to a group characterised by a specific "nationality" has to be collected and consolidated independently of the residency of each of these units.

17 For a review of the methodological and practical issues related to the consolidation of corporate groups, see Inter-Agency Group on Economic and Financial Statistics (2015).

18 For an introduction to the national accounts framework, see, for instance, Lequiller and Blades (2014) or Carnot et al (2011), Annex I.

19 The concepts are similar but not exactly overlapping. Consolidated data capture the exposures of affiliates but aggregate this information at the group level. On the other hand, nationality information can be displayed at the level of the affiliates before their consolidation (cf for instance the BIS international banking statistics, for which one dataset is presented on a nationality though non-consolidated basis).

In order to construct such nationality-based statistics, one needs to access granular, institution-level data. A number of data sets have been developed along these lines. The BIS consolidated IBS collect data on internationally active banks' foreign claims broken down by the nationality of the reporting parent banks at the top level of consolidation and by the country of residence of the counterparties. They build on measures used by banks in their internal risk management systems and are broadly consistent with the consolidation scope followed by banking supervisors. In particular, one part of the IBS is presented on an ultimate risk basis, ie claims are attributed to the country where the final counterparty resides (taking account of risk transfer mechanisms such as guarantees). For simplicity's sake, the nationality concept is applied here at the reporting bank group level but also at the level of the counterparties of this reporting bank. That is, the positions of each initial (immediate) borrower are reassessed to take into account the transfer of risks to the ultimate borrower.

Another important BIS data set collected on a consolidated basis is the international debt securities statistics (IDS). It is compiled from a granular, security-by-security database that enables unique identification of each security. This allows each bond to be identified by its nationality defined as the residency of the parent company controlling it. Turning to the IMF, the compilation of the Financial Soundness Indicators (FSIs) is based on data on a consolidated basis for deposit-takers. The OECD has also developed a framework for collecting information on multinational enterprises (MNEs) on a consolidated basis.

Certainly, the computation of such datasets is posing significant challenges. A key issue is to identify, in all the micro data collected, each institution precisely and the aggregation rules to be applied. Hopefully, the international community is developing tools to facilitate such exercises. The recently introduced Legal Entity Identifier (LEI) is a 20-digit reference code to uniquely identify legally distinct entities that engage in financial transactions. Work is ongoing to develop principles and standards for aggregating this information at the level of ultimate parents of legal entities.

The bottom line is that micro data are a prerequisite but also a trigger for new types of economic analysis. By getting rid of "traditional" country boundaries, nationality-based consolidated data facilitate the understanding of who makes underlying economic decisions, who takes on the final risk and who needs to hold sufficient buffers to cover global potential losses. This, in turn, is moving the knowledge frontier. By allowing the identification of the ultimately responsible unit, one can analyse the ways in which economic decisions are made and, in times of stress, which area is ultimately impacted. Such information is crucial for fiscal, monetary and prudential authorities alike. It can be mobilised to enhance the stability of the financial system at the macro level. For example, it facilitates the monitoring of the borrowing activities of global groups outside their resident markets through their offshore affiliates (an activity which has numerous implications for the conduct of national policies). It can also help identifying spillover effects form national policies to other areas. A telling example is the recent estimate that banks and bond investors have increased outstanding US dollar credit to non-bank borrowers outside the United States – including affiliates of US residents – to $9 trillion today, underscoring the importance of the links between US monetary policy and credit extended globally (McCauley et al (2015)).

Lastly, additional progress is under way in the standardisation of reporting financial operations – including the definition of a unique transaction identifier (UTI) and unique product identifier (UPI). This will further facilitate the ability to share granular data and combine them in new, still unpredictable ways.

