Lending behavior and credit risk: does effective risk management matter?

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Abstract

This paper examines the macroeconomic and firm-specific determinants of bank loan portfolio deterioration, that is proxied by the ratios of non-performing loans over gross loans and loan loss provisions over gross loans. In particular, we verify the empirical relevance of two novel bank-specific characteristics, i.e. the effectiveness of bank risk management and the bank's risk profile. Our analysis is based on a panel data set covering the period 2006-2015 for 177 banks from 14 European countries. We find significant evidence that the quality of bank loan portfolio is lower for banks with a stronger risk attitude, but higher for those banks which, all else being equal, rely on more effective and accurate risk-management tools and procedures. Overall, our results confirm that more effective risk management helps to contain credit risk both during economic downturns and also when the bank had adopted an expansive lending policy in previous years.

Keywords: bank loans; credit risk; non-performing loans; internal rating based model.

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1. Introduction

A number of studies have sought to explain the determinants of bank asset quality and loan portfolio performance. It is well understood that a high level of non-performing loans (henceforth NPLs) negatively affects banks' lending capacity, reduces their profitability and ability to raise new capital and, ultimately, threatens their stability. The current literature has investigated in great detail the relationship between the economic cycle and banks' credit risk and lending policies (Salas and Saurina, 2002; 2002; Laeven and Majnoni, 2003; Bikker and Metzemakers, 2005). These studies have found empirical evidence supporting the hypothesis of pro-cyclicality of credit growth and anti-cyclicality of credit risk, supporting the view that those banks that during an economic downturn are more dynamic, i.e. lend more than the others, can expect to face a higher increase in credit risk. According to this view, banks should trim their credit offer during negative economic cycles in order to avoid a deterioration of their loan portfolios, thus supporting the popular saying that 'banks lend their umbrellas only when it's sunny'. Of course, such behaviour might amplify the negative implications of the economic downturn and give rise to a credit crunch. This is also the reason why, since the international financial crisis, the prudential supervisory framework has been modified to better cope with the effects of the economic cycle on credit risk, and the countercyclical capital buffer has been introduced.

However, despite robust evidence of a negative relationship between credit risk and economic cycle, the amount of risk appears to differ significantly among banks in the same country facing the same macroeconomic conditions (Marcucci and Quagliariello, 2009; Glen and Mondragon-Velez, 2011). Besides, recent studies focusing on the performance of Italian banks during the last economic cycle (Di Battista and Nieri 2012; Bongini, Cucinelli, Di Battista, Nieri 2015) have found evidence that the credit risk level is not necessarily higher for those banks that in previous years lent more.

This evidence suggests that credit risk is not driven exclusively by adverse macroeconomic conditions and an expansive credit policy, but also to some extent by other bank-specific factors. Indeed, according to bank management principles, differences between banks in credit risk levels depend mainly on the effectiveness of credit risk management, i.e. on the ability to screen and monitor borrowers more efficiently. Better credit allocation skills might allow some banks to sustain robust loan growth despite the economic downturn, without giving rise to an excessive level of risk. Besides, the level of credit risk is also determined by a bank's risk profile and appetite, that may be considered a strategic choice of banks' shareholders.

Previous studies have tried to verify the nexus between the effectiveness and efficiency of bank management and the level of credit risk (Berger and Udell, 1997, Louzis et al. 2014). In these studies the management quality is proxied by the previous or simultaneous performance (ROE) and/or by the cost-income ratio of the bank and empirical results lend support to the so-called 'bad management' hypothesis, suggesting that more efficient banks have a lower risk. The extant literature suggests also that credit risk tend to be higher when the bank has a stronger appetite for risk, that is when it is weakly capitalised and moral-hazard incentives may lead managers to accept higher risk.

This paper investigates the empirical relevance of bank-specific characteristics in determining the level of risk in bank loan portfolios. In particular, we focus on two types of credit risk determinants, i.e. the effectiveness of a bank's risk management and its risk attitude. Our analysis contributes to the existing literature in two ways. Firstly, in addition to the macroeconomic and bank-specific variables identified in the literature as determinants of loan portfolio deterioration, we establish the significance of two new variables capturing the bank risk profile and its risk management effectiveness. The first is the Risk Weighted Assets to total assets ratio – also referred to as 'RWA density' – that may be considered a valuable proxy of banks' risk profile (Leslé and Avramova, 2012; Cannata et al.,2012; Beltratti and Paladino, 2014). The second variable is a dummy variable that equals 1 if the bank/banking group uses the internal rating based (IRB) approach to calculate the regulatory capital minimum requirement, and 0 otherwise. Under the present regulatory framework, the use of IRB models to calculate the minimum capital requirement is conditional on the supervisory authorities having assessed the soundness and appropriateness of internal credit risk measurement and management systems. We can therefore assume that those banks whose IRB models have been validated, have demonstrated the accuracy and effectiveness of their risk management models. Secondly, our data set spans the period from the onset of the international financial crisis until the recent real economic crisis, thus covering the whole economic downturn that has hit the European economy, while most other studies that are based on bank-level data cover a shorter period.

Our analysis is based on a panel data set covering the period 2006-2015 for 177 banks from 14 European countries, accounting for about 63% of the European banking system's total assets. We initially rely on fixed-effect econometric techniques that allow for individual bank heterogeneity and time-specific effects without over-restrictive assumptions on idiosyncratic disturbances.

We find significant evidence that the amount of credit risk, proxied by the ratios of NPLs over gross loans and loan-loss provisions (LLPs) over gross loans. is higher for banks with a stronger risk attitude, but lower for those banks which, all else being equal, rely on an internal rating methodology which supervisory authorities have deemed sound and accurate and deserving of 'validation'. Overall, our results confirm that more effective risk management helps to contain credit risk both during economic downturns and also when the bank had adopted an expansive lending policy in the previous year.

