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Use of credit registers to monitor financial stability risks: A cross-country application to sectoral risk[1]

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Use of credit registers to monitor financial stability risks: A cross-country application to sectoral risk

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Abstract

This paper discusses the use of credit register data for financial stability purposes, illustrating possible applications of these data to the monitoring of sectoral risks, with focus on risks related to construction and other commercial real estate activities in a cross country framework.

The paper first reviews how central credit register (CCR) data can be used for financial stability purposes and illustrates the advantages of granular data to detect vulnerabilities. While existing national central credit register (CCR) data are used in several EU Member States, possibilities for cross country analysis are currently limited due to the heterogeneity of national credit registers. The introduction of the AnaCredit Regulation adopted in May 2016 for the collection of harmonised loan-by-loan data fosters the comparability across countries and thus also increase the relevance of credit register data.

The paper presents a euro area initiative which aims at illustrating the potential of AnaCredit for macroprudential analysis by bridging data gaps on the euro area level. The project puts forward a set of coherent indicators for the monitoring of commercial real estate (CRE) risk, derived from the national CCR of a number of euro area countries. While the focus of the project is on the risk posed by the CRE sector, many of the constructed indicators are not sector-specific and can be easily used to monitor other systemic sectors.

The paper will also highlight the challenges associated with comparing and analysing indicators calculated based on national credit registers and will outline strategies how a maximum of cross country consistency can be achieved despite heterogeneous data sources.

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Contents

1. Introduction and motivation

This paper discusses the use of credit register data for financial stability purposes, illustrating possible applications of these data to the monitoring of sectoral risks, in particular risk related to construction and other commercial real estate activities.

Given the severe data gaps in the area of commercial real estate activities, the use of national credit register data can provide a valuable contribution to shed more light on this particular sector and activities. The global financial crisis has highlighted the importance of real estate markets for financial stability and the relatively pronounced cyclicality (Ellis and Naughtin (2010), Olszewski (2013), ESRB (2015)) of commercial real estate.

The project puts forward a set of coherent indicators for the monitoring of risk related to construction and commercial real estate activities, derived from the national CCR of a number of euro area countries. While the focus of the project is on the risk posed by the commercial real estate sector, many of the constructed indicators are not sector-specific, and can be easily used to monitor other sectors of potential systemic importance.

The remaining part of the paper is structured the following way. Section 2 reviews how central credit register (CCR) data can be used for financial stability purposes. Section 3 presents how national credit registers differ and also outlines how the introduction of AnaCredit will improve cross-country comparability. Section 4 recalls the importance of CRE monitoring for financial stability, highlighting the severe data gaps in the area of commercial real estates, and motivates why looking at credit register data can contribute to monitoring risks from this sector. Particular attention is dedicated to the challenges associated with the definition of Commercial Real Estate in the context of credit register data. Section 5 presents a list of indicators that can be calculated using credit register data and highlights the challenges associated with comparing and analysing indicators across countries. Strategies to achieve a maximum cross country consistency despite heterogeneous data sources are outlined. Section 6 presents the preliminary results of a euro area initiative which aims at illustrating the potential of AnaCredit for macroprudential analysis by bridging data gaps on the euro area level. Section 7 concludes and outlines further work.

2. The use of credit register data for financial stability

Credit register data represents a particularly valuable source of information for financial stability analysis due to the granularity of the data. Micro level credit and credit risk data provides useful insights not only at aggregated level, but also allow analysis of distributions and help identifying tail risks. This is particularly relevant for macroprudential analysis as averages and aggregated values are often not sufficient to detect vulnerabilities and risks.

Several examples of analytical projects based on the use of credit register data are present in the recent literature. A number of authors focus on credit risk analysis, such as large exposure concentration or sector concentration (see e.g. Konečný et al (2015), Holub et al (2015)). Thanks to their granularity, CCR data are particularly suitable also for network and interconnectedness analysis. The data can

also be used to assess the effectiveness of macroprudential measures.[1] The impact of LTV and DSTI measures was for example studied by the Banque de France (Dietsch and Welter-Nicol, (2014)), while Basten and Koch (2015) and Uluc and Wieladeck (2015) focus respectively on the effects of capital requirements and CCyB on mortgage lending.

Girault and Hwang (2010) stress that credit register data present an important factor to enhance supervision and regulation of the financial system. The information can be used to monitor credit risks undertaken by individual institutions, the banking sector as a whole, or segments of it. Credit register data allows supervisors to look at a broad picture of the concentration of risk exposures by sector, geographic distribution, type of borrower or type of credit (see Dent, 2014). Moreover, CCRs can help supervisors to identify parts of the loan portfolio which might require a more in-depth review and can thus play a role as input in supervisory planning decisions. IFC (2012) also supports the role CCR can play in monitoring risk on and off-site, for example by helping to detect differences in the ratings assigned to borrowers by different banks (World Bank, 2011). In general, CCR data can serve as key input to model PDs or LGDs (Artigas (2004)), which are key risk indicators, and also support the development of early warning systems, stress tests and other monitoring tools or methods (Centre for European Policy Studies — European Credit Research Institute (2013)). Dent (2014) highlights the importance of CCR data in the area of real estate risk monitoring by central banks and banking supervisors. Analysis of the credit conditions is vital for monitoring credit risk and applying the correct macroprudential tools. CRR data allows identifying trends in lending, gaining a better understanding of underwriting standards and borrower creditworthiness and can thus contribute from a macroprudential perspective in achieving a higher stability for the entire financial system.

For these types of analysis, information about the distribution of risk indicators within the credit portfolio is crucial, which can only be extracted from granular data.

Due to the granularity of CCR, it is not only possible to extract information about the distribution of risks within the loan portfolio of banks, but also to look at further break downs in terms of either sectors, counterparts or borrower characteristics. A tribute to the importance of CCRs for macroprudential monitoring can also be found in Konečný et al (2015). They present some of the indicators extracted by CCR data and used for credit risk monitoring in Czech National Bank, such as a default rate indicator, a credit standards indicator, the ratio of NPLs to total loans, indicators for differences in client risk classification across banks, as well as for credit risk vintage analysis.

A survey conducted among several NCBs within the work of the Advisory Group on AnaCredit has highlighted the importance of credit registers for financial stability and macroprudential analysis in national central banks and provided interesting insights of the current use of these data by financial stability departments in the euro area. Some examples of projects carried out include: (i) credit risk analysis (e.g. monitoring of concentration risk, assessment of banks exposures, assessment of creditworthiness of debtors), (ii) network analysis and analysis of contagion risk, to

[1] See e.g. the Closing Conference of the BIS CCA CGDFS Working Group "The impact of macroprudential policies: an empirical analysis using credit registry data", June 2016.

help the assessment of banks' systemic importance, (iii) stress tests and impact assessment exercises and (iv) assessment of the impact and effectiveness of macroprudential measures.

3. National credit registers and the introduction of AnaCredit

While existing national central credit register data are used in several EU Member States for financial stability analysis and are very useful to analyse risks at country level, possibilities for cross country analysis are currently limited due to the heterogeneity of national credit registers.

Currently, 15 Member States have a CCR (see Table 1). Characteristics of national CCRs can vary significantly along different dimensions. First, the reporting threshold can range from EUR 0 in countries such as Belgium to EUR 1 million in Germany, inducing huge differences in the type of lending recorded in the database. Furthermore, the length of time series is highly diverse; some national CCRs date back to the nineties, and in some cases the data collection started even before (Spain, 1984), while other countries, e.g. Lithuania, only recently developed one (2011). Although credit register data are generally collected from resident lenders on an unconsolidated basis, there can be differences in the reporting scope of national CCRs, e.g. for what concerns the type of borrowers (in some cases non-resident borrowers are excluded from the perimeter) and the type instruments. Finally, the type of information collected within the different CCRs is neither complete nor comparable, as the range of available attributes considerably differs across country, and it is based on non-harmonised definitions.

Table 1: Overview of thresholds in national CCRs in the EU

	AT	BE	CZ	DE	ES	FR	IE	IT	LV	LT	MT	PT	RO	SI	SK
Threshold	350,000	0	0	1,000,000	6,000	25,000	500	30,000	0	290	5,000	50	4,440	0	0

The need for a euro area level granular analytical database on credit and credit risk data based on a common set of definitions has become more and more urgent in the aftermath of the financial crisis, and as a consequence the idea of AnaCredit was put forward. The introduction of the AnaCredit Regulation[2] adopted in May 2016 for the collection of harmonised loan-by-loan data fosters the comparability across countries and thus also increases the relevance of credit register data.

AnaCredit is a loan-by-loan database containing information on credit to companies and other legal entities granted by credit institutions and their foreign branches on a monthly basis. The information collected consists of 88 different attributes based on harmonised concepts and definitions and covers various aspects of the credit exposure. The dataset is organised in several tables based on three

[2] Regulation (EU) 2016/867 of the ECB of 18 May 2016 on the collection of granular credit and credit risk data (ECB/2016/13), OJ L 144, 1.6.2016, p. 44.

main elements: instruments, counterparties and protection received. The reporting threshold is EUR 25 000[3].