7. Conclusion

As summarised in the table below, micro data can bring a lot a value to address the information gaps revealed by the Great Financial Crisis. The international community is very well aware of that, and in fact many of the recommendations of the DGI have, to a significant extent, a micro data dimension. The financial regulatory response to the crisis is also another important development force. As shown in the summary Table on *The role of micro data in international statistical initiatives* below, micro data sources can play a key and multiform role to support the following objectives:

- access institution-level information that is relevant for the financial system as a whole;
- provide a sense of the distribution of macro-economic indicators;
- enhance the quality of macro statistics;
- better support the design, implementation and assessment of evidence-based policies; and
- expand the knowledge frontier, by bringing new ideas and concepts to our attention.

The role of micro data in international statistical initiatives

Area	Initiatives (1)	Access to granular data	Information on distribution (4th dimension)	Enhanced macro statistics	Policy assessment	Knowledge frontier
Quality of statistics	II-1			✔		
FSI indicators	II-2, 3 (I-2, 3)		✔		✔	
G-SIFIs	II-4 (I-8, 9)	✔			✔	✔
Shadow banks	II-5 (I-4)	✔		✔	✔	✔
Derivatives	II-6 (I-5)	✔		✔	✔	✔
Securities	I-6, II-7 (I-7)	✔		✔		
Sectoral accounts	II-8 (I-15)			✔		
Distribution information	II-9 (I-16)		✔		✔	✔
International statistics (eg IIP, IBS, CPIS, CDIS, GFS, PSDS, RPPI, CPPI)	II-10, 11, 12, 13, 15, 16, 17, 18 (I-10, 11, 12,17, 18, 19			✔		
Cross-border exposures	II-14 (I-13, 14)	✔		✔		✔
Granular identifier (eg LEI)	II-4, 5, 6, 14	✔				✔
Data sharing	II-19	✔		✔		✔
QIS exercises	Basel III, II-4, other regulatory work	✔			✔	✔

(1): I- and II- relate to, respectively, the first and second phases of the Data Gaps Initiative (DGI) endorsed by the G-20.

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Irving Fisher Committee on
Central Bank Statistics

BANK FOR INTERNATIONAL SETTLEMENTS

IFC workshop on *"Combining micro and macro statistical data for financial stability analysis. Experiences, opportunities and challenges"*

Warsaw, Poland, 14-15 December 2015

Discussion of session 6 on *"Intensifying cooperation between national and international institutions: from a national perspective to the global financial system"*[1]

Pietro Franchini, FSB Secretariat

[1] The views expressed are those of the author and do not necessarily reflect the views of the BIS or the central banks and other institutions represented at the meeting.

