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Laurence Deborgies Sanches and Marno Verbeek

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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

Basel methodological heterogeneity and banking system stability: The case of the Netherlands*

Laurence Deborgies Sanches[a] and Marno Verbeek[b]

[a] *De Nederlandsche Bank*
[b] *Erasmus University of Rotterdam*

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Abstract

The paper investigates how the mix of credit risk measurement methodologies under Basel capital adequacy rules influenced banking stability in the Netherlands during 2008-2015. It presents a first descriptive analysis that helps to examine the micro-regulation of individual banks and the macro-regulation of the banking system in one unified framework. Its goal is to draw regulators' and researchers' attention to interesting issues based on the comparison of the literature highlighting the weak points of the regulatory framework with what is observed in the dataset. Its purpose is to stimulate discussions on certain methodological and policy options.

Keywords: macro-regulation, banks, credit rating, Basel methodology.
JEL classifications: G001, G21, G24, G28.

* *Corresponding author: E-mail: l.d.m.sanches@dnb.nl* The view expressed in this paper are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank. We are particularly grateful to Gisella Van Vollenhoven and Jakob de Haan for their important help in the process of this paper. We would like to thank David Keyser for providing the datasets, Paul Cavelaars, Tom van Veen, Ron Jongen and all the persons interviewed at De Nederlandsche Bank with whom Laurence Deborgies Sanches had interesting and helpful discussions. Finally, we do not forget the useful help of Gareth Bunnen.

1. Introduction

With the adoption of the risk-sensitive capital requirements in the Basel Capital Accords, banks have to hold a minimum level of capital contingent on the risk of their portfolio.[1] For credit risk, capital requirements depend on the creditworthiness of the bank's borrowers. As the credit rating is a proxy of the probability that an individual borrower may default, it has been used to calculate the capital charges necessary to support the credit risk incurred in the transactions.

Since the introduction of Basel II, banks' required capital is calculated using two approaches. The Standardized Approach includes banks' loan exposures that may either be unrated or rated by officially recognized credit rating institutions, the "external credit assessment institutions".[2] In the Internal Rating-Based Approach, banks are allowed to use their own internal risk estimation models to estimate the probabilities of default, the loss-given-default, loan maturities and loan exposure at default. As a result, there are significant differences in the methodologies used to calculate capital requirements for banks. These differences are not only observed between the two approaches but also, within each of them because both, the external the credit rating institutions and the banks use their own internal estimation models to assess borrowers' creditworthiness. It results in a mix of methodologies which is specific to each individual bank.

This study focuses on this resulting heterogeneity of methodologies empirically observed in the Netherlands over the period 2008 – 2015. More precisely, this paper documents how the risk measurement methodologies used in the Basel Capital Accord to calculate banks' required capital, influence the stability of the banking system during and after the global crisis. In the context of the present paper, the stability is analyzed from the impact of the macro-economic environment on banks' credit losses, as reflected in their loan exposure, provisioning policy and capital requirements. As a major cause of instability, the cyclicality of capital requirements is examined. The analysis therefore focuses specifically on the evolution of credit risk during the period.

The period analyzed is particularly interesting because it includes a financial crisis (2007 – 2009) with several dramatic events like the interbank market liquidity shortage (end 2007), the respective collapse of Bear Stearns and Lehman in 2008 and a sovereign debt crisis in 2009 – 2012. Banks' activities and soundness have suffered considerably in all countries. Confronted by such huge problems, national governments had to intervene in order to save their banks, stop the spillover effect to the entire banking system and its propagation to the broader economy. Moreover, each time the European Central Bank had to take action to influence the banks' funding in the euro area.

[1] Annex 2 describes the twelve portfolios considered in this study. These portfolios are grouped among four main portfolios: Sovereign, Corporate, Financial Institutions and Retail.

[2] These institutions are either a credit rating agency for example Moody's, Standard & Poors and Fitch or a central government. Annex 1 describes the regulatory framework adopted since the application of Basel II in 2007.

In the meantime, the methodological framework of Basel regulation was subject to three searching criticisms. First, due to the key destabilizing role in the origin and amplification of the crisis and major corporate defaults, the well established and growing regulatory reliance on credit ratings provided by the credit rating institutions was questioned.[3] The second problem is the procyclicality of the risk-sensitive capital requirements consequence of allowing banks to use their own credit rating systems. The procyclicality translates into lower (or higher) required capital in periods of favorable (or unfavorable) economic conditions during which bank lending activity increases (or decreases). In forcing banks to alter their lending behavior, regulatory constraints indirectly amplify the business cycles; banks being obliged to restrict their supply of credits in economic downturns, which magnifies the recession. Finally, during the global crisis a third problem came to light: the necessity and difficulty (i.e. Blinder et al. [2016]) of extending the regulation from banks individually to the banking system as a whole and thus the need to put in place a macro-regulation.

In reaction, important reforms of the micro-regulation involving individual bank capital supervision have progressively been enforced since 2013. However, policies designed to maintain the stability of the banking system are still limited by the difficulties encountered in developing the necessary macro-regulation of the banking system. The lack of linkages between the micro- and macro-regulation is still a serious defect in banking supervision.

Based on these critics, this paper presents a first descriptive analysis that sheds new light on the existing bank capital regulatory framework. We use information provided on a quarterly basis by banks to their supervisory authority, De Nederlandsche Bank. We adopt a macro-regulatory point of view by gathering and / or aggregating individual banks' reports.[4] We examine and compare the micro- and the macro-regulation respectively related to individual banks and to the banking system as a whole in one unified framework. This paper is a preliminary analysis that aims to draw the attention of regulators and researchers to interesting issues that come from the comparison between the relevant literature and what is observed in the dataset. Our intention is to offer new insights into the much debated Basel methodological framework in order to open the way to further developments.

We start our analysis of the banking system in constructing the curves of the loan exposure (measure of banking activity) and required capital. This step is important to consider because their relationship is at the heart of the cyclicality issue involved in Basel regulatory framework. We observe that, as expected due to the global crisis, banking activity and therefore required capital strongly decrease. Splitting the loan exposure between the two approaches reveals the effects of a transfer of activity

[3] Credit rating agencies' controversial role appears in the Asian crisis (1997), the recent financial crisis with the late and sudden downgrades of a great number of participants and securities in the market of structured assets and finally in the major corporate bankruptcies like Enron in the US.

[4] No diversification effect is taken into consideration. This process is adopted in the Basel regulatory framework when the total required capital is calculated for each bank.

from the Standardized to the Internal Rating-Based Approach observed until 2010Q2. From that date, the loan exposure in the Standardized Approach stabilizes at a low level and the Internal Rating-Based Approach becomes largely preponderant. This trend is not surprising in Basel regulation. Compared to the Standardized Approach, the Internal Rating-Based Approach benefits from reduced risk weights and then lower required capital. We also notice that these two decreasing trends follow different time evolutions. Such imbalance highlights the importance of considering the methodological frameworks used in the two approaches to estimate the risk borne by the banking system.

Our results reveal that only focusing on the risk-weighted assets does not help to understand the relationship between loan exposure and required capital. In the two approaches, loan exposure and risk-weighted asset follow similar trends. However, our investigation highlights the major role played by the (regulatory) credit risk ratio (risk-weighted amount divided by loan exposure value). For each portfolio we calculate the probability of default and the loss-given-default both in terms of the quarterly average across all banks. We find that depending on the portfolio and the period considered, the credit risk ratio either follows the trends of one or of the two averaged risk aggregates. We explain these "similarities" from the difficulties banks have in estimating the credit risk of their lending activity. For example, in the Sovereign portfolio we notice that the curves describing the average probability of default and the credit risk ratio are very similar. Indeed, as Sovereign lending is characterized by scarce but very large defaults, the loss-given-default is extremely difficult to estimate. At the opposite, in the Retail Real-Estate portfolio, the curve of the credit risk ratio tends to result from a combination of average probability of default and average loss-given-default. Banks' internal models can better estimate the two risk aggregates because they have excellent knowledge of the risk involved in their local retail lending activity and thus long historical data of defaults.

A more detailed examination of the methodological framework shows that the credit risk ratio has very specific cyclical trends independent of the variations of the risk-weighted asset. We observe in some portfolios, like Banks for example, that the credit risk ratio follows an opposite increasing trend compared with the decrease of the loan exposure, of the risk-weighted asset and thus of the required capital. At the opposite in other portfolios like Retail Real-Estate, the three variables rise while the credit risk ratio is stable at low levels. Put in their macro-economic context, these observations suggest that the credit risk ratio brings additional dynamic information relatively to the risk-weighted asset which is thus better described as a static measure of risk. We believe that regulators could use the credit risk ratio type of measure to adjust the direct effect of the risk-weighted asset on banks' capital constraints. It would contribute to dampening the negative consequences of Basel capital procyclicality on major sectors of activity like the Retail Real-Estate in the Netherlands.

Our observations reveal that the influence of the defaulted loans on the relationship between loan exposure and risk-weighted asset (equivalent to required capital) does not only affect the results of

banks' estimation models. During the global crisis, banks reacted to the increase of the defaulted exposure by considerably hardening their protection policy.[5] During the first sub-period of our sample, we find in the Standardized Approach that the growing and large amounts of provisions considerably reduce the level of the risk-weighted asset (or capital requirements). In the Internal Rating-Based Approach, such an effect is only observable from the calculation of the risk coverage ratios (provision over expected loss). The level of provision and coverage ratio remain high after the crisis. We also calculate the respective coverage ratios for the defaulted, non-defaulted and total loan exposure. The coverage ratio determined for the total exposure follows the coverage ratio of respectively, the defaulted loans during the crisis period and the non-defaulted exposure after the crisis. Consequently, we believe that these results should be integrated into the macro-regulatory framework. The coverage ratio deserves particular attention from the supervisory authorities. Moreover, since the application of the forward looking provisioning in 2017, it is expected to become a useful indicator of banks' opinion on their macro-economic environment and their confidence in the future.

Our analysis of the methodological heterogeneity in Basel regulation also reveals that compared with the Standardized Approach, in the Internal Rating-Based Approach the credit risk ratios and the defaulted loans exposures react earlier and their variations are smaller. We then find signs of through-the-cycle properties in the Standardized Approach whereas the Internal Rating-Based Approach appears more point-in-time. Our analysis of the rating methodologies used in the two approaches is in line with the literature. Our focus on rating system properties raises the major problem of the procyclicality resulting from Basel methodological framework. For this aim, we examine the correlation calculated between the risk-weighted asset and the GDP growth rate. During the entire period, we find that the banking system is weakly procyclical. However, unexpectedly our results reveal that the Internal Rating-Based Approach is countercyclical and the Standardized Approach is procyclical. More precisely, the unrated loan positions are countercyclical while the exposures assessed by external ratings are strongly procyclical.

In order to find an explanation to our counterintuitive results, we split the period in two sub-periods defined by "during" (2008−2012) and "after" (2013 – 2015) the crisis. Our goal is to examine whether and to what extent the criticism of he role played by the credit rating agencies and the regulatory reliance on credit ratings have had an impact on the rating methodologies used by banks and the external rating entities. We find that from one period to the other, the procyclicality increases in the loan exposures assessed by the external rating entities. Thus, our results show that the change in the rating agencies' behavior revealed and studied in the literature has observable repercussions on the

[5] Credit risk mitigation techniques include collateral, guaranties and derivatives. As these techniques are not clearly identified during the whole period analyzed in our dataset and that their effect on the exposure value results from a specific calculation briefly presented in the footnote 14, they are not examined in the present paper.

cyclical behavior of banks' required capital in the Standardized Approach. Contrary to all expectations due to Basel recommendations, in the Internal Rating-Based Approach we find that, generally the internal rating systems change from strongly countercyclical during the global crisis to procyclical after the crisis.

To develop our analysis, the present paper is organized as follows: Section 2 starts with a regulatory snapshot of the Dutch banking system. As the empirical analysis of the procyclicality of Basel regulatory framework is the focus of the present paper, the relationship between loan exposure and required capital is presented and the impact of the credit risk management process is investigated. In Section 3, we examine how the heterogeneity of methodological frameworks of Basel regulation influences the risk borne by the banking system. Section 4 investigates how this mix is subject to two major criticisms of Basel capital regulation related to the use of credit ratings for regulatory purposes and the major issue of the capital requirements cyclicality. The last section concludes.

2. A regulatory view of the Dutch banking system

This study is based on a specific regulatory dataset.[6] This dataset includes information on loan exposure, defaulted loan, provision, credit risk mitigation techniques (derivatives, guarantees and collateral) and risk-weighted asset. The latter is a specific percentage of the required capital. Under the Basel regulatory framework, the risk-weighted asset measures the amount of risk borne by a bank (Basel (2004) and Basel [2006]). In the Standardized Approach, the risk-weighted asset is calculated from pre-specified percentages named risk weights. The higher the credit risk, the bigger the risk weight is. In the Internal Rating-Based Approach, banks report in this regulatory dataset all the risk aggregates necessary to calculate the risk-weighted asset (the probability of default and the exposure-at-default in its Foundation version in addition with, the loss-given-default and the maturity in its Advanced version).[7] The primary aim of our dataset is to find the information disaggregated among the risk weights in the Standardized Approach and the probabilities of default in the Internal Rating-Based Approach.

In this section, we start by presenting a general overview of the Dutch (regulatory) banking system. We start by focusing on the relationship between loan exposure and required capital in order to highlight how banks react to the fluctuations of the macro-economic environment. This preliminary step is necessary to understand the evolution over 2008 − 2015, of the financial stability of the banking system in the context of a macro-regulation. We first observe that, from March 2008 until December 2015, our sample includes 65,102 observations of which 33,170 are provided by the Standardized Approach. An observation consists of all information from the original exposure to the risk-weighted

[6] This dataset has already been used in Chaudron (2016).
[7] Annex 1 summarizes how the required capital charges are calculated in the two approaches.

asset necessary to calculate a specific level of capital requirement. This information is provided each quarter by one bank, at each level of probability of default, for each claim or portfolio defined under the Basel methodological framework. During this period, to calculate their required capital, 69 banks use the Standardized Approach and 18 the Internal Rating-Based Approach. In March 2015, 38 banks are still present in the Standardized Approach (SA) and 10 banks in the Internal Rating-Based Approach (IRB). In our sample "pure" SA banks exist (banks which only use the Standardized Approach for all their exposures and claims) and most of the IRB banks (banks using the Internal Rating-Based Approach) also employ the Standardized Approach.

We next focus on the average loan exposure calculated for each approach over the entire period. Figure 1 reveals a different view of the banking system depending on the approach considered. The Standardized Approach (the pie chart on the left) appears more balanced between the shares of the different banks comprising it.[8] Out of the six largest shares, the first two belong to two "pure" SA banks. The Internal Rating-Based Approach reveals a different picture. The pie chart on the right in Figure 1 shows the monopolistic structure which characterizes the Dutch banking system.

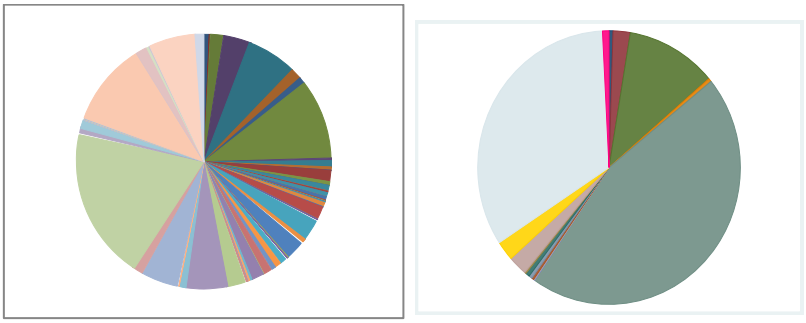


Figure 1: Sample composition per bank in the Standardized Approach (left) and in the Internal Rating-Based Approach (right). Percentages calculated for all banks over 2008q1-2015q4. For confidentiality reasons the banks identifiers are removed.

In the first quarter 2014 (2014Q1), the structure of the information provided in our (regulatory) dataset was revised. This date is thus a transitory period during which banks had to report the required information under both the previous and the reformed dataset. This modification does not directly affect our data as the methodologies applied to calculate the capital charges do not change. However the list of claims was modified, with some claims being added and others removed. The most noticeable changes concerned two portfolios. The portfolio "Banks" completely disappeared in the two approaches and, the portfolio "Corporate-SME" was only removed in the Standardized Approach. Annex 2 documents the differences between the two sub-periods (2008 – 2004Q1 and 2004Q1 – 2015).[9]

[8] In this chart, a correction is done to remove a special case in order to present a more realistic view of the Standardized Approach used by the Dutch banks. This correction is only done in this particular figure and not in the rest of the analysis.

[9] We keep in our analysis the data provided in 2014Q1by the dataset used during the period 2008-2014Q1.

Figure 2 illustrates the major events which affect our data during 2008 – 2015. The periods pre- and post-reform of the dataset identified before and after the transitory period 2014Q1, are for convenience re-termed to as the "old" and the "new" dataset. Figure 2 shows the banking and the Sovereign debt crises which affected all banking systems in the world at the beginning of the period. Their propagation to the rest of the economy is revealed in the context of the Netherlands by the sharp fall in the GDP growth rate from 2008Q1 till 2009Q1 when the two crises start to overlap.

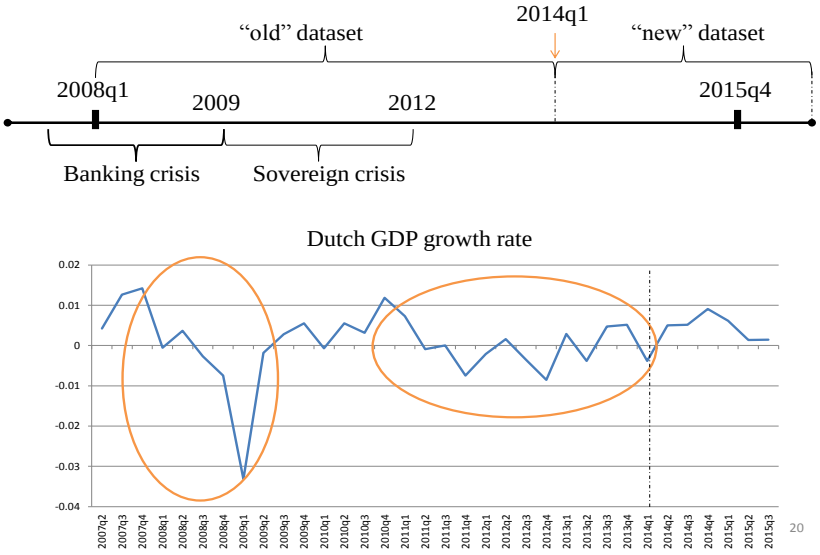


Figure 2: Economic and regulatory context of the study. The graph at the top documents the main economic and regulatory events observed during the period analyzed. The graph at the bottom shows the evolution of the Dutch GDP growth rate with 2007Q2 as the starting date.

We start our analysis of the banking system in constructing the curves of the loan exposure (measure of banking activity) and required capital. This step is important to consider because their relationship is at the heart of the cyclicality issue involved in Basel regulatory framework.

Not surprisingly in Figure 3, our data reveal a decrease in the Dutch banking activity and, as a consequence, a strong reduction in the required capital. The graph on the left shows that the banking activity evolved by stages of periods of decline (2008Q2 – 2009Q4) and (2011Q3 – 2013Q3) interrupted by periods of stability, (2009Q4 – 2011Q3) and (2015Q1 – 2015Q4). Interestingly, periods of GDP growth recoveries coincide with periods of stabilization in banks' activity. Moreover, we observe that bad macroeconomic performances and falls in banking activity occur at the same time. The graph on the right shows the strong and constant diminution of the required capital until 2013Q3 (period of bad GDP performances) followed by an increase and stabilization around €45 billion. Such distinct evolutions reveal that the reduction in the total loan exposure is not the only cause of the diminution of the required capital. In the following subsections we thus investigate what factors may influence the relationship between these two main aggregates.

