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Towards an investigation of credit risk determinants in Eurozone countries

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Abstract: The main objective of this article is to define which macroeconomic and accounting factors determine loan quality, hence credit risk, in Eurozone. Non Performing Loans, Loan Loss Provisions and Loan Loss Reserves are used as proxies for loan portfolio quality. Through dynamic regression techniques, the empirical analysis is carried out at both aggregate and individual bank level data, from 2000 to 2012, including booming and instability periods of European economy. The evaluation of econometric results establishes that macroeconomic environment (public debt, economic activity and inflation) and accounting variables (past loan quality, bank size, capital ratio and liquidity) influence considerably credit risk in Euro countries.

Keywords: Credit risk, loan quality, non performing loans, loan loss provisions, loan loss reserves, accounting factors and macroeconomic factors.

JEL codes: M41, G21.

1. Introduction

Loan quality is an increasingly important issue in credit risk management, especially the last decades. Credit risk is inevitably linked to bank assets quality, bank failures (e.g. Gup & Kolari, 2005; Samad, 2012) and instability in the financial sector (Desmet, 2000; Calomiris *et al.*, 2004; Ninimaki, 2012). To put it in another way, credit risk is considered one of the most important menaces that financial institutions have to deal with, which affects considerably the vulnerability

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of the banking system. Several studies have identified that bank loan quality can be quantified through quite a few accounting/banking ratios collected from banks' financial statements. The most popular indicators are Non Performing Loans to total loans (NPL), Loan Loss Provisions to total loans (LLP), Loans Loss Reserves to total loans (LLR) and other such as Probability of Default rate (PD) and Loan Losses.

This study is an attempt to address the issue of credit risk determinants in Eurozone, since the last decade its country members undoubtedly undergo severe problems with problem loans. On the basis of currently available evidence, NPL in Euro area reached from 1.8% (2005) to 7.6% (2014)[1]. Furthermore, Eurozone's banking industry is currently on consolidation process, in order to succeed in cost reduction, deleveraging and restructuring, especially in countries mostly affected by recession (ECB, 2014). Moving towards, the consensus view seems to argue that Eurozone is at the heart of the global economic interest. The severe fiscal problems that many country - members are facing (e.g. Greece, Spain, Portugal, Italy), as well as the implemented measures and policies in response to financial crisis, obviously place Euro area at the center of our investigation. This fact, combined with the increasing burden of problem loans in Eurozone's financial system, makes the investigation of this subject imperative.

Despite issue's importance, at research level, European Monetary Union (EMU) is at a very early stage. Given that only few studies were focused on Eurozone system as a whole (Chen, 1997; Makri *et al.*, 2014), there are still important issues to be addressed. The vast majority of previous studies, covering a limited number of countries (Rinaldi & Sanchis-Arellano, 2006; Jimenez & Saurina, 2006; Bofondi & Ropele, 2011 etc.), do not present results for all Eurozone members. In addition, most of them, by not including updated data, emerge results without taking into account the prolonged crisis period of European economy and therefore may not reflect the real situation from the adoption of Euro until nowadays. Moreover, numerous researches come to conclusions by examining only one loan quality indicator, limited number of explanatory factors and only one type of data (individual or aggregate). To the author´s best knowledge, this is the first empirical effort that determines which accounting and macroeconomic (including fiscal) factors are responsible for changes in NPL, LLP and LLR in EMU, at both banking system and individual bank level data, considering both booming and instability periods of European economy.

The remainder of the paper is divided into five sections. Section 2 discusses the merits of the relevant empirical literature. Section 3 outlines the methodological research approach and framework, as well as the econometric estimations. In addition, section 4 describes the sample and data and section 5 analyzes the empirical findings. Finally, section 6 is devoted on the discussion of the empirical findings.

2. Literature review

Researchers, in order to investigate credit risk determinants, have examined different indicators of loan quality (e.g. NPL, LLP, LLR, PD and loan losses), alternative explanatory variables and several econometric techniques and types of data. One of the first studies was that of Brookes *et al.* (1994), which investigated factors affecting mortgage arrears and repossessions in United Kingdom. Through the analysis of quarterly data, spanning from 1970 to 1990, they examined various socioeconomic and financial indices as possible determinants of problem loans. Their results demonstrated that the probability of being in arrears is related to total household debt, income, unemployment, interest rates and inflation. Regarding repossessions, they found significant associations with unemployment, number of divorces and property value.

De Lis *et al.* (2000) identified various bank and macroeconomic factors of problem loans in Spanish commercial and savings banks, between 1985 and 1997. Through dynamic panel data analysis, they showed that GDP growth rate has a negative impact on problem loans, confirming that loan quality is deteriorated in recession. Moreover, bank size and families' indebtedness found to affect negatively problem loans, while loan growth, loans without collateral, net interest margin, branch growth rate and problem loan of previous period, positively. Moving towards the same direction, Jimenez and Saurina (2006) explored the determinant factors of NPL and PD on Spanish commercial and savings banks for 1984 – 2002. Their results suggested that credit growth and economic cycle have considerable impact on loan quality.

Rinaldi and Sanchis-Arellano (2006) addressed macroeconomic determinants of NPL in Euro area. Nevertheless, their results were limited to seven Eurozone countries from 1989 to 2004 and covered only sectoral household NPL. They suggested that disposable income, households' financial wealth and nominal lending rates have significant explanatory power on household NPL.

The impact of micro and macro variables on LLP and new bad debts was the main objective of Quagliariello (2007). His sample included data from 207 Italian banks from 1985 to 2002. His main concluding point provided strong evidence that LLP and new bad debts move along economic cycle. Moreover, it was recorded the decisive contribution of various macroeconomic factors such as various stock market indices, the 10-year Italian bond rate and the difference between lending and deposit rate. Besides macroeconomic environment, accounting ratios like credit growth, capital adequacy, earnings before taxes to total assets and cost to income can be responsible for variations in bank loan portfolio quality.

Chen (2007) dealt with the relationship between credit risk (NPL and LLP) and banking competition in the light of deregulation of European banking market. For the empirical analysis, she elaborated annual micro and macro data from 15 countries of the European Union, for the period 1990 - 1999. Her results provided evidence that interest margin and capital ratio are negatively linked with loan quality, while ambiguous impact was recorded for GDP growth.

Additionally, Bofondi and Ropele (2011) focused on Italian banks, from 1990 to 2010, by defining which macro factors affect business and household loans. The results for households supported that NPL is positively related with unemployment and interest rates but negatively with GDP and real estate prices. Moreover, regarding business loans, unemployment and interest expenses to operating profits were found to influence loan quality positively, while consumption of durable goods negatively.

Festić *et al.* (2011) investigated the relationship between NPL and various accounting and macroeconomic factors, in five new country members of European Union, from 1995 to 2008. Their findings showed that Δloans, foreign direct investment and loans to total assets are responsible for the deterioration of loan quality. On the contrary, loans to deposits ratio, exports, gross capital formation, compensation of employees, net foreign assets to total assets and compliance of banking systems with Basel, improve considerably loan quality.
Louzis *et al.* (2012) focused on loan quality determinants, by examining different loan categories in nine Greek banks, between 2003 and 2009. They concluded that unemployment, lending rates and public debt are macro variables, which record significant effect on NPL. Furthermore, regarding accounting factors, they detected that performance and efficiency show additional explanatory power.