FINANCIAL STABILITY BOARD

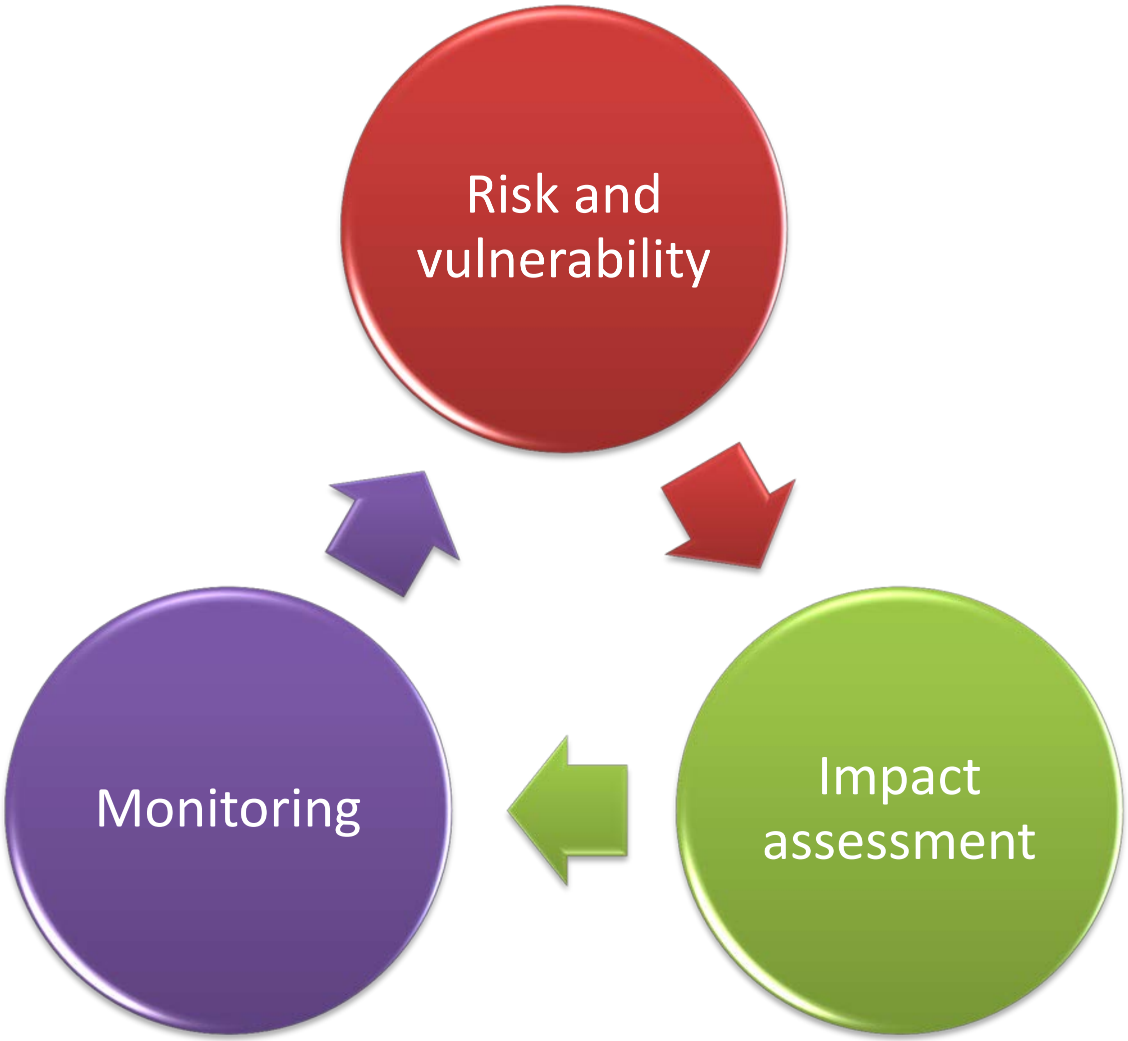
Intensifying cooperation between national and international institutions: from a national perspective to the global financial system

Pietro Franchini

FSB Secretariat

IFC - Warsaw, 14 December 2015

Data for financial stability



Main data needs

- Assess the **structure** and **interconnections** in the global financial **network**
  - Links between **banks** and **non-bank** intermediaries
    - Detect financial institutions not identified as systemic (including shadow banks) but deeply interconnected with several GSIBs
- Identify risk **concentrations** and funding **dependencies**
  - Classification of counterparties (countries, sectors)
- Identify potential **spill-overs** and **externalities**
  - Direct or indirect exposure of a GSIBs to one or several GSIBs themselves exposed to sovereign risk
- Understand financial **innovation** and market **complexity**

Data sources

- From micro-data …

  credit registers, security-by-security databases, transaction based surveys

  … to granular aggregated data
- Front office vs accounting systems vs risk management
  - Consolidation / granularity / timeliness / frequency: cost – quality trade-off?
  - timely information that can be rapidly mobilised and escalated by authorities if problems arise at an institution in the global network
  - Supervisory expectations to improve the quality of risk management data
- Confidentiality: systemic relevance named counterparties for interconnectedness / contagion