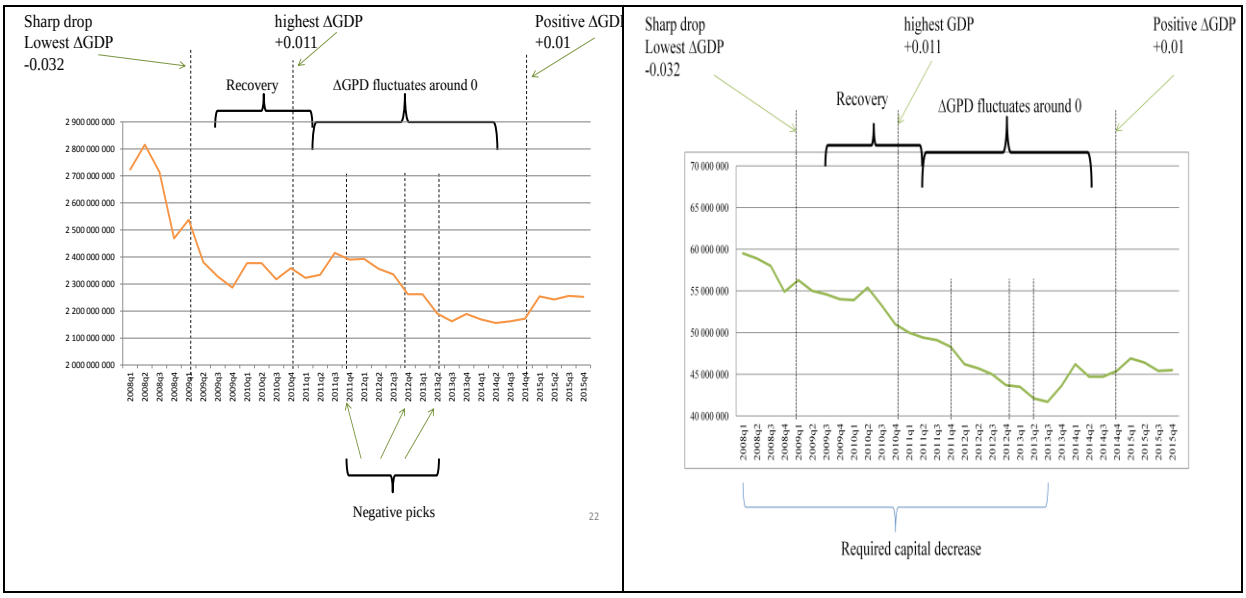


Figure 3: The banking activity is measured by cumulating the exposure values provided in the Standardized Approach and in the Internal Rating-Based Approach over all banks and claims. Exposure value is the expression of the exposure-at-default from which the risk-weighted-exposure amount is calculated. The banking activity or the exposure value of the total loan is shown on the left hand side of the graph. The evolution of the total required capital (sum of the required capital calculated in the two alternative approaches) is seen in the right hand side. ΔGDP refers to GDP growth rate. The amounts are expressed in thousands of Euros.

2.1. What regulatory data reveal about the link between loan exposure and required capital

To understand why different time evolutions are observed between the loan exposure and the required capital, we split the total amounts among the two approaches. In Figure 4, we show that the two approaches start in 2008Q1 at the same level (around €1,360 billion). Then, the loan exposure processed in the Internal Rating-Based Approach becomes rapidly dominant. A transfer of activity from the Standardized Approach to the Internal Rating-Based Approach is clearly identified from 2009Q4 to 2010Q2. During this period, the two approaches seem to mirror each other. Very early from 2010Q3, the loan exposure stabilizes around €500 billion in the Standardized Approach. Finally, Figure 4 reveals that before 2009Q4, the decrease of the loan exposure processed in the Standardized Approach leads the evolution of the total exposure. After 2010q2, the total amount is essentially driven by the variations of the loan exposures processed in the Internal Rating-Based Approach.

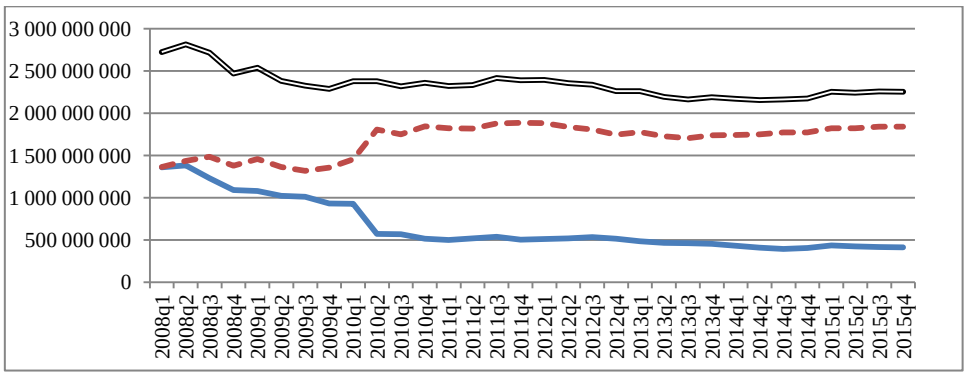


Figure 4: Relative proportion of the Standardized Approach (single line in blue) and the Internal Rating-Based Approach (dash line in red) in the total loan exposure (compound line). The amounts are expressed in thousands of Euros.

Interestingly, Figure 5 shows that the Standardized Approach stays as the main "provider" of required capital charges until 2008Q3, while the loan exposure in the Internal Rating-Based Approach is already largely predominant. We see that the required capital falls until 2010Q1 in parallel with the increase of loan activity in the Internal Rating-Based Approach which happens during this period, at the expense of the Standardized Approach. This trend is not surprising. Basel (2004) has defined the Internal Rating-Based Approach to allow banks which adopt it to benefit from an official reduction of the risk-weights and lower capital requirements relative to the Standardized Approach. The underlying goal, clearly announced in Basel II, was to motivate unsophisticated banks adopting the Standardized Approach, to progressively move to the more elaborated approach in developing their internal risk management process. Such behavior is also highlighted by Das et al. (2012), Plosser et al. (2014) and Colliard (2014) among banks located in Asia, Europe and US.

At the end of the period, we observe in Figure 5 that the increase of capital is mainly originated in the Internal Rating-Based Approach. However, from 2013Q3, this increase in the required capital occurs well before the rise in loan exposure which starts almost one year later, in 2014q4. Looking at the Standardized Approach, we see that the required capital stabilizes in 2013q2 at around €10 billion. Interestingly, much earlier in 2010q3 the loan activity reaches a threshold located around €500 billion (Figure 4). We also see in Figure 5 that in the Standardized Approach, the decreasing evolution by steps of the required capital contrasts with the stability of its corresponding loan exposure seen in Figure 4. Simultaneously in the Internal Rating-Based Approach, we see that, from 2010Q2 to 2013Q3, the increasing fluctuating trend of the loan exposure does not reflect the decrease of its corresponding required capital. Thus, the distinct evolution between loan exposure and required capital already observed at the macro-level in Figure 3 is then, also present in both approaches (Figures 4 and 5).

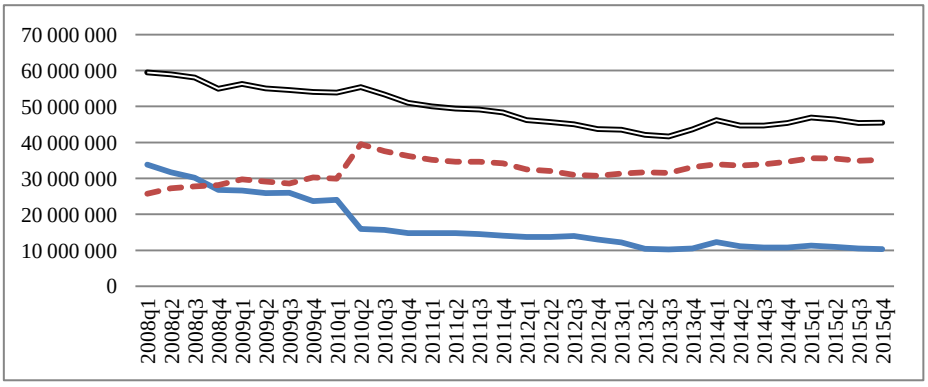


Figure 5: Relative contribution of the Standardized Approach (single line in blue) and the Internal Rating-Based Approach (dash line in red) in the total required capital (compound line). The amounts are in expressed in thousands of Euros.

In order to study this distinct evolution between loan activity and required capital, we split our dataset into the portfolios. In each approach, we then investigate how the macro-economic environment influences the risk-weighted asset measured in each portfolio. This risk aggregate is important because

it directly results from the methodological framework applied in Basel to calculate the required capital. More precisely, we use the notion of "regulatory credit risk profile" first introduced by Jacobson et al. (2006). The authors define a risk profile as a specific distribution of loans over a bank's credit rating grades as seen in the Internal Rating-Based Approach with the distribution of loans over the probabilities of default. We extend their notion to include the distribution also observed over the risk weights in the Standardized Approach. Moreover, to make the two approaches comparable in terms of credit risk, we consider the risk-weighted asset divided by its corresponding exposure value. For convenience, we refer to this important ratio as the regulatory credit risk ratio. Moreover, in the Internal Rating-Based Approach, the risk-weighted asset is determined by each bank using a model derived from Merton (1974) in which probability of default and loss-given-default are two major inputs. For each portfolio, we determine quarterly averages over all banks of these two risk aggregates. Our results are seen in Annex 3 for the Standardized Approach and in Annex 4 for the Internal Rating-Based Approach.

Whatever the approach and portfolio considered, the risk-weighted asset and the (regulatory) risk ratio have very different trends. Moreover, the relationship between exposure value and risk ratio is not stable during the period whereas the risk-weighted asset and the exposure value approximately follow similar trends. From the perspective of the portfolios, our results show that the Standardized Approach (Annex 3) still plays an important role for the three portfolios Sovereign, Financial Institutions and more specifically Banks, while the Internal Rating-Based Approach (Annex 4) is clearly preponderant for Corporate and Retail.[10] This is not surprising as in the last two portfolios, data availability and the relationship lending make it easier for banks to internally estimate the creditworthiness of their borrowers (e.g. Boot (2000), Brunner et al. (2000), Bharat et al. (2007) and Cotugno et al. (2013)).

More specifically, in the Sovereign portfolio, banks considerably reduce their exposure assessed in the Standardized Approach (Annex 3) during the Sovereign crisis (2009 – 2012). This trend coincides with a higher and more volatile risk ratio. In the Internal Rating-Based Approach (Annex 4), the rise of the exposure takes place with the decrease of the level and volatility of the credit risk ratio. Annex 4 Graph 4.d supports the idea of a reallocation of the lending activity in favor of countries with low probabilities of default meaning higher creditworthiness.[11]

Not surprisingly, the banking crisis (2007 – 2009) has deeply affected the lending activity of the two portfolios, Financial Institutions and Banks. In the two approaches the exposure value falls and the credit risk ratio increases with large fluctuations in the Internal Rating-Based Approach.

[10] Annex 2 describes the twelve portfolios considered in this study. These portfolios are grouped among four main portfolios: Sovereign, Corporate, Financial Institutions and Retail.

[11] It is unfortunately impossible to know the composition of borrowers' countries before 2014Q1. However, we find that during 2014Q1-2015Q4, banks' lending activity is mainly based in the Netherlands, Belgium, Germany, UK, France, Spain, US, Turkey, Switzerland, Ireland and Italy by order of importance.

During the period 2012Q1 – 2015Q4, the required capital (or the risk-weighted asset) sharply increases in the Retail Real-Estate portfolio in the Internal Rating-Based Approach (Graph 4.b). Its trend seems disconnected from the cyclical behavior of the credit risk ratio around what looks like a long term level of 0.135. This trend is surprising between 2013Q3 and 2015Q3 as during this period, risk ratio and loan exposure stabilize. This puzzling issue is however understandable when looking at Graphs 4.d and 4.e, describing respectively the two risk aggregates, probability of default (PD) and loss-given-default (LGD). We observe that the degradation of borrowers' creditworthiness revealed by the increase of the probability of default (Graph 4.d) induces a substantial rise of the mean LGD (Graph 4.e). After 2014Q2, this rise counteracts with the decrease of the mean PD. The resulting effect is expressed in the increase of the risk-weighted asset and in the stability of the credit risk ratio.

Focusing on mean PD, mean LGD and the credit risk ratio, we observe interesting "similar" behavior that may be explained taking into account some portfolio characteristics. For example in the Sovereign portfolio, we see that the two curves probability of default and the credit risk ratio have identical shapes. It seems to indicate that banks' internal models tend to give "more importance" in their credit risk evaluations to the probabilities of default than to the loss-given-default. This observation is not surprising as loss-given-default is a very difficult risk factor to estimate and manage when obligors are countries. At the opposite, for the two portfolios Financial Institutions and Corporate SME, the mean LGD seems to have the most influential effect on the credit risk ratio. Finally, the portfolio Retail Real-Estate tends to show a special case where the credit risk ratio results from a combination of mean PD and mean LGD. Banks have a good knowledge and management of the credit risk involved in this type of activity.

Moreover, we notice that the credit risk ratio helps to identify general credit risk cyclical trends (Annex 4, Graph 4.c). Thus, based on the two major risk aggregates, probability of default and loss-given-default, we show that these risk cyclical trends directly reflect how internal models estimate the risk borne on each portfolio by the banking system. This observation gives some support to the idea that the curves included in Annex 4 should deserve a sustained attention from regulators in the context of the macro-regulation.

The graphical analysis of banks' lending activity and the fluctuations of the (regulatory) risk ratio give us the opportunity to highlight how, in each portfolio, the macro-economic environment has affected banking stability. The credit risk ratio looks like a dynamic measure of risk. It efficiently complements the risk-weighted asset in the evaluation of the risk borne by the banking system. Accordingly, in the context of financial stability and macro-regulation, this risk ratio deserves sustained attention from the supervisory authority. Including it in the final calculation of the required capital may help regulators to reduce the distortions observed in Annex 4 between banks' lending, required capital and risk taken. The final effect would dampen the procyclicality of the required capital.

The strong influence of the economic environment on banks' regulatory risk profiles is then well represented in our data. However, we also highlight the substantial differences existing between the two approaches. Thus, our analysis points toward the importance of banks' ability to estimate and thus manage the credit risk involved in their lending activity. It is then important to understand how the economic environment influences banks' risk management techniques. The resulting effect on banks strategic behavior helps give new insights into bank lending activity and regulatory credit risk profiles.

2.2. What regulatory data reveal about the influence of banks' regulatory risk management

We describe banks' risk management process from the defaulted loans, banks' anticipations of loss and the protection policy. In the Basel Capital Accord, the obligors' loan original exposure is called the original exposure and the exposure-at-default from which the risk-weighted asset is determined, the exposure value. In the Standardized Approach, the exposure value is directly calculated in subtracting from the original exposure, the amount of provisions and in taking into consideration the credit risk mitigation techniques. In the Internal Rating-Based Approach the amount of provisions directly influences the level of required capital. We decide to focus our analysis on the two risk aggregates, provision and risk-weighted asset.[12] Our choice is motivated by the fact that, in the Basel regulatory framework the consequence of the amount of provisions on the exposure value is, contrary to the set of credit risk mitigation techniques, clearly identified all over the period.

One important effect of the macro-economic environment on banks health and thus on banking stability is evaluated from the amount of defaulted loans. Figure 6 shows the extent of banks' difficulties at the banking system level and, Annex 5 displays the same results for several portfolios. We first note that, in Figure 6 and in Annex 5, the two aggregates, original exposure and exposure value follow in each approach very identical trends. In Figure 6, we observe that the defaulted loans exposure aggregated over all banks and portfolios, increase by steps in the Standardized Approach with a peak in 2013Q4 (Figure 6.a). In the Internal Rating-Based Approach, the defaulted loans exposure continuously rise and stabilize in 2010Q2 (Figure 6.b).

Starting with the Standardized Approach, we notice that the gap between the two exposures rises by increasing proportion relative to the rise observed in the deficient loans. The size of the gap is very small at the start of the period when the deficient loans are low. It becomes high when the amount of deficient loans shows increasing trends. The higher the amount of deficient loans, the bigger the gap

[12] The credit risk mitigation techniques (collateral, guarantees, credit derivatives…) are defined from the balance between "outflows" counted negatively and "inflows" counted positively. These "inflows" and "outflows" are calculated from a specific regulatory formula using the values of each risk mitigation techniques as input. This methodology is applied in Basel in order to take into account the fact that if these techniques "reduces or transfers credit risk, it simultaneously may increase other risks… [like] legal, operational, liquidity and market risks… Where these risks are not adequately controlled, supervisors may impose additional capital charges or take other supervisory actions as outlined in Pillar 2" (Basel (2004) p.27). Thus, when the outflows are higher (or lower) than the inflows, the balance is negative (or positive) and lowers (or increases) the risk-weighted asset and thus capital requirements.

is. From 2014Q2, the exposure value dropped to an amount less than the half of the original exposure. Figure 6.a highlights how banks strategically adapt their protection policy to the size of their deficient loans. Thus, our results show that in the Standardized Approach, banks' risk management process exerts an important influence on the level of the required capital during periods of economic stress.

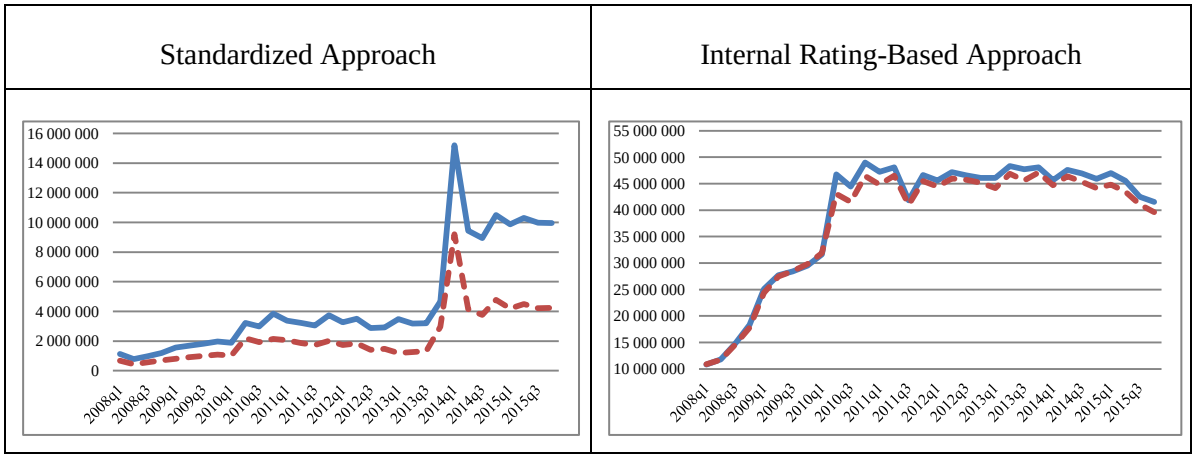


Figure 6.a Figure 6.b

Figure 6: Exposures of the defaulted loans: The original exposure is in blue-single line and the loan exposure value in red dashed line. The amounts are in thousands of Euros.