The paper is organized as follows: Section 2 provides a brief description of credit risk trends among European banks during the period analysed; Section 3 surveys the relevant literature and proposes our hypotheses; Section 4 describes the sample and the methodology adopted. In Section 5, we comment on the results obtained and in the last section we draw our conclusions.

2. Stylized facts concerning bank credit risk

The level of credit risk of European banks has risen during the last decade and has become one of the main concerns for regulators and banks. Indeed, a high burden of NPLs is viewed simultaneously as being a consequence of persistent adverse macroeconomic conditions, and as a major obstacle to bank credit growth and the recovery of the European economy (IMF, 2015). In this paragraph, we briefly analyse the evolution of the loan portfolio quality of our sample of European banks[1] over the period from 2006 to 2015.

Since the outbreak of the international financial crisis, credit risk has significantly increased in all European banks (Figure 1). However, the deterioration of bank loan portfolios – measured by the ratio of NPLs to gross loans[2] - has been more intense for countries such as Ireland, Portugal, Spain and Italy (henceforth IPSI countries) where, according to the supervisory authority (EBA, 2015a[3]), the level of credit risk is still quite high. The rise in NPLs mirrors the economic downturn (approximated by the GDP growth rate), thus confirming the hypothesis of the cyclical behaviour of bad loans postulated by many scholars, and is followed by a decrease in the growth of bank loans. According to the findings reported in the relevant literature, an increase in NPLs causes a decline in commercial bank loans, as banks with a high level of NPLs become increasingly reluctant to take on new risks and commit to new loans (Cucinelli, 2015). It is interesting to note that the decrease in

[1] For the description of the sample see Section 4.

[2] Despite the importance of NPLs in terms of market discipline, the disclosure of NPLs among European banks has been affected by differences in the definition and in the recognition of problem loans. Since in our analysis we rely on accounting measures, we are aware of a potential bias when comparing the NPL ratio among European banks.

[3] Data collected by EBA for the EU-wide Transparency Exercise with reference to 2015 year-end are not affected by accounting differences since they are based on the same definition of non-performing exposures (see EBA/ITS/2013/03). Our results are consistent with those of EBA.

bank loan growth registered after the onset of the crisis is stronger for banks in the IPSI countries, i.e. the banks which before the crisis had adopted the most expansive lending policies. This evidence – which is in line with other related studies (Jimenez and Saurina, 2006) - hints that an aggressive lending policy may be one of the determinants of a subsequent deterioration of loans, especially if the loan expansion has occurred during a negative economic cycle.

<Figure 1 approximately here >

A trend similar to that of the NPL ratio is revealed by another proxy of credit risk, i.e. the ratio between LLPs and gross loans[4] (Figure 2). Although the LLP ratio may be affected by bank earnings management policies, it is more reactive and dynamic that the NPL ratio and could also be used as a proxy of the bank's perception of the risk embodied in its portfolio. By comparing the NPL ratio with the LLP ratio it seems that at the beginning of the crisis ISPI banks underestimated risk, making lower provisions than their peers despite the higher incidence of NPLs. This explains why the coverage ratio[5] of IPSI countries remained lower than that of the rest of Europe until 2012.

<Figure 2 approximately here >

To deepen our understanding of the relation between lending policies and credit risk, we divided the sample into two groups according to the rate of loan growth. The first group includes 'faster' banks, i.e. those banks that showed an average growth rate[6] of gross loans above the median of the total sample; the second group includes 'slower' banks, whose loans grew at a rate below the median of the sample. As shown in Figure 3, we cannot identify a stable relationship between loan growth and the two indicators of credit risk – i.e. the NPL and the LLP ratios - over the observed period. This evidence, however, is not robust enough to reject the hypothesis that banks which lend more during a negative economic cycle accumulate more risk.

<Figure 3 approximately here >

In conclusion, our data show that the increase in credit risk in bank portfolios is undoubtedly associated with the economic cycle and with banks' lending behaviour, but the great dispersion among banks of different countries and also among banks of the same country suggest that other factors concur to determine the overall credit risk of a bank. In the following paragraph, a more thorough analysis will be performed to shed some light on this issue.

[4] The Loan Loss Provision ratio is a measure of the cost of risk in banks. It is the ratio between the loan loss provision that each year a bank sets aside as reserve to face possible future problem loans, and the amount of gross loans.
[5] The coverage ratio is the ratio between the loan loss reserve and non-performing loans. It measures the bank's ability to absorb potential losses from its non-performing loans.
[6] We use a geometric average of the growth rate of gross loans for the period 2006-2015.

3. The determinants of credit risk: a review of the literature and our hypotheses

Our paper relies mainly on the wide literature covering the determinants of credit risk level in bank loan portfolios. These studies are quite diverse and can be divided according to the types of factors that are considered as a determinants of the asset quality of loans, and the type of data used in the empirical analysis. The first group includes studies that use only macroeconomic variables, often at the aggregate level (Bofondi and Ropele, 2011; Beck et al., 2013); the other group includes studies acknowledging the concurrent importance of both macroeconomic and microeconomic variables in explaining the level of credit risk and also use bank-level data (Salas and Saurina, 2002; Boudriga et al., 2009; Louzis et al., 2011, Glen and Mondragon-Velez, 2011).

With regard to the first group, Bofondi and Ropele (2011) conclude that loan portfolio quality is determined mainly by a small number of macroeconomic variables, such as the growth rate of real GDP, the unemployment rate, the level of house prices and the interest rate, which affect the level of credit risk with a time lag of between 2 and 4 quarters, and the unemployment rate, which has an immediate effect. Their study analyses separately loans to households and loans to firms, in Italy, during the period 1990-2010, and finds that for the former the level of risk is primarily affected by the growth rate of real GDP, house prices and the unemployment rate, and the short-term nominal interest rate. As for loans to firms, credit risk increases with the unemployment rate and with an increase in the ratio of net interest expenses to gross operating profits, while it decreases as consumption of durables increases.