FSB FINANCIAL STABILITY BOARD

FSB policy targets

Policy Development and Coordination

- Building Resilient Financial Institutions
- Addressing SIFIs
- Effective Resolution Regimes and Policies
- More Effective Supervision
- Making Derivatives Markets Safer
- Transforming Shadow Banking
- Additional Policy Areas
  - Addressing Data Gaps
  - Improving Risk Disclosures
  - Accounting Convergence and Enhanced Audit Quality
  - Reforming Financial Benchmarks
  - Reducing Reliance on CRA Ratings
  - Legal Entity Identifier (LEI)

GSIFIs common data template

Global SFT data collection and aggregation

Aggregation of OTC derivatives data

Implementation monitoring

- Progress Reports to the G20
- Monitoring of Priority Areas
- Monitoring of Other Areas
- Peer Reviews
- Initiative on Cooperation and Information Exchange

Data Gaps Initiative

Key Standards for Sound Financial Systems

FSB vulnerability assessment

Macro-financial related vulnerabilities and risks

Arising from structural weaknesses in the financial system

Misaligned incentives, amplification mechanisms or other forms of potential market stress

Potential for international spill-overs across financial systems, difficult to cover in a domestic or regional context

- *Global Shadow Banking Monitoring Report*
- *Corporate Funding Structures and Incentives*
- *Currency Mismatches and Leverage on Corporate Balance Sheets*
- *Early warning exercises (EWE) jointly with IMF, based on forward-looking risk scenarios*

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Discussion of the papers

- Matched firm – bond data (BdE)
- Shadow banking (ECB)
- Reporting derivatives transactions (ECB)
- Closing information gaps (BIS)

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Matched firm - bond data

- Granular data do not provide a complete view of risk
  - Exposure data needed (on ultimate risk basis)
  - Intra-group positions, collateral, hedges, bilateral netting agreements
  - Link granular (securities) with firm-level (balance sheet) data
- Pockets of risk: need for individual data / distributions
- Arbitrage between markets with different regulation / disclosure

?

Systemic relevance of markets / firms	Disclosure of financial statements	Integration with international statistics	Impact on lenders
Leverage / Mismatches	Details / format	SNA - BIS	Subordination (eg TLAC)
Spillovers / Interlinkages	Frequency / timeliness	Coverage across Jurisdictions	DB on security owners (eg SHS)
Role of Collateral			

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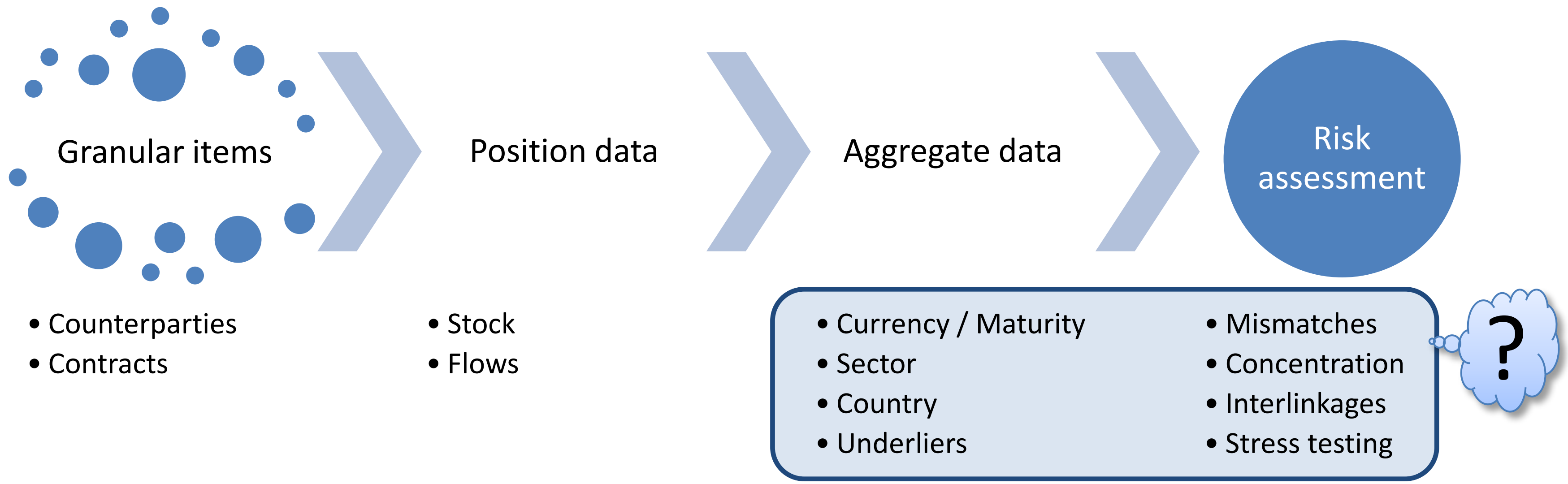
Shadow banking