We focus in Annex 5 on the time evolutions of the defaulted loans observed for several portfolios. In the Standardized Approach, the exposure in default in the Sovereign portfolio is quite surprising. No amounts are reported before 2008Q4 as well as over the long period of time 2011Q1 – 2013Q4. Unfortunately, we cannot check if this "lack" of data is due to reporting mistakes or caused by the fact that none of the Sovereigns included in this approach defaulted in that period of time.[13] On the contrary, Annex 5 shows that the Internal Rating-Based Approach seems to better reflect the consequences of the Sovereign crisis. As expected, the exposures in default jump dramatically during 2011Q1 – 2012Q1 and are only back to their starting level in 2015Q1.

In the other portfolios, our results show that the macro-economic environment has affected the two approaches in very different ways. In the Standardized Approach for the two portfolios Financial Institutions and Banks, Annex 5 shows that the effect of the financial crisis is seen during the crisis, by the presence of peaks of the defaulted exposures. In a complementary analysis, not reported here, we find that the provisions are essentially allocated in these two portfolios to exposures assessed by external institutions, the credit rating agencies. For the Corporate and Retail portfolios, the influence of the stress period on the defaulted exposures appears in the Standardized Approach, at the end of the period from 2013Q4 with sudden and huge jumps. In the Internal Rating-Based Approach, Annex 5 shows that the increase of the defaulted loans in the portfolio Retail Real-Estate is spread throughout the period. For the two portfolios, Financial Institutions and Corporate, a decreasing trend is observed from respectively 2011Q3 and 2013Q3.

[13] Our view is to favor this second explanation because it seems unlikely that every bank made the same omission at the same time

Due to the complexity and the different methodological framework applied in the Internal Rating-Based Approach, we next complement our analysis in calculating a new aggregate, the (regulatory) credit risk coverage ratio. Figure 7 illustrates our results for the two approaches.

In the Standardized Approach (Figure 7.a) we determine the risk coverage ratio from the proportion of the provision relative to its corresponding original exposure. The ratio is counted negatively because by definition, provisions reduce the risk borne by the banks. Then, the bigger the ratio, the higher the banks' protection against the credit risk is. We find that the ratio increases considerably until 2013Q1 then it stabilizes and fluctuates between -1.2 and -1.6. These high levels allow banks to reduce considerably the amount of their (regulatory) credit risk. Our findings confirm the results observed in Figure 6 relatively to the gap observed between original exposure and exposure value. We then highlight that in the Standardized Approach, the provision policy has a great impact on the level of the required capital.

In the Internal Rating-Based Approach, the expected loss is an essential metric based on models using a value-at-risk methodology type. It measures the average amount of losses that bank managers expect to lose over a pre-defined period of time.[14] We show in Figure 7.b that the size of the expected loss determined on the defaulted loans is very high. It substantially increases over the period, from the half to the three quarter of the expected loss calculated for the total (defaulted and non-defaulted) loan exposures. Since they result from credit risk anticipations, by definition expected losses are covered by provisions. We then calculate the (regulatory) credit risk coverage ratio in dividing provisions by expected losses. The result is seen in Figure 7.c. Interestingly the linear relationship awaited between the expected loss and the provision is not found. More specifically, the risk coverage ratio increases strongly over the period and then stabilizes in 2012Q4 at a maximum value equal to 80% for the total loan exposures, and 100% for the deficient loans.

Our analysis reveals a surprising finding in 2008Q1 and Q2, for some of the banks using the Internal Rating-Based Approach we observe positive amounts of provision. It appears that, at the start of the financial crisis, severe readjustments were realized probably in order to correct what was judged by regulators at that time as undervaluation in the calculation of the capital charges. On the one hand, these corrections may be explained by the fact that until 2016, the prevailing accountancy rules determined the amount of provisions from the realized losses and not from the expected losses. Consequently, banks provisioned losses observed in the previous period and not the losses anticipated by their own internal models. It was then impossible to be efficiently protected against sudden deteriorations of their counterparties' creditworthiness even if banks successfully forecasted them. On the other hand, the period covered by the "old" dataset (2008 – 2014Q1) is also characterized by a high level of uncertainty during which all models failed to anticipate accurately any of the sudden and

[14] Expected loss = PD × LGD × EAD

strong deterioration of the creditworthiness of famous counterparties.[15] Hence readjustments were probably used to correct the possible undervaluation in banks' loss assessments and "artificially" strengthen their capital.

Standardized Approach	Internal Rating-Based Approach	
Provision / Original exposure	Expected loss	Provision / Expected loss

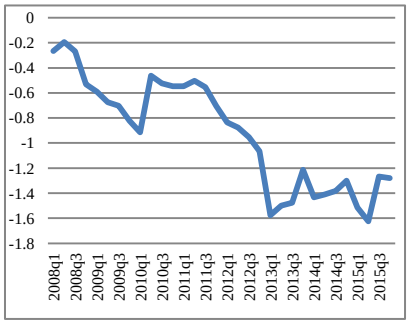
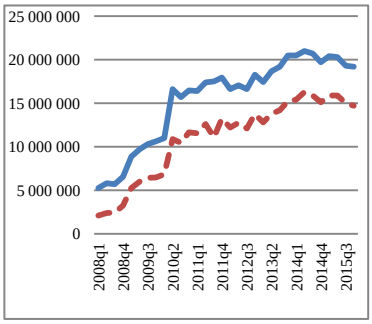
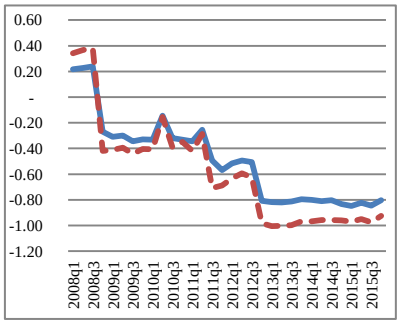

		

Figure 7.a	Figure 7.b	Figure 7.c

Figure 7: In the regulatory data the amounts of provision are negatively reported to clearly reveal their mitigating effect on the credit risk involved in the exposure. In the Internal Rating-Based Approach, the amounts calculated over all banks and all portfolios are in blue (single line), while the red dashed lines indicate the calculation restricted to the defaulted loans.

We examine in Annex 6 banks' protection policy for each portfolio.[16] We calculate in the Standardized Approach, the coverage ratio restricted to the defaulted loans exposure. In the Internal Rating-Based Approach, for each portfolio we present two graphs. The first graph includes two curves that illustrate the time evolutions of respectively the expected loss calculated on the total (defaulted and non-defaulted) loan exposure and, the expected loss of the defaulted loans. In the second graph, we compute the coverage ratio for successively, the total loan exposures, the defaulted loans and the non-defaulted loans.

In the Internal Rating-Based Approach, the strong impact of the deficient loans on the expected loss is well observed in the Sovereign portfolio.[17] Due to the type of obligors included in this portfolio, the curves describing the expected loss determined for the total loans and for the defaulted loans overlap. Sovereign credit risk is characterized by few very high amounts, of defaults. This characteristic is illustrated in Annex 6, by the peak observed in 2011. In this portfolio, the coverage ratio of the non-defaulted loans is very stable around -0.10. The coverage ratio of the total loans is driven by the ratio restricted to the defaulted loans until 2013Q3. It is positive in 2011 increasing consequently the risk borne by the banks. From 2013Q4, the two ratios calculated over the total loans and the non-defaulted

[15] Several of the "too big to fail" international banks, important companies and even several countries included the Euro area encountered severe financial difficulties.
[16] Because of the small amount of data in the Standardized Approach, no graph is reported for the portfolio Sovereign.
[17] Due to the absence of defaulted loans in the Standardized Approach revealed in Annex 5 for the portfolio Sovereign, we do not draw the equivalent graph.

loans overlap. Thus, the credit quality of banks' Sovereign claims improves, even if at the same time, banks considerably provision the loss expected on the defaulted loans.

For the portfolios, Financial Institutions and Banks, we observe that the two approaches follow very different trends. Focusing on the Internal Rating-Based Approach, we observe in the Banks portfolio that the curves describing the evolution of the expected loss simultaneously calculated for the total loans and for the defaulted loans, overlap during the first half-year of 2011. This observation shows that the expected loss of the total loans tends to follow the trend of the expected loss determined for the defaulted loans. This is not surprising according to the resulting dramatic consequences of the financial crisis. We see an improvement in the credit quality of the Financial Institutions portfolio, with the decrease observed in Annex 6, of the level of expected loss, during the last two years, 2014 and 2015.

In the Standardized Approach, the coverage ratios observed in the two portfolios Banks and Financial Institutions, strongly fluctuate. The peak observed in the portfolio Banks during 2009 – 2010, is caused by a sudden increase in the provision realized by the banks in order to cover the jump of defaulted loans exposure seen in Annex 5. Alternatively in the Internal Rating-Based Approach, during the financial crisis the coverage ratio on the non-defaulted loans dramatically fluctuates and takes high positive values (+1.35) in 2010. By the end of the global crisis, it becomes stable at low levels (-0.20). The coverage ratio on defaulted loans fluctuates strongly with two positive bumps during the crisis. Then in 2012, after a "quiet" stable period (around zero), banks increase their provision policy from 2013.

Finally, in each approach, the two other portfolios Corporate and Retail follow relatively identical trends (Annex 6). The expected losses and coverage ratios regularly increase over the period with stabilization from 2013. Common to the other portfolios, positive provisions also appear at the very start of the period in 2008 in the Internal Rating-Based Approach. We also notice that the fluctuation of the three coverage ratios during 2010 and the first half-year of 2011 coincide with a big jump in corporate defaulted loans (Annex 5).

In summary, we observe that high and fluctuating levels of counterparties' defaults relative to their normal trends has a strong impact on banks' protection policy. This is clearly seen in the Internal Rating-Based Approach during 2008. Our results reveal that the need to strengthen the stability of the banking system explains the presence of "positive" provisions expressing that corrections have been made by the regulators in order to artificially increase the level of banks' required capital. However, banks also react to the dramatically high level of risk and uncertainty observed during 2008 – 2014Q1. We find that consecutively to the substantial increases and fluctuations of their aggregate expected loss, they harden their provision policy. We then conclude that banks' protection policy plays a role in the distinct evolution between the loan exposure and the required capital observed in Figure3.

Except in specific periods during the financial and the Sovereign debt crises, the coverage ratio of the non-defaulted loans is the lowest and the most stable of the three (regulatory) credit risk coverage ratios respectively calculated on the total, the non-defaulted and defaulted loan exposure. Our findings document that periods of macroeconomic troubles coincide with an increase of the volatility of the coverage ratios calculated for the defaulted and the non-defaulted loans. We then show that high volatility only appears during unfavorable macroeconomic environments. In conclusion, our analysis points out that, in the context of a macro-regulation the inspection of the location and the volatility of these (regulatory) credit risk coverage ratios are interesting to follow.

3. Influence of the rating system heterogeneity on banks' required capital

In the previous section we highlight that, combined with banks' protection policy, the two approaches have extremely different trends and volatilities which considerably vary according to the portfolio and the macro-economic environment. As the two approaches involve specific methodologies in calculating the risk aggregates used to determine the required capital, it is now important to investigate Basel regulatory framework in terms of its modeling characteristics. A growing literature studies the methodological framework from the perspective of the banks' incentives to take advantage of Basel regulation. Below, we present some papers which investigate how banks tend to "artificially" report reduced levels of risk, in order to alleviate the constraint of capital regulation.

Such "strategic" (dishonest) behavior has been theoretically highlighted by Blum (2008) in the context of the Internal Rating-Based Approach. His analysis is based on two types of banks: the safe and the risky banks. From the observation that outsiders (regulators) have difficulties knowing ex-ante the type of banks due to their opaqueness, Blum models banks' behavior by their attitude in reporting honestly or not to their supervisors, the risk aggregates determined by their internal models. Hence, to reduce the misreporting possibility of the banks that are not honest, he shows the importance of regulatory sanctions in addition to the constraint of holding a minimum required capital calculated from a leverage ratio.[18]

Using only publicly available data from a sample of 115 banks located in 21 OECD countries, Mariathasan et al. (2014) find evidence of the presence of strategic modeling choices. Begley et al. (2014) reveal that such banks' behavior is also observable when the capital requirements for market risk are investigated. Their evidence is based on a sample of 18 Financial Institutions from the US, Canada and Europe. Finally, Behn et al. (2016) identify banks' opportunistic behavior which tries to circumvent regulation when it is based on complex methodologies that are difficult to supervise. They use publicly available data and a confidential regulatory dataset quarterly provided by the German banks to their supervisory authorities, the Bundesbank. Their panel regressions reveal that, compared

[18] The leverage ratio has been included in Basel III.

with the Standardized Approach, the probabilities of default assigned to the same borrowers having loans present in the two approaches, are always lower in the Internal Rating-Based Approach. However, the authors find that banks compensate for the assumed lower credit risk. Comparing the same borrowers assessed in the two approaches, they observe that higher interest rates are always charged in the Internal Rating-Based Approach compared with the Standardized Approach.

In the Standardized Approach, such banks' incentives may also be present. Banks have the choice to use one or a combination of several credit rating institutions to calculate their required capital. This discretion may lead banks to reduce their capital requirement in choosing the credit rating institutions that favor minimum risk weights. Such banks' incentive is analyzed by Van Roy (2005). From a sample of long term issuer ratings of, corporate, bank and Sovereign loans graded by Moody's, S&P and Fitch, he finds that this behavior may lead banks to significantly decrease the amount of their required capital.[19]

Our paper differs from these studies. While we base our research on data provided by individual banks, concerns about banks' reporting in the Internal Rating-Based Approach and selection "biases" in the Standardized Approach are not a real issue in the context of our paper. We focus on the methodological differences existing between the Standardized and the Internal Rating-Based Approaches. Our goal is to investigate whether or not the problems of regulatory reliance on credit rating systems and Basel required capital procyclicality can be identified from our regulatory data. So, we do not study this banks' incentive problem described above.

For the purposes of this goal, we study in the next sub-section, how the degree to which each methodology is used influences the level of risk reported by each bank in the context of the macro-regulation. We examine how the methodological heterogeneity may influence the stability of the banking system. We define banking stability in terms of lending activity and (regulatory) credit risk profile, observed during and after the global crisis.

3.1. A "macro" heterogeneity introduced in Basel regulatory framework

Basel regulation involves a mix between different risk measurement methodologies which is specific to each bank. Consequently, we split the banking activity into unrated, externally and internally rated frameworks in order to study the implied heterogeneity in the context of a macro-regulation. Basically, the Standardized Approach implied the use of risk weights that banks apply either according to the credit rating provided by external rating entities, or according to specific rules if the loan position is

[19] He estimates a reduction of 6% maximum for the three claims considered

unrated.[20] In the Internal Rating-Based Approach banks use internally developed risk estimation models.

Our results are illustrated in Figure 8 where the loan exposure in the Standardized Approach is disaggregated into the unrated and externally rated positions. The exposures evaluated by external institutions are always higher than the unrated positions. We observe that the loan exposure assessed by the external entities, mainly credit rating agencies, falls sharply by approximately €400 billion in 2010Q1. We note that the simultaneous increase in the unrated loan exposure is too small to explain this fall by a transfer of loan exposure from the external to the unrated methodological framework.

At the same time as the "new" dataset is introduced in 2014Q1, we see in Figure 8 a sudden break in the data. Observing the curves gives the feeling that in 2014Q2 part of the loan exposure was transferred from the external rated to the unrated positions. However, this trend is also influenced by the reform in the data that banks report to their supervisory authorities. The reform implies that the information about the distinction between unrated and external rated frameworks is now only available for one aggregate, the risk-weighted asset.[21] Moreover, contrary to the "old" dataset that divides this information among two risk weights (50% and 100%), the "new" one shares it among all the existing risk weights. Consequently in order to evaluate the unrated and externally rated loan positions, from 2014Q2 we recalculate the missing aggregate, exposure value, from the risk-weighted assets. This calculation has also played a role in the size of the break seen in 2014Q2. We then have to be cautious about comparing the relative size of the two rating methodological frameworks before and after the application of the reform. However we remark that, apart from the break observed in 2014Q1 – 2014Q2, the general trend from 2010Q2 is a relative stability between the two rating frameworks with the highest part of loans rated by external entities.

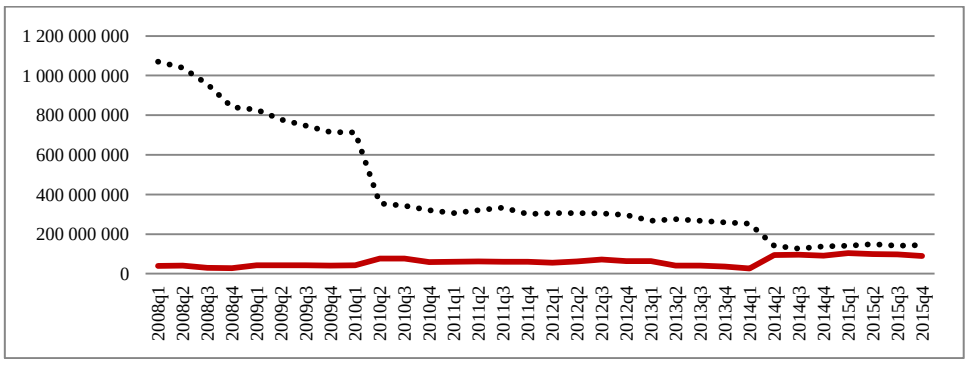


Figure 8: In the Standardized Approach, decomposition of the exposure value between unrated positions (single line in red) and positions rated by external agencies like Moody's, S&P, Fitch or a governmental institution (dash line). The amounts are in thousands of Euros.

[20] For example, mortgage loans receive a 35% risk weight whatever the creditworthiness of the concerned borrowers.

[21] The distinction between unrated and externally rated loans is not anymore available for the variables, original exposure, exposure value, provision, expected loss and the set of credit risk mitigation techniques.

Figure 9 shows that the Advanced Internal Rating-Based Approach is much higher than its Foundation version. We note that the sudden jump observed in 2010q2 appears at the same time and is of the same size (around €400 billion) as the fall of the exposure value assessed by the external rating institutions seen in Figure 8. Our finding confirms a transfer of loan exposure from the external rating agencies to banks' internal models. This trend reveals that the general loss of confidence in the ability of credit rating agencies to give accurate and independent credit risk evaluations and notations was also a common feeling among banks. It has to be noticed that this distrust appears far before the official recommendation of Basel to reduce the use of credit ratings provided by the credit rating agencies for regulatory purposes. Around 2009 − 2010, this distrust toward the credit rating agencies has motivated banks to develop their own risk estimation models in order to internally evaluate the loans initially rated by these external credit rating institutions. The global crisis has a direct unexpected consequence on the development of banks' risk management process.

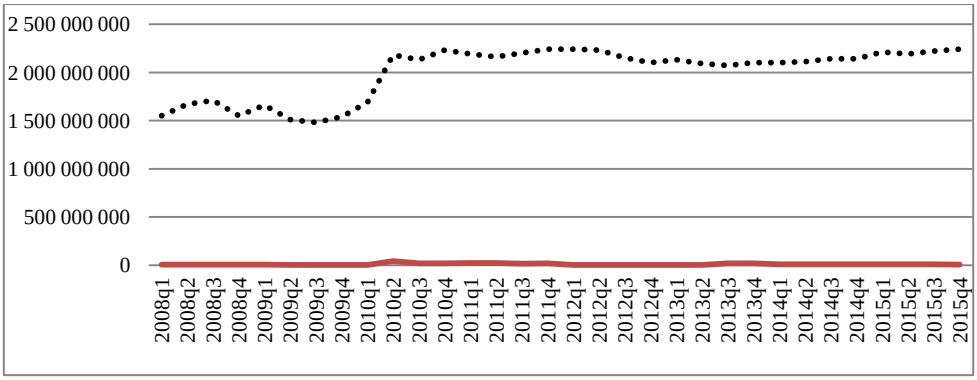


Figure 9: In the Internal Rating-Based Approach the original exposure is shared between the Foundation version (single line in red) and the Advanced version (dashed line). The amounts in are expressed in thousands of Euros.