The introduction of AnaCredit will enhance data availability and harmonisation of information, allowing more in-depth and accurate analysis. However, AnaCredit will only be available as from end-2018, and no time series dimension will be available for data users. In order to already illustrate the potential of AnaCredit and to complement the existing risk assessment indicators available from other data sources without delay, this paper presents a project to construct (time series) indicators for sectoral risk monitoring based on existing national CCRs, focusing on risk in the CRE sector.

4. Sectoral risk monitoring, data gaps in CRE and CRE sector definitions

Monitoring risks stemming from CRE markets and understanding how they can affect the financial system is crucial for financial stability. The recent global financial crisis has shown that CRE markets are prone to strong boom and bust cycles (Olszewski (2013)). In comparison with residential real estate, cumulated prices changes in CRE between the boom and bust were around twice as high, as analysis in Ellis and Naughtin (2010) shows and also contributed to the significant losses of banks in the financial crisis. Disorderly price adjustments in the CRE markets can significantly affect financial stability since loans for CRE account for a significant part of the total mortgage lending: banks in most euro area countries are significantly exposed to CRE via their loan portfolio (see ECB (2008) and Hiebert and Wredenborg (2012)). Furthermore, commercial property markets tend to be more cyclical and volatile than residential property, due to closer linkages with general economic developments and to the lower elasticity of supply (see ECB (2008) and ESRB (2015)).[4] Cyclicality is further exacerbated by opaqueness of CRE markets, as the lack of reliable information and data sources hampers the possibility of efficiently pricing CRE properties. Overall, the CRE market therefore presents a relatively risky market for banks (see Nyberg (2005)).

It is also observed that CRE loans present higher default rates compared to RRE loans, increasing the riskiness of this sector.[5] This is partly due to the highly capital intensive nature and the strong reliance on external financing, which has characterised the market for many years.[6] This higher riskiness is especially relevant considering that exposures to CRE markets are more concentrated than exposures to RRE, given the lower number of borrowers which though hold a higher share of banks exposures (Olszewski (2013)).

The importance of CRE sector for financial stability is also reflected a study undertaken by the ESRB in 2015, which identified the CRE sector as potentially

[3] Israël et al. (2017).

[4] See for example Benford and Burrows (2013), ECB (2008), Ellis and Naughtin (2010) and ESRB (2015).

[5] ESRB (2015).

[6] ECB (2008), Gyourko (2009).

systemic, along with 3 other economic sectors: consumer durables (mainly automotive industry), materials and fabrication (mainly steel and chemical industries), and utilities (mainly gas and electricity).

Given the importance of the sector, it is crucial from a financial stability perspective to monitor risks and vulnerabilities stemming from these exposures held by the financial sector. However, such an analysis is currently hampered by the general scarcity of CRE data. Therefore, collection data and closing data gaps is an important and necessary step towards a better monitoring of risks (Olszewski (2013)). Until credit gaps are closed in a more encompassing way, credit register data can be a valuable source of information for the monitoring of risks in the CRE markets.

The closing of data gaps in the area of Commercial Real Estate is complicated by the fact that there is no harmonised definition of CRE. The recent work in an ESRB Expert Group on commercial real estate has confirmed that there is, as yet, no consensus on a precise definition of what should fall under "exposure to CRE". The ESRB report however suggested the following working definition for commercial property: "buildings, including occupied land, which are held for the express purpose of generating an income. While the expert group broadly agrees that CRE should include multi-family residential dwellings, there is some debate as to whether buy-to-let housing and property under development should also be included." (ESRB (2015)).

For the purposes of the project, CRE exposures are defined very broadly as all the bank loans — mainly to corporations — falling under the NACE economic branches "Construction" (NACE code 41) and "Real estate activities" (NACE code 68). This definition was chosen, as credit registers only allow distinguishing between different NACE codes and therefore a NACE-code based definition of the sector is the only feasible option.

One can certainly dispute this definition, as it probably includes more (and potentially at the same time also less) exposures than what is needed to efficiently assess all risks associated with commercial real estate, as it is defined by the ESRB. On one hand, the definition of CRE used in this project can be considered as broader than the ESRB definition, as the analysis focuses on all loans to corporations active in NACE branches 41 and 68, regardless of whether these loans serve to produce or hold income-producing real estate. On the other hand, the definition of CRE on the basis of the NACE codes is narrower than the ESRB definition, as the exposure of banks to CRE should preferably also take into account the loans made to non-CRE companies but collateralised with their CRE assets (e.g. office buildings, retail commerce buildings). The proposed definition of CRE is relatively broad, but nonetheless not entirely comprehensive as regards banks' exposure to potential risks related to commercial real estate assets that are defined — as a working definition — in the abovementioned ESRB report as "buildings, including occupied land, which are held for the expressed purpose of generating an income". These differences notwithstanding, the proposed definition of CRE based on NACE codes presents good proxy for monitoring of risks associated with CRE. The next section details the indicators for CRE monitoring that were developed.

5. Cross-country sectoral risk monitoring based on national credit register data

The following section presents the indicators which are calculated based on national credit register data. It is important to keep in mind that the indicators in isolation do not present a complete monitoring framework, as they are designed to be complementary to other, existing information, coming from other public or private data sources (see also section 4). The indicators will provide added-value on the national level given the overall scarcity of CRE data, and will also help to assess developments from a cross-country perspective.

5.1 Set of indicators

Sectoral risk concentration

The following indicators partly reproduce those developed in the ESRB report on Sectoral Risk (2015) and focus on risk concentration. Other credit risk or exposure indicators presented in the remaining part of this section can also be calculated for a subsample of banks with high exposure concentration scoring.

Table 2: Sectoral risk concentration indicators

Indicator description	Description	Details and formula
Sector granularity	HHI of firms' borrowing within a sector, to see how concentrated borrowing is within a sector	$HHI_k^{firms} = \sum_{i=1}^{N} s_i{}^2$ With s_i being the share of lending to firm *i* over total lending to that sector i.e. $s_i = E_i / \sum_{i=1}^{n}(E_i)$ for each firm *i*=1..*N* in sector *k*
Risk of funding concentration	HHI of banks' shares of total exposures towards a sector, to see how dependent a given sector is on a certain number of banks. The lower the HHI index, the more diversified that sector is in terms of its funding sources	$HHI_k^{banks} = \sum_{j=1}^{J} s_j^2$ With $s_j = E_j / \sum_{i=1}^{J}(E_j)$ for each bank *j*=1.*J* lending to sector *k*

Credit risk indicators

The following indicators examine credit risk by monitoring the evolution of PDs and NPLs. Moreover, they help to assess how well credit is protected and collateralised, which would provide insight into the losses banks may face in the event of defaults.

There are a number of other descriptive statistics that can provide further insight into sectoral risk. As mentioned in the ESRB Report on Sectoral Risk (2015), for each sector one could look at the average and the standard deviation of the PD. Another possibility is also to look at the quartiles of PDs within sectors, and complement this with the share of sectoral exposure coming from the worst quartile of the PD distribution. These descriptive statistics could be calculated for both the stock and flow of lending.

Table 3: Exposure indicators

Indicator description	Details and formula
Total exposure to sector as % of Tier1 capital (or other capital measure) per bank, *potential additional version: quartiles of this indicators*	$\lambda_{k,j} = \frac{\sum_1^H E_h}{T1_j}$ Loop over all exposures of bank j to sector k, divided by Tier1 capital of bank j
% of total exposures with collateral, by sector *potential additional version: quartiles of bank level indicators*	$\mu_k^1 = \frac{\sum_1^H E_h \, \delta_h}{\sum_1^H E_h}$ Loop over all exposures to sector k, with $\delta_h = 1$ if exposure E_h has dedicated collateral
Total pledged collateral as a % of total collateralised exposures, by sector for all banks in one country, *potential additional version: quartiles of bank level indicators*	$\mu_k^2 = \frac{\sum_1^H C_h}{\sum_1^H E_h \delta_h}$ Loop over all exposures E_h.to sector k, where C_h is the collateral value assigned to E_h with $\delta_h = 1$ if exposure E_h has dedicated collateral

Table 4: Credit risk indicators

Indicator description	Details and formula
% of total exposures with positive non-performing amount (exposure weighted)	$\omega_k^1 = \frac{\sum_1^H E_h \, \delta_h}{\sum_1^H E_h}$ with $\delta_h = 1$ if exposure E_h has positive non-performing amount
% of total exposures to vulnerable debtors (% of total exposures to debtors with any positive non-performing amount); Calculation for each bank, then illustration of the distribution in each country (anonymised)	$\omega_{k,j}^2 = \frac{\sum_1^N E_i \, \delta_i}{\sum_1^N E_i}$ Loop over all *N* debtors of a bank *j*, where E_i is the total borrowing of debtor *i*, and $\delta_i = 1$ if debtor i has any positive non-performing amount
% of new lending towards a certain sector going to borrowers already registered as non-performing	$\omega_{k,j}^3 = \frac{\sum_1^N NewLending_i \, \delta_i}{\sum_1^N NewLending_i}$ Loop over all *N* debtors of a bank *j*, where $NewLending_i$ is the amount of new lending to borrower *i*, and $\delta_i = 1$ if debtor i has any positive non-performing amount
Value of collateral pledged to non-performing exposures as a % of total non-performing exposures	$\omega_k^3 = \frac{\sum_1^H C_h \, \delta_h}{\sum_1^H E_h \delta_h}$ Loop over all collateral C_h for exposures *H* with