- Definition: broad / narrow
- Role of consolidation
- National accounts vs. cross-border
- Need for granular data

?

- Coverage / details of Flow of funds reporting
- Avoid arbitrage
  - Interconnection between banks and non-banks credit intermediation
- More risk data: eg liquidity and maturity transformation

Reporting derivatives transactions



Standardised High Quality Data	Harmonised definitions, identifiers, metadata, consolidation perimeter
	Removal of double-counting: UTI / UPI
	Disclosure framework (access, format)
	Validation rules, global governance

Closing information gaps

- Granular enough for analytical purposes
  - Flexibility
- Consolidated / ultimate risk data
- Common identifiers to combine granular information
- Structured reporting vs surveys vs «big data»
- Policy assessment
  - Consequences over time

?

Additional dimension: by type of intermediary

- Systemic relevance (size, interconnection, cross-border, etc.)
- Avoid arbitrage

Sharing agreements

- Fit to purpose data for
  - Supervisors
  - Macro-prudential / financial stability
  - Market / general public

Integrate different sources

- Public / private
- Risk / accounting
- Quality / timeliness

Data Gaps Initiative - I

- Widespread consultation with official users of economic and financial data with a "Users Conference on the Financial Crisis and Information Gaps" jointly organized by IMF and FSB in July 2009
- The key outcomes of the Conference were:
  - "There is a need to strengthen the analytical/conceptual framework for financial stability analysis and global monitoring of financial stability risks"
  - "…the evidence of increasingly global financial transmission mechanisms and strong feedbacks between the financial system and the real economy are considered very important topics for further investigation…"
- In November 2009, the G-20 endorsed 20 recommendations to close the data gaps identified following the global financial crisis in order to support enhanced policy analysis

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Data Gaps Initiative - II

- Further work is needed to encourage convergence of data provision among the G-20 economies and to consolidate the progress made during DGI-1
  - data coming out of the DGI are increasingly being used for policy purposes
  - DGI facilitated the dialogue between the national agencies responsible for economic and financial statistics and those for analysis and policy making
- The main focus of the DGI-2 is to consolidate the progress made
  - Implementation and completeness

Regular collection of comparable, integrated, high quality, and standardized statistics

DGI-II priorities

- Consistent and comparable Financial Soundness Indicators
- Regular collection of the International Banking Statistics and the Coordinated Portfolio Investment Survey
- Consistent securities statistics and from-whom-to-whom tables
- Availability of sectoral accounts data
- Timely and comparable general government operations and debt data
- Policy users of the data indicated interest in the regular collection and sharing of data on
  - global systemically important banks (G-SIBs)
  - increasing availability of consistent information on shadow banking
  - household distributional information due to the growing policy issues on income and wealth inequality
- Private sector
  - importance of data standardization through adoption of international standards to allow cross country comparison and consistency, supported by standards such as the Legal Entity Identifier (LEI)