Klein (2013) studied the impact of macro and micro indicators to NPL in the 10 largest banks of 16 Central and Southeast Europe countries, during 1998 – 2011, via static and dynamic regression models. The results confirmed that macroeconomic environment (unemployment, inflation, exchange rates and stock indices) and accounting indices (ROE, loans to total assets, equity index) determine the level of problem loans. Furthermore, Castro (2013) explored exclusively the macroeconomic determinants of credit risk in five Eurozone countries, for the period 1997 – 2011, via aggregate data. His findings supported the view that during crisis NPL is increased considerably and is determined by ΔGDP, real estate price, credit growth, exchange rates and unemployment.

Curcio and Hasan (2015) investigated the linkage of LLP with earnings and capital manipulation. Their sample included accounting data from 491 banks, between 1996 and 2006, including countries within and outside Eurozone. Although, they examined mainly accounting variables and only GDP as macro indicators, they concluded that LLP reflect loan quality for all banking institutions. Regarding Euro

area, they found that LLP serve as a means of manipulating profits and that GDP is not linked with provisions. Conversely, in countries outside Eurozone, provisions are negatively related to GDP and used as an instrument of conveying information to investors.

Makri and Papadatos (2014) examined the impact of accounting information and macroeconomic environment on aggregate LLP, for the Greek banking sector, from 2001Q1 to 2012Q4. They revealed that LLP is positively associated with unemployment, public debt, previous quarter's LLP and negatively with capital adequacy ratio. Moreover, the accounting and macro drivers of LLP and LLR in Greece were the main research objective of Makri (2015). By processing individual bank and banking system level data, from 2000 to 2012, she supported that loan quality is negatively related with GDP, capital ratio, inflation and profitability and positively with unemployment, public debt, past loan quality and liquidity. Finally, Makri *et al.* (2014) explored which accounting and macro factors affect NPL in Eurozone's banking systems, during 2000 and 2008. Their results unveiled significant relationships between NPL and public debt, unemployment and economic activity, capital ratio, previous year's NPL and ROE.

Based on the above studies, it is obvious that there is a large gap in the literature regarding the determinant factors of credit risk in Eurozone's banking industry. Specifically, it is important to conduct a research performing results for all Euro area countries, including more updated data, so as to reflect the current situation in EMU and covering both booming and instability periods. In this context, in order to record safe conclusions, it is necessary to investigate the most commonly used loan quality indicators, by examining micro and macro (including fiscal) explanatory variables, via both individual bank level and aggregate banking system level data.

3. Methodology

3.1 Methodological research approach

The econometric specification implemented on the current study is the Generalized Method of Moments (GMM) and specifically the GMM First Difference or GMM Difference. The simple GMM estimator is firstly realized by Hansen (1982) and GMM Difference by Holtz-Eakin *et al.* (1988) and Arellano and Bond (1991), which was expanded by Arellano and Bover (1995) and Blundell and Bond (1998). It is worthwhile to underline that GMM estimators can eliminate problems that might arise from the presence of autocorrelation and heteroskedasticity in econometric models, producing results with correct standard errors (Cragg, 1983).

There is overwhelming evidence corroborating the notion that credit risk is described from the appearance of dynamic relationships (e.g. Castro, 2013). This type of relationship is defined by the existence of lagged dependent variable as independent variable (Baltagi, 2001). Econometric methods like ordinary least square (simple models OLS and Fixed OLS) are not assumed suitable for the investigation of credit risk's dynamic persistence, making the implementation of advanced econometric approaches necessary (Baltagi, 2001; Quagliariello, 2007). Indeed, GMM Difference is appropriate for calculating dynamic equations, as it controls for endogeneity problems and inconsistent results (fixed or random effects estimations) and it is suitable for panel data analysis, which is the case in the present empirical investigation.

A basic prerequisite for the implementation of GMM difference is the involvement of instrumental variables. It is supported that GMM provides better results when lagged values of dependent and independent variables are used as instruments (Arellano & Bond, 1991). In the same way, Roodman (2009) puts forward the view that instrumental variables might be stemmed from the same dataset and equaled to lagged variables. Nonetheless, Hansen J statistics for overidentifying restrictions is implemented to check the validity of instrumental variables. Hansen J statistics, commonly known as Sargan/Hansen test, is the most commonly diagnostics test in GMM for the assessment of model's suitability (Baum, 2006). Finally, AR statistical tests are applied in order to check for serial correlation in the residuals and Kao panel cointegration test (Kao, 1999) to explore whether the series are autoregressive.

3.2. Methodological framework

Current research appears to validate the view that credit risk is determined by past loan quality, accounting indicators and macroeconomic environment. Based on this notion, the basic econometric model under investigation is shaped as follows:

$$CR_t = CRI_{t-j} + ACC_{t-j} + MAC_{t-j} \quad (1)$$

Where CR corresponds to various credit risk indicators, ACC denotes accounting factors, MAC refers to macroeconomic indices and t-j to examining period. As mentioned before, credit risk is highly dependable on loan quality. Loan quality can be measured through several accounting indices, where the most commonly used are NPL, LLP and LLR. In particular, non performing loans are bank assets that do not generate income and are used to evaluate asset quality and detect systemic banking problems (Meeker & Gray, 1987; Cihák & Schaeck, 2010). The most common definition considers that NPL ratio includes all loans, which are 90 days overdue. Loan loss provisions is defined as the outcome of banks' financial activities and reflect the ratio of arrears, insolvent loans and loan losses after the

retrieval of possible collateral (Kearns, 2004; Anandarajan *et al.* 2007; Balás, 2009 etc.). Furthermore, loan loss reserves are estimations formulated from changing macroeconomic environment, credit risk and loan quality (Walter, 1991; Ahmed *et al.* 1999; Balla & Mckenna, 2009). One o the advantage of this research that is not limited to a particular bad loans indicator. Instead, the most popular loan quality indices are explored, in order to present more accumulated results for credit risk.

Literature introduces two different research approaches concerning the category of data used in the exploration of credit risk factors. In the first one (individual bank level data) accounting information are extracted from each bank separately (e.g. Berger & De Young, 1997; Salas & Saurina, 2002; Fuertes & Espinola, 2006; Espinoza & Prasad, 2010; Cotugno *et al.* 2010; Fiordelisi & Mare, 2013) and in the second (aggregate bank level data) from the overall banking system (e.g. Brookes *et al.* 1994; Shu, 2002; Barajas *et al.* 2008; Marcucci & Quagliariello, 2008; Festić & Romih, 2008; Jakubik & Reininger, 2013; Castro, 2013). Nevertheless, the reliability of our results is significantly increased, since both individual bank and aggregate bank level information are used.