	$\delta_h = 1$ if exposure is non-performing.
Change in exposure-weighted PD, by sector *Alternative: Graphically, PD in period t on the x axis and PD in period t-1 on the y axis to illustrate the development of PDs in the sector*	$\Delta\overline{PD}_k = \sum PD_{it} \cdot s_{it} - \sum PD_{i,t-1} \cdot s_{i,t-1}$ Where s_i is defined as above, and we are comparing periods *t* and *t-1*
Change in the % of exposures with non-performing status	$\Delta NPL_{k,t} = \frac{\sum_1^H E_{h,t}\,\delta_h}{\sum_1^H E_{h,t}} - \frac{\sum_1^H E_{h,t-1}\,\delta_h}{\sum_1^H E_{h,t-1}}$ with $\delta_h = 1$ if exposure E_h is non-performing

Maturity developments and debt roll over indicators

The indicators below can help to judge whether there are a large number of firms who will want to rollover their debt, and how the maturity profile of their exposures has changed over time.

Table 5: Maturity profiles indicators

Indicator description	Description	Details and formula
Maturity Profile of Exposures	Distribution of maturity of exposures	Distinguishing between 3 maturity buckets ([<1Y], [1Y, 5Y], [>5Y])
Debt rollover demand *potential additional version: quartiles of this indicators on bank level*	% of exposures with maturity less than one year, by sector	$\eta_k = \frac{\sum_1^H E_h\,\delta_i}{\sum_1^H E_h}$ with $\delta_h = 1$ if exposure *h* has a maturity of less than one year and $\delta_h = 0$ otherwise
Maturity of new loans *potential additional version: quartiles of this indicators on bank level*	The weighted average maturity of loans issued, by sector	$m_{k,j} = \sum_1^H s_h M_h$ Where *H* is the total number of loans issued to sector *k* within a given period, $s_h = \frac{E_h}{\sum E_h}$, and M_h is the original maturity of loan *h*
Average loan volume *potential additional version: quartiles of this indicators on bank level*	The average volume of loans issued, by sector	$v_k = \frac{\sum_1^H E_h}{H}$ Where *H* is the total number of loans issued to sector *k*, and E_h is the volume of loan *h*

Lending standards

Monitoring lending standards through indicators such as LTV at the origination of new loans or interest rate margins is very important from a financial stability perspective. However, calculating these indicators is not feasible for most of the countries. Moreover, information on the general level of interest rates as well as on

interest rate margins can only be found in other data sources (e.g. iMIR) at bank level.

Common exposures/multiple lending

These indicators examine how many borrowers have multiple banking relationships. If a borrower has many banking relationships, this can contribute to a higher degree of interconnectedness. However, multiple lending can also have stabilising effects on the market. To have a clearer picture of how significant this issue is, the proposed list could be potentially complemented by a measure that reflects the number of relationships, e.g. the number of lending relationships in case of a multiple lending relationship.

Table 6: Indicators for common exposures and multiple lending (Single vs. multiple borrower relationship).

Indicator description	Details and formula
% of total exposure going to borrowers with multiple banking relationships, by sector	$\alpha_k^1 = \frac{\sum_i^N E_i \delta_i}{\sum_i^N E_i}$ Where $\delta_i = 1$ if firm i borrows from more than one bank and is equal to 0 otherwise
% of firms with multiple banking relationships, by sector	$\alpha_k^2 = \frac{\sum_i^N \delta_i}{N}$ Where $\delta_i = 1$ if firm i borrows from more than one bank and is equal to 0 otherwise, and *N* is the total number of firms in sector *k*

Cross-border risk

The indicators in Table 7 help to assess whether a sector is particularly reliant on funding from abroad; such funding could be less stable in the event of turbulent market conditions. Moreover, the degree to which domestic banks lend to foreign entities and whether this foreign lending is exposed to currency risk could be monitored. These exposures could be more risky not only due to potential exchange rate risk, but also due to the issue of asymmetric information which could be more relevant for these exposures. Data availability for these indicators across countries is rather low. In general, it is only possible to monitor borrowing from foreign branches or subsidiaries.

Table 7: Cross-border risk indicators

Indicator description	Description	Details and formula
Lender Origination	% of total exposures that are being lent from foreign	$\beta_k = \frac{\sum_{j=1}^J E_j \delta_j}{\sum_1^J E_j}$

	entities, by sector	E_j is the money lent to sector k by bank j. With $\delta_j = 1$ if j is a foreign bank and is equal to 0 otherwise.
Currency Risk	% of credit issued domestically but denominated in foreign currency, by sector	$\gamma_{k,c} = \frac{\sum_1^H \widetilde{E}_h^c}{\sum_1^H E_h}$ With $\widetilde{E}_h^c$ being denominated in foreign currency *c*

5.2 Challenges and robustness checks

As mentioned above, national credit registers are not harmonised and therefore the list of attributes, but also the definitions of attributes as well as the threshold of transactions included in CCR can vary significantly across countries. These differences need to be taken into account when choosing the sample of underlying data to be included for the calculation of the indicators. A careful review of the selection choices is therefore needed for each indicator to ensure a maximum level of comparability.

The lack of a commonly agreed EU definition of CRE and the subsequent heterogeneity of underlying data can be another challenge in terms of cross-country comparability of indicators. It may be useful to consider exposures towards construction and real estate firms (NACE codes F41 and L68) as a starting point. Moreover, quality checks are envisaged to identify possible problems in the data or to avoid the inclusion of companies that could distort results. A percentile analysis can be useful in this respect. Moreover, to further test the quality of the indicators, cross-checks with other data sources such as FINREP were performed. Nevertheless, given the different characteristics of the national CRE markets, caution and expert judgement will always be needed to interpret results.

Scope of the analysis

As discussed above, the reporting scope of different national CCRs is not comparable in many cases. To overcome this issue and with the aim of having the most comparable sample across countries, the following perimeter of the analysis was defined.

Regarding **lenders**, only resident credit institutions, including branches and subsidiaries of foreign institutions are considered. Loans from special purpose vehicles (SPVs) can be included for those countries (e.g. Italy) that deem it advisable. Data are on an unconsolidated level.

Only the following types of **borrowers** are included in the analysis: resident individuals, resident institutions, resident NFCs and resident general government or other public entities. For sake of comparability, non-resident borrowers are excluded from the scope of the analysis.

For what concerns the type of **instruments**, only cash credit (including defaulted loans) is considered.

Regarding the **threshold**, no harmonisation is imposed. Considering the high threshold in some countries (e.g. Germany), a common threshold would imply a considerable loss of information. The same reasoning applies to the **length of time series**. To strike a good balance between harmonisation and amount of information, 2004 Q1 was chosen as starting point for the time series.

Attributes definition and cross-country comparison

Given the high heterogeneity in concepts and attributes definition across national CCRs, a thorough review of existing definition and cross-country comparison was carried out among the attributes involved in the calculation of indicators. Decision on which attribute or definition to choose was made with the aim of ensuring highest cross-country comparability.

Availability of each attribute at national level is shown in Table 8.

Table 8: Availability of each attribute at national level

Attribute	Description	AT	BE	DE	ES	FR	IT	SK
Threshold		350,000	0	1,000,000	6,000	25,000	30,000	0
Currency	EUR/non-EUR distinction	✗	✓	✗	✓	✓	✓	✓
NACE codes	Any type of NACE coding	✓	✓	✓	✓	✓	✓	✓
Borrower ID/Lender ID	Any type of coding	✓	✓	✓	✓	✓	✓	✓
Exposure Value	Book value, gross carrying amount	✓	✓	✓	✓	✓	✓	✓
Residual Maturity/Original Maturity	3 buckets: [<1Y], [>1Y to <5Y], [>5Y]*	✗	✓	✗	✓	✗	✓	✓
Collateral Value	Total amount of all collaterals/protections which is recorded	✓	✓	✓	✓	✗	✓	✓
Type of Protection	Create new dummy variable for "Protection Availability"**	✓	✓	✓	✓	✗	✓	✓
NP Status	As two dummy variables, one at obligor level and one at loan level if available.	✗	✓	✗	✓	✗	✓	✓
NP amount	Amount if available (as a sum of past-due over 90 days + unlikely to pay + bad loans)	✗	✓	✓	✓	✗	✓	✓
PDs	Use PDs available in national CR	✓	✓	✓	✓	✓	✓	✓

** For Italy only 2 buckets: [<1Y], [>1Y]. A different dummy will be used to distinguish from the three buckets variable.*
*** Can be also calculated through collateral value*
**** To define NP status, use all subcategories if different sub-categories are available (past-due over 90 days + unlikely to pay + bad loans)*

Some basic attributes (green highlighted in Table 8) are either relatively harmonised (e.g. NACE code) or the fact that they rely on different approaches in the national CCRs does not matter in the context of this project (e.g. borrower/lender ID). Regarding the exposure value to be considered, it was agreed to use the book value (gross carrying amount), which is available in all CCRs.