We find it interesting to report in Figure 10, the original exposure processed in the Foundation Internal Rating-Based Approach represented by the single red line in Figure 9. We observe that banks have suddenly increased their lending activity during successively the two periods 2010 – 2011 and 2013Q2 – 2014Q3. In order to understand why such a trend occurs at these particular periods of time, we first focus on the lending activity for each portfolio. We discover that the original exposures seen in the two portfolios, Corporate and Sovereign (or Corporate and Retail), contributed to the first (or second) bump. To investigate the reason for these sudden jumps, we calculate the correlation of the original exposure with the defaulted loans exposure. We find a relatively high correlation equal to 0.43. Our result gives some support to the idea that, banks are quite likely to turn to the simplest version when sudden problems occur in order to update their internal estimation models. This observation reveals the existence of a minimum of activity or threshold which increases from € 5 billion to €8 billion in 2014Q3.

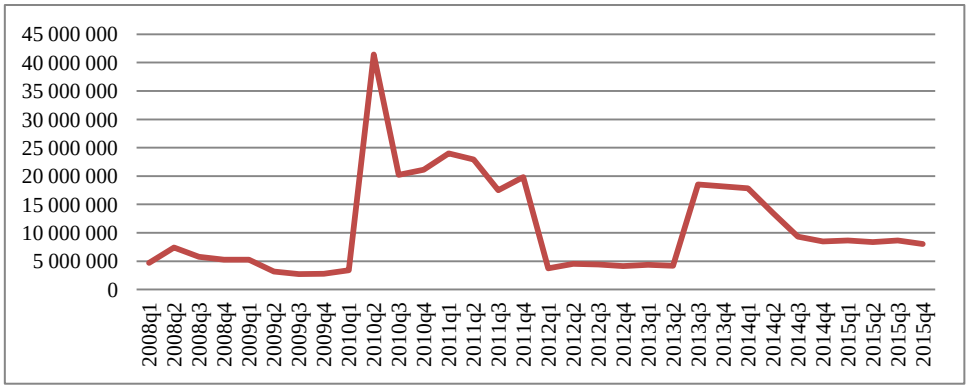


Figure 10: Time evolution of the original exposure in the Foundation version of the Internal Rating-Based Approach (expressed in thousands of Euros).

In summary, our results suggest that the simplest approaches, the Standardized Approach (Figure 4) and the Foundation Internal Rating-Based Approach (Figure 10), have stabilized at a minimum threshold under which the loan exposure does not fall. On the one hand, the fall of the loan exposure assessed by external ratings associated with the rise observed in the unrated and in the internally rated systems strongly suggests a reaction of banks to the general loss of confidence towards the credit rating agencies. On the other hand, we notice that the increases of the exposures assessed in the Foundation version of the Internal Rating-Based Approach simultaneously occur with the sudden deteriorations of their borrowers' creditworthiness.

We thus deduce that, due to the difficulties in developing efficient estimation models of the loss-given-default (e.g. Altman et al. (2003); Bastos (2010); Deborgies-Sanches et al. (2013); Gütler et al. (2013) ; Jokivuolle et al. (2013a) and Jokivuolle et al. [2013b]), the simplest version of the Internal Rating-Based Approach can be temporarily used as a substitute to the Advanced version when banks need to improve or update these models. Thus, our analysis complements the literature on the factors influencing banks' modeling choice in Basel regulation. Whereas banks' incentive to benefit from the lowest capital requirement is an important factor, we also highlight in this sub-section, that unfavorable environments have influenced banks' attitude as seen during and after the global crisis.

As in a banking system, the level of required capital is the result of the mix of (regulatory) risk estimation models, in the next sub-section we focus on how the risk aggregates determined under the Basel regulatory framework have evolved.

3.2. A "micro" heterogeneity observed inside bank's regulatory credit risk profiles

A large body of literature, (e.g. Livingston et al. (2010) in the context of credit rating agencies and Jacobson et al. (2006) for banks) shows that each rating entity differs according to their methodology, estimation models and opinion toward obligors' creditworthiness. In this paper, we gather all individual banks' reports to analyze the resulting mix present in the banks' capital regulation from the

rating architectures and types of rating system used by each bank to assess the credit quality of their borrowers.

By definition, a rating system is a mapping function of counterparties' probability of default into several grades. In the Standardized Approach, the credit quality of banks' borrowers is classified based on from the rating scale used by Standard and Poor's. Hence, for each claim, specific rules are provided in order to translate borrowers' rating into one of the available risk weights.[22] In the Internal Rating-Based Approach, the type of estimation models that banks can use as well as the minimum number of grades present in the risk classification of borrowers' creditworthiness are also precisely defined by Basel regulation. In this sub-section, we study the methodological heterogeneity from the rating systems by focusing on the design of each bank's regulatory credit risk profiles.

In the Standardized Approach, we define the design as the relative importance of the risk weights used in each claim. Basel framework proposes a maximum of fifteen pre-fixed risk weights among which loan exposures are shared according to the creditworthiness of the borrowers, having or not, a credit rating provided by an officially recognized rating entity. We show in Figure 11 that the number of risk weights used considerably varies during the period for each bank but also between banks. For example during 2008 − 2015, the first bank uses between six risk weights (in 25% of the cases) and seven risk weights (in 75%) to classify its loan exposure values. By comparison, the second bank always uses six risk weights. By convenience in this paper, this number is also called the number of grades.

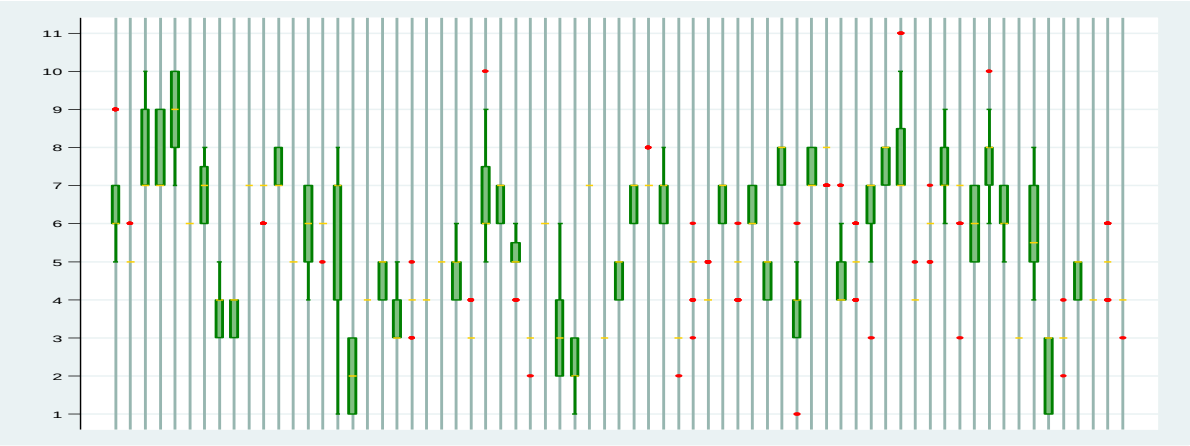


Figure 11: Total number of different risk weights used by each bank in the Standardized Approach. Medians are in yellow. For confidentiality reasons, banks' identifiers are removed.

The description of the design is completed by examining the relative importance of each risk weights. During the period studied, we find in Figure 12 and in Annex 7 that seven specific risk weights ("0", "0.2", "0.35", "0.5", "0.75", "1" and "1.5") are on average greatly used by the banks.

[22] See in Basel (2004) and in Basel (2006) for the description of the rules applied to classify the claims in the two approaches.

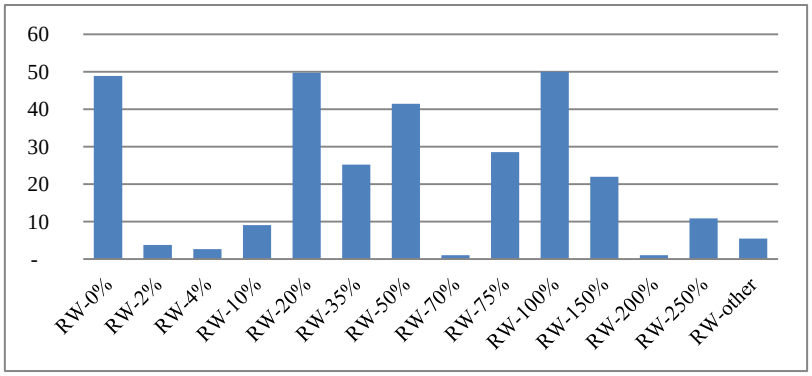


Figure 12: Quarterly average number of "presence" in the sample calculated per risk weights (all activities per bank)[23]

In Figure 13, we determine the risk weights used for the five main portfolios. In the Sovereign portfolio, we see that the loan exposure is essentially included in one grade corresponding to very high quality loans with a "zero" risk weight. This information helps to understand why due to borrowers' characteristics, in Annex 7 the weight "0" has also the highest exposure values in terms of average (€ 325 billion) and maximum value (€ 715 billion). We also find that around 80% of the average exposure of the portfolio Financial Institutions is classified into two risk weights: 20% and 50%. We notice that, a great percentage of the average exposure of the Corporate portfolio is included in the high risk weight 100%. Finally, the average exposure of the Retail portfolio is mainly distributed among the highest risk weights starting from 75%.

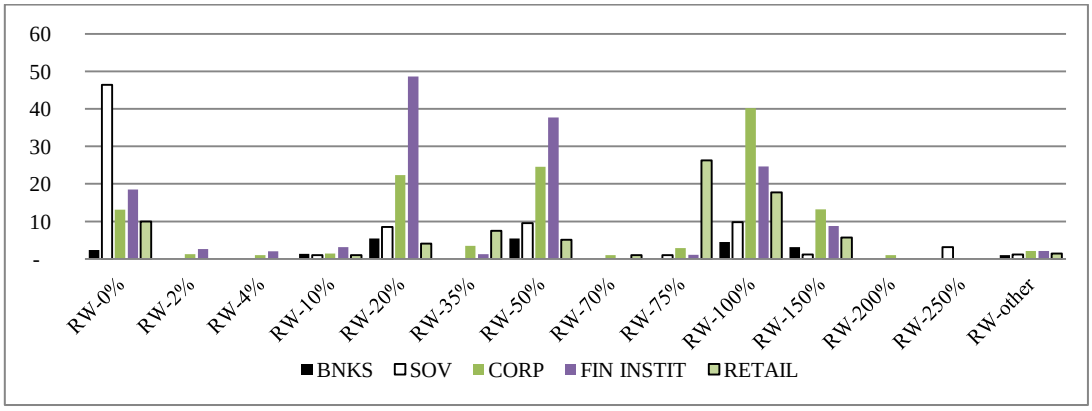


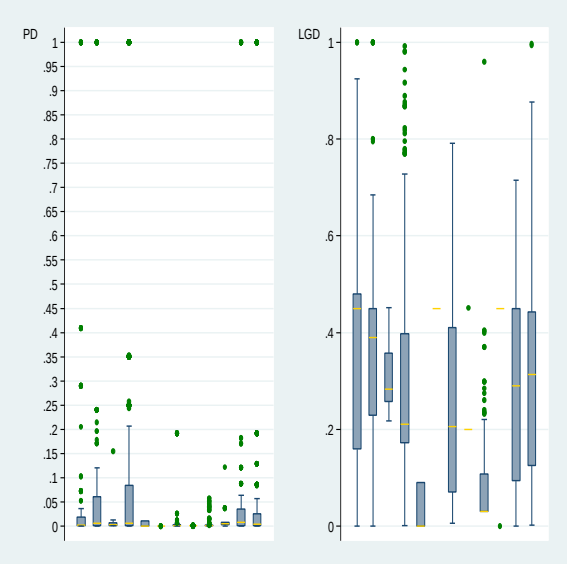
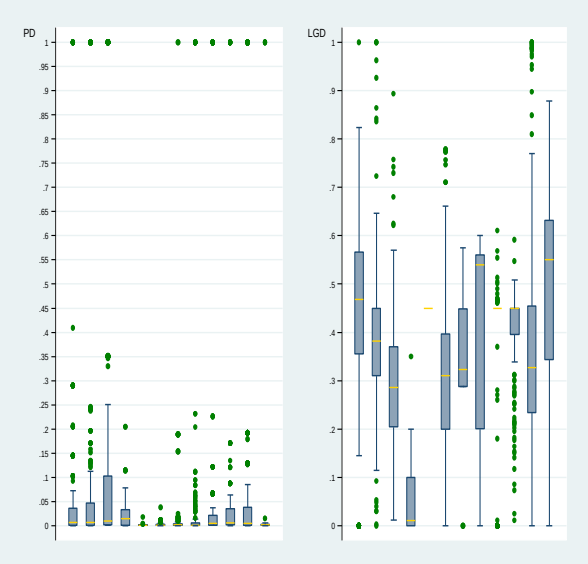
Figure 13: Quarterly average number of times each risk-weight is used in each portfolio

In the Internal Rating-Based Approach, the design of banks' regulatory credit risk profiles is investigated from the distribution of the loan exposure among the probabilities of default (PD) and loss-given-default (LGD). As expected and in line with Treacey et al (1998) for fifty US banks and Jacobson et al. (2006) for two major Swedish banks, we find in Figure 14, that the distributions of these two main risk aggregates vary considerably among banks and portfolios. Interestingly, the two portfolios, Corporate-SME and Retail Real-Estate, have the highest granularities (number of PD grades) and their LGD distributions are much more concentrated at lower levels. An extreme situation

[23] The risk weight 1250% is not present in the graph because banks do not use it in the portfolios considered in this paper.

is seen for the Retail Real-Estate portfolio where, for all banks, the median of the LGD is lower than 20%. At the opposite the portfolio Sovereign is characterized by the fewest numbers of PD grades, the largest LGD distributions and extremely dispersed medians (between 20% and 45%). These observations are not surprising. They reveal banks' ability to estimate the credit risk of each specific portfolio during the period analyzed. The two last examples confirm that the largest is the LGD, the lowest is the banks' ability to control borrower behavior and estimate creditworthiness.

Finally, for each portfolio, we have calculated in Annex 8 the average number of grades. We find that the granularity varies between 8 and 11/12. The highest numbers are observed in the Retail portfolios and the smallest numbers in the portfolios Sovereign, Financial Institutions and Corporate Specialized-lending. Treacy et al (1998) show that the number of grades included in banks' rating systems is a strategic variable. They find that it results from the difficulty in assessing borrowers' creditworthiness, the proportion observed between the large and the small borrowers and finally, the purpose for which the rating system is used. A finer granularity is valuable in assessing the credit quality of large corporations and to profitability analysis. They show that the number of grades used by the US banks has increased on average during the previous years of their study. In our data, the granularity of each Dutch bank's rating system follows a much differentiated trend with small to high fluctuations and in some cases has an incremental evolution.[24] By comparison, we have included in Annex 8 the average number of risk weights in the Standardized Approach used over the period for all the banks. Contrary to the Internal Rating-Based Approach, no specific trends are seen in the Standardized Approach.

Sovereign portfolio	Financial Institution
	

[24] For confidentiality reasons, no further details are disclosed.

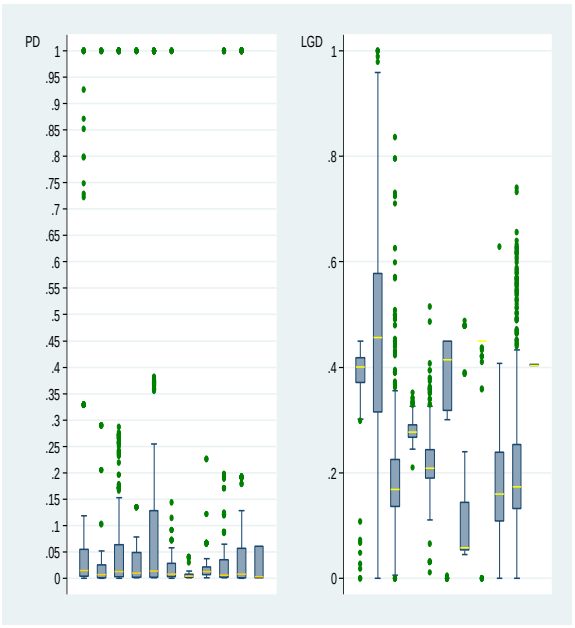
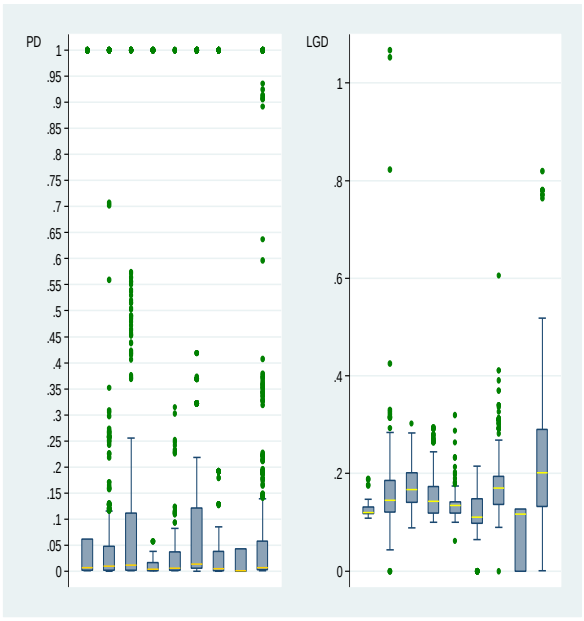
SME	Retail Real-Estate
	

Figure 14: Each graph box describes banks' internal regulatory risk profiles adopted in the Internal Rating-Based Approach in four specific portfolios. In each box plots, the graphs include all the data points available over the period 2008Q1-2015Q4 for one specific bank for the probability of default and the loss-given-default respectively. For confidentiality reasons, banks' identifiers have been removed in the graphs and the order of banks is only respected in the two graphs describing the same portfolio but not from one portfolio to another.

Hence, not surprisingly, we find the presence of high differences between banks and within each approach and each portfolio. Our analysis highlights four interesting points. First, in terms of regulatory purpose, our results may help regulators to fine tune some aspects of the micro-regulation. Looking into banks' own estimations of the loss-given-default (LGD) in the Advanced internal rating-based approach, our results suggest that the rule allocating prescribed percentages of LGD in the Foundation Internal Rating-Based Approach should take into consideration the disparity of the LGD observed among the portfolios.[25] Percentages of LGD more in line with the LGDs estimated in each portfolio would relieve the banks using the Foundation approach of a part of their capital requirements. So, when regulators judge necessary, a better alignment with for example the median of all the LGDs estimated by banks in the Advanced approach, would contribute to redressing the balance of the capital charges calculated inside the internal rating-based approach.[26] Such regulatory change would be beneficial to the lending activity in reducing the disparity observed between big and very sophisticated banks and small and less sophisticated ones.