Given that accounting and macroeconomic indicators considered as possible determinants of credit risk, Table 1 shows the investigated factors that were added in our econometric estimations and their expected sign. As mentioned before, credit risk measured through NPL, LLP and LLR ratios, is distinguished by dynamic persistence. For this reason, the inclusion of past loan quality as an explanatory variable on econometric models is considered inevitable, so as to explore whether the past loan decisions define the current level of loan quality, hence the dynamic persistence of credit risk in time.

Table 1. Presentation of variables

	Symbol	Explanation	Expected Sign
Past Loan Quality	NPL_{t-j}	Non Performing as % of Total Loans	(+)
	LLP_{t-j}	Loans Loss Provisions as % of Total Loans	(+)
	LLR_{t-j}	Loans Loss Reserves as % of Total Loans	(+)
Accounting Variables	CAP	Bank Capital and Reserves to Total Assets	(+)/(-)
	LtD	Bank Liquidity: Total Loans to Total Deposits	(+)
	ROA	Performance indicator: Return on Assets	(-)
	SIZE	Bank Size: The natural logarithm of Total Assets	(+)/(-)
Macroeconomic Variables	GDP	GDP Growth Rate	(-)
	UNEMP	Unemployment Rate	(+)
	INFL	Average Inflation Rate	(+)/(-)
	DEBT	Public Debt as % of GDP	(+)

In addition, the impact of several accounting ratios, which are derived from financial statements, is also investigated. According to Jahankhani and Lynge (1980) and Lee and Brewer (1985), bank risk is affected from managerial decisions, where the latter can influence banks' financial statements. Hence, accounting variables considered appropriate proxies for such decisions. Moreover, several accounting indices (e.g. capital and liquidity ratios) assumed to be crucial factors of banking crises and financial stability (Barell *et al.* 2010; Karim *et al.* 2012). Generally, accounting ratios can provide valuable hindsight characteristics for banking sector (Louzis *et al.* 2012), representing information regarding operation, performance and managerial decisions of each financial institution. More precisely, this type of indices can signal structural problems and vulnerabilities of a banking system. It is obvious that financial stability is vital for a country's general economic condition. To this direction, Arpa *et al.* (2001) underlined that banks' health mirrors substantially borrowers' financial wellbeing, which consecutively demonstrates the soundness of the economy.

To begin with, capital ratio is used as a proxy variable of capital adequacy, showing bank's attitude towards risk. There is growing support that the relationship between capital ratio and loan quality is equivocal (e.g. Shrieves & Dahl, 1992; Fiordelisi & Mare, 2013). The fist interpretation, which is based on moral hazard hypothesis, claims that banks with low capital ratios correspond more easily to moral hazard incentives and therefore their problem loans are considerably increased. By contrast, a positive relation is also possible due to the fact that banks may rise their capital in advance so as to protect from growing loan quality indicators (Berger & De Young, 1997).

Bank resources (deposits), which are transformed into loans, are expressed through liquidity index LtD. Liquidity problems are associated with bank failures, reflecting bank's behavior toward risk (Sinkey & Greenwalt, 1991; Khemraj & Pasha, 2009; Festić & Repina, 2009; Dash & Kabra, 2010; Guy & Lowe, 2011; Dimitropoulos *et al.* 2010; Cotugno *et al.* 2010). That is to say, low bank liquidity equals a high value of LtD. It is expected a positive association between loan quality and liquidity, since high (low) LtD indicates high (low) exposure to credit risk. This positive influence has been detected in literature by Cavallo and Manjoni (2001), Ahmad and Ariff (2007), Floro (2010), Misra and Dhal (2010), etc.

Bank profitability, measured through ROA, is also considered as a possible determinant factor of loan quality. Sinkey (1998) claimed that financial institutions with escalated level of bad loans in their portfolios must formulate higher provisions, hence expenses, which are responsible for decreasing profitability. The above negative relationship can also be attributed to bankers' risk behavior. In particular, banks with low profitability ratios have greater pressure to generate income, so they are involved into riskier lending activities. On the contrary, high-profit banks show fewer stimulus to augment their revenue and thus fewer motives

to provide loans to unreliable clients. Moreover, Boudriga *et al.* (2009) supported that low profit banks might encounter difficulties in overseeing their operating costs and their borrowers' quality. This negative relationship has been confirmed empirically by Cotugno *et al.* (2010), Liu and Yang (2010), Mare (2012) etc.

Bank size, measured by the natural logarithm of total assets, is also examined as possible factor of credit risk. Similar to capital ratio, the relationship between bank size and credit risk is ambiguous (Greenidge & Grosvenor, 2010; Gropp *et al.* 2010). On one hand, it is argued that bank size is positively associated with poor loan quality. Specifically, it is supported that large sized banks can take more risk by granting loans even in low quality borrowers, due to the notion that they are "too big to fail" (Boyd & Getler, 1994; Boyd *et al.* 2009; Walter, 2009; Laeven *et al.* 2014). This perception is based on the premise that governments should support large bankrupt financial institutions in order to avoid the diffusion of negative effects into the economy (Moosa, 2010). Another explanation of the positive impact lies at the fact that small banks, due to their size, may have greater administrative efficiency in terms of control and monitoring loans, which may result in fewer problem loans and thus fewer bad debts. In this context, Nakamura (1993 & 1994) argued that small banks are treated better information compared to large ones, due to their structure, their ability to confront agency problems and grant access to confidential information of the borrower's financial condition. On the other hand, research has provided ample support for the assertion that bank's size is associated negatively with problem loans. More specifically, it has been observed that large banks are more able to monitor problem loans (due to economies of scale and well trained staff), since they can manage effectively credit risk (e.g. Clair, 1992; Hughes & Mester, 2013; Laeven *et al.* 2014). According to Hu *et al.* (2004), large banks have more resources and are more familiar to the management of poor quality borrowers. Consequently, the effect of bank size can be either positive or negative.

Macroeconomic environment undeniably specifies the development of credit risk, as several empirical researches have associated existing macro conditions to loan quality. To that end, the investigation of macroeconomic indicators is considered inevitable. To begin with, the impact of economic activity and business cycle to credit risk is examined via GDP growth rate. In periods of significant economic development, problem loans are kept low, forasmuch households and businesses comply with their loan obligations. As economic growth still exists, loans demand is amplified, banks in view of severe competition relax their lending criteria and grant loans to less trustworthy customers. When recession takes place, borrowers' economic status is substantially worsening, thus NPLs and default loans are being raised. Simultaneously, by cause of loan losses, banks performance is decreased and the funding of new investments is notably limited. Consequently, this credit crunch phenomenon sharpens even more the pre-existing unfavorable economic

situation. All the above, verify the presence of procyclicality, establishing that GDP and loan quality are negatively related (Salas & Saurina, 2002; Pederzoli *et al.* 2010; Jakubik & Reininger, 2013).

Likewise, unemployment was also considered so as to control for economic environment. There seems to be no compelling reason to argue that an enhancement of economic situation leads to a decrease in unemployment and an increase on disposal income. By contrast, when the number of unemployed is expanded, a decrement of their disposable income is documented and under these circumstances, the payment of their loan installments may be burdensome. Therefore, it is anticipated a positive influence between unemployment and credit risk indices (Brookes *et al.* 1994; Bikker & Metzemarkes, 2005; Glogowski, 2008 etc.).