For other attributes (yellow highlighted in Table 8), some adjustments were needed. Regarding original and residual maturity, it was decided to only collect information divided in three buckets (<1Y; >1Y to <5Y; >5Y), to allow the highest possible country coverage. Protection and collateral value are treated as the same variable and include the total amount of all collaterals and protections recorded. Whenever such amount is greater than EUR 0, it is considered that a protection is available.

Credit risk attributes represent the most critical in terms of heterogeneity of definitions across CCRs. For the scope of our analysis, the non-performing amount is defined as the sum of loans past-due over 90 days, unlikely to pay loans and bad loans. The probability of default (PD) is used whenever possible. This can be supervisory PD (as in Austria and Belgium), ICAS PD (Italy), or it can be derived from complementary data sources (Slovakia). In some countries the PD is not available, and some similar concepts are used instead. In France, Banque de France's internal credit rating is used, while in Spain the default rate can be a proxy for this attribute.

A particular attention has to be paid when analysing indicators for which the underlying attributes present relevant differences across countries.

Robustness check: a comparison with FINREP data

Exposures to commercial real estate related sectors such as construction and real estate activities are available also in FINREP data. To strength the basis of our analysis, a comparison between exposures amount in the national CCRs and in FINREP was carried out. First, the differences in scope between these two data sources are recalled.

FINREP data (*consolidated basis*): these supervisory data show the banks' exposures to various economic sectors (FINREP Table F.06.00), including their geographical breakdown (F.20.07). The CRE exposures from this data source correspond to banks' on-balance sheet exposures. In this connection, it is important to flag that what is understood as the construction sector in FINREP is somewhat broader than the scope of CRE defined above. In FINREP, the construction sector does not only encompass the NACE economic branch 41 "Construction of buildings" but also 42 "Civil engineering" and 43 "Specialised construction activities". For the other sector ("Real estate activities"), the FINREP concept coincides with the NACE branch 68.

National Corporate Credit Register data (*unconsolidated basis*): This data source normally provides detailed (generally borrower-by-borrower and more rarely – e.g. Spain – credit by credit) information on bank exposures to companies of the NACE branches 41 and 68, which are mainly vis-à-vis domestic counterparties. In addition to the "used" amounts (which correspond to the amounts shown in the balance sheet), credit registers sometimes also provides "authorised" amounts, which include the contingent/off-balance sheet exposures (credit lines). The table below summarises the main differences in the scope between both data sources:

Table 10: Comparison between FINREP and CCR scopes

	FINREP	National CCR[7]
Reporting entities	All consolidating banks	All credit institutions (incl. branches of foreign banks)
Reporting basis	Consolidated	Unconsolidated
Nature of information	Aggregated at the level of the economic sector	Borrower-by-borrower (Spain: credit-by-credit)
	Amount of non-performing loan and coverage ratio	Some credit risk data (extremely patchy and heterogeneous across countries)

[7] The table refers to Belgian CCR. However, CCR in the other euro area countries share similar features.

When comparing CCR and FINREP data, other differences has to be taken into account. First, very often CCR data are subject to a reporting threshold, which in some cases can be very high (e.g. Germany). No reporting threshold is foreseen in the case of FINREP data. Furthermore, the sector classification system between the two data sources generally differs, as the internal NACE code attributed by a bank to the borrower may differ from the NACE code used in the CCR. The NACE code and institutional sector of domestic companies in the CCR are assigned by the NCBs. One entity could be classified differently (different NACE code or institutional sector) in FINREP (banks' classification) and in the CCR (NCBs' classification). Finally FINREP data include all borrowers independently from the state of residence, while in some CCRs (e.g. Italy) no NACE code is available for non-resident borrowers.

All these differences notwithstanding, a simple comparison of total exposure value in some national CCRs and FINREP data show that values are fairly comparable. Major differences are registered in Germany and to a lesser extent in Austria. This is mainly due to the fact that the number of banks included in the FINREP sample is much smaller than in the CCR.

Chart 1: Exposures to all NACE sectors

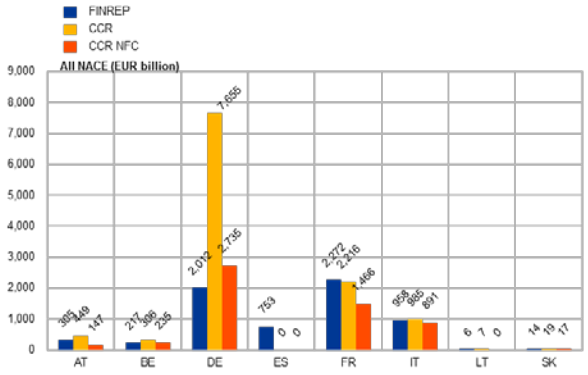
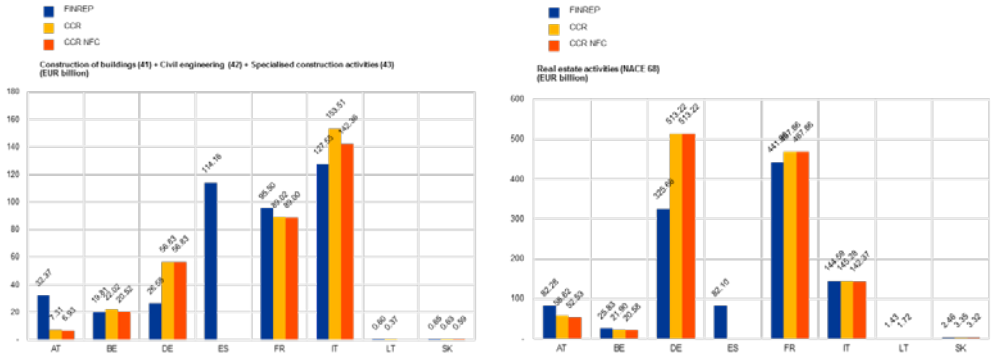


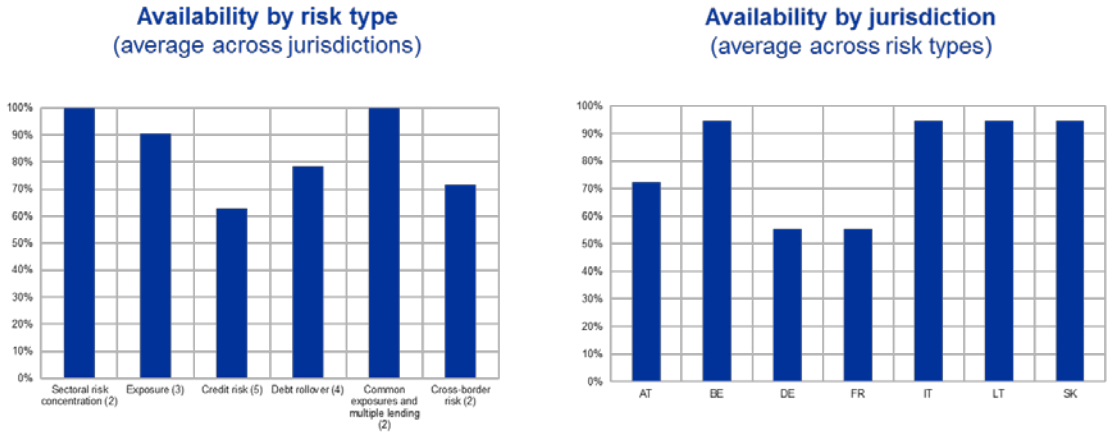
Chart 2: Exposures to Construction sector (left) and real estate activities (right)



6. Overview of results

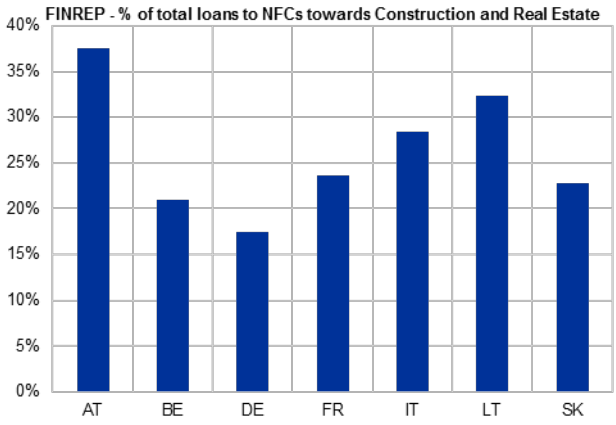
This section presents the main findings of the analysis. Not all indicators can be calculated for all countries, due to availability of attributes or data quality. Chart 3 provides an overview of the general availability of indicators across countries.