The relevance of the economic cycle as a crucial determinant of bank loan quality – proxied by the ratio of loan loss provision (LLP) to gross loans – is also confirmed by Laeven and Majnoni (2003), who consider a large sample of banks from 45 countries for the period 1988-1999, as well as by Bikker e Metzemakers (2005), who analyse a sample of banks from 29 OECD countries for the period 1991-2001. The negative relationship between LLP and GDP growth rate is also found in a study that focusses on 22 major developing countries (Glen and Mondragon-Velèz, 2011), where the relationship between credit risk and GDP growth rate is tested using data both at the country-level and at the individual bank-level over the 1996-2008 period. However, the authors note that the increase in credit risk caused by a reduction in GDP is larger at the individual bank level than at the banking system level. This evidence suggests that the loan portfolio quality of banks in the same country reacts differently to the same GDP shock, and this different reaction persists even after controlling for potential differences in the banks' business models (loans to total assets), leverage, and previous reservation policies (loan loss reserves to gross loans).

Beck et al. (2013) applied a dynamic panel model to estimate the macroeconomic determinants of NPLs using country-level data for 75 countries over the 2002-2010 period. As in previous studies, GDP growth rate (simultaneous and lagged) was found to have an overall negative impact on credit risk, although the simultaneous GDP growth rate has a negative sign, while the lagged variable shows a positive sign. The authors interpreted this latter evidence as loan portfolio deterioration being caused by the adoption of laxer credit standards during the previous upward phase of the economic cycle. Among the other variables that significantly affect NPLs, the study identifies the lending interest rate (positively), and share prices, used as a proxy of the general financial condition of a country as well as of the value of collaterals, (negatively); the latter's effect is larger for countries with large stock markets.

Macroeconomic variables are also deemed to be significant determinants of NPL by bank managers, as highlighted by Farhan et al. (2012), who used data collected in 2006 through a questionnaire survey. Answers provided by more than 200 Pakistani bankers involved in lending decisions or in credit risk management acknowledged the importance of interest rates, unemployment, inflation, GDP growth and exchange rates in determining the level of NPLs.

Overall, these studies confirm that changes in the level of bank loan quality are to a large extent due to simultaneous or previous changes in macroeconomic conditions and to the economic cycle. Macroeconomic variables can be used both by supervisory authorities to predict potential crises, and by banks for risk management purposes. However, the effect of the economic cycle on bank credit risk does not seem to be symmetrical, as Marcucci and Quagliariello (2009) demonstrated. Having access to the comprehensive data base collected for regulatory purposes by the Italian supervisory authority, the authors exploited a wide data-set that also includes non-public information relating to more than 200 Italian banks for the period 1989-2005. As a proxy of credit risk they used the default rate, i.e. the ratio of the flow of new bad loans to the existing stock of performing loans. Their results highlight the fact that i) the cyclicality of the default rate is more marked during economic downturns and ii) the portfolios of riskier banks (i.e. those with higher default rates) are more sensitive to the cycle.

Salas and Saurina (2002) were among the first to include the effect of bank-specific features when considering bank risk-taking. They used both macro- and microeconomic variables for a sample of Spanish commercial and savings banks in the period spanning 1988-1997. With reference to the macroeconomic drivers of NPL, they focused on proxies of the economic cycle and of the indebtedness of families and firms, while as microeconomic drivers they identified three groups of bank-level variables to proxy the rate of credit growth, the composition of loan portfolios and the

incentives of the bank to take risk. They found that the level of credit risk (proxied by the ratio of problem loans to gross loans) increases, as expected, during an economic downturn, but credit risk is also positively affected by the previous adoption of aggressive loan and branch growth policies (with a 3- to 4-year lag), the use of non-collateralized credit contracts and the degree of inefficiency of the bank.

Boudriga et al. (2009) investigated the determinants of NPL in a sample of 59 countries for the period preceding the international financial crisis (2002-2006) using country-level data. In particular, in addition to the traditional proxies of macroeconomic performance and conditions, such as GDP growth and a financial development indicator, they also considered industry-specific variables, such as market concentration, the degree of independence of the supervisory authority and its power, and banks' ownership structures (relevance of state-owned and foreign-owned bank assets), as well as bank-specific variables, such as profitability, provisioning policy and capitalization. Findings underline the fact that at the bank-specific level, higher capital ratios and higher provisions seem to reduce the level of NPL, while profitability has no effect. As for the banking industry features, the study identifies a positive impact on the quality of loan portfolios due to i) concentration in the banking market, ii) private and foreign shareholdings, and iii) the financial development of the country.

Louzis et al. (2011) analysed the factors causing NPL in the Greek banking sector from 2003 to 2009. These authors used dynamic panel model data and studied separately three loan categories (corporate loans, consumer loans and mortgage loans). They found that GDP growth, unemployment rates, public debt and management quality have strong effects on the NPL of Greek banks, although they have different effects on the 3 types of loans. Consumer loans are the most sensitive to changes in the lending rates (positive relation); business loans react mainly to the real GDP growth rate (negative relation); mortgages are the least affected by macro-economic developments. As for the impact of bank-specific determinants, the study provides evidence of the significance of some features such as efficiency (measured as the ratio between operating costs and operating income) and profitability (ROE), hinting that bad loans are largely the result of management quality.

Klein (2013) also studied the macro and bank-specific determinants of NPLs, using a sample of CEESE banks during the period 1998-2011 and applying a panel VAR methodology to country-level data. The study concluded that not only macroeconomic conditions (GDP growth, unemployment rate and inflation) are significant in determining the level of NPLs to gross loans ratio. Indeed, NPLs are lower the higher previous profitability and capitalization were, thus

suggesting that credit risk is crucially influenced by the quality of management, in the same vein as the findings of Louzis et al. (2011) and Berger and De Young (1997). On the other hand, credit risk is higher the lower the risk aversion of banks, as measured by the loans-to-assets ratio and the growth rate of a bank's loans.