Furthermore, although inflation may induce borrower's competence on abiding their loans commitments, the sign of this correlation is not obvious. On one part, high inflation diminishes borrowers' real incomes (when wages and salaries remain stable) and makes loan payoffs more complicated, whereas on the other part, high inflation may ease payment by lessening the real value of loans (Babihuga, 2007; Jakubík & Schmieder, 2008; Nkusu, 2011; Castro, 2013). The equivocal impact of inflation is also presented on the existing literature (Babihuga, 2007; Kavkler & Festić, 2010; Guy & Lowe, 2011; Fadare, 2011).

Ultimately, in order to examine whether a country's financial position shapes loan quality, public debt to GDP ratio is entered to the empirical estimations. There is overwhelming evidence corroborating the notion that debt and banking crises are interrelated (Furceri & Zdzienicka, 2012; Tagkalakis, 2014). However, until now, apart from very few empirical studies (Louzis *et al.* 2012; Makri *et al.* 2014; Makri, 2015), little importance has been given to the relation of public debt with credit risk, especially in the Euro area as a whole. When a country's economic status is aggravated, its banking system is considerably affected, since its creditability is on stake. To put it another way, banks might confront significant liquidity problems by cause of the devaluation of country's credit liability (Reinhart & Rogoff, 2010). In addition, governments are imposed to establish strict fiscal measures with regard to reduce their expenditure (abolition or reduction social benefits), especially in periods of public debt outbursts. Consequently, it is concluded that loan payments might be getting more and more difficult, as the disposable income is significantly restricted (Perotti, 1996). Given the aforementioned analysis, it is foreseen a positive relationship between public debt and credit risk.

Based on the above discussion, three research hypotheses are formulated as follows:

H_1: *Past loan quality is positively related with the current loan quality indicators.*
H_2: *Accounting factors define significantly the loan quality indicators.*
H_3: *Macroeconomic conditions influence significantly bank loan quality*

Apart from the basic model (1), in which both accounting and macroeconomic variables are included in the same equation, micro and macro factors were also investigated separately with a view to obtain greater information. Furthermore, based on the premise that current loan quality can be determined not only by current accounting and macroeconomic variables, but also by those of previous period, all econometric models examined twice. Firstly, the explanatory variables explored at current time (t) and secondly at previous year (t-1), since their impact may be either direct or with a time lag[2].

3.3 Econometric estimations

The main objective of the present study is to specify which factors are responsible for changes of credit risk in Eurozone. Existing research suggests that both individual and aggregate bank level data are analyzed for similar analysis. Our basic target was to explore all loan quality indicators (NPL, LLP and LLR) at individual and aggregate analysis. Nevertheless, due to data limitations, we probed NPL at aggregate and LLP and LLR at bank level data. With this in mind, the empirical investigation consists of two separate case studies and their econometric models are showed below.

3.2.1 Aggregate level data

Taking into account that aggregate bank level data eliminate the risk of non-representativeness of the sample (Boudriga *et al.* 2009), in this case study, it is attempted to reveal the explanatory factors of NPL, via aggregate data, for the period 2001-2012 in Eurozone. Given the methodological framework of the study, the first model assessed is:

$$NPL_{i,t} = a_0 + a_1 NPL_{i,t-1} + a_2 CAP_{i,t} + a_3 LtD_{i,t} + a_4 ROA_{i,t} + a_6 GDP_{i,t} + a_7 UNEMP_{i,t} + a_8 INFL_{i,t} + a_9 DEBT_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where NPL is the non performing loans to total loans ratio and stands for credit risk, i corresponds to the examined country and t to he examined year. Table 1 demonstrates the considered independent factors in combine with their anticipated signs. To the extent of studying micro and macro factors separately, econometric specifications are accordingly shaped:

$$NPL_{i,t} = a_0 + a_1 NPL_{i,t-1} + a_2 CAP_{i,t} + a_3 LtD_{i,t} + a_4 ROA_{i,t} + \varepsilon_{i,t} \quad (2a)$$
$$NPL_{i,t} = a_0 + a_1 GDP_{i,t} + a_2 UNEMP_{i,t} + a_3 INFL_{i,t} + a_4 DEBT_{i,t} + \varepsilon_{i,t} \quad (2b)$$

In addition, it is checked whether the current level of NPL index is determined by micro and macro variables of previous year. Therefore, the following equations are also tested:

$$NPL_{i,t} = a_0 + a_1 NPL_{i,t-1} + a_2 CAP_{i,t-1} + a_3 LtD_{i,t-1} + a_4 ROA_{i,t-1} + a_6 GDP_{i,t-1} + \\ + a_7 UNEMP_{i,t-1} + a_8 INFL_{i,t-1} + a_9 DEBT_{i,t-1} + \varepsilon_{i,t-1} \quad (3)$$

$$NPL_{i,t} = a_0 + a_1 NPL_{i,t-1} + a_2 CAP_{i,t-1} + a_3 LtD_{i,t-1} + a_4 ROA_{i,t-1} + \varepsilon_{i,t-1} \quad (3a)$$

$$NPL_{i,t} = a_0 + a_1 GDP_{i,t-1} + a_2 UNEMP_{i,t-1} + a_3 INFL_{i,t-1} + a_4 DEBT_{i,t-1} + \varepsilon_{i,t-1} \quad (3b)$$

3.2.2 Individual bank level data

Contrary to the first case study, in the present examination, individual bank level data are used. Moreover, instead of NPL, in order to record a clearer picture for the credit risk determinants, LLP and LLR are explored as proxies for loan portfolio quality, for the period 2000-2012. Hence, the models for LLP and LLR, at current time (t), can be written as:

$$LLP_{i,t} = a_0 + a_1 LLP_{i,t-1} + a_2 CAP_{i,t} + a_3 LtD_{i,t} + a_4 ROA_{i,t} + a_5 SIZE_{i,t} + a_6 GDP_{i,t} + \\ + a_7 UNEMP_{i,t} + a_8 INFL_{i,t} + a_9 DEBT_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$LLP_{i,t} = a_0 + a_1 LLP_{i,t-1} + a_2 CAP_{i,t} + a_3 LtD_{i,t} + a_4 ROA_{i,t} + a_5 SIZE_{i,t} + \varepsilon_{i,t} \quad (4a)$$

$$LLP_{i,t} = a_0 + a_1 GDP_{i,t} + a_2 UNEMP_{i,t} + a_3 INFL_{i,t} + a_4 DEBT_{i,t} + \varepsilon_{i,t} \quad (4b)$$

$$LLR_{i,t} = a_0 + a_1 LLR_{i,t-1} + a_2 CAP_{i,t} + a_3 LtD_{i,t} + a_4 ROA_{i,t} + a_5 SIZE_{i,t} + a_6 GDP_{i,t} + \\ + a_7 UNEMP_{i,t} + a_8 INFL_{i,t} + a_9 DEBT_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$LLR_{i,t} = a_0 + a_1 LLR_{i,t-1} + a_2 CAP_{i,t} + a_3 LtD_{i,t} + a_4 ROA_{i,t} + a_5 SIZE_{i,t} + \varepsilon_{i,t} \quad (5a)$$

$$LLR_{i,t} = a_0 + a_1 GDP_{i,t} + a_2 UNEMP_{i,t} + a_3 INFL_{i,t} + a_4 DEBT_{i,t} + \varepsilon_{i,t} \quad (5b)$$

Where LLP is the loans loss provisions to total loans ratio and LLR is the loans loss reserves to total loans ratio, which stand for credit risk, i corresponds to the examined bank and t to he examined year. All the independent variables along with their expected signs are briefly outlined on Table 1.