Chart 3: Availability of calculated indicator



The analysis shows that banks are highly exposed to both construction and real estate sectors in all countries participating to the project, with exposures to these sectors accounting from 35% of total exposures in Austria to around 17% in Germany in 2016Q2 (Chart 4). However, a qualitative analysis of the largest CRE exposures in some jurisdictions has revealed that the nature of these exposures is very heterogeneous. This finding needs to be taken into account when performing a risk assessment of this sector.

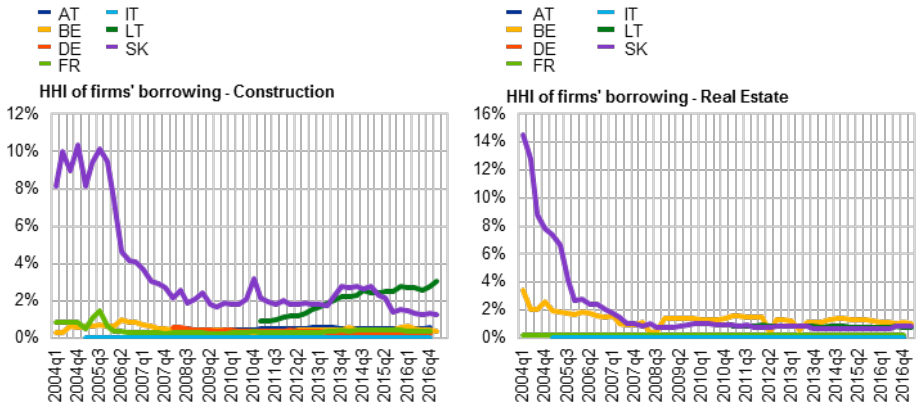
Chart 4: Share of exposures to construction and real estate activities over total exposures to NFCs.



As an example of results obtained, calculated indicators show that the concentration of firms borrowing is generally low for all countries in both constructions and real estate activities sectors. The industry is generally highly competitive (HHI < 0.01) or unconcentrated (HHI < 0.15), meaning that no single borrower or a small group of borrowers attracts a high share of lending. The analysis shows that the trend in concentration has remained fairly stable, although some differences exist across countries. Slovakia presents a sharp decrease in borrowing concentration of both sectors from 2004 (more than 10%) to 2007 (less than 1%). An increasing trend in the construction sector is observed in Lithuania since 2012, indicating a decreasing competition in this sector. Some minor fluctuations are observed in the case of France, but these can be attributed to a possible outlier (the exposure of a single bank to one borrower) and may also reflect an accounting problem. This low

concentration however only implies diversification benefits for lenders, if the sector is not characterised by strong co-movements.

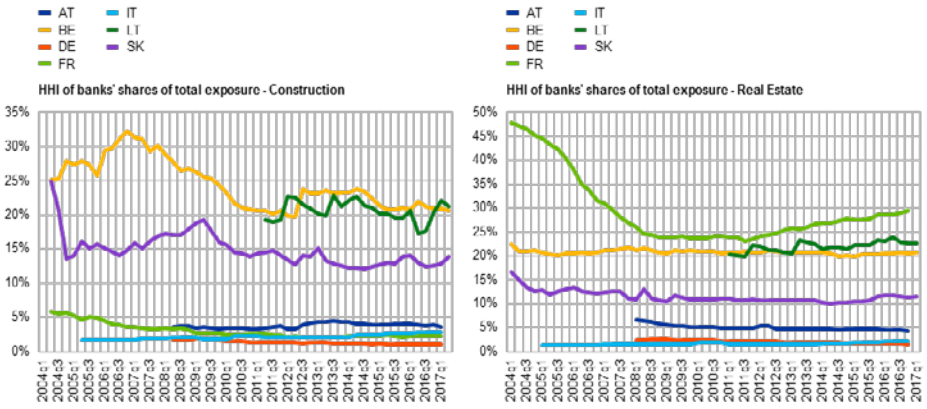
Chart 5: Borrowing concentration.



Source: national CCRs.

More cross-country variation is observed in funding concentration. Unsurprisingly, smaller countries characterised by a more concentrated banking system present a moderate funding concentration (ranging from around 15% in Slovakia to more than 20% in Belgium and Lithuania). Conversely, funding concentration is extremely low in Austria, Germany and Italy. France represents an exception, as notwithstanding the large number of banks, lending concentration to companies involved in real estate activities was over 45% in 2004 and stands currently at around 30%. However, this is due to the weight of the public bank financing the social housing. When excluding it, the HHI is flat at around 3%.

Chart 6**:** Lending concentration.



Source: national CCRs.

Other findings are as follows. The results based on the ratio of non-performing exposures (NPEs) to total exposures indicate that the CRE sector, and especially its construction component, is highly cyclical and volatile. According to previous studies, this is explained by the closer linkages with general economic developments and the lower elasticity of supply of commercial property compared to residential property (see ECB (2008) and ESRB (2015)). In addition, the NPE ratio appears to be higher and more volatile in the construction sector than in the real

estate activities sector, which could suggest a higher riskiness and pro-cyclicality of the former sector compared to the latter. The high heterogeneity observed across countries, both in terms of levels and trends, is probably partly due to different cyclical situations but it should also interpreted with care given that the definition of nonperforming exposures has only been recently (2014) harmonized in the EU and that some jurisdictions part of the project relied on proxies to calculate this indicator. Nevertheless, the relatively large fluctuations of the NPL ratios over time and the existence of high peaks, in particular for the construction sector, can be interpreted as a sign of the general riskiness of the sector in economic downturns.

Exposures to construction and real estate activities are generally highly collateralised, although these levels should be interpreted with caution given the somewhat heterogeneous definition of the collateral variable across countries. The evolution over time nevertheless suggests that the financial crisis has led to a significant increase in collateral requirements, which is expected to improve the resilience of the banking sector towards a shock, as long as the applied valuation measures are reliable and consistent over time.

In terms of maturity profile, the share of long-term exposures to firms active in the construction and real estate activities sector is higher and seems to have even increased in the recent past, potentially due to firms taking advantage of the low interest rate environment. The maturity of exposures to construction firms is shorter in all countries, probably due to the more short term project length in this sector, where financing is normally only needed until the constructed building is sold. In the presence of a drop in demand for buildings, this short-term funding can present a vulnerability of the sector.

7. Outlook and conclusions

The granularity of credit register data provides an excellent basis for analysing risk and vulnerabilities in the banking sector, as information about the distribution of key risk indicators can be obtained. Apart from the distribution of risks within banks and the banking sector as a whole, credit register data in particular allows to identify links between banks, either via similar exposures or via direct or multiple lending relationships.

While on the national level, countries with a credit register are already able to exploit this rich set of information, cross-country comparisons are currently hampered by the different definitions and coverage of national credit registers. The AnaCredit project, starting in September 2018 with the first data collection, will overcome this situation by introducing a euro area wide, harmonised credit register. Still, the time series dimension of the AnaCredit database will only gradually develop over time, as past data will not be available. Until harmonised time series are available in AnaCredit, efforts can be undertaken to create indicators for financial stability monitoring based on credit registers in a cross-country framework.

This paper presented a project to build indicators to monitor risks stemming from the sectors construction and real estate related exposure (NACE codes 41 and 68) for several countries. The recent global financial crisis has shown that CRE markets are prone to strong boom and bust cycles and should therefore be

monitored from a macroprudential perspective. However, analysis of CRE markets is currently hampered by significant data gaps. The project presented in this paper puts forward a set of coherent indicators, derived from the national CCR of a number of euro area countries and aims at bridging some of the data gaps which hinder analysis of commercial real estate exposures and associated risks in banks' balance sheets. The indicators capture different aspects of risk, like a) concentration measures, b) exposures and credit risk indicators, c) maturity profile, d) common exposures and multiple lending and e) cross-border exposures. Thanks to the granularity of credit register data, it is possible to calculate indicators on bank level, and therefore to capture the distribution of certain risk dimensions in the banking sector. Moreover, depending on the specificities of the national banking sector, different breakdowns of the indicators could be constructed for further analysis. The paper gives a preview on results of the project for selected indicators for one country as illustration. However, work is still ongoing and in particular the time series dimension of indicators will provide additional insights.

Given the different definitions and thresholds in the national credit registers, efforts were undertaken to ensure a sufficient level of comparability across countries. Nevertheless, the interpretation of results requires expert judgement and background information about national characteristics and specialities of the national credit register. Moreover, when combining indicators calculated based on credit register data for specific NACE codes, and data about CRE market developments from other data sources, potential deviations in terms of definitions and sectoral coverage need to be kept in mind.

While the focus of the project is on the risk posed by the commercial real estate sector, many of the constructed indicators are not sector-specific, and can be easily used to monitor other systemic sectors.