Many contributions have studied the impact of credit growth on credit risk; however most of these studies relate to the period before the financial crisis (Keeton, 1999; Radlet and Sachs, 1998; Ranjan and Dhal, 2003; Jimenez and Saurina, 2005; Foos, 2010). Keeton (1999), Radlet and Sachs (1998) and Ranjan and Dhal (2003) analysed whether faster loan growth led to higher loan losses. In particular, Keeton (1999) explained the relationship between rapid credit growth and the subsequent increase in loan losses. We obviously observe an increase in the growth rate of loans during business expansion, while loan losses tend to rise when the business cycle contracts. Moreover, Rajan and Dhal (2003), in a study of East Asian banks, found that banks were more willing to lend before the beginning of the Asian crisis and that gross loans grew considerably in that period. This behaviour triggered an increase in NPLs during the subsequent financial crisis.

Jimenez and Saurina (2005) emphasized the relationship between rapid credit growth and the subsequent increase of risk in the credit portfolio. Rapid credit growth is considered one of the most important causes of an increase in problem loans: when banks are more willing to lend (i.e. during a positive business cycle), they are also more likely to reduce their credit standards and accept a lower quality of borrower. This behaviour amplifies credit risk and causes an increase in problem loans during the following negative business cycle. In addition, Hess et al. (2009) analysed the determinants of banks' credit loss in Australia. Their findings confirmed the existence of a positive relation between past credit growth and the level of NPLs. In particular, the authors showed that strong credit growth leads to higher credit losses, with a lag of 2-4 years. Finally, Foos et al. (2010) investigated whether loan growth affects the riskiness of individual banks in 16 major countries during the 1997–2007 period. Loan growth was shown to lead to an increase in loan loss provisions during the subsequent three years.

In conclusion, the extant literature on the determinants of credit risk acknowledge the importance of both macroeconomic and bank-specific factors. The most significant explanatory variables are the economic cycle (negative relation), bank lending behaviour in previous years (positive relation) and other bank operating features, such as efficiency, capitalization, profitability and liquidity (negative relation). In other terms, banks that are better managed and display more conservative lending behaviour are more resilient to adverse macroeconomic conditions.

In this paper we delve into the bank-specific determinants of credit risk, examining the significance of two new variables that capture the bank risk profile and its risk management effectiveness. Moreover, we try to disentangle the effects on credit risk of the following types of factors: economic cycle, lending behaviour, credit-risk management quality, and other bank-specific variables. We argue that an important factor that can offset the deterioration of loan portfolios during a negative economic cycle is a bank's ability to evaluate and manage credit risk effectively. Hence, banks that are more efficient in allocating credit may continue to offer credit without taking on excessive risk and putting their stability at risk, even when macroeconomic conditions worsen. This also implies that banks whose loans have grown considerably during a positive economic cycle may not necessarily face a harsh increase in credit risk during the following downturn.

In the rest of the paper we test the following hypotheses:

Hyp. 1. The amount of credit risk in bank loan portfolios is affected by the bank's ability to evaluate and manage credit risk (negative relationship) and by its risk attitude and profile (positive relationship).

Hyp. 2. The level of credit risk is negatively affected by the economic cycle (negative relation) but is not necessarily affected by a bank's lending behaviour (i.e. the growth rate of loans).

4. Data and Methodology

4.1 Sample

As previously mentioned, one of the main contributions of this paper is to verify whether the asset quality of bank loan portfolios may be improved by the adoption of sound and appropriate credit-risk management systems and practices, approximated by the use of a validated IRB model to calculate the regulatory minimum capital requirement according to Basel II. Data on the use of a validated IRB model for regulatory purposes are contained in the SNL data-set. Therefore, as our first step we identified those banks for which this information is available for the period ranging from 2006 to 2015[7]. The initial sample consisted of 341 banks from 14 European countries[8]. We restricted our analysis to commercial banks, cooperative banks, savings banks, real estate banks and bank holdings, i.e. the types of banks that are most exposed to credit risk. Banks with total assets of less than 10 billion euros at 2015 were excluded and, in line with De Haas and Van Lelyveld (2014)

[7] Basel II was enacted in 2004 and in the following years supervisory authorities started to validate the IRB models. This is why we restricted our analysis to the period starting from 2006.

[8] Austria, Belgium, German, Denmark, Spain, Finland, France, UK, Ireland, Italy, Netherlands, Norway, Portugal and Sweden.

and Mascia, Keasey and Vallascas (2015), we also excluded banks with annual growth of total earning assets greater than 75%, to control for the effects of mergers and acquisitions. The final sample consisted of 177 European banks, which in terms of total assets account for approximately 63% of the European banking system.

< Table 1 approximately here >

In our analysis we focused on the period 2008-2014; we thus covered the whole economic downturn that hit the European economy[9]. Our data set was built using different sources: the macroeconomic data were collected from the IMF, the World Bank and the Eurostat databases; the bank-specific data were drawn from Bankscope, with the exception of the data relating to the use of validated IRB models, which was collected by SNL. As for the accounting data, we used consolidated balance-sheet data, on the basis that credit risk and the ensuing capital policies are usually envisaged and managed mainly at the group level. For banks that are independent (no shareholder recorded with more than 50% of direct ownership) we used unconsolidated data. All data are available on an annual basis.

4.2 Econometric Methodology

For our analysis we used an unbalanced panel of 177 individuals over the period 2006 - 2015[10]. We used panel data econometric methodologies to assess the impact of the macroeconomic and the bank-specific variables on two proxies of credit risk, i.e. the NPL to gross loans ratio and LLPs to gross loans ratio while allowing for individual and time specific heterogeneity. As a preliminary step, we performed Dickey Fuller tests on the dependent and all the independent variables, finding that the null hypothesis of unit root non-stationarity can be rejected for all the variables in our panel.

Random and fixed effect estimation techniques have been widely employed in the static panel literature to identify causal relationships. Indeed, the two methodologies offer different advantages: if the individual heterogeneity and the time specific effect are not correlated with the idiosyncratic disturbances, it can be shown (Wooldridge, 2002) that the between estimator under the assumption of random effects is more efficient than the within estimator. However, the latter is robust to failures of the random effect assumption.