Likewise NPL, the econometric specifications with micro and macro variables of previous year can be formed below:

$$LLP_{i,t} = a_0 + a_1 LLP_{i,t-1} + a_2 CAP_{i,t-1} + a_3 LtD_{i,t-1} + a_4 ROA_{i,t-1} + a_5 SIZE_{i,t-1} + \\ + a_6 GDP_{i,t-1} + a_7 UNEMP_{i,t-1} + a_8 INFL_{i,t-1} + a_9 DEBT_{i,t-1} + \varepsilon_{i,t-1} \quad (6)$$

$$LLP_{i,t} = a_0 + a_1 LLP_{I,t-1} + a_2 CAP_{i,t-1} + a_3 LtD_{i,t-1} + a_4 ROA_{i,t-1} + a_5 SIZE_{i,t-1} + \varepsilon_{i,t-1} \quad (6a)$$

$$LLP_{i,t} = a_0 + a_1 GDP_{i,t-1} + a_2 UNEMP_{i,t-1} + a_3 INFL_{i,t-1} + a_4 DEBT_{i,t-1} + \varepsilon_{i,t-1} \quad (6b)$$

$$LLR_{i,t} = a_0 + a_1 LLR_{i,t-1} + a_2 CAP_{i,t-1} + a_3 LtD_{i,t-1} + a_4 ROA_{i,t-1} + a_5 SIZE_{i,t-1} + \\ + a_6 GDP_{i,t-1} + a_7 UNEMP_{i,t-1} + a_8 INFL_{i,t-1} + a_9 DEBT_{i,t-1} + \varepsilon_{i,t-1} \quad (7)$$

$$LLR_{i,t} = a_0 + a_1 LLR_{i,t-1} + a_2 CAP_{i,t-1} + a_3 LtD_{i,t-1} + a_4 ROA_{i,t-1} + a_5 SIZE_{i,t-1} + \varepsilon_{i,t-1} \quad (7a)$$

$$LLR_{i,t} = a_0 + a_1 GDP_{i,t-1} + a_2 UNEMP_{i,t-1} + a_3 INFL_{i,t-1} + a_4 DEBT_{i,t-1} + \varepsilon_{i,t-1} \quad (7b)$$

All the above estimations, for both case studies, are computed via GMM difference method. Previous periods variables (time lags) are used as instruments and their validity was checked through Hansen J statistics. Finally, statistical tests AR1 and AR2 are performed so as to control for serial correlation in the residuals of first differences.

4. Sample and data

4.1 Aggregate bank level data

In the first case study, annual aggregate data were analyzed for each country's banking system participating in Eurozone. The main goal was to collect as much as possible information, covering the maximum time period, including both economic growth and recession periods of the European economy. Nevertheless, the nature of the research and the multitude variables searched, posed significant difficulties in collecting the necessary data for all the examined countries. Therefore, an unbalanced panel data considered more appropriate since, as noted by Rinaldi and Sanchis-Arellano (2006), it encloses a greater number of observations and the results are less depended on specific time periods. In this context, the final sample consisted of an unbalanced panel data of 17 countries, with 180 total observations for the period 2001-2012[3]. The data used are drawn from IMF, World Bank and Eurostat. The distribution of observations per country is depicted on Table 2.

Table 2. NPL: Observations per country

Country	Symbol	Observations
Austria	AT	12
Belgium	BE	12
Cyprus	CY	3
Estonia	EE	12
Finland	FI	12
France	FR	12
Germany	DE	12
Greece	GR	11
Ireland	IE	12
Italy	IT	12
Luxembourg	LU	12
Malta	MT	7
Netherlands	NL	9
Portugal	PT	12
Slovak Republic	SK	8
Slovenia	SI	10
Spain	ES	12
Total Sample	**180**	

4.2 Individual bank level data

Contrary to NPL, for the exploration of LLP and LLR, individual bank level data were used to maximize the sample observations and get greater insight for the determinants of credit risk. The main objective was to process data for the greatest number of banks available, operating in Eurozone countries, covering the maximum period. Accounting data are extracted from Thomson Reuters Datastream and macroeconomic indicators from Eurostat. With regard to control for missing values amongst LLP and LLR, two separate unbalanced panel data are established, one for each dependent variable, extending from 2000 to 2012. Regarding LLP, the final sample consisted of 900 observations collected by 98 banks, from 16 Eurozone countries[4]. Additionally, the final sample of LLR included 637 observations obtained from 86 banks of 15 Eurozone countries. Table 3 presents the number of banks and observations per country participating in the final sample for each loan quality indicator.

Table 3. LLP & LLR: Observations per country

Countries		LLP		LLR	
	Symbol	Banks	Observations	Banks	Observations
Austria	AT	7	65	7	52
Belgium	BE	2	20	2	16
Cyprus	CY	4	16	2	8
Finland	FI	3	32	3	14
France	FR	21	180	21	173
Germany	DE	12	100	7	47
Greece	GR	11	105	11	105
Ireland	IE	2	24	2	24
Italy	IT	17	195	14	50
Luxembourg	LU	1	9	1	9
Malta	MT	1	4	-	-
Netherlands	NL	1	10	1	2
Portugal	PT	4	43	4	43
Slovak Republic	SK	2	4	1	3
Slovenia	SI	2	4	2	2
Spain	ES	8	89	8	89
Total		**98**	**900**	**86**	**637**

5. Empirical findings[5]

5.1 NPL: Aggregate level data

The empirical findings concerning NPL determinants are showed in Table 4, in which are demonstrated the coefficients of the independent variables with their corresponding p-values and the statistical tests AR1, AR2 and J. It is essentially significant to underline that for the majority of the models, the statistical tests outline acceptable p-values. In order to test whether the series are autoregressive, Kao panel cointegration test is also carried out, illustrating that the null hypothesis (H_0: no cointegration) is not rejected (p-value =0.278).

The econometric models examined at time t, suggest that GDP growth rate and public dept define significantly non performing loans. Specifically, models (2) and (2b), demonstrate that GDP influence credit risk negatively while public debt positively. Aside from macroeconomic factors, model (2a) indicates that the current level on non performing loans is also determined positively by its previous year values, confirming the dynamic resistance of credit risk in time.