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BANK FOR INTERNATIONAL SETTLEMENTS

IFC-National Bank of Belgium Workshop on "*Data needs and Statistics compilation for macroprudential analysis*"

Brussels, Belgium, 18-19 May 2017

Use of credit registers to monitor financial stability risk: An application to commercial real estate[1]

Patrick van Roy, National Bank of Belgium,

and

Gaia Barbic, Anne Koban and Charalampos Kouratzoglou, European Central Bank

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

EUROPEAN CENTRAL BANK

EUROSYSTEM

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IFC-NBB Workshop on data needs and statistics compilation for macroprudential analysis

Brussels, 19 May 2017

Disclaimer: The views expressed are those of the authors and do not necessarily reflect those of the ECB or NBB

Overview

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What is the CRE sector?

- **Many definitions** of the CRE sector exist.

- **ESRB:** “Buildings, including occupied land, which are held for the express purpose of generating an income” (2015 Report on commercial real estate and financial stability in the EU).

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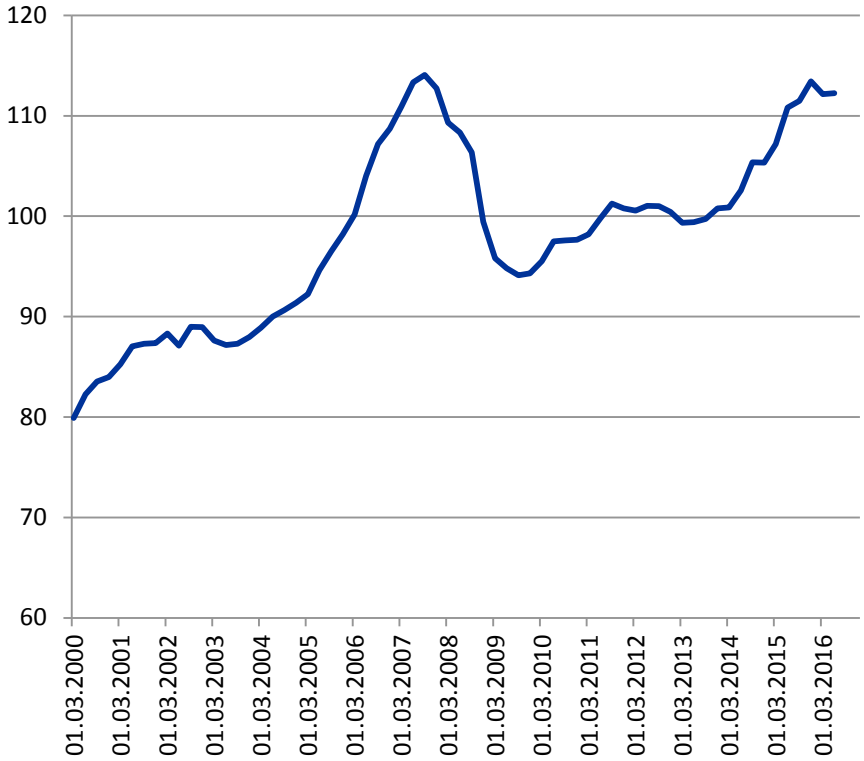
Why focusing on the CRE sector? (1/2)

EU CRE Property Price Index
(all types, 2011 = 100)



Sources: ECB and Experimental ECB estimates based on MSCI

- EU CRE prices have recently **reached their pre-crisis level.**
- Disorderly price adjustments in the CRE markets could affect **financial stability** because:
  - Loans for CRE account for a **significant part** of the **total mortgage lending** in some euro area countries;
  - Commercial property markets tend to be **more volatile** and **more reactive** to business cycles than residential property.

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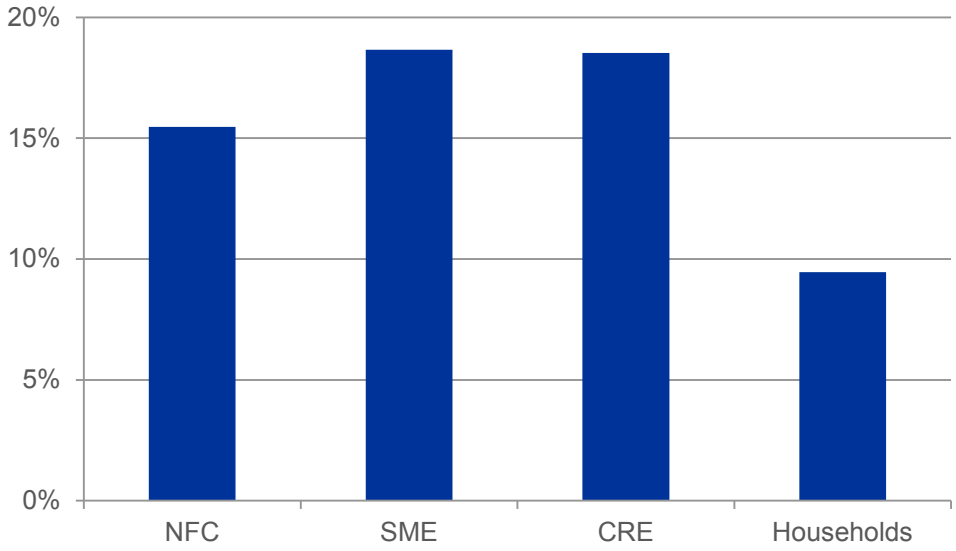
Why focusing on the CRE sector? (2/2)

Non-performing loan ratios by sector, Q4 2016
(average across euro area countries)



Source: ECB stocktake reports of national supervisory practices and legal frameworks related to NPLs

- CRE loans show almost the **highest NPL ratio** in the euro area.
- Large amounts of NPLs affect **financial stability**:
  - For **banks in "going concern"**, they lower profitability and constrain the ability to provide new financing to the economy;
  - For **banks in "gone concern"**, they can hamper efficient resolution.

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Which data is missing?

- Although the regulatory reporting framework (e.g. Finrep/Corep) has improved and ECB/ESRB initiatives have been taken to enhance the monitoring of national CRE markets, **data gaps remain**.

- For instance, the available commercial real estate figures from private vendors only cover *prime* commercial real estate sector and reflect a combination of market evidence (where available) and a survey of expert opinion, **rather than transaction (volume) or valuation (price) information**.

- In addition, there is not much information available on the **credit granted by banks and associated exposures and risks**. In our paper, we focus on the **latter dimension**.

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Credit registers can shed light on credit, exposures and risks because they contain:

- **Many variables** thereby allowing to look at several risk types.

- **Granular (i.e. borrower or loan) level information**, which is important given that financial stability risk assessment is interested in the tails (not so much in averages).

⇒ Key question: make use of national credit registers or wait for AnaCredit?

- **AnaCredit** (see also presentation in this session):
  - No data available before end-2018
  - No time-series available before a couple of years

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Advisory Group on AnaCredit (AGA)

- Group set-up under the ECB's FSC. Current membership: **AT**, **BE**, **DE**, **ES**, **FR**, **IT**, **SK**, **LT** and the **ECB**.

- In order to already **illustrate** the potential of AnaCredit and to **complement** the existing risk assessment indicators available **without delay**, the AGA has constructed **financial stability indicators for CRE based on existing national credit registers**.

- This approach could also be extended later to **other sectors** e.g. those identified as being **systemic** in the 2015 ESRB report on sectoral risk.

- AGA's indicators of sectoral risk are useful not only from an **ESRB/ECB perspective**, but also from a **national perspective**, as countries do not yet calculate these or similar indicators.

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3. Work of AGA

Challenges

- Finding **harmonised risk indicators** across countries was **not obvious** due to different set-up and definitions of national credit registers.
- **CRE definition** needed to be operationalized.

Implications

- **Careful choice** of underlying data and definitions of indicators was made to ensure sufficient comparability.
- **CRE definition**: “Bank loans – mainly to corporations – falling under the NACE economic branches **Construction** (41) and **Real estate activities** (68)”.

Caveat

- Indicators can **only** provide **additional input** among other hard and soft evidence.
- Emphasis should not only be on **cross-country comparisons** but also on **time-series evolution** for the same country.