Alternatively, in the Standardized Approach, regulators may consider basing the allocation of the loan exposure among the risk weights not only according to the rating mapping proposed by the major

[25] In the Foundation IRB approach, the LGD is set between 40% and 50% depending on the value of the collateral attached to the loan.
[26] For example in this study, the Retail Real-Estate could benefit from a pre-fixed LGD of 15%.

credit rating agencies, but also on the bank's internal estimate of probability of default. This aspect of regulation is particularly important in the Sovereign portfolio where the overwhelming use of the risk weight "zero" is a major concern.

Second, for each portfolio our dataset reflects well the differences between the rating strategies developed by each credit rating entity. The literature highlights the reasons for the presence of split ratings (so-called when the differences concern the same borrower). Relative to the ratings provided by credit rating agencies, the causes are due to the obligor's opaqueness (Morgan, 2002), the characteristics of the rating systems and the methodology used (Güttler et al., 2007, Hill et al., 2010) and Livingston et al. 2010). Carlin et al. (2001) and Jacobson et al. (2006) show that the same issue also exists among banks' internal rating systems. However, empirical experience reveals that the location and the characteristics of the borrowers also play an important role.[27]

4. What makes heterogeneity so important?

The heterogeneity of the rating systems observed in the Standardized and in the Internal Rating-Based Approaches is important to consider because credit ratings are not a neutral indication of credit risk, as they are dependent on the objective of the rating entity.

Banks use their rating systems in the credit risk management process. Their ratings are based on assessing the current condition of their borrowers' creditworthiness and its evolution over time. Banks then use rating systems based on a point-in-time rating philosophy. Alternatively, credit rating agencies assist investors in the management of their portfolio by providing the ratings of the claims included in it. Thus, in order to reduce costly portfolio readjustments that may too frequently involve rating changes, credit rating agencies base their rating on the expected long term borrowers' credit quality. Their ratings tend to be independent of the current variation of the business cycles or changes in the macro-economic conditions. The rating systems applied by the credit rating agencies follow a through-the-cycle rating philosophy.

Thus, in the Internal Rating-Based Approach a point-in-time type of rating philosophy should be identified. Treacy et al. (1998) reveal that almost all the US banks included in their sample have chosen to grade their counterparties using point-in-time rating systems. Whereas in the Standardized Approach, a through-the-cycle type of rating philosophy should be observed. However, such distinctions between point-in-time and through-the-cycle is not as obvious because empirical observations show that, following each crisis, credit rating agencies react by increasing the reactivity of their ratings to the fluctuation of their obligors' creditworthiness. Moreover, Basel recommends the adoption of a more through-the-cycle approach to calculate the required capital in the Internal Rating-

[27] Remark kindly made by G. Van Vollenhoven, director at DNB

Based Approach. Aguais et al. (2008) document how banks' rating systems may also be based on through-the-cycle rating systems or may be the result of a mix of the two philosophies.

Studying how such distinctions between point-in-time and through-the-cycle may have an influence in the context of the macro-regulation is essential due to the consequences of the regulatory reliance on credit rating systems. Over the last 20 years, empirical evidence and observations have revealed the destabilizing role of the through-the-cycle rating systems in the origin and amplification of the Sovereign crises and the default of large corporations (Ferri et al. (1999), Mora (2006), Frost (2007), Partnoy (2009), Hunt (2009), and Mullard (2012)). While the recent financial crisis has put in practice the procyclicality bias of the point-in-time rating systems, already theoretically described before the implementation of Basel II by Jackson (2000), Borio et al. (2001), Kashyap et al. (2004) and Catarineu-Rabell (2005). We investigate these two major problems below.

4.1 Mix of credit rating systems and rating philosophies in the Basel regulatory framework

In this sub-section, we identify whether and how the rating philosophies may influence the estimation models of the credit risk under the Basel regulatory framework. Our goal is to compare the Standardized Approach with the Internal Rating-Based Approach in order to ascertain whether some of the properties peculiar to the credit rating philosophies highlighted in the literature could influence the evolution of the risk-weighted asset of equivalently the required capital.

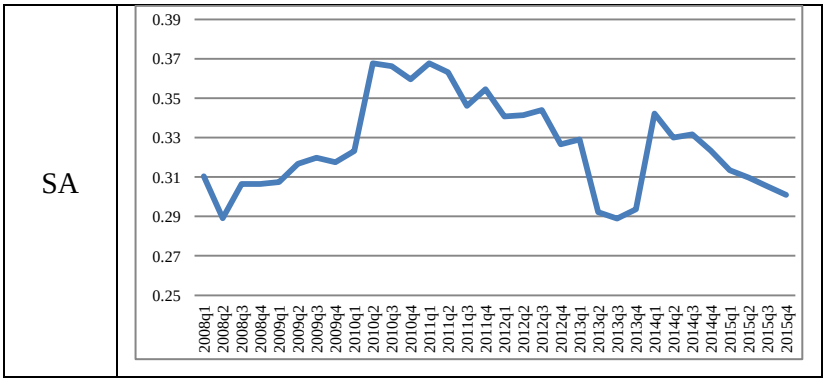
We first focus on the different rating changes observed in the two approaches. We expect to identify in the Standardized Approach, the "too late" and as a consequence "too strong" downgrading policy generally described as the characteristics of ratings provided by the rating agencies. Löffler (2004) documents how this so-called cliff-effect problem is inherent to the through-the-cycle methodology. Altman et al. (2004) show how credit rating agencies reach the rating stability in reducing the sensibility of their ratings to the short term variations of the borrowers' creditworthiness in using a prudent credit rating migration policy. In particular, we expect to identify in the Standardized Approach such cliff-effect problem from the potential destabilizing effects generated by the presence of sudden unwarranted and strong deteriorations of the regulatory credit risk profile.

Our results are shown in Figure 15 for the (regulatory) credit risk ratio in the two approaches (Graph 15.a for the Standardized Approach and Graph 15.b for the Internal Rating-Based Approach). At first sight, the two curves follow the same trend: a period of relative stability, then a bump followed by a trough and a return back to approximately their initial position. However, big differences are observed in the "speed" of the fluctuations, in the time during which the extreme values are reached, and finally, in the gaps between the upper and the lower phases.

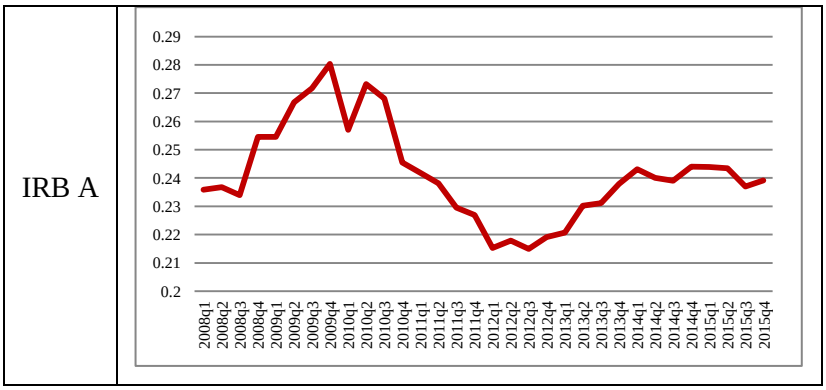
More precisely, the credit risk ratio reacts faster in the Internal Rating-Based Approach (IRB A) than in the Standardized Approach (SA). At the start of the period, the stability observed on average in the IRB A, is shorter (ends in 2008Q3) compared with 2010Q1 for the SA. A peak is reached earlier in the IRB A (2012Q1) relatively to 2013Q2 in the SA. Then in the IRB A, the ratio falls to its lowest value in 2012Q1; the same trend is seen six months later in the SA. Finally, in the IRB A the ratio returns back to its initial value in 2014Q1, while the same trend is observed one year later in the SA.

Moreover, we note that the two approaches are also characterized by large differences in the size of the gaps between the extreme values. For example, the first gap of 0.08 (0.37-0.29) in the SA is almost double compared to that of 0.045 (0.28-0.235) which is present in the IRB A. Finally, the SA shows what could be identified as an "over-reaction", with the abrupt second peak in 2013Q4-2015Q1 which is not present in the IRB A. These graphical observations suggest that the (regulatory) credit risk ratio, calculated at the banking system level, shows the characteristics of a point-in-time philosophy in the IRB A and respectively, a through-the-cycle philosophy in the SA.

We report in Annex 3 for the Standardized Approach and in Annex 4.c for the Internal Rating-Based Approach the (regulatory) credit risk ratio determined for several portfolios. Approximately the same observations can be made for the three portfolios Financial Institutions, Corporate and Retail Real-Estate.



Graph 15.a



Graph 15.b

Figure 15: Time evolution of the regulatory credit risk ratio (risk-weighted amount divided by exposure value) shown in Graph 15.a for the Standardized Approach (SA) and in Graph 15.b for the Internal Rating-Based Approach (IRB A).

We continue our investigation of the properties which characterize the two types of credit rating systems in observing that the literature have revealed that credit rating agencies are unsuccessful in downgrading the borrowers' ratings before a default (Ferri et al. (1999), Amato et al. (2003) and Altman et al. (2005)). Their (much criticized) late reactions exacerbate financial difficulties that the borrowers are already in by the disturbing consequences of the cliff-effect behavior of agencies' through-the-cycle rating systems. We are then interested in examining whether such an effect may be identified in our sample.

Figure 6 shows the time evolution of the defaulted loans in the Standardized and Internal Rating-Based Approaches. From the time evolutions of the defaulted loan exposures, we see that banks react "faster" in the Internal Rating-Based Approach. An increase of 400% is observed which spreads out over ten quarters. Conversely, in the Standardized Approach such evolution appears later with an abrupt variation (+403%) limited only over three quarters.

We then focus on the time evolution of the defaulted loan exposure realized per portfolio. It is important to examine this point in order to strengthen our descriptive analysis of the rating properties previously identified in the two approaches. Annex 5 reveals that the characteristics of the through-the-cycle seen in the Standardized Approach and point-in-time in the internal-rating-based approach are also observed for the two portfolios, Corporate and Retail Real-Estate. These results are in line with the empirical studies which generally use data extracted from one of these two portfolios to investigate the properties of the credit rating systems.

In conclusion, our results show that the graphs describing the credit risk ratio and the default exposure suggest the presence of point-in-time rating philosophy in the Internal Rating-Based Approach and alternatively of through-the-cycle philosophy in the Standardized Approach. We complement our analysis in studying in the next sub-section, how these rating systems may influence the cyclical behaviors of the required capital.

4.2 Mix of rating systems and cyclical behavior of Basel required capital

The adoption of the risk-sensitive capital regulation, Borio et al. (2001) and Kashyap et al. (2004) show that bank managers have more limited freedom in their capital decisions. A bank short of capital faces intensified supervisory scrutiny and the necessity to rapidly restore its capital position. Banks may then face higher costs of funds and the necessity to cut back their lending activity. The recent financial crisis has highlighted this procyclical issue. Knowing the cyclical behavior of the required capital buffer is then essential information for the macro-regulation.

A large body of literature (e.g. Estrella (2004), Saurina et al. (2007), Cofinet et al. (2012) and Agénor et al. (2012)) studies the cyclical behavior of bank capital buffers and their determinants. The

underlying process has long been understood. In theory, Jackson (2000), Borio et al. (2001), Löffler (2004), Heitfield (2004) and Catarineu-Rabell et al. (2005)) show how credit rating systems following a point-in-time philosophy are procyclical. As their probability of default is lower (or higher), in periods of booms (or recessions) borrowers' credit rating move up (or down) in the credit rating scale. Thus in a point-in-time philosophy, the measured credit risk is negatively correlated with the business cycles because higher (or lower) grades mean smaller (or larger) credit risk. Consequently, capital requirements tend to increase when the economy falls into a recession and to decrease when the economy is in a period of expansion. With through-the-cycle rating systems, borrowers' probabilities of default are evaluated in a worst-case scenario, the ratings are then less likely to change. The through-the-cycle rating systems are shown to be weakly procyclical.

In this paper, we investigate the cyclicality of the required capital from the correlations of the risk-weighted asset with the GDP growth rate. Our findings are seen in Figure 16 for the whole banking system and in Annex 9 for each portfolio. We calculate two types of correlations. At a micro-level, the correlations are based on the whole data sample (Figure 16.a and Annex 9). At a macro-level, we aggregate the data per quarter over all banks and portfolios in Figure 16.b and, for each portfolio, per quarter over all banks in Annex 9. We notice that our results are slightly influenced by the level at which the analysis is done. We always obtain much smaller correlations at the micro-level compared with the macro-level.

In Figure 16, we find very small correlations. They change in value, from weakly negative at the micro-level to slightly positive at the macro-level. Our analysis shows that the cyclical behavior of the Dutch banking system is very weak during the period 2008-2015. We obtain an interesting finding when we exclude the claims only included in the Standardized Approach and we restrict the definition of the banking system to the four main portfolios present in the two approaches (Sovereign, Financial Institutions, Corporate and Retail).[28] The correlations decrease at the micro-level and the increase at the macro-level. This means that in the Standardized Approach, all over the period, the risk-weighted asset or required capital determined from these (excluded) claims has a relatively strong procyclical effect. Our result is not surprising as these claims include "Items belonging to regulatory high-risk categories" and "Past-due items" for which banks need point-in-time rating systems to efficiently screen and monitor them.

We next investigate if the cyclical behavior related to the type of rating system used to calculate the required capital may be observed in our sample. We then disaggregate the data between the

[28] Our goal is to focus on banks' lending activity and to directly compare the Standardized Approach and the Internal Rating-Based Approach. Thus in this paper, we have excluded the claims which are specific to the Standardized Approach. We have just reintroduced them in order to examine their specific cyclical effect on the required capital of the banking system. See Basel (2006) for the complete description of the claims only included in the Standardized Approach.

Standardized and the Internal Rating-Based Approaches and, within the Standardized Approach, between unrated and externally rated systems. According to the literature, we expect to find that the through-the-cycle philosophy of the unrated and externally rated systems involves a countercyclical Standardized Approach, whereas the point-in-time characteristic attributed to banks' internal rating systems leads the Internal Rating-Based Approach to be procyclical. We do not obtain the expected results. On the contrary, with negative correlations in the Standardized Approach and positive correlations in the Internal Rating-Based Approach, our analysis strongly suggests that, during the period 2008 – 2015, the Standardized Approach is procyclical, and the Internal Rating-Based Approach is countercyclical. We discover that the procyclicality in the Standardized Approach is essentially due to the loans rated by the credit rating agencies even if it is slightly reduced by the countercyclicality of the unrated position.

However, when we split the timescale into the global-crisis (2008-2012) and the after-crisis (2013-2015) we interestingly find that the procyclicality of the Standardized Approach generally increases from one period to the other. From the literature, we explain these results observed in the Standardized Approach, by the consequence, on banks' required capital buffers, of the drastic change in the credit rating methodology followed by the credit rating agencies. Hence, Posch (2011), Opp et al. (2013) and Salvator et al (2014) document how the severe criticism of their role in the financial crisis, have induced credit rating agencies to adopt more point-in-time systems. Such behavior has already been observed in the literature. Amato et al. (2003) highlight the procyclical behavior of agencies' ratings from the study of the ratings of investment grade firms, initial credit ratings or credit rating changes. More recently, Alp (2013) and Baghai et al (2014) show how, in response to their inability to predict borrowers' default, credit rating agencies have increased the reactivity of their credit ratings to the fluctuation of obligors' creditworthiness in hardening their credit rating policy.

Alternatively, in the Internal Rating-Based Approach the countercyclicality becomes strongly reduced. Focusing on the portfolios, we observe that, for Banks and Corporate, the Internal Rating-Based Approach becomes procyclical after the global crisis. The countercyclicality seen in the portfolio Financial Institutions almost disappears. However the two portfolios, Corporate-SME and Retail Real-Estate stay largely countercyclical. Finally, Sovereign is the only portfolio which changes over the two periods, on the opposite direction, from pro- to counter-cyclical.

In conclusion, we notice that, whereas the Standardized Approach is more point-in-time during and after the global crisis, the through-the-cycle properties of banks' credit rating systems considerably weakens from one period to the other. Our findings suggest that after the crisis, banks' credit ratings are back to their primary goals: an essential "point-in-time" input to their risk management process.

Micro-level (All data)	Macro-level (aggregated data)

	2008-2015	2008-2012	2013-2015
Banking system	(obs=36364) -0.0028	(obs=22279) -0.0017	(obs=14130) -0.0022
Banking system (restricted)	(obs=30273) -0.0011	(obs=18730) -0.003	(obs=11543) 0.0024
Standardized Approach	(obs=13624)	(obs=9197)	(obs=4427)
RWA	-0.0226	-0.0152	0.0065
RWA_unrated	0.0157	0.0053	0.0403
RWA_rated	-0.0327	-0.0188	-0.0464
IRB approach	(obs=16649) 0.0131	(obs=9533) 0.0124	(obs=7116) -0.0058

Figure 16.a

	2008-2015 (obs=32)	2008-2012 (obs=20)	2013-2015 (obs=12)
Banking system	0.0019	-0.0476	0.0046
Banking system (restricted)	0.0284	-0.0768	-0.0089
Standardized Approach			
RWA	-0.3734	-0.2685	-0.1317
RWA_unrated	0.3321	0.2436	0.5654
RWA_rated	-0.3916	-0.2702	-0.4944
IRB approach	0.3014	0.3291	0.0052

Figure 16.b

Figure 16: Correlation analysis over the period 2008-2015. This period is split in two sub-periods 2008-2012 and 2013-2015 to examine the correlations during and after the global crisis. The micro-level (Table 16.a) is defined when the correlations are calculated with all the data. In the macro-level (Table 16.b), the correlations are calculated using the data quarterly cumulated over all banks and portfolios. The banking system is said "restricted" when it includes the four main portfolios: Sovereign, Financial Institutions, Corporate and Retail. These portfolios are then split according to their contribution between unrated and externally rated in the Standardized Approach and, internally rated in the Internal Rating-Based Approach.

5. Conclusion

This study examines how the mix of methodologies under the Basel regulation has influenced the stability of the banking system in the Netherlands during 2008-2015. Our analysis is based on a macro-regulatory point of view.

We use a specific regulatory dataset to document banks' reactions in such unfavorable macro-economic environment market by two crises and their propagation to the rest of the economy. We take advantage of a very sophisticated banking system to analyze the combined effect of models heterogeneity present in the Standardized Approach and inside the Internal Rating-Based Approach to examine the weak points of Basel regulation revealed in the literature during the period considered. The paper is focused on the consequences of regulatory reliance on credit ratings for banks' required capital buffers, with the goal of understanding its cyclical behavior. Such a study has never been done to our knowledge.

We observe that during the entire period studied, the strong decrease in loan exposure as a consequence of the required capital buffers evolves differently over time. These trends are even more pronounced when we split our data into the Standardized Approach and the Internal Rating-Based Approach at the portfolio level. We show that besides the methodological heterogeneity present in the two approaches to estimate the credit risk, these different trends are notably influenced by banks' reactions in stress situations.

An important and novel finding of this paper is that, at the macro-level of the banking system, the cyclical behavior of the required capital determined on the credit risk borne by banks is far from being

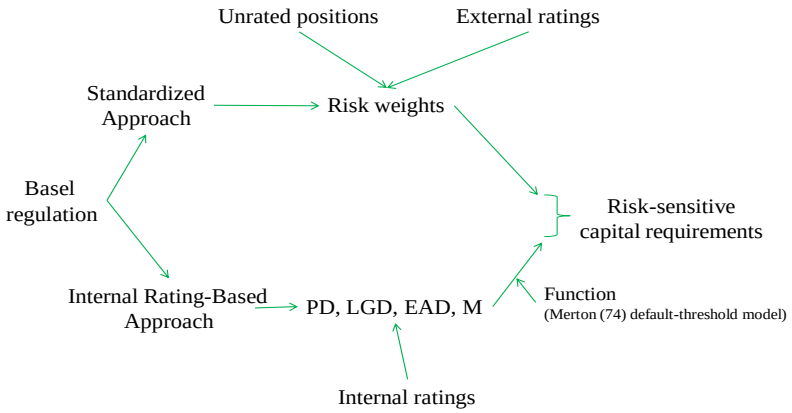
a stable factor. We find that it is largely influenced by the macro-economic environment in conjunction with banks' ability to adapt to it.