DGI-I and II recommendations

DGI-I Recommendations	DGI-II Recommendations
I.1: Mandate	**II.1:** Mandate
Build-up of risk in the financial sector	**Monitoring risks in the financial sector**
I.2: Financial Soundness Indicators (FSI) **I.3:** Tail risk **I.4:** Aggregate Leverage and Maturity Mismatches **I.5:** Credit Default Swaps (CDS) **I.6:** Structured Products **I.7:** Securities data	**II.2:** Financial Soundness Indicators (FSI) **II.3:** FSI Concentration and Distribution Measures (CDM) **II.4:** Data for Global Systemically Important Financial Institutions (G-SIFIs) **II.5** Shadow Banking **II.6** Derivatives **II.7** Securities Statistics
Cross-border financial linkages	**Vulnerabilities, Interconnections, and Spillovers**
I.8 &I.9: Data for Global Systemically Important Financial Institutions (G-SIFIs) **I.10&I.11:** Coordinated Portfolio Investment Survey (CPIS) and International Banking Statistics (IBS)Participation & Enhancement **I.12:** International Investment Position (IIP) **I.13&I.14:** Financial and Non-financial corporations' cross border exposures	**II.8:** Sectoral accounts **II.9:** Household Distributional Information **II.10:** International Investment Position (IIP) **II.11:** International Banking Statistics (IBS) **II.12:** Coordinated Portfolio Investment Survey (CPIS) **II.13:** Coordinated Direct Investment Survey (CDIS) **II.14:** Cross border exposures of non-bank corporations **II.15:** Government Finance Statistics (GFS) **II.16:** Public Sector Debt Database (PSDS) **II.17:** Residential Property Prices (RPPI) **II.18:** Commercial Property Prices (CPPI)
Vulnerability of domestic economies to shocks	
I.15: Sectoral accounts **I.16:** Distributional Information **I.17:** Government Finance Statistics (GFS) **I.18:** Public Sector Debt **I.19**: Real Estate Prices	
Communication of Official Statistics	**Communication of Official Statistics**
I.20: Principal Global Indicators	**II.19:** International Data Cooperation and Communication **II.20:** Promotion of Data Sharing

Recommendations that are completed based on the targets that were introduced in 2014.

Recommendations where significant progress was made and are close to completion pending participation by all G-20.

Recommendations where progress was slow.

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DGI-I progress made

	Rec. #2 FSIs	Rec. #5 CDS	Rec. #7 Securities Statistics	Rec. #10/11 (IBS)	Rec. #10/11 CPIS	Rec. #12 IIP	Rec. #17 GFS	Rec. #18 PSD	Rec. #19 Real Estate Prices
1 Argentina									
2 Australia									
3 Brazil									
4 Canada									
5 China									
6 France									
7 Germany									
8 India									
9 Indonesia									
10 Italy									
11 Japan									
12 Korea									
13 Mexico									
14 Russia									
15 S.Arabia									
16 S. Africa									
17 Turkey									
18 UK									
19 US									
# of economies	14	all	all	15	16	18	9	17	17
# of economies	5	-	-	2	1	1	6	-	-
# of economies	-	-	-	2	2	-	4	2	2