[9] This allows us to rely on homogeneous balance-sheet data. Since 2005 all public companies have been required to prepare their consolidated accounts using the new standards (IAS/IFRS). Thus, balance-sheet data from 2005 onwards incorporate IAS/IFRS requirements (Ong, 2014).

[10] A few independent variables have a 2-years lag, thus our original dataset has been restricted to the period 2008-2015.

In order to determine the more appropriate econometric methodology, we performed a Hausman test. Our results show a clear rejection (p-value 0.0003) of the null hypothesis of random effects with the finite sample test statistic and its asymptotic approximation.

To study the empirical determinants of credit risk, we employed the following regression based on a static panel model:

$$CR_{j,i,t} =$$

$$\alpha_i + \beta_1 IRB_{i,j,t-2} + \beta_2 \text{RWA\_TA}_{j,i,t-2} + \beta_3 ROAE_{j,i,t-2} + \beta_4 C\_I_{j,i,t-2} + \beta_5 E\_A_{j,i,t-2} +$$

$$+\beta_6 GLGR_{j,i,t-2} + \beta_7 GDP_{j,t-1} + \beta_8 HPI_{j,t-1} + \lambda_t + u_{it} \qquad (1)$$

where α_i and λ_t denote respectively the individual heterogeneity of bank i and a time specific effect common across individuals. Our dependent variable $CR_{j,i,t}$ is measured by two different ratios: the ratio of gross NPLs to gross loans at time t ($NPL\_GL_{i,j,t}$) and by ratio of LLPs to gross loans at time t ($LLP\_GL_{i,j,t}$). The NPL ratio is a common measure of the level of credit risk in bank loan portfolios. This accounting variable has been widely used in other relevant studies as an ex-post measure of the credit risk accumulated by a bank (Salas and Saurina, 2002; Jimenez and Saurina, 2005; Ayuso et al., 2004, Hess et al., 2009; Boudriga et al., 2009; Louzis et al., 2012; Amador, 2013; Beck et al., 2013), although it may be affected by differences in the accounting policies adopted across Europe[11]. As an alternative proxy of the quality of bank loans we have used the LLP ratio; in comparison to the NPL ratio this variable reacts more quickly to the deterioration of loan portfolio, thus it might be more volatile.

In line with the previous literature, our explanatory variables were divided in two different categories: macroeconomic variables and bank-specific variables. The first group included two measures of the economic cycle, i.e. the growth of GDP ($GDP_{j,t-1}$) and the house price index ($HPI_{j,t-1}$)[12]. A reduction in the economic growth of a country, and the subsequent rise in the unemployment rate and fall of house prices, are among the primary determinants of the deterioration of bank asset quality which tends to occurs 3-4 quarters later (Bofondi and Ropele, 2011); to account for this evidence, we applied a 1-year lag to these variables.

[11] Only in 2013did the EBA publish a common definition of non-performing loans; before this date, European countries used different classifications of problem loans.

[12] In our original specification we included also the unemployment rate but to avoid issues of multicollinearity it was dropped. Indeed, the strong correlation between the unemployment rate and the GDP growth rate did not allow for a correct identification of the marginal effect of GDP growth rate on the dependent variable. This issue of multicollinearity could be controlled for in a panel data set with a larger time dimension. Unfortunately, this was not possible due to the heterogeneity of accounting data before 2005 and the lack of data on validated IRB models

The second group consists of bank-specific variables and includes a measure of the bank's profitability ($ROAE_{j,i,t-2}$) and a proxy of the bank's efficiency ($Cost\_Income_{j,i,t-2}$). These measures have been used in previous studies to test the so called 'bad management hypothesis' (Berger and Udell, 1997; Louzis et al. 2011) and should approximate the quality of the bank management and its ability in managing risk. To better capture the bank ability in screening and monitoring credit risk we introduced a dummy variable ($IRB_{j,i,t-2}$) that proxies the effectiveness of a bank in measuring the credit risk associated with its lending activity and equals 1 if the bank/banking group uses the IRB approach to calculate the regulatory capital minim requirement, and 0 otherwise[13]. The ability of a bank to evaluate credit risk effectively depends on several aspects, such as the availability of a wide array of data with a forward-looking informative content, sound risk management practices, an effective scoring/rating system, etc. Indeed, all these aspects are crucial for effective risk management, and so they are among the determinants of banks' credit risk levels and should be taken into account in the empirical test. However, this type of information is not publicly available. As a proxy of a bank's credit risk management expertise and quality, we used a dummy variable that equals 1 if the bank/banking group uses the internal rating based (IRB) approach to calculate the regulatory capital minim requirement, and 0 otherwise; this dummy had a 2-year lag. Under the current regulatory framework, the use of IRB models to calculate the minimum capital requirement is conditional on the supervisory authorities' validation, i.e. can occur after supervisors have assessed the soundness and appropriateness of internal credit risk measurement and management systems. We can therefore assume that those banks whose IRB models have been validated, have demonstrated the accuracy and effectiveness of their risk management models. Thus, we can infer that, to some extent, banks whose IRB model has been validated may screen and manage credit risk more effectively than other banks. Our decision is supported by the fact that, since its introduction, the IRB framework has proven its validity as a risk-sensitive way of measuring capital requirements (EBA, 2015). Furthermore, the EBA recently confirmed a general agreement on the validity of this approach and the intention to continue to use the IRB models, although its extreme flexibility may have compromised comparability across banks to some extent, thus urging the need for a revision and harmonization of technical aspects (EBA, 2016). Considering that non-performing loans and the need for loan loss provisions usually do not arise in the same year as the loan has been granted, for these three explanatory variables we have used a 2-years lag.