This paper is a preliminary study that confronts the relevant literature with a detailed analysis of a specific regulatory dataset. Its potential value is to identify and give new insights into interesting issues. Our goal is to draw the attention of regulators and researchers to different topics related to Basel methodological framework. Further extensions of this paper may lead to new opportunities in the development of the macro-regulation.

ANNEX

1. Basel methodology used to calculate the required capital for the credit risk

Basel bank capital regulation results from specific methodologies applied in two approaches available to calculate capital requirements. External ratings provided by officially recognised credit rating agencies (CRA) [1] are used in the Standardized Approach (SA). The rating of the borrower[2] determines in which risk category the transaction has to be classified. Each risk class carries its own risk weight. When no external rating is available, the loan exposure is classified in the unrated positions and pre-fixed risk weights are applied. The minimum capital requirement for credit risk is set at 8% of the total sum of the risk-weighted assets. The risk-weighted asset is the loan exposure amount times the corresponding risk weight. Alternatively, if approved by the supervisory authorities, banks may opt for the Internal Rating-Based Approach (IRB A) and use their internal credit risk assessment models to determine their required capital. First, banks evaluate the probability of default (in the foundation version of the IRB A) in addition with the loss-given-default, the exposure-at-default and the loan maturity (in the advanced version). Then, the risk-weighted-assets are calculated in applying these risk aggregates in a specific function[3] derived from the default-threshold model of Merton (1974). Finally as previously, the capital charges are, determined in taking 8% of the total sum of the risk-weighted assets. After an official approval, a bank can opt to transfer a part or its entire portfolio of loans from the Standardized Approach to the Internal Rating-Based Approach. The graph bellow illustrates the Basel regulatory framework.

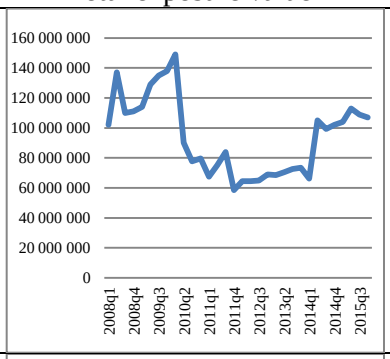
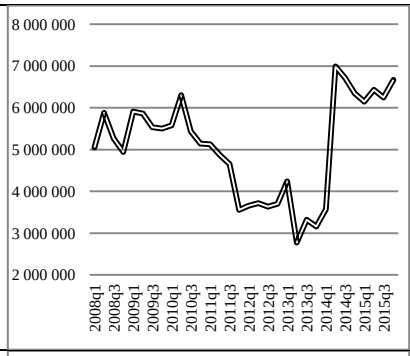
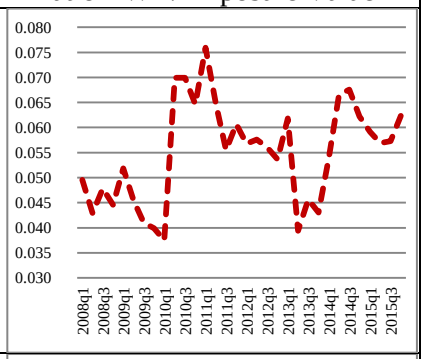
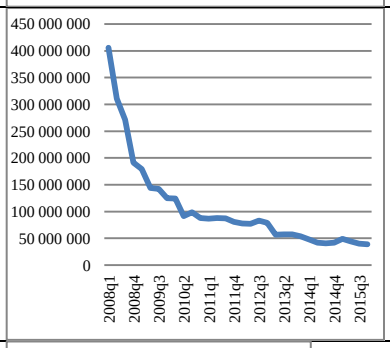
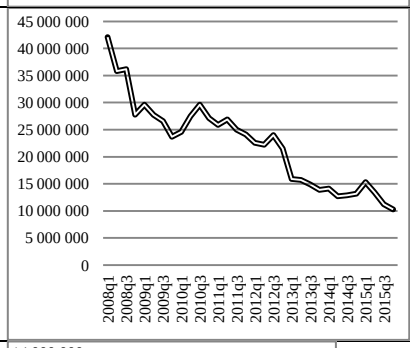
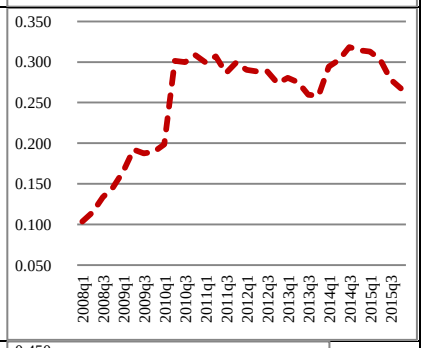
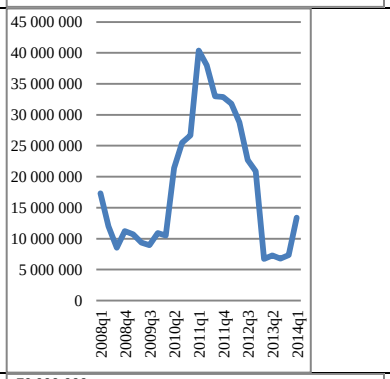
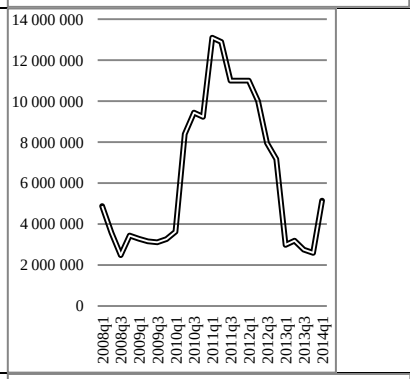
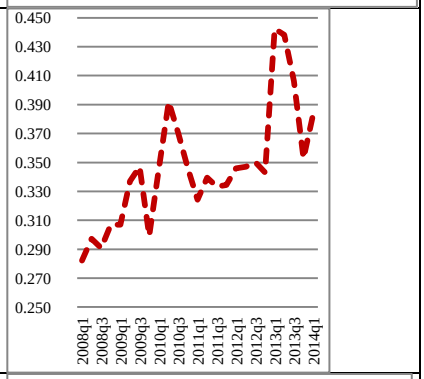
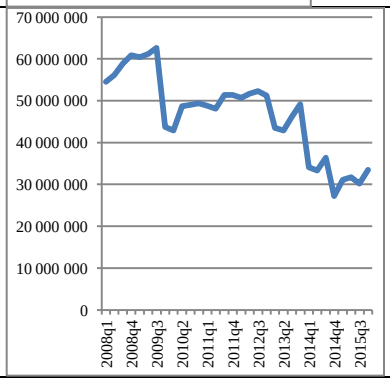
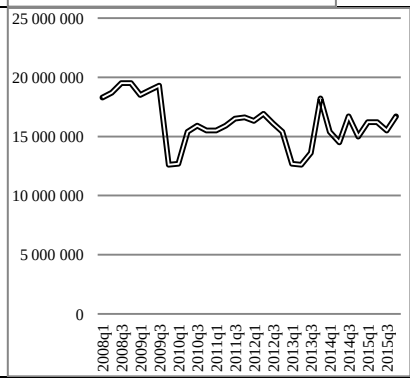
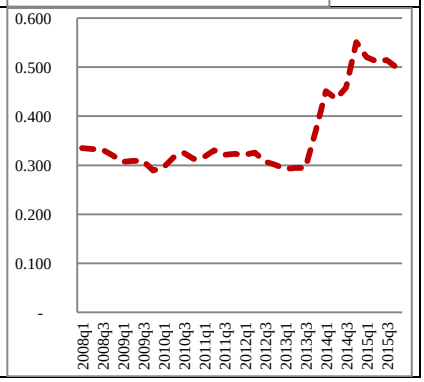


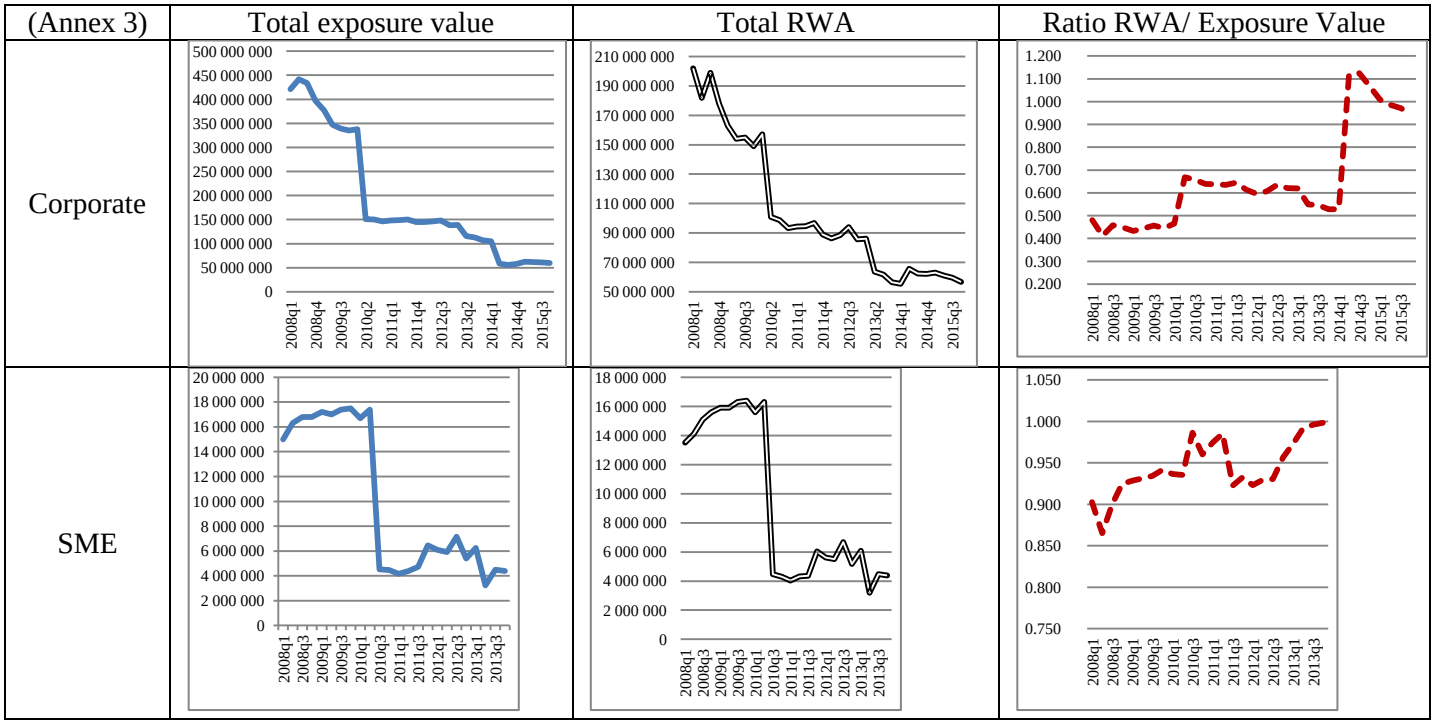
[1] A credit rating agency (e.g. Moody's; Standards & Poors and Fitch)
[2] The rating of the borrower is used for the all the portfolios except the Retail portfolios for which the creditworthiness of the loan transaction is evaluated
[3] The asymptotic single risk factor model developed by Gordy (2003)

2. Portfolios included in the Standardized Approach (SA) and in the Internal Rating-Based Approach (IRB A) before and after the reform of COREP. The abbreviations of the business lines are defined as follows: "CGOV" is for "Sovereign"; "RGOV_LA" for "Regional governments or local authorities"; "MLD BNKS" for "Multilateral developments banks"; "INT_ORG" for "International Organizations"; "AB_NCU" for "Public sector entities" (which name becomes "Public sector" after the reform of 2014Q4); "INSTIT" for "Financial Institutions"; "BNKS" for "Banks"; "CORP" for "Corporate"; "CORP Spec Lend" for "Corporate – Specialized lending"; "CORP_OTHER" for the large companies; "RET RE" for "Retail Real-estate" and "RET REVOLV" for "Retail revolving". We focus in the Standardized Approach on the claims directly comparable with the claims included in the Internal Rating-Based Approach. For the complete list of claims included in the Standardized Approach see in Basel (2004) and Basel (2006).

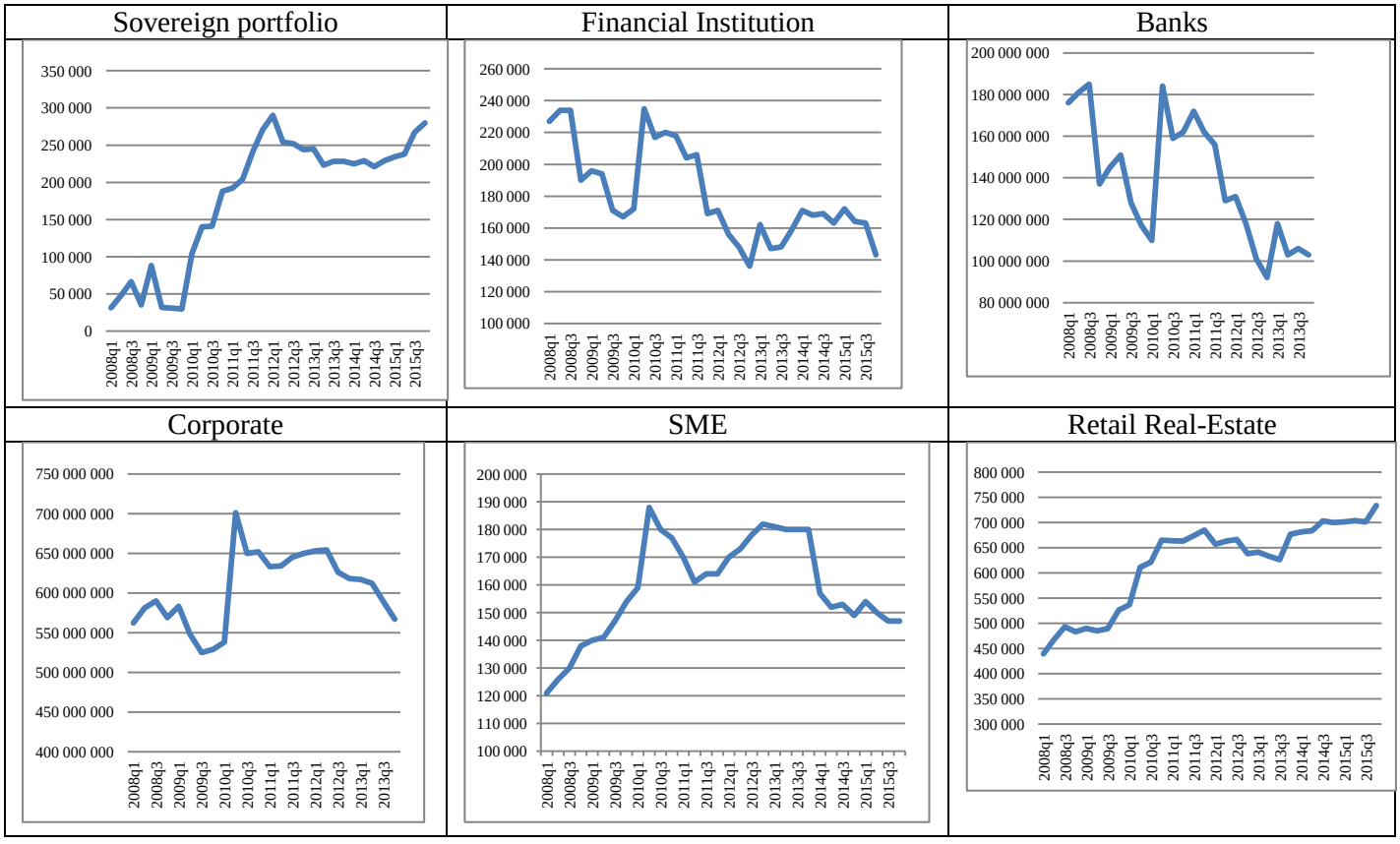
IRB A		SA	
2008Q1 – 2014Q1	2014Q1 – 2015Q4	2008Q1 – 2014Q1	2014Q1 – 2015Q4
CGOV	CGOV	CGOV	CGOV
		RGOV_LA	RGOV_LA
		MLD BNKS	MLD BNKS
		INT_ORG	INT_ORG
		AB_NCU	PUBLIC SECTOR
INSTIT	INSTIT	INSTIT	INSTIT
of which BNKS	---	of which BNKS	---
CORP	---	CORP	CORP
of which CORP Spec Lend	CORP Spec Lend	of which CORP Spec Lend	---
of which SME	SME	of which SME	---
---	CORP_OTHER	---	---
RETAIL	---	RETAIL	RETAIL
of which RET RE	RET RE	of which RET RE	RET RE
of which RET REVOLV	RET REVOLV	of which RET REVOLV	---
of which RET_OTHER	RET_OTHER	of which RET_OTHER	---
including RET SME	RET SME	including RET SME	---

3. Regulatory credit risk profile in the Standardized Approach: The total exposure is in blue, the total risk-weighted asset (RWA) is the compound line and the regulatory credit risk ratio is the dash line in red. The amounts are in thousands of Euros.