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22 indicators organized by risk types (see Annex)

Sectoral risk concentration(2)	• Sector granularity • Risk of funding concentration
Exposures (4)	• Total exposures (with or without collateral) • Total pledged collateral as a % of total collateralised exposures
Credit risk (7)	• Vulnerable exposures and exposures towards vulnerable debtors (firms) • PDs and NPLs • Collateral and protection amounts
Debt rollover (4)	• Debt rollover ability and demand • Maturity of new loans and average loan volume
Common exposures and mult. lending (2)	• % of exposures to firms with multiple banking relationships • % of firms with multiple banking relationships
Cross-border risk (3)	• Lender origination • Borrower origination • Currency risk

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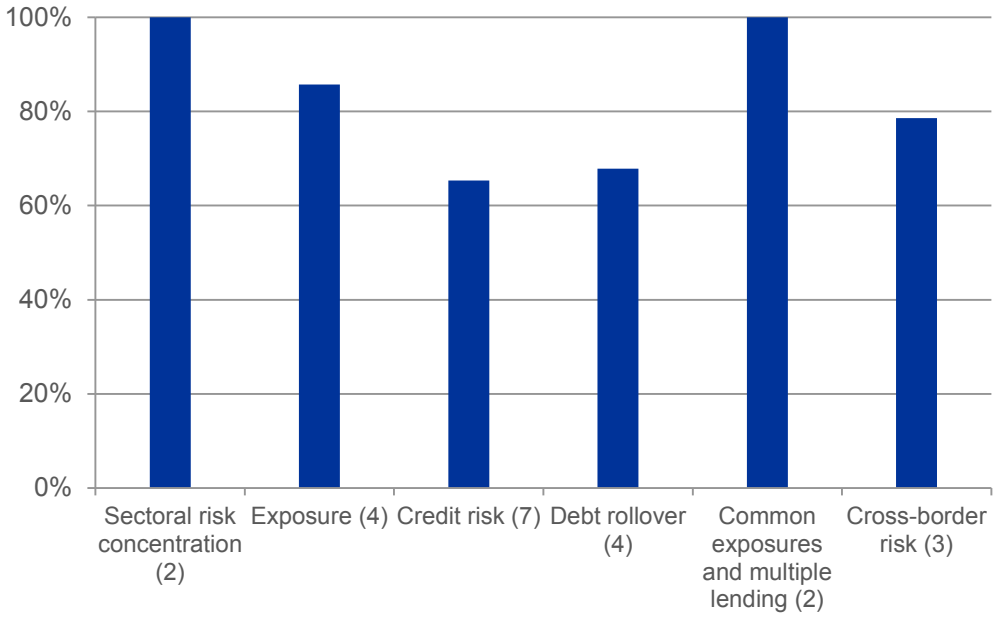
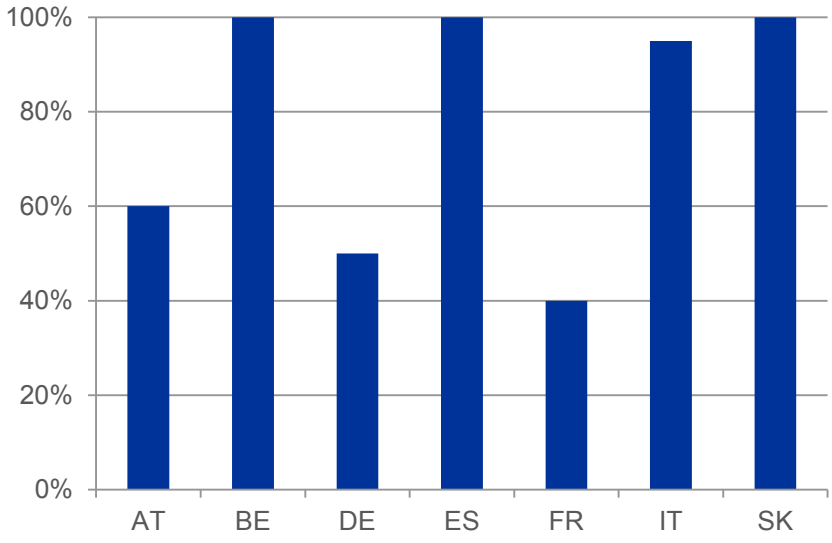
Availability of risk indicators (Q4 2016) - Preliminary assessment

Availability by risk type
(average across jurisdictions)



Source: Advisory Group on AnaCredit

Availability by jurisdiction
(average across risk types)



Source: Advisory Group on AnaCredit

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Caveat

The following slides **illustrate** some very preliminary results of AGA's work for:

- **2 indicators** (instead of 22)
- **1 jurisdiction** (instead of 7)
- **1 quarter** (instead of a 10-year history, when available)

Indicators can be calculated at the **jurisdiction** or at the **bank level**. In the case of the latter, **only aggregated statistics** will be shared within the AGA.

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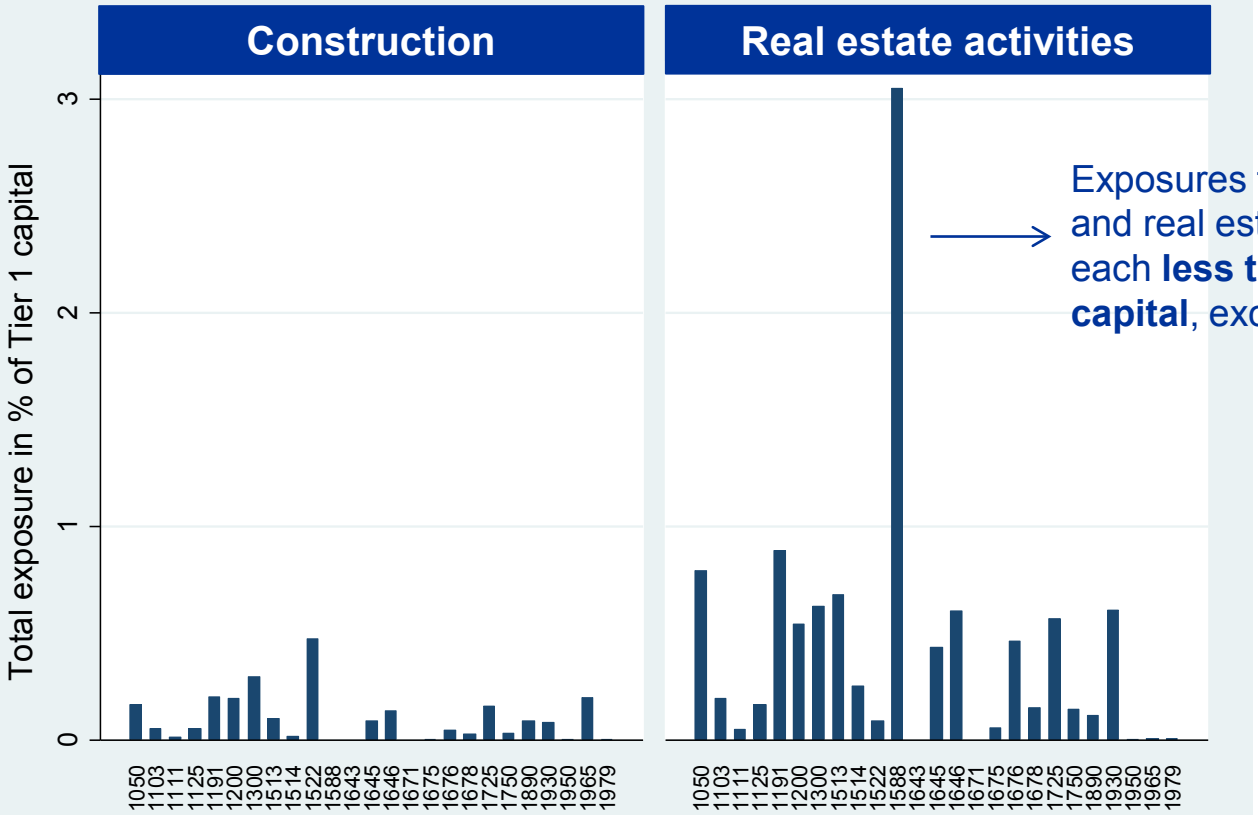
Example of concentration indicator (Q4 2016)

Distribution of banks (X-axis) according to the size of their CRE exposures scaled their by Tier 1 capital (Y-axis, %):



Exposures towards construction and real estate activities represent each **less than 1% of Tier 1 capital**, except for one bank