Table 4. NPL: Empirical results

	t			t-1		
Variables	**Model (2)**	**Model (2a)**	**Model (2b)**	**Model (3)**	**Model (3a)**	**Model (3b)**
NPL_{it-1}	0.542 (0.293)	**1.027*** **(0.000)**		0.214 (0.570)	**1.098*** **(0.000)**	
CAP_{it}	0.028 (0.943)	0.249 (0.596)				
CAP_{it-1}				0.074 (0.826)	-0.332 (0.650)	
LtD_{it}	0.000 (0.932)	0.007 (0.298)				
LtD_{it-1}				**0.008*** **(0.058)**	0.006 (0.476)	
ROA_{it}	0.199 (0.549)	-0.049 (0.922)				
ROA_{it-1}				-0.571 (0.190)	0.079 (0.948)	
GDP_{it}	**-0.189*** **(0.004)**		**-0.113*** **(0.080)**			
GDP_{it-1}				-0.077 (0.195)		**-0.152*** **(0.000)**
$UNEMP_{it}$	0.099 (0.766)		0.279 (0.224)			

Variables	t			t-1		
	Model (2)	Model (2a)	Model (2b)	Model (3)	Model (3a)	Model (3b)
$UNEMP_{it-1}$				0.085 (0.546)		0.112 (0.423)
$INFL_{it}$	0.098 (0.627)		0.138 (0.509)			
$INFL_{it-1}$				**0.523*** (0.000)**		**0.465*** (0.000)**
$DEBT_{it}$	**0.132** (0.026)**		**0.168*** (0.000)**			
$DEBT_{it-1}$				**0.143** (0.014)**		**0.194*** (0.000)**
AR1 ***(p-value)***	0.071	0.063	0.027	0.092	0.029	0.059
AR2 ***(p-value)***	0.650	0.490	0.250	0.750	0.281	0.407
Hansen J test ***(p-value)***	0.154	0.545	0.714	0.192	0.086	0.130
Sample	180	180	180	180	180	180

*Note: Table shows the coefficients estimates (coefficients in boldface are significant), and p-values of the difference GMM regression model. * Significance at the 10% level, ** significance at the 5% level, *** significance at the 1% level. Where NPL is the ratio of nonperforming loans to total loans, CAP is the capital ratio which is defined as capital and reserves to total assets, LtD is the loans to deposits ratio, ROA is the profitability ratio: return on assets, GDP is the annual percentage growth rate of GDP, UNEMP is the annual unemployment rate, INFL is the annual average rate of inflation and DEBT is the annual public debt as percentage of GDP. Where i corresponds to the examined country and t to the examined year*

The assessment of models for time t-1, exhibits that inflation, public debt and GDP growth of previous period, stand also as explanatory variables of credit risk. $INFL_{it-1}$ and $DEBT_{it-1}$ record a significant positive relationship (model 3 and 3b), while GDP_{it-1} a negative one (model 3b). As regards accounting factors, previous year's loans to deposits ratio demonstrates a significant positive influence on the current level of NPL (model 3). Similar to model (2a), dynamic performance of credit risk is also certified on model (3a). On the contrary, unemployment, capital adequacy and profitability were not noted as significant explanatory factors, supporting the view that they do not exert important influence on non performing loans, neither at current time nor with a time lag.

5.2 LLP & LLR: Individual bank level data

At variance with section 5.1, the current case study provides results dealing with LLP and LLR, analyzed via individual bank level data on Table 5 and 6, respectively. More precisely, the aforementioned tables introduce the coefficients of the independent variables with their corresponding p-values and the statistical

tests AR1, AR2 and J. These tests, for the majority of the equations, perform acceptable p-values, along with KAO panel cointegration test in which the null hypothesis (H_0: no cointegration) is not rejected for both LLP (p-value: 0.394) and LLR (p-value: 0.276).

From the evaluation of Table 5, econometric models at time t reveal that macroeconomic variables explain changes in LLP ratio. Specifically, economic activity and public debt proved significant determinants of loan quality, with negative and positive correlation, respectively (models 4 and 4b). However, apart from macroeconomic environment, it seems that accounting variables can also define LLP, insomuch capital adequacy ratio poses a significant negative effect (model 4 and 4a), while bank size a positive one (model 4a). Finally, the existence of dynamic strength of loan quality is once again affirmed, as previous year's provisions exert a positive statistically significant impact on current LLP values (model 4).

Estimations (5), (5a) and (5b) contribute that accounting and macroeconomic indices of previous year are significantly interrelated with the current level of loan loss provisions. More precisely, a significant negative correlation is presented between LLP and GDP_{it-1} (models 5 and 5b) and a positive one with $INFL_{it-1}$ (models 5 and 5b) and $DEBT_{it-1}$ (model 5b). Concerning accounting indicators, both previous period's bank size and capital ratio are emerged statistically significant, affecting LLP positively (models 5 and 5a) and negatively (model 5), correspondingly.

Table 5. LLP: Empirical results

	t			t-1		
Variables	**Model (4)**	**Model (4a)**	**Model (4b)**	**Model (5)**	**Model (5a)**	**Model (5b)**
LLP_{it-1}	**0.374**** (0.027)**	0.090 (0.748)		0.096 (0.663)	-0.030 (0.918)	
CAP_{it}	**-0.103*** (0.000)**	**-0.247* (0.086)**				
CAP_{it-1}				**-0.286*** (0.000)**	-0.071 (0.535)	
LtD_{it}	-0.001 (0.464)	0.00032 (0.792)				
LtD_{it-1}				0.001 (0.520)	0.0003 (0.847)	
ROA_{it}	-0.013 (0.440)	-0.021 (0.286)				
ROA_{it-1}				-0.001 (0.984)	0.049 (0.220)	
$SIZE_{it}$	-0.013 (0.245)	**0.038*** (0.008)**				
$SIZE_{it-1}$				**0.028*** (0.002)**	**0.037*** (0.001)**	

	t			t-1		
Variables	**Model (4)**	**Model (4a)**	**Model (4b)**	**Model (5)**	**Model (5a)**	**Model (5b)**
GDP_{it}	**-0.078*** (0.003)**		**-0.050** (0.043)**			
GDP_{it-1}				**-0.050** (0.046)**		**-0.062** (0.014)**
$UNEMP_{it}$	-0.074 (0.358)		-0.035 (0.743)			
$UNEMP_{it-1}$				0.072 (0.344)		-0.025 (0.714)
$INFL_{it}$	-0.001 (0.464)		-0.008 (0.869)			
$INFL_{it-1}$				**0.237*** (0.000)**		**0.183*** (0.000)**
$DEBT_{it}$	**0.041*** (0.002)**		**0.053*** (0.000)**			
$DEBT_{it-1}$				0.017 (0.270)		**0.047*** (0.000)**
AR1 (p-value)	0.013	0.037	0.002	0.044	0.183	0.093
AR2 (p-value)	0.511	0.373	0.196	0.406	0.153	0.282
Hansen J test (p-value)	0.473	0.229	0.221	0.310	0.154	0.203
Sample	900	900	900	900	900	900

*Note: Table shows the coefficients estimates (coefficients in boldface are significant), and p-values of the difference GMM regression model. * Significance at the 10% level, ** significance at the 5% level, *** significance at the 1% level. Where LLP is the ratio of loan loss provisions to total loans, CAP is the capital ratio which is defined as capital and reserves to total assets, LtD is the loans to deposits ratio, ROA is the profitability ratio: return on assets, SIZE is the bank size: the natural logarithm of total assets, GDP is the annual percentage growth rate of GDP, UNEMP is the annual unemployment rate, INFL is the annual rate of inflation and DEBT is the annual public debt as percentage of GDP. Where i corresponds to the examined bank and t to the year.*

Table 6 describes the explanatory factors of LLR ratio. The examination of econometric equations at period t concludes that public debt clearly defines loan loss reserves positively (models 6 and 6b). Equivocal findings are showed for bank size, since its impact is negative at model (6) and positive at model (6a). Similar to NPL and LLP, the dynamic persistence of credit risk is again verified as a determinant of LLR (model 6a).