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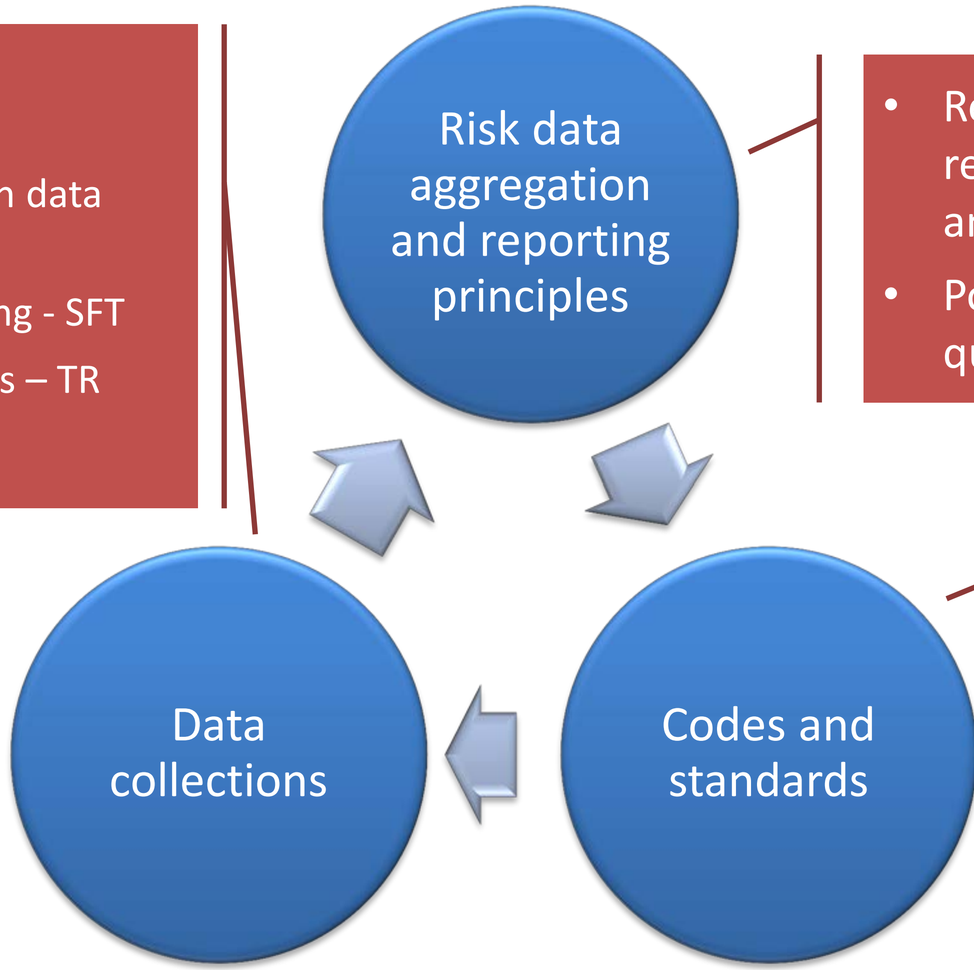
An integrated framework

- G-20 DGI
  - #4 GSIFIs common data template
  - #5 Shadow banking - SFT
  - #6 OTC derivatives – TR reporting



- Regulatory requirements on IT and data governance
- Policies on data quality

- LEI (incl. Level 2)
- UPI
- UTI
- Definitions and metadata

Enhancing disclosure

IFC Workshop on "Combining micro and macro statistical data for financial stability analysis"
Warsaw, 14–15 December 2015

Closing remarks by Turalay Kenç, IFC Chair and Deputy Governor, Central Bank of the Republic of Turkey

Summary of the sessions

The recent financial crisis emphasised the shortcomings of making financial policy decisions based on micro-level data. The introductory session outlined a general framework for combining micro and macro perspectives and highlighted the importance of this integration for a comprehensive analysis of financial system. The Consolidated Banking Data (CBD) of ECB is a good example that includes detailed information on the profitability, balance sheets, asset quality, solvency ratios and liquidity position of banks.

However, the redesign of financial stability policies to integrate better micro and macro data has its own difficulties. The experiences and main challenges were shared in the second session. Such analysis will certainly contribute to the ongoing development of new macro policy tools.

Timely access to the accurate, standardised, high-quality and comparable granular data is crucial to take precautions against financial risk. This was the main subject of the third session. The G20 Data Gaps Initiative is indeed focusing on this objective as a way to close data gaps within and across countries.

Credit registers can play a central role in supporting the harmonisation of micro data, as highlighted with the country experiences in session four. In particular, they can provide a wealth of information for monitoring the contagion of financial risks and cross-border spillovers.