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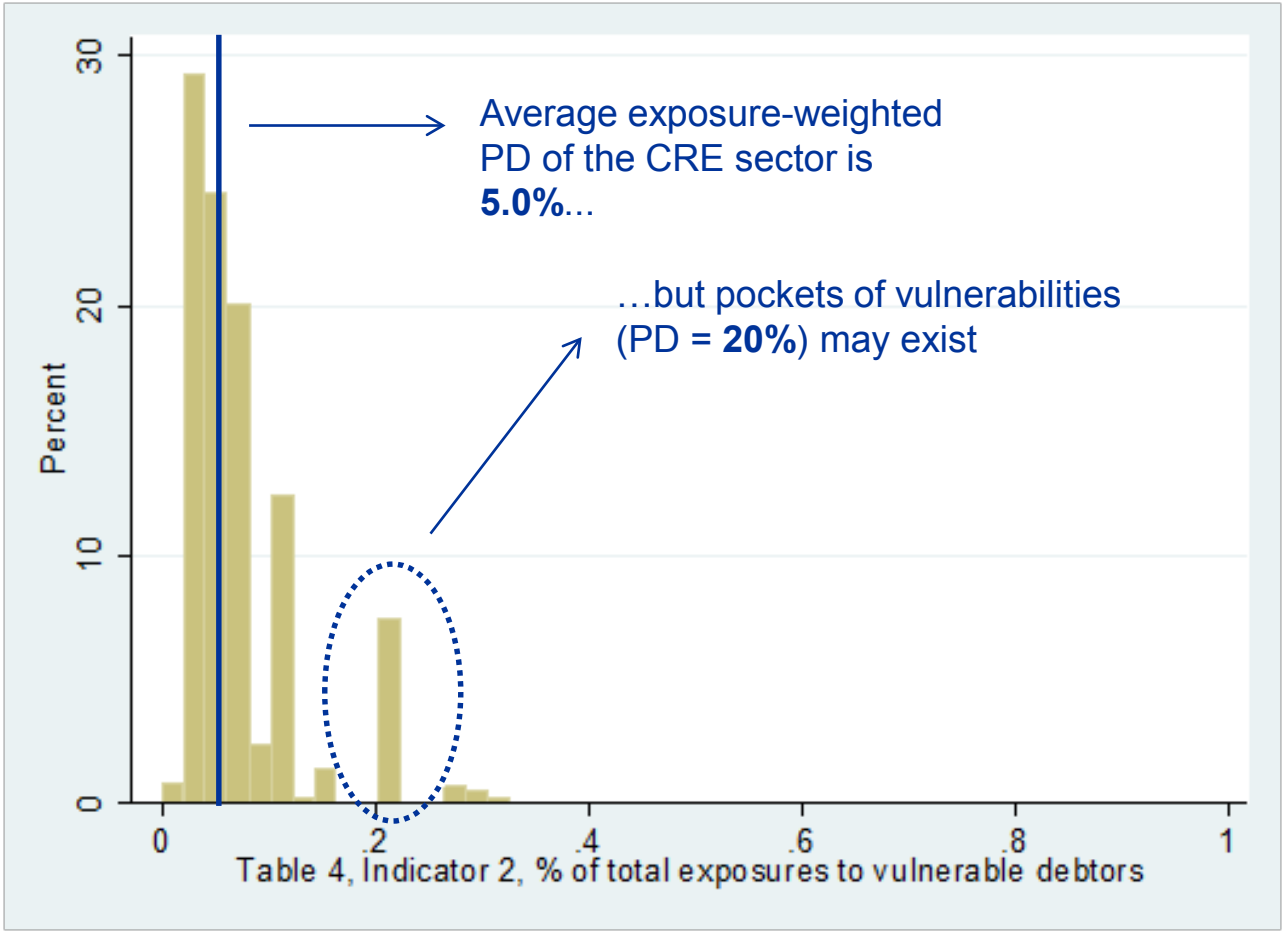
Example of credit risk indicator (Q4 2016)

Distribution of CRE exposures (Y-axis, in %) according to their probability of default (X-axis, in %):



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Outlook

- **June 2017:** first results for all jurisdictions.
- **Summer 2017:** review of first results.
- **Fall 2017:** final results to be integrated into monitoring frameworks and approach to be possibly extended to other sectors.

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ANNEX

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Sectoral risk concentration indicators (2)

Indicator description	Description	Details and formula
Sector granularity	HHI of firms' borrowing within a sector, to see how concentrated borrowing is within a sector	$HHI_k^{firms} = \sum_{i=1}^{N} s_i^2$ With s_i being the share of lending to firm *i* over total lending to that sector i.e. $s_i = E_i / \sum_{i=1}^{n}(E_i)$ for each firm *i*=1..*N* in sector *k*
Risk of funding concentration	HHI of banks' shares of total exposures towards a sector, to see how dependent a given sector is on a certain number of banks. The lower the HHI index, the more diversified that sector is in terms of its funding sources	$HHI_k^{banks} = \sum_{j=1}^{J} s_j^2$ With $s_j = E_j / \sum_{i=1}^{J}(E_j)$ for each bank *j*=1..*J* lending to sector *k*

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Exposure indicators (4)

Indicator description	Details and formula
Total exposure to sector as % of Tier1 capital (or other capital measure) per bank, *potential additional version: quartiles of this indicators*	$\lambda_{k,j} = \frac{\sum_1^H E_h}{T1_j}$ Loop over all exposures of bank j to sector k, divided by Tier1 capital of bank j
% of total exposures with collateral, by sector *potential additional version: quartiles of bank level indicators*	$\mu_k^1 = \frac{\sum_1^H E_h \delta_h}{\sum_1^H E_h}$ Loop over all exposures to sector k, with $\delta_h = 1$ if exposure E_h has dedicated collateral
Total pledged collateral as a % of total collateralised exposures, by sector for all banks in one country, *potential additional version: quartiles of bank level indicators*	$\mu_k^2 = \frac{\sum_1^H C_h}{\sum_1^H E_h \delta_h}$ Loop over all exposures E_h.to sector k, where C_h is the collateral value assigned to E_h with $\delta_h = 1$ if exposure E_h has dedicated collateral

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Credit risk indicators (7) – Part 1

Indicator description	Details and formula
% of total exposures with positive non-performing amount (exposure weighted)	$\omega_k^1 = \frac{\sum_1^H E_h \delta_h}{\sum_1^H E_h}$ with $\delta_h = 1$ if exposure E_h has positive non-performing amount
% of total exposures to vulnerable debtors (% of total exposures to debtors with any positive non-performing amount); Calculation for each bank, then illustration of the distribution in each country (anonymised)	$\omega_{k,j}^2 = \frac{\sum_1^N E_i \delta_i}{\sum_1^N E_i}$ Loop over all *N* debtors of a bank *j*, where E_i is the total borrowing of debtor *i*, and $\delta_i = 1$ if debtor *i* has any positive non-performing amount

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Credit risk indicators (7) – Part 2

Indicator description	Details and formula
% of new lending towards a certain sector going to borrowers already registered as non-performing	$\omega^3_{k,j} = \frac{\sum_1^N NewLending_i \, \delta_i}{\sum_1^N NewLending_i}$ Loop over all N debtors of a bank j, where $NewLending_i$ is the amount of new lending to borrower i, and $\delta_i = 1$ if debtor i has any positive non-performing amount
Value of collateral pledged to non-performing exposures as a % of total non-performing exposures	$\omega^3_k = \frac{\sum_1^H C_h \ \delta_h}{\sum_1^H E_h \delta_h}$ Loop over all collateral C_h for exposures H with $\delta_h = 1$ if exposure is non-performing.
Change in exposure-weighted PD, by sector *Alternative: Graphically, PD in period t on the x axis and PD in period t-1 on the y axis to illustrate the development of PDs in the sector*	$\Delta\overline{PD}_k = \sum PD_{it} \cdot s_{it} - \sum PD_{i,t-1} \cdot s_{i,t-1}$ Where s_i is defined as above, and we are comparing periods t and $t-1$
Change in the % of exposures with non-performing status	$\Delta NPL_{k,t} = \frac{\sum_1^H E_{h,t} \delta_h}{\sum_1^H E_{h,t}} - \frac{\sum_1^H E_{h,t-1} \delta_h}{\sum_1^H E_{h,t-1}}$ with $\delta_h = 1$ if exposure E_h is non-performing

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Debt rollover indicators (4)

Indicator description	Description	Details and formula
Maturity Profile of Exposures	Distribution of maturity of exposures	Distinguishing between 3 maturity buckets ([<1Y], [1Y, 5Y], [>5Y])
Debt rollover demand *potential additional version: quartiles of this indicators on bank level*	% of exposures with maturity less than one year, by sector	$\eta_k = \frac{\sum_1^H E_h \delta_i}{\sum_1^H E_h}$ with $\delta_h = 1$ if exposure h has a maturity of less than one year and $\delta_h = 0$ otherwise
Maturity of new loans *potential additional version: quartiles of this indicators on bank level*	The weighted average maturity of loans issued, by sector	$m_{k,j} = \sum_1^H s_h M_h$ Where H is the total number of loans issued to sector k within a given period, $s_h = \frac{E_h}{\sum E_h}$, and M_h is the original maturity of loan h
Average loan volume *potential additional version: quartiles of this indicators on bank level*	The average volume of loans issued, by sector	$v_k = \frac{\sum_1^H E_h}{H}$ Where H is the total number of loans issued to sector k, and E_h is the volume of loan h

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Common exposures / multiple lending indicators (2)

Indicator description	Details and formula
% of total exposure going to borrowers with multiple banking relationships, by sector	$\alpha_k^1 = \frac{\sum_i^N E_i \delta_i}{\sum_i^N E_i}$ Where $\delta_i = 1$ if firm i borrows from more than one bank and is equal to 0 otherwise
% of firms with multiple banking relationships, by sector	$\alpha_k^2 = \frac{\sum_i^N \delta_i}{N}$ Where $\delta_i = 1$ if firm i borrows from more than one bank and is equal to 0 otherwise, and N is the total number of firms in sector k

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Cross-border risk indicators (3)

Indicator description	Description	Details and formula
Lender Origination	% of total exposures that are being lent from foreign entities, by sector	$\beta_k = \frac{\sum_{j=1}^{J} E_j \delta_j}{\sum_{1}^{J} E_j}$ E_j is the money lent to sector k by bank j. With $\delta_j = 1$ if j is a foreign bank and is equal to 0 otherwise.
Currency Risk	% of credit issued domestically but denominated in foreign currency, by sector	$\gamma_{k,c} = \frac{\sum_{1}^{H} \tilde{E}_h^c}{\sum_{1}^{H} E_h}$ With $\tilde{E}_h^c$ being denominated in foreign currency c

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