Finally, the econometric equations at period t-1 argue that previous period macroeconomic factors lead to significant changes on LLR, as public debt and inflation exercise positive impact (models 7 and 7b) and GDP a negative one (models 7). Moreover, from accounting perspective, previous period's bank size and loan loss reserves are positively related with loan quality (model 7a). Contrary to the aforementioned factors, unemployment, profitability, liquidity and capital adequacy ratios do not appear to interpret changes in the levels of LLR, neither at current time t nor with one year lag.

Table 6. LLR: Empirical results

Variables	t			t-1		
	Model (6)	Model (6a)	Model (6b)	Model (7)	Model (7a)	Model (7b)
LLR_{it-1}	0.108 (0.652)	**0.595*** (0.006)**		0.184 (0.477)	**0.801*** (0.000)**	
CAP_{it}	-0.070 (0.725)	-0.217 (0.399)				
CAP_{it-1}				-0.274 (0.113)	-0.188 (0.296)	
LtD_{it}	-0.003 (0.255)	0.002 (0.608)				
LtD_{it-1}				-0.016 (0.198)	-0.007 (0.588)	
ROA_{it}	-0.065 (0.767)	-0.215 (0.342)				
ROA_{it-1}				0.052 (0.798)	0.024 (0.909)	
$SIZE_{it}$	**-0.053* (0.051)**	**0.046*** (0.003)**				
$SIZE_{it-1}$				0.006 0.729	**0.043*** (0.001)**	
GDP_{it}	-0.068 (0.203)		-0.058 (0.556)			
GDP_{it-1}				**-0.123** (0.035)**		-0.045 (0.438)
$UNEMP_{it}$	-0.027 (0.751)		-0.042 (0.677)			
$UNEMP_{it-1}$				-0.125 (0.205)		-0.041 (0.584)
$INFL_{it}$	0.124 (0.202)		0.117 (0.241)			
$INFL_{it-1}$				**0.231** (0.034)**		**0.138* (0.096)**
$DEBT_{it}$	**0.110*** (0.000)**		**0.117*** (0.000)**			
$DEBT_{it-1}$				**0.115*** (0.000)**		**0.103*** (0.000)**
AR1 ***(p-value)***	0.057	0.059	0.000	0.053	0.052	0.000
AR2 ***(p-value)***	0.504	0.542	0.145	0.522	0.441	0.988
Hansen J test ***(p-value)***	0.607	0.168	0.079	0.967	0.304	0.139
Sample	637	637	637	637	637	637

*Note: Table shows the coefficients estimates (coefficients in boldface are significant), and p-values of the difference GMM regression model. * Significance at the 10% level, ** significance at the 5% level, *** significance at the 1% level. Where LLR is the ratio of loan loss reserves to total loans, CAP is the capital ratio which is defined as capital and reserves to total assets, LtD is the loans to deposits ratio, ROA is the*

profitability ratio: return on assets, SIZE is the bank size: the natural logarithm of total assets, GDP is the annual percentage growth rate of GDP, UNEMP is the annual unemployment rate, INFL is the annual rate of inflation and DEBT is annual the public debt as percentage of GDP. Where i corresponds to the examined bank and t to the year

6. Discussion

The assessment of econometric findings, both at aggregate and individual level data, establishes strong evidence that accounting and macroeconomic factors play a decisive role on defining loan quality (NPL, LLP and LLR), hence credit risk in EMU.

In the matter of macroeconomic environment, our results are in good agreement with Berge and Boye (2007) that adverse macroeconomic conditions hamper households and businesses in meeting their loan obligations. More precisely, all loan quality indicators acknowledged public debt as a decisive factor. Indeed, it was unveiled that the current loan quality is ascertained positively not only by the current values of public debt but also from its past values. Until now, little importance has been given to the relationship between loan quality and public debt (Vatansever & Hepşen, 2013; Castro, 2013; Makri & Papadatos, 2014; Kasselaki & Tagkalakis, 2014; Makri, 2015) and still less in Eurozone (Makri *et al.* 2014). Nevertheless, the inclusion of this explanatory variable aimed to contribute on the ongoing discussion whether a country's financial condition is associated with loan quality, due to the open-ended debt crisis in the Eurozone and its linkage with banking systems. In fact, the overall findings pinpoint powerful impact of this public finance indicator in Euro area. This result reinforces Makri *et al.* (2014) and can be attributed to the notion that the deterioration of public finances arouses both financial system and society. On one hand, the deterioration of fiscal indices affects negatively country's creditability and therefore its banks might face severe liquidity issues (Reinhart & Rogoff, 2010). On the other hand, in periods that characterized by high public debt levels, governments might require to undertake strict actions (increase taxation, benefit cuts etc.), which impede debtors on meeting their loans obligations (Perotti, 1996).

Economic activity is another essential macroeconomic determinant of loan quality in Euro area, although with negative effect. Specifically, its negative impact is not only verified at current time t, since previous period's GDP also influences all dependent variables (NPL, LLP and LLR). The above results clearly demonstrate the existence of procyclicality phenomenon in Euro area. In other words, it occurs that in periods of economic growth, households and companies have sufficient income to repay their loans and problem loans indicators are being kept low. Conversely, in times of recession, borrowers' economic status is declining and

consequently loan quality indicators are expanded substantially. Procyclicality, in European financial system, has also been corroborated by Frait and Komárková (2009), Cotugno *et al.* (2010), Castro (2013), Curcio and Hasan (2015), Makri *et al.* (2014) and generally by many other studies like Salas and Saurina (2002), Gerlach *et al.* (2005), Ghosh (2005), Breuer (2006), Festić and Repina (2009), Al-Smadi and Ahmad (2009), Dash and Kabra (2010), Guy and Lowe (2011), De Bock and Demyanets (2012), Jakubik and Reininger (2013), Klein (2013) etc.