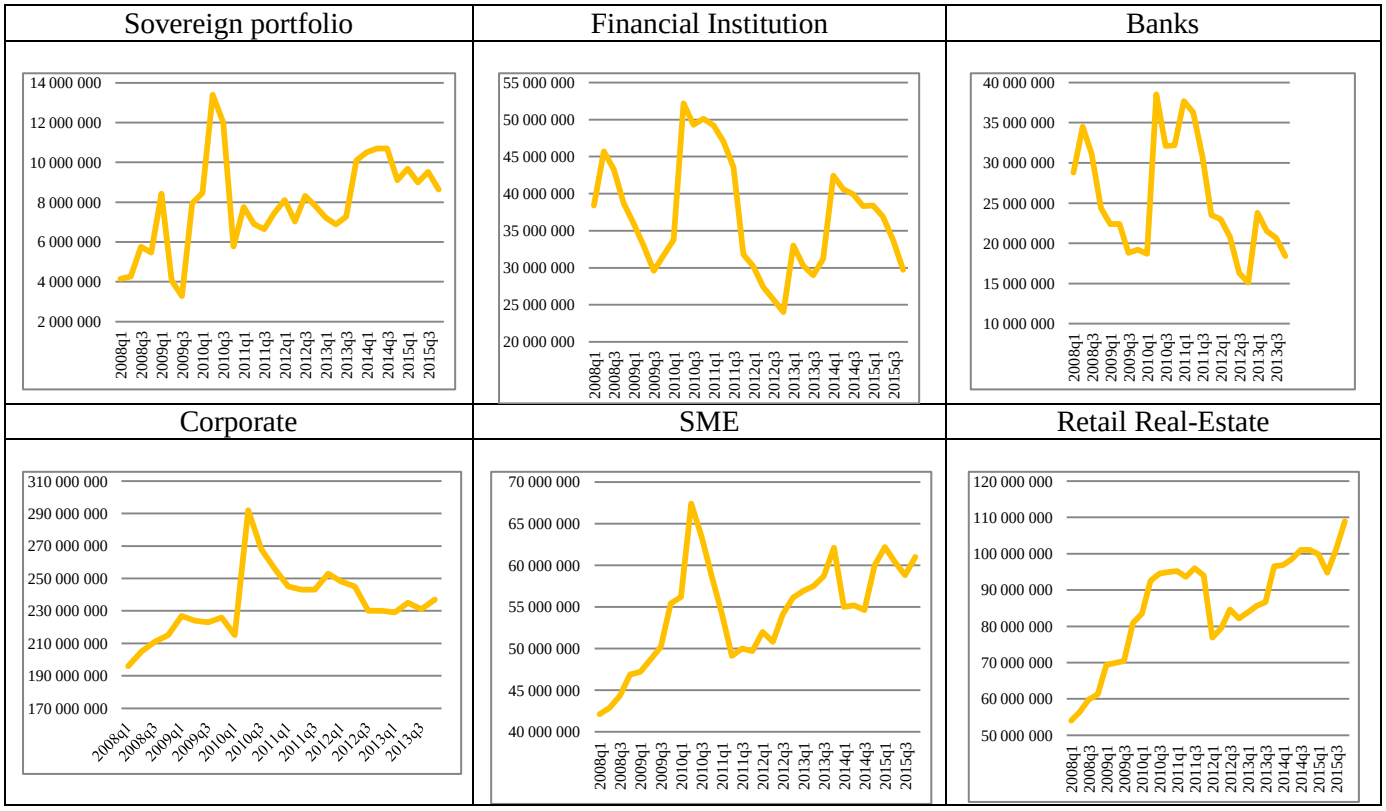
	Total exposure value	Total RWA	Ratio RWA/ Exposure Value
Sovereign			
Financial Institution			
Banks			
Retail Real-Estate			



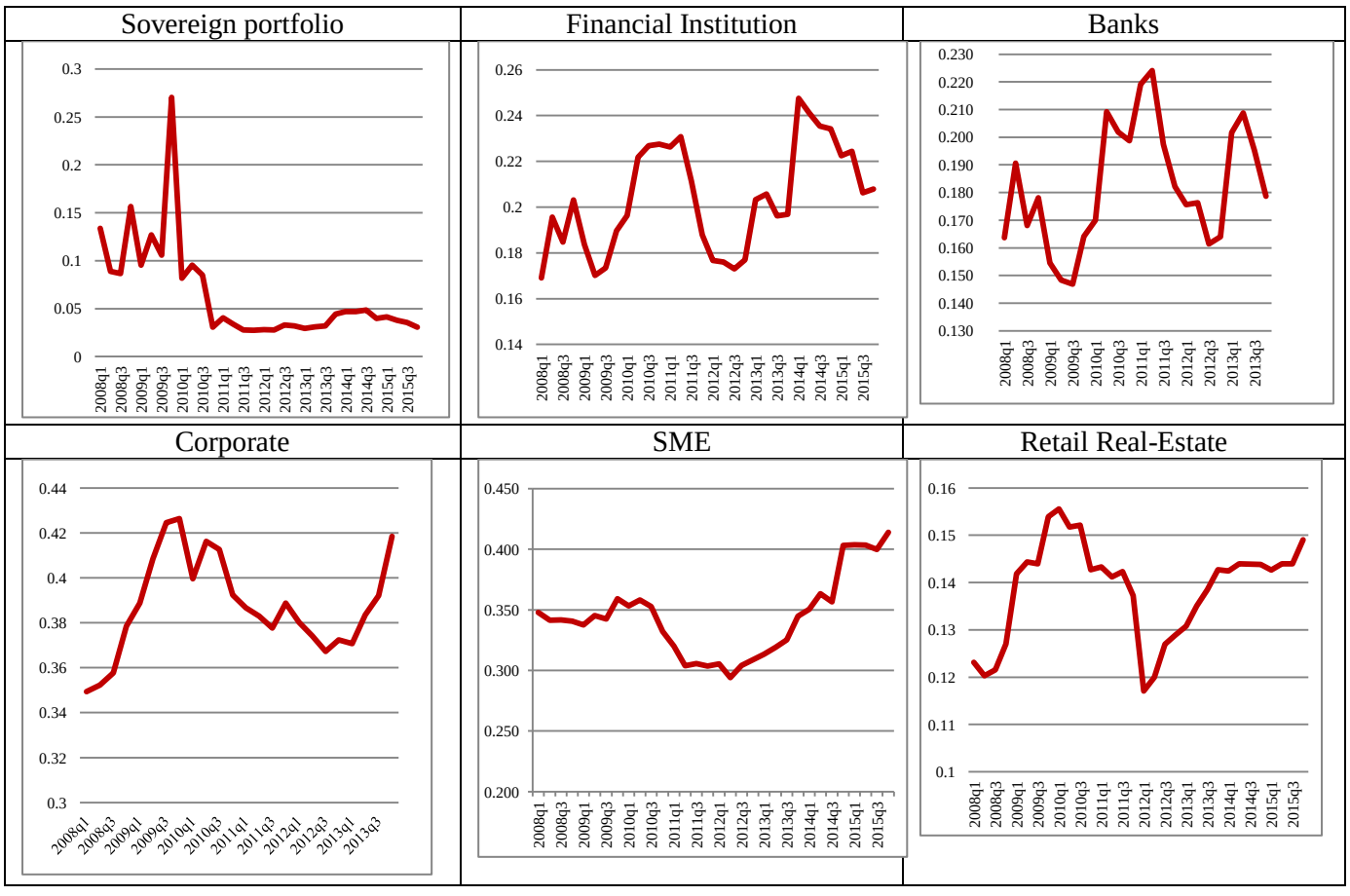
4. Regulatory risk profiles in the Internal Rating-Based Approach. Graphs 4.a show the time evolution of the aggregated loan exposure value in million Euros. Graphs 4.b reveal the time evolution of the risk-weighted assets. Graphs 4.c illustrate time evolution of the ratio aggregated RWA/aggregated exposure value. Graphs 4.d (respectively 4.e) depict the time evolution of the mean PD (LGD) calculated as the weighted average of their associated exposure values.



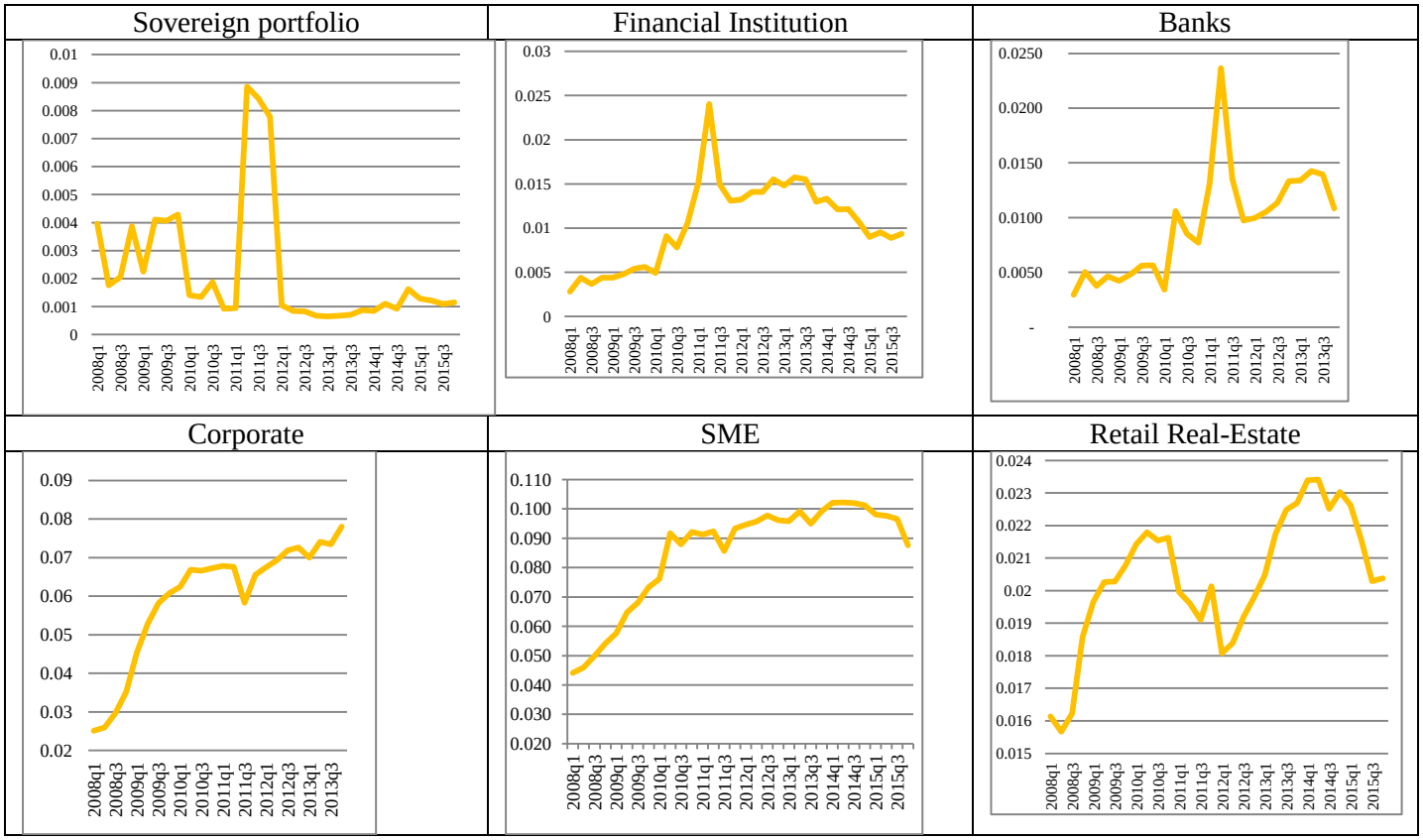
Graphs 4.a: Exposure value



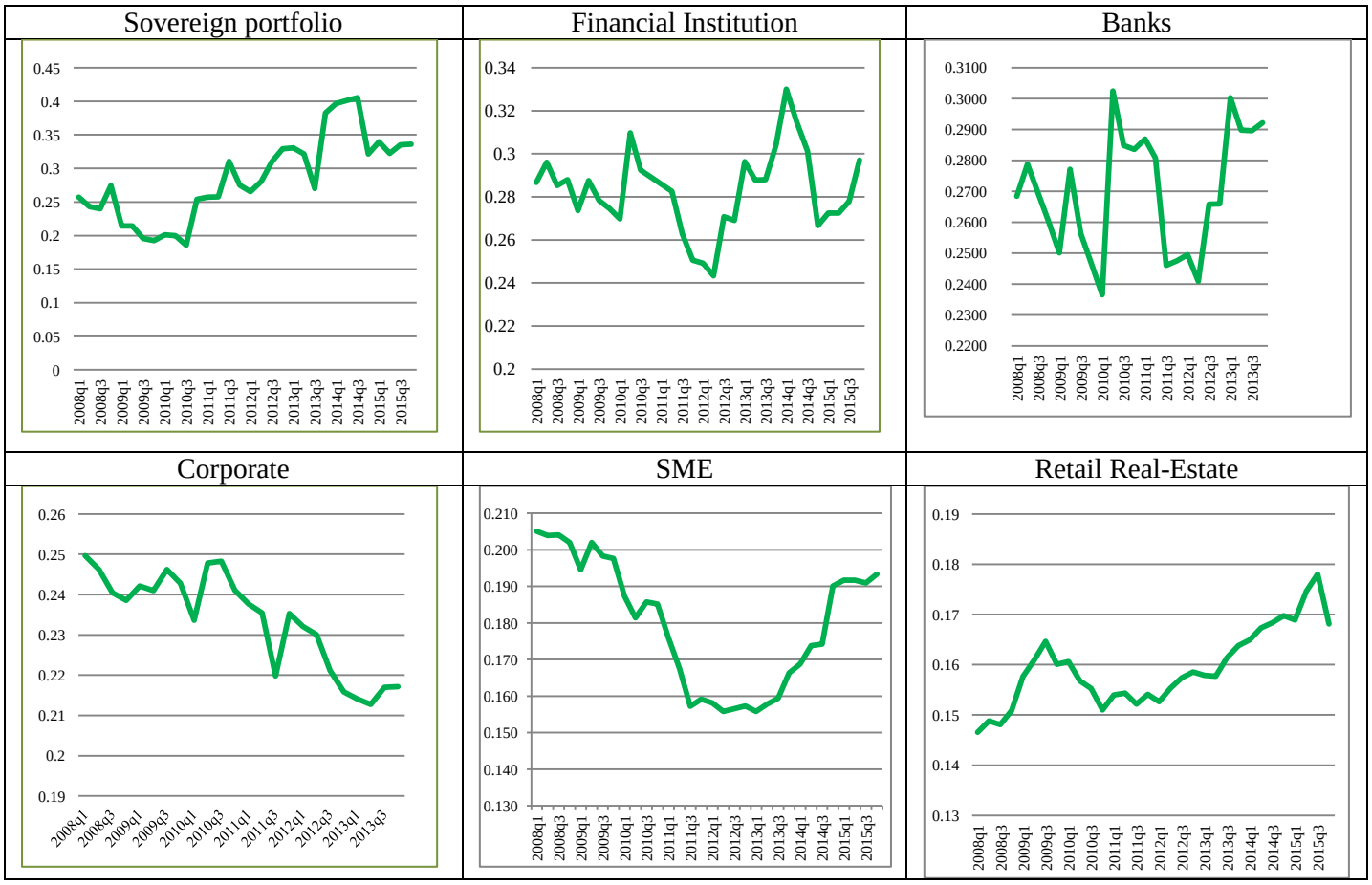
Graph 4.b: Risk-weighted assets



Graphs 4.c: Regulatory credit risk ratio (Risk-weighted asset divided by Exposure value)

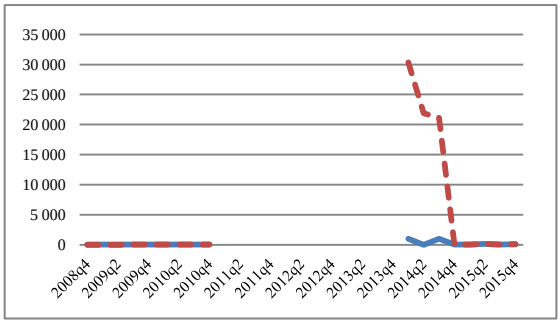
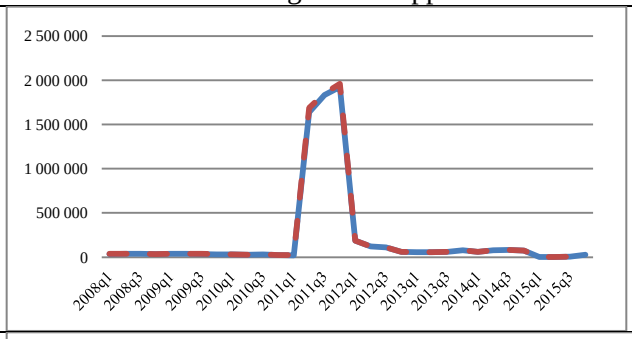
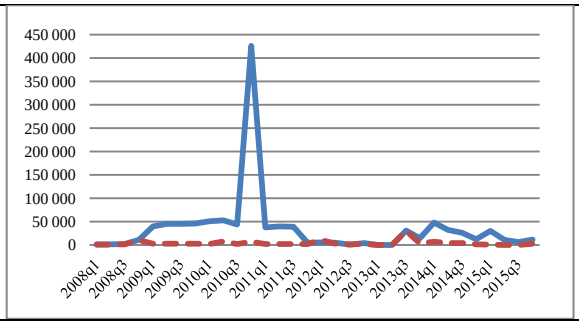
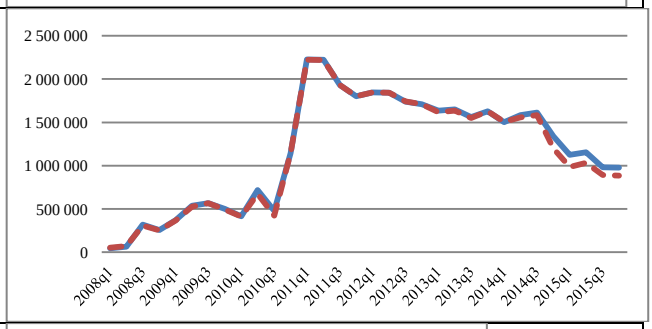
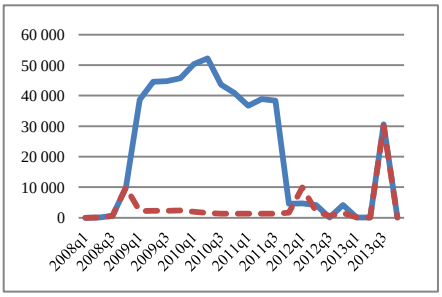
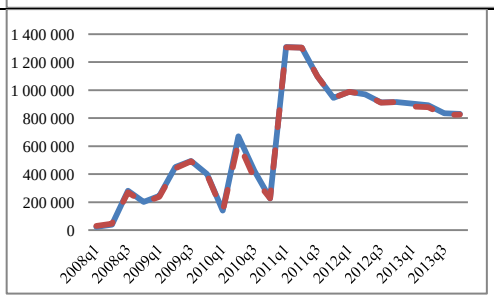
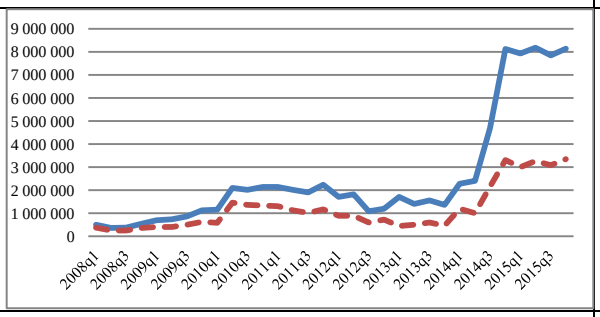
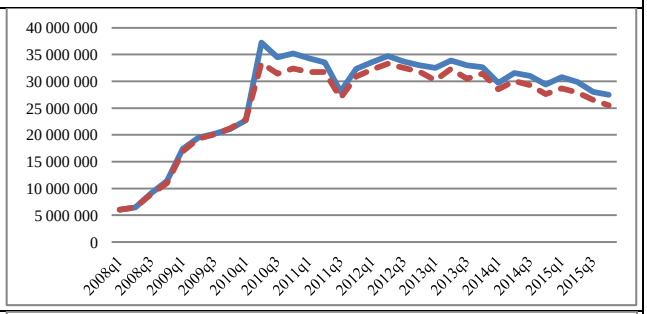
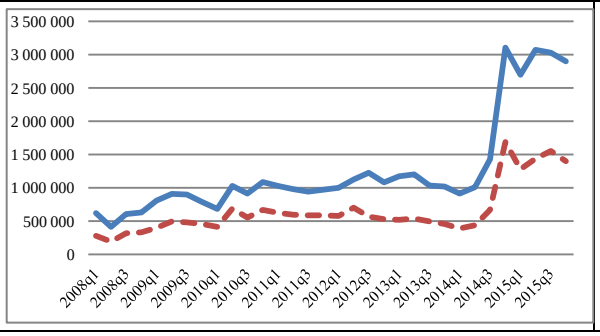
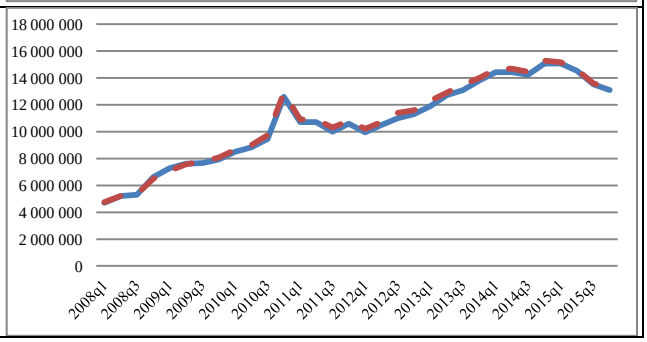