[13] As for the method used to calculate the regulatory minimum capital requirement, the SNL data base reports one of following items of information for each bank and each year: 'Standardized', when the bank/banking group adopts the standardized approach for the whole loan portfolio; 'Mixed' when, referring to different segments of the loan portfolio, both the standardized and the IRB approach are used; 'Foundation IRB' and 'Advanced IRB' when the respective approach is used for the whole bank loan portfolio. Our dummy is equal to 1 when the bank adopts a 'Mixed' or a pure IRB approach and zero when it uses the 'Standardized' approach.

As a proxy of the bank risk attitude/appetite we use a measure of the capitalisation of the bank ($E\_A_{j,i,t-2}$)[14] which have been already used in previous empirical studies. The relation between the bank capitalisation and its risk exposure is not completely clear. On the one hand, a week capitalisation may create moral-hazard incentives to take more risk. On the other hand, given the current prudential regulation only banks with a strong capital base may engage in riskier businesses. Hence we add a new variable that captures the risk profile of the bank, i.e. is the ratio of Risk Weighted Assets to total assets ($RWA\_TA_{j,i,t-2}$). This ratio – also referred to as 'RWA density' - has often been used as a proxy of the risk profile of banks' assets (Shim, 2013, Ayadi and De Groen, 2014). Assuming that the risk weights assigned to each asset category correctly represent its contribution to the overall risk borne by a bank, the higher the RWA to total assets ratio, the higher the risk attitude of the bank. As noted by previous studies (Le Leslé and Avramova, 2012; Cannata et al.,2012), the 'RWA Density ratio' may be influenced by the bank business model as well as by the loan portfolio composition[15]. Nonetheless, it is considered a valuable proxy of banks' risk profile.

Finally, we have included in our model the rate of growth of gross loans with a 2-years lag ($GLGR_{j,i,t-2}$). As suggested by the economic theory and confirmed by empirical evidence (Jimenez and Saurina, 2005, Foos et al., 2010), the expansion of bank loan portfolios may be the result of laxer credit standards, which may cause a subsequent deterioration of credit quality. We can therefore expect a positive relation between past credit growth and the level of credit risk.

Table 2 provides further details on the calculation of variables, sources of information and the expected sign.

< Table 2 approximately here >

5. Results

The findings of the empirical analysis are in line with stylized facts and expectations. Fixed effect results are reported in Table 3. The estimation was performed using the Arellano-Bond robust standard error correction to avoid misspecification of the test statistics. Overall, the models appears very significant, displaying both a high goodness of fit and a robust F test result.

[14] We included also the natural logarithm of the total assets as a proxy of the size of the bank, and a proxy of the bank's business model (gross loans to total assets). Both variables were not statistically significant.

[15] The level of RWAs depends on the entire range of risks born by a bank – i.e. credit risk, market risk and operational risk - therefore banks with the same (total) RWAs may have a different level of credit risk due to a different business model. Besides, each component of the loan portfolio, i.e. sovereign/corporates/retail loans, may be associated to different weights depending on the prudential approach (standardized or IRB) used by the bank. We control for the business model by including in our regression the Gross Loans to Total Assets ratio, but we could not control for the loan portfolio mix because of lack of data.

< Table 3 approximately here >

We found a negative and significant explanatory power of the GDP_{t-1} growth rate, in line with the current literature, and also a negative and significant coefficient for the house price index (HPI_{t-1}). Overall, our findings confirm the fact that adverse macroeconomic conditions are among the main drivers of credit risk.

As for the bank-specific determinants of credit risk, the most innovative result is the negative coefficient of the dummy variable IRB_{t-2}. This evidence confirms that banks relying on risk-management tools and procedures which have been judged accurate and effective by the supervisory authorities, have weathered the economic downturn and curbed the deterioration of their loan portfolios better than other banks. This finding is consistent with the negative relation between the level of risk and bank profitability ($ROAE_{t-2}$) and the positive sign of the efficiency measure (C_I_{t-2}), supporting the hypothesis that banks that are better managed are more efficient in managing risk.

We also found evidence that credit risk is higher the higher the bank risk profile (RWA_TA_{t-2}), suggesting that loan quality deterioration is greater for those banks that have a greater risk appetite and, thanks to a stronger capitalisation (E_A_{t-2}), have (willingly) invested in riskier assets also. Finally, another important and original result is the negative sign of the proxy of lending behaviour ($GLGR_{t-2}$); the sign is different from that found in most previous studies, which instead find evidence of a positive relation between expansive credit policy and credit risk. As a matter of fact, our result lends support to the view that banks with more effective risk management are better able to evaluate risk and are less affected by adverse selection problems that may arise when offering credit to new customers and increasing market share. This result is in line with Mascia et al. (2015), who find that banks using the IRB approach have moved towards safer borrowers without decreasing their lending activity.

6. Conclusions

In this paper we set out to verify the empirical relevance of two novel bank-specific characteristics in determining the level of risk in bank loan portfolios, i.e. the effectiveness of bank risk management and the bank's risk appetite. It is well understood that a high burden of NPLs threatens the profitability and even the stability of banks, and is also a major obstacle to bank credit growth. However, better credit allocation skills might allow some banks to sustain an expansive lending policy despite the ongoing recession, without giving rise to an excessive level of risk.

Our results confirm that banks can to some extent offset adverse macroeconomic effects on credit risk by means of more effective and accurate risk-management tools and procedures. We also find support for the view that banks with more effective risk management are better able to evaluate risk and are less affected by adverse selection problems that may arise when adopting an expansive lending policy. Overall, during the recent financial and economic crisis these banks have weathered the economic downturn and curbed the deterioration of their loan portfolios better than other banks, without trimming their loan portfolios.

These results represent a first step towards a more rigorous understanding of the role of risk management in determining the level of credit risk, and are still preliminary. However, they represent a good starting point for future research. Further analysis may contribute to shedding more light on the relationship between the economic cycle, banks' lending behaviour and bank risk management effectiveness and to gauge their dynamic features (by using a dynamic panel and estimating with GMM).