The first session of the second day was devoted to the experiences of emerging markets in integrating micro and macro data. Indonesia, Chile and Turkey were among those who shared their experiences and faced challenges. The last session put forth the importance of cooperation between national and international institutions for maintaining global financial stability. These practices have also been included in G20 framework, and progress in this area has been remarkable. Having said that, there is no time for complacency: we have a terrific opportunity to complete the work undertaken and promote better data to support financial stability all over the globe. I would like to highlight the recent contribution of Turkey to this endeavour, as Chair of the G20.

G20 statistical agenda and Turkey's presidency

In 2009, the G20 endorsed a set of 20 initial recommendations to close the data gaps revealed by the crisis. The implementation of most of the recommendations has now been completed. This significant progress is thanks to the efforts of the relevant authorities of the G20 economies, policymakers and international organisations. The national, regional and international level data coming from the Data Gaps Initiative is important to support financial stability analysis and macro policy decisions. The initiative has also been a good motivation for the members to improve their statistical systems. It has facilitated dialogue between the national agencies that are responsible for economic and financial statistics and those for analysis and policymaking.

The intention of compiling and disseminating comparable, accurate, increasingly consistent and timely data across the G20 economies will be the focus of the second phase, which will start in 2016. The range of recommendations will be broadly comparable to the first phase of the Data Gaps Initiative, and a five-year horizon is foreseen for the completion of this second phase. The Inter-Agency Group on Economic and Financial Statistics (IAG) has been tasked with coordinating and monitoring the implementation of the new Data Gaps Initiative recommendations. As you know, the IAG includes the BIS, so the central banking community and the IFC will be closely involved in this endeavour.

To say the least, there will be a lot to develop. Country members are expected to report the core and the expanded list of Financial Soundness Indicators (FSIs) with a particular focus on non-financial corporations. Besides the FSIs, member states will ensure the regular collection and appropriate sharing of data on global systemically important banks to support the International Data Hub at the BIS. For monitoring shadow banking, the collection and aggregation of consistent data will be enhanced at the global level. Likewise, over-the-counter derivatives data collection will be a key priority, as well as the reporting of holdings of debt securities and sectoral from-whom-to-whom tables. Moreover, a specific focus will be on vulnerabilities, interconnections and spillovers. Better, more comprehensive data will be collected for the adequate monitoring of cross-border exposures, in the context of the International Banking Statistics (IBS), the Coordinated Portfolio Investment Survey (CPIS), the Coordinated Direct Investment Survey (CDIS) and the International Investment Position (IIP). The second phase of the Data Gaps Initiative also emphasises the importance of international data cooperation and communication. Last but not least, in response to the requests of data users and data compilers on improved data sharing, the exchange of data across and within G20 economies and with international organisations will be strongly encouraged.

Turkey, as the 2015 G20 Chair, has strived to ensure inclusive and robust growth through collective action. We have defined three I’s as the key formula: inclusiveness, implementation and investment for growth. Inclusiveness can be thought of as ensuring the benefits of growth and prosperity for all segments of society, with small and medium-sized enterprises being an important example. Inclusiveness is very important for creating quality employment for more people, raising living standards and eliminating inequalities. At the international level, Turkey has also emphasised the need to hear the voice of low-income developing countries. On implementation, 2015 was the year for the completion of most of the initiatives based on targets, and the focus will be now more on implementing them. Turning to investment for growth, the emphasis is to promote investment as a powerful driver of global economic well-being.

Under our presidency, progress has also been made this year in one important area as part of finalising the remaining core elements of the G20 financial regulation agenda. The common international standards on total loss-absorbing capacity

(TLAC) for global systemically important banks and higher loss absorbency (HLA) requirements for global systemically important insurers have been issued. These standards require these institutions to have sufficient loss-absorbing and recapitalisation capacity available in resolution so that authorities can implement an orderly resolution which minimises impacts on financial stability, maintains the continuity of critical functions and avoids exposing public funds to loss.

To conclude my remarks, I would like to thank all participants and their valuable contributions in presenting the micro and macro aspects of financial stability analysis. Thank you very much for your attention.