Graphs 4.d: Mean PD



Graphs 4.e: Mean LGD

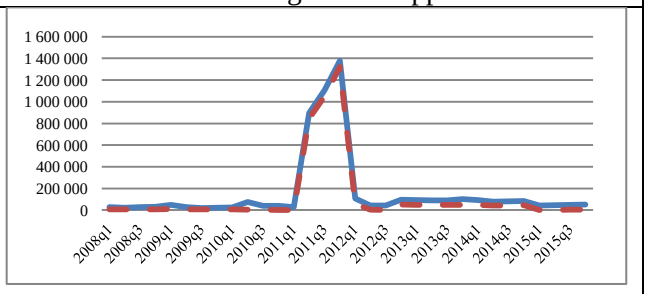
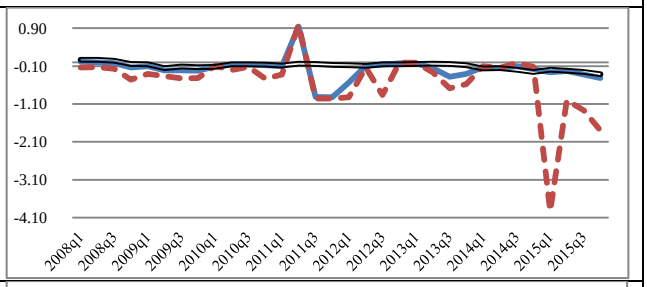
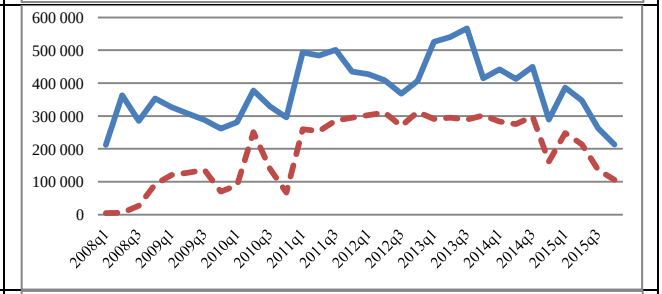
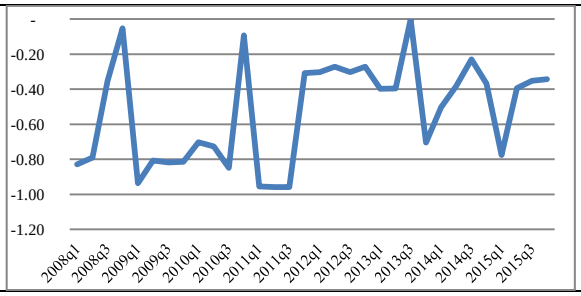
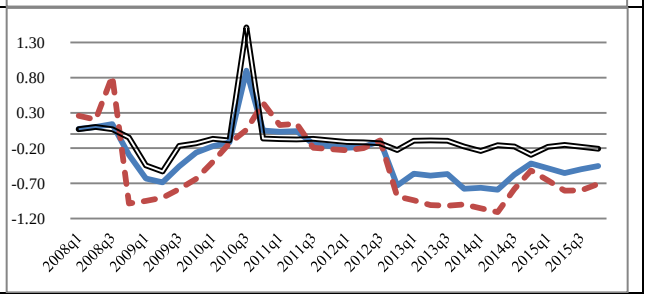
5. Defaulted loans observed in selected portfolios. The original exposure is in blue-single line and the exposure value is in red-dash line. The exposures are in thousands of Euros.

	Standardized Approach	Internal Rating-Based Approach
Sovereign		
Financial Institutions		
Banks		
Corporate		
Retail		

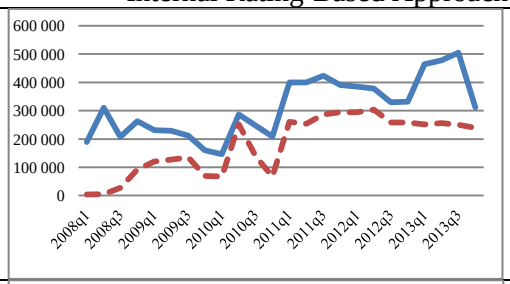
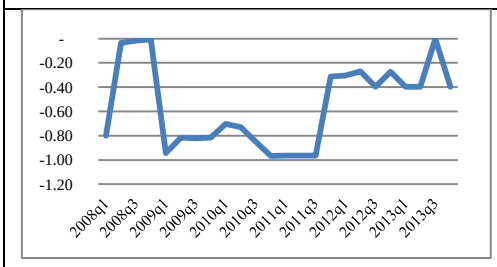
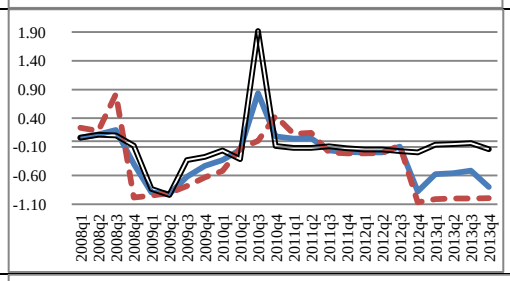
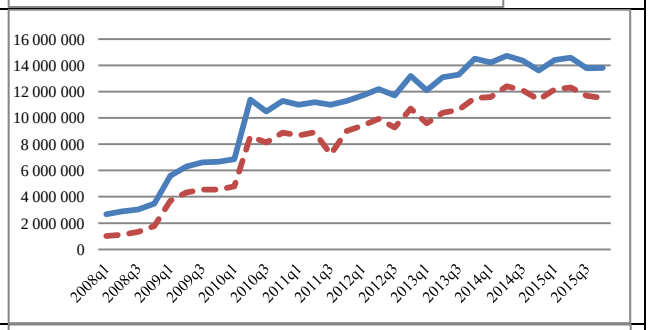
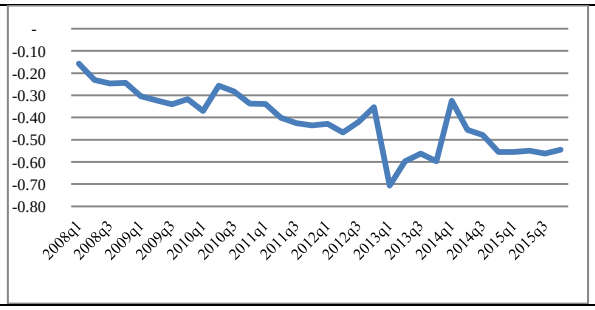
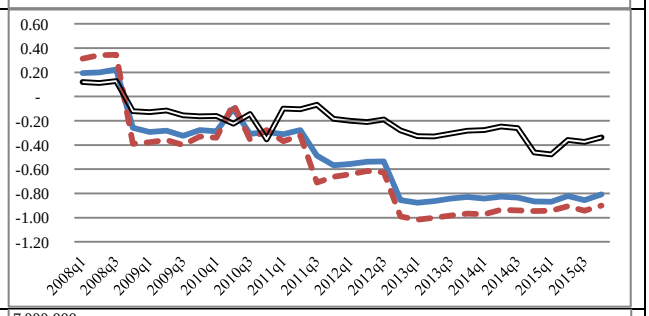
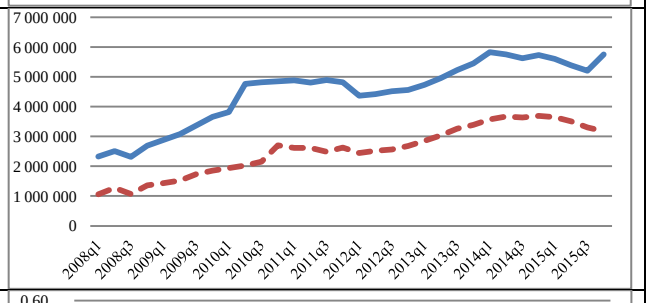
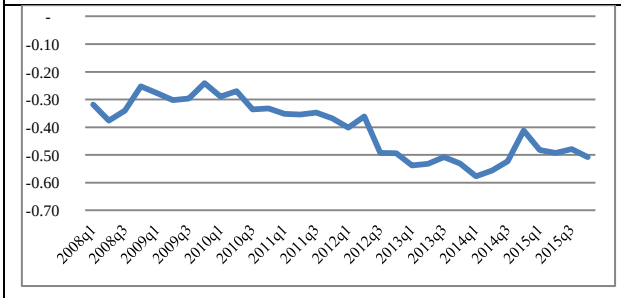
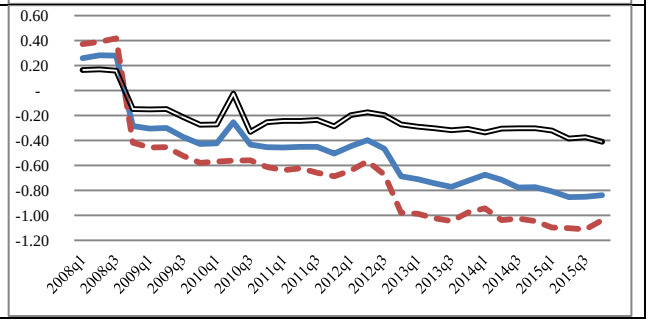
6. Time evolution of the aggregates standing for banks' reported credit risk management.

In the Standardized Approach the curve shows the ratio provision to original exposure for the deficient loans. The graph for the portfolio "Sovereign" is not realized because of the few and very small amounts included in the sample.

In the Internal Rating-Based Approach, the first graph on the top reveals the expected loss (EL). The curve in blue shows the EL aggregated over all banks and loans. The curve in red (dash line) illustrates the EL calculated for the defaulted loans. The second graph below shows the (regulatory) coverage ratio, provision to EL. The ratio is calculated over all banks and loans (curve in blue-single line). The ratio is then disaggregated into the defaulted loans (curve in red (dash line)) and the non-defaulted loans (curve in black-compound line).

	Standardized Approach	Internal Rating-Based Approach
Sovereign	---	 
Financial Institutions	---	  

6. (end)

	Standardized Approach	Internal Rating-Based Approach
Banks	---	
		
Corporate	---	
		
Retail	---	
		

7. Descriptive statistics in the Standardized Approach: For each risk weight (RW) the values are determined over all banks and portfolios. In the column “Obs”, the first number indicates the number of times the risk weight category appears in the total sample. For example, the risk weight “RW=0” appears 5842 times in the sample. The second number “RW nber” and “Exp Value” show the number of quarters upon which the average and standard deviations are calculated. Averages and standard deviations are computed on a quarterly basis. Hence for the risk weight “RW=0”, “RW nber=49” means that the banking activity uses this risk weight in average 49 times over the period 2008q1-2015q4. This period indicates the dates during which the risk weights are available. The amounts are in thousands of Euros.

		Obs	Mean	Std. Dev.	Min	Max
RW = 0	Time	5842			2008q1	2015q4
	RW nber	32	49	5	39	56
	Exp. Value	32	325 000 000	148 000 000	221 000 000	715 000 000
RW = .02	Time	60			2014q1	2015q4
	RW nber	8	4	0	3	4
	Exp. Value	8	5 717 041	1 400 134	4 045 947	7 718 511
RW = .04	Time	44			2014q1	2015q4
	RW nber	8	3	1	1	4
	Exp. Value	8	184 558	91 106	51 430	292 112
RW = .1	Time	632			2008q1	2015q4
	RW nber	32	9	2	6	12
	Exp. Value	32	8 781 488	9 658 550	1 238 047	28 100 000
RW = .2	Time	5135			2008q1	2015q4
	RW nber	32	50	6	38	58
	Exp. Value	32	65 300 000	48 500 000	24 300 000	204 000 000
RW = .35	Time	1958			2008q1	2015q4
	RW nber	32	25	3	20	29
	Exp. Value	32	33 300 000	13 400 000	14 700 000	56 500 000
RW = .5	Time	4571			2008q1	2015q4
	RW nber	32	41	4	33	48
	Exp. Value	32	46 500 000	38 400 000	14 200 000	127 000 000
RW = .7	Time	18			2012q3	2015q2
	RW nber	7	1	0	1	1
	Exp. Value	7	11 785	21 689	46	59 708
RW = .75	Time	2279			2008q1	2015q4
	RW nber	32	29	2	24	32
	Exp. Value	32	32 100 000	4 968 905	22 700 000	39 300 000
RW = 1	Time	6617			2008q1	2015q4
	RW nber	32	50	6	39	57
	Exp. Value	32	125 000 000	61 600 000	69 700 000	281 000 000
RW = 1.5	Time	2548			2008q1	2015q4
	RW nber	32	22	2	18	25
	Exp. Value	32	3 386 585	809 123	1 458 081	4 319 529
RW = 2	Time	20			2009q4	2012q1
	RW nber	10	1	0	1	1
	Exp. Value	10	61 299	22 947	24 135	101 245
RW = 2.5	Time	204			2014q1	2015q4
	RW nber	8	11	1	9	12
	Exp. Value	8	2 116 402	158 053	1 953 852	2 442 558
RW = 12.5	Time	8			2014q4	2015q1
	RW nber	2	2	0	2	2
	Exp. Value	2	737	121	651	822
RW = other	Time	480			2008q1	2015q4
	RW nber	32	5	1	4	8
	Exp. Value	32	3 244 890	4 150 820	114 413	16 000 000

8. Average number of grades calculated for each business line. A grade is a particular risk weight in the Standardized Approach; whereas, it is a probability of default in the Internal Rating-Based Approach.

Nber of "grades"	SA	IRB A
CGOV	9	8
INSTIT	11	9
BNKS	7	8
CORP	13	10
CORP_SpLend	6	8
CORP_SME	8	10
RETAIL	10	11
RET_RE	8	10
RET_REVOLV	3	11
RET_OTHER	8	11
RET_SME	7	11

9. Correlations calculated per portfolio of the risk-weighted assets (RWA) with the GDP growth rate. At the macro level, the correlations are calculated using the RWA quarterly aggregated.

	Micro-level (All data)		
	2008-2015	2008-2012	2013-2015
Sovereign		(obs=1678)	(obs=803)
SA (obs=2481)	0.0156	0.003	0.0339
RWA_unrated	0.0147	0.0023	0.0108
RWA_rated	0.0109	0.0027	0.0328
IRB (obs=2474)		(obs=1657)	(obs=817)
	0.0158	-0.0086	0.0092
Financial Instit.		(obs=3085)	(obs=1610)
SA (obs=4695)	-0.0236	-0.0042	0.003
RWA_unrated	0.0371	0.0213	0.0509
RWA_rated	-0.0375	-0.0107	-0.0401
IRB (obs=3408)		(obs=2199)	(obs=1209)
	0.0195	0.0231	0.0058
Banks	2008-2014q1	(obs=441)	(obs=111)
SA (obs=552)	0.0281	0.0454	-0.0805
RWA unrated	0.0387	0.043	0.0066
RWA rated	0.0094	0.0312	-0.1784
IRB (obs=2402)		(obs=2065)	(obs=337)
	0.021	0.0236	-0.0137
Corporate		(obs=2714)	(obs=1285)
SA (obs=3999)	-0.0255	-0.0173	0.0146
RWA unrated	0.0162	0.0069	0.0515
RWA rated	-0.0369	-0.022	-0.0609
IRB (obs=5311)		(obs=3162)	(obs=2149)
	0.0202	0.0236	-0.0114
SME	(2008-2014q1)	(obs=286)	(obs=70)
SA (obs=356)	-0.0594	-0.055	0.0354
RWA unrated	-0.0378	-0.0366	0.1076
RWA rated	-0.0544	-0.0472	-0.1461
IRB (obs=2776)		(obs=1692)	(obs=1084)
	0.0316	0.037	0.002

	Macro-level (aggregated data)		
	2008-2015 (obs=32)	2008-2012 (obs=20)	2013-2015 (obs=12)
Sovereign			
SA	0.1883	0.0846	0.481
RWA unrated	0.2052	0.0639	0.1128
RWA rated	0.0873	0.0485	0.5547
IRB			
	0.0158	-0.0298	0.2218
Financial Instit.			
SA	-0.2512	-0.0155	-0.1622
RWA unrated	0.4222	0.3116	0.5793
RWA rated	-0.304	-0.1068	-0.4317
IRB			
	0.0195	0.3692	0.074
Banks	(2008-2014q1)		(obs=5)
SA	0.1694	0.2731	-0.747
RWA unrated	0.2907	0.3191	-0.2861
RWA rated	0.0902	0.1977	-0.77
IRB			(obs=4)
	0.021	0.3854	-0.3522
Corporate			
SA	-0.3274	-0.2101	0.1012
RWA unrated	0.2405	0.2443	0.5775
RWA rated	-0.35	-0.2216	-0.5663
IRB			
	0.217	0.2513	-0.2495
SME	(2008-2014q1)		(obs=5)
SA	-0.2284	-0.2119	0.3795
RWA unrated	-0.1276	-0.1174	0.7453
RWA rated	-0.1727	-0.1436	-0.5894
IRB			(obs=12)
	0.4398	0.3597	0.3563

	Micro-level (All data)		
	2008-2015	2008-2012	2013-2015
Retail		(obs=1720)	(obs=729)
SA (obs=2449)	-0.0518	-0.0423	-0.0076
RWA unrated	0.0573	-0.0001	0.0849
RWA rated	-0.0664	-0.0425	-0.0833
IRB (obs=5456)		(obs=2515)	(obs=2941)
	0.0061	0.0187	0.0057
Retail Real-estate		(obs=1026)	(obs=683)
SA (obs=1709)	-0.0215	-0.0228	0.0359
RWA rated	-0.0703	0.0042	0.1053
RWA unrated	0.0915	-0.0235	-0.1085
IRB (obs=3562)		(obs=2254)	(obs=1308)
	0.0343	0.0237	0.0068
Retail Real-SME		(obs=370)	(obs=103)
SA (obs=473)	0.0168	0.0204	-0.0119
RWA unrated	0.0211	0.0325	-0.1129
RWA rated	0.0162	0.0193	-0.0099
IRB (obs=2144)		(obs=1241)	(obs=903)
	-0.0018	0.0271	-0.0104

	Macro-level (aggregated data)		
	2008-2015 (obs=32)	2008-2012 (obs=20)	2013-2015 (obs=12)
Retail			
SA	-0.4875	-0.4239	-0.4204
RWA unrated	0.2913	-0.0158	0.4597
RWA rated	-0.4733	-0.4116	-0.4414
IRB			
	0.3203	0.3171	0.1909
Retail Real-estate			
SA	-0.3183	-0.343	0.1958
RWA rated	-0.3656	0.2386	0.4106
RWA unrated	0.2938	-0.3589	-0.3882
IRB			
	0.3914	0.2918	0.3231
Retail Real-SME			(obs=5)
SA	0.4554	0.5167	-0.2634
RWA unrated	0.1425	0.1927	-0.6329
RWA rated	0.4619	0.5251	-0.2309
IRB			(obs=12)
	0.184	0.2978	-0.0955

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De Nederlandsche Bank N.V.
Postbus 98, 1000 AB Amsterdam
020 524 91 11
dnb.nl