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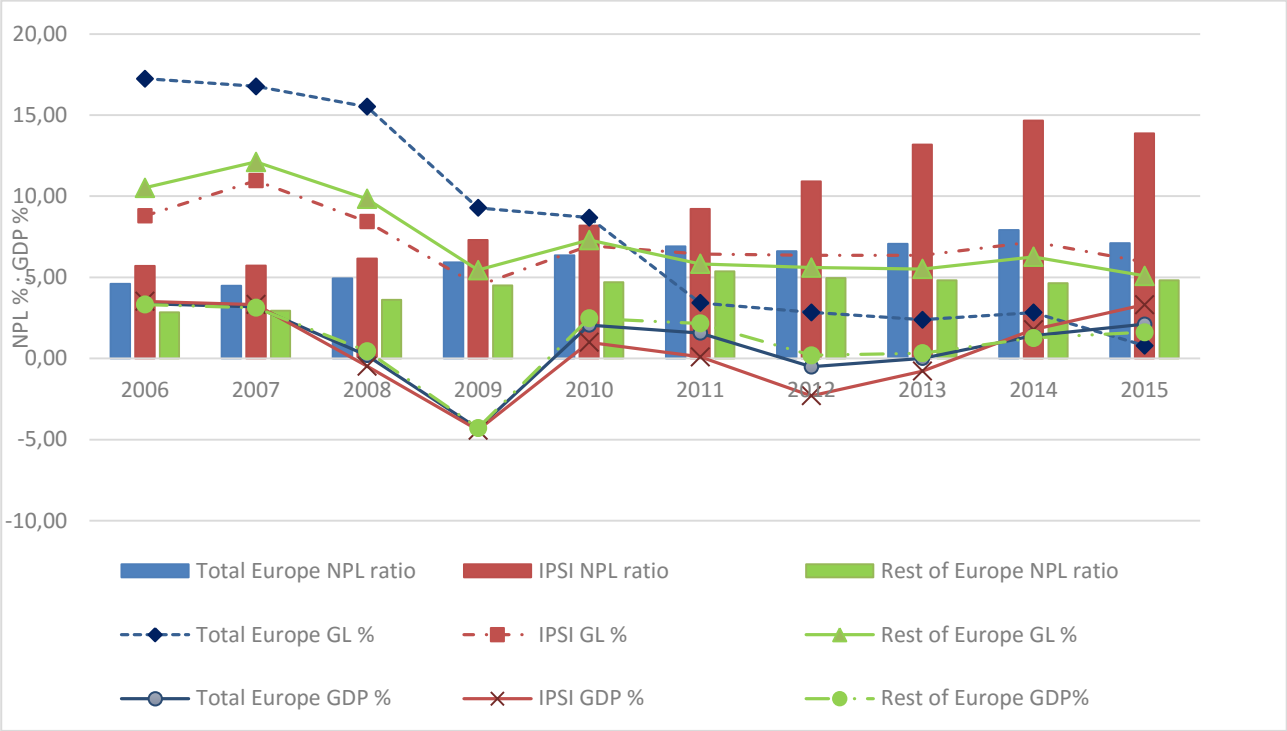
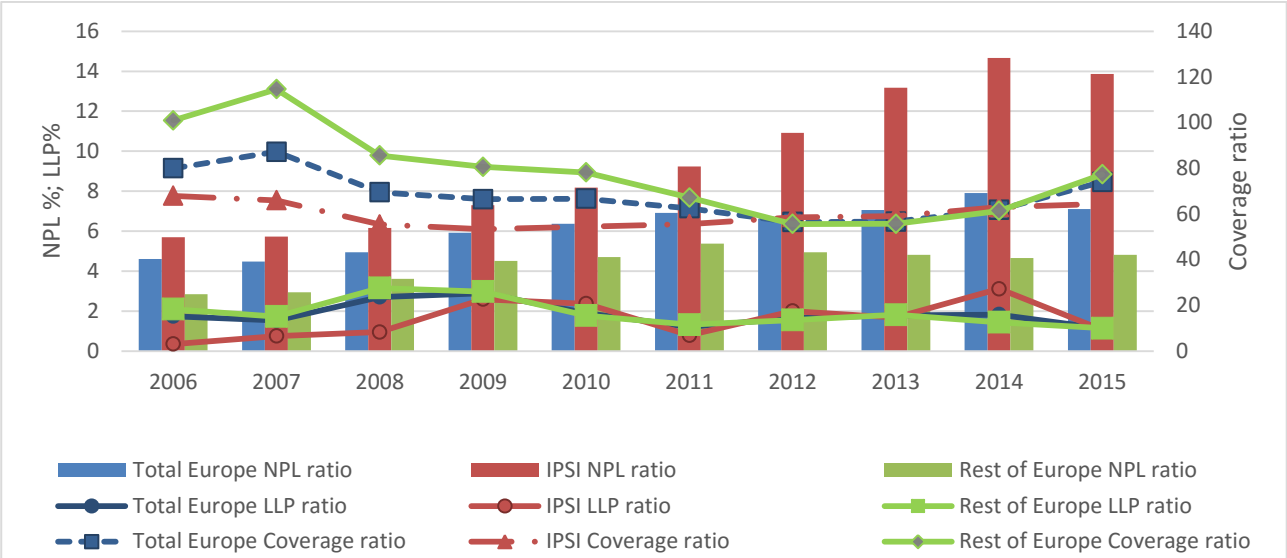
Figure 1 Economic cycle, bank loans and asset quality among European banks



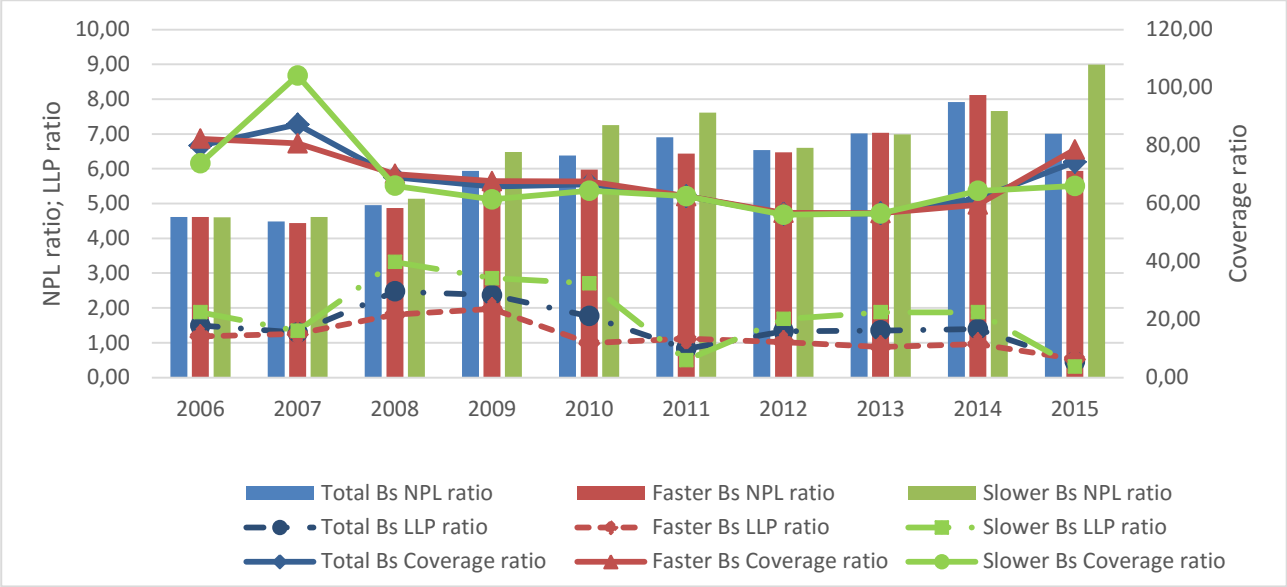
Notes: NPL ratio is the ratio between NPLs and Gross Loans; GDP% is the annual growth rate of GDP and Gross Loans % is the annual growth rate of Gross Loans. ISPI banks are banks from Ireland, Portugal, Spain and Italy.

Figure 2 Loan portfolio quality and provisioning of NPLs among European banks



Notes: NPL ratio is the ratio between NPLs and Gross Loans; LLP ratio is the ratio between year-end NPL provisions for credit risk and Gross Loans; Coverage ratio is the ratio between total provisions set aside on existing loans since their origination and gross NPLs. ISPI banks are banks from Ireland, Portugal, Spain and Italy.

Figure 3 Loan portfolio quality, provisioning for NPL and loan growth rate.



Notes: NPL ratio is the ratio between NPLs and Gross Loans; LLP ratio is the ratio between year-end NPL provisions for credit risk and Gross Loans; Coverage ratio is the ratio between total provisions set aside on existing loans since their origination and gross NPLs. 'Faster Banks' are those whose gross loans grew during the period 2006-2015 at an average geometric rate higher than the median value of the total sample. 'Slower Banks' include banks whose gross loans grew at a rate below the median value of the sample.

Table 1 Sample description

Country	% Total assets	N. banks
AT	72,61	10
BE	96,78	8
DE	63,57	22
DK	72,87	10
ES	41,49	6
FI	41,37	4
FR	86,46	41
GB	45,69	17
IE	83,36	5
IT	74,98	27
NL	37,54	7
NO	83,48	9
PT	51,04	5
SE	91,87	6
TOT SAMPLE	**62,62**	**177**

Table 2 Variables and expected sign

Variable	Meaning	Source	Expected sign
Dependent variables			
NPL_GL	Non-performing loans on gross loans as measure of bank's asset quality	Bankscope	/
LLP_GL	Loan loss provisions on gross loans as measure of bank's asset quality	Bankscope	/
Macroeconomic variables			
GDP_{t-1}	Growth of GDP at time t-1 at the bank's country-level	Eurostat	negative
HPI_{t-1}	House price index at time t-1 at the bank's country-level	Eurostat	negative
Bank-specific variables			
IRB_{t-2}	A dummy variable that equals 1 if at time t-2 the bank uses IRB model to calculate the regulatory minimum capital requirement, and 0 otherwise. It is used as a measure of the quality of credit risk management.	SNL Unlimited	negative
RWA_TA_{t-2}	Risk weighted assets to total assets at time t-2 as measure of bank's risk appetite	Bankscope	positive
$ROAE_{t-2}$	Return on average equity at time at time t-2 as a measure of bank's performance and management's quality and effectiveness		negative
C_I_{t-2}	Total operating costs on total operating income at time t-2; measure of management's (in)efficiency	Bankscope	positive
E_TA_{t-2}	Equity over total assets. Measure of the ability of a bank to support risk	Bankscope	positive/negative
$GLGR_{t-2}$	Growth rate of Gross Loans at time t-2	Bankscope	negative

Table 3 Results of static panel model - Fixed Effect Estimation

Dependent Variable		
	NPL_GL	**LLP_GL**
	Model 1	**Model 2**
Constant	0.001101 (0.8533)	0.039981* (0.0840)
IRB t-2	−0.200297*** (0.00401)	−0.265797*** (0.0050)
RWA_TA t-2	0.154124** (0.0200)	0.138214*** (5.66e-018)
ROAEt-2	−0.029762** (0.0292)	−0.0601966*** (2.02e-07)
C_I t-2	0.001981* (0.8358)	0.00456* (0.8712)
E_TA t-2	0.0926*** (0.00651)	0.1278*** (0.00129)
GLGR t-2	−0.19871*** (0.00125)	−0.219731** (0.0477)
GDP t-1	−0.067217*** (0.0031)	−0.121551*** (0.0045)
HPI t-1	−0.032100* (0.7531)	−0.145117** (0.0217)
R squared	0.7996	0.8001
F-statistics	87.42	97.110
P-value	0.000	11.24e-023