Aside from public debt and economic activity, inflation is an additional macroeconomic determinant of credit risk. However, unlike public debt and GDP growth rate, inflation does not seem to pose significant influence at current time t, but only with one year time lag. Despite the fact, economic theory and literature argue that inflation's effect is equivocal, the detected positive relationship support the view that high inflation reduces borrowers' real income (when wages and salaries remain stable) and consequently loan repayment is getting more and more difficult. This result is also endorsed by Babihuga (2007), Havrylchyk (2010), Fadare (2011), Nkusu (2011) and Klein (2013) etc.

Conclusively, despite that unemployment was not recorded as statistically significant explanatory variable, it becomes clear that macroeconomic conditions strongly determine loan portfolio quality in Eurozone and therefore hypothesis H_3 is accepted.

Along with macroeconomic environment, past loan quality is considered an additional exploratory factor of credit risk. In other words, past performance of NPL, LLP and LLR indicators is positively associated with the current level of credit risk, upholding H_1 hypothesis. The dynamic performance of credit risk has also been designated by many empirical studies such as Chase *et al.* (2005), Jimenez and Saurina (2006), Fonseca and González (2008), Espinoza and Prasad (2010), Carbó-Valverde *et al.* (2012), Makri and Papadatos (2014), Makri *et al.* (2014).

Contrary to the aforementioned explanatory variables, the results for the accounting factors are not similar for all the examined loan quality indicators. The assessment of LLP and LLR revealed that bank size is an additional interpretative accounting factor. Notwithstanding that the findings are not perfectly clear, the majority of the models showed a positive impact, confirming the "too big to fail" hypothesis (Boyd & Getler, 1994; Boyd *et al.* 2009; Walter, 2009; Laeven *et al.* 2014). Furthermore, the positive relationship can be attributed to the fact that small banks, due to their size, their organizational structure and their ability to solve agency problems, can process information and monitor their loan portfolio more effectively compared to large banks (Nakamura 1993 & 1994). Similar positive relationship was observed by Deelchand and Padgett (2009), Cotugno *et al.* (2010) and Misra and Dhal (2010).

Additionally, capital ratio is an interpretive accounting variable. However, its impact is detected statistically significant only with LLP ratio. More precisely, it is showed that the current level of LLP is negatively related with both current values of capital ratio and those of previous year. Economic theory and empirical findings are not very clear regarding the relation between capital and credit risk. Nevertheless, the negative correlation detected in EMU, demonstrates that financial institutions with low (high) capital ratios formulate high (low) loan loss provisions. This linkage corroborates moral hazard hypothesis, in which banks with low capital ratios respond more easily to moral hazards, raising the risk of loan portfolios (Berger & De Young, 1997). This finding is consistent with Salas and Saurina (2002), Chen (2007), Angklomkliew *et al.* (2009), Deelchand and Padgett (2009), Espinoza and Prasad (2010), Floro (2010), Fiordelisi and Mare (2013), Klein (2013), Makri and Papadatos (2014), Makri *et al.* (2014).

Finally, liquidity ratio is another statistically significant accounting factor with positive impact, but only for NPL with one year time lag. This means that an increase of liquidity index is translated into a downgrade of liquidity and leads to an increase in next period's non performing loans. This result is explained by the fact that loans to deposits ratio depicts banks' behavior towards risk, since high (low) values of the index, imply high (low) exposure to credit risk (Guy and Lowe, 2011). Similar conclusions have been recorded by Cavallo and Manjoni (2001), Ahmad and Ariff (2007), Misra and Dhal (2010), Floro (2010), Festic and Kavkler (2012), Klein (2013) and Monokroussos and Thomakos (2014). On the contrary, profitability ratio is not linked to loan quality at any econometric equation. Based on the above analysis, even if accounting factors do not affect loan quality indicators in the same way, it is clearly that accounting ratios shape fundamentally loan quality in Eurozone and consequently H_2 hypothesis is also accepted.

The investigation of credit risk determinants divulged important implications for taxpayers, supervisory authorities and bank's management. The defined accounting and macro factors can serve as a crucial signaling tool for the protection of financial stability, potential reduction of severe loan losses, policy formulation and designing decision-making strategies (both at overall banking system level and individually for each bank separately).

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Appendix A

Table A1. NPL: Descriptive statistics (%)

Variables	Mean	Median	Max	Min	SD
NPL_{it}	3.729	2.850	24.600	0.100	3.502
CAP_{it}	6.193	5.800	13.300	2.700	1.964
LtD_{it}	136.717	120.240	694.740	42.230	103.257
ROA_{it}	0.483	0.600	3.500	-9.500	1.134
GDP_{it}	1.779	1.900	11.200	-14.100	3.508
$UNEMP_{it}$	8.151	7.700	25.000	1.800	3.610
$INFL_{it}$	2.632	2.500	10.600	-1.700	1.533
$DEBT_{it}$	60.392	61.800	170.300	3.700	33.620

Note: Where NPL is the ratio of nonperforming loans to total loans, CAP is the capital ratio which is defined as capital and reserves to total assets, LtD is the loans to deposits ratio, ROA is the profitability ratio: return on assets, GDP is the annual percentage growth rate of GDP, UNEMP is the annual unemployment rate, INFL is the annual average rate of inflation and DEBT is the annual public debt as percentage of GDP. Where i corresponds to the examined country and t to the examined year.

Table A2. LLP: Descriptive statistics (%)

Variables	Mean	Median	Max	Min	SD
LLP_{it}	0.646	0.490	11.670	-0.370	0.871
CAP_{it}	6.347	5.840	17.830	-4.310	3.202
LtD_{it}	197.121	155.955	1413.190	43.390	155.960
ROA_{it}	0.441	0.920	7.380	-106.160	5.453
$SIZE_{it}$	7.454	7.410	9.340	4.690	0.810
GDP_{it}	1.329	1.700	10.500	-8.500	2.650
$UNEMP_{it}$	8.548	8.400	21.700	2.800	2.850
$INFL_{it}$	2.331	2.300	5.500	-1.700	1.078
$DEBT_{it}$	78.730	69.200	170.300	6.100	27.465

Note: Where LLP is the ratio of loan loss provisions to total loans, CAP is the capital ratio which is defined as capital and reserves to total assets, LtD is the loans to deposits ratio, ROA is the profitability ratio: return on assets, SIZE is the bank size: the natural logarithm of total assets, GDP is the annual percentage growth rate of GDP, UNEMP is the annual unemployment rate, INFL is the annual rate of inflation and DEBT is the annual public debt as percentage of GDP. Where i corresponds to the examined bank and t to the year. All the examined variables are presented as %, apart from $SIZE_{it}$ which is the natural logarithm of total assets.

Table A3: LLR: Descriptive statistics (%)

Variables	Mean	Median	Max	Min	SD
LLR_{it}	2.728	2.230	31.520	0.130	2.405
CAP_{it}	6.338	5.680	17.830	-4.310	3.483
LtD_{it}	192.058	153.890	1362.400	43.390	124.642
ROA_{it}	0.813	0.950	7.380	-21.210	1.485
$SIZE_{it}$	7.539	7.490	9.340	5.690	0.778
GDP_{it}	1.535	1.900	10.500	-8.500	2.680
$UNEMP_{it}$	8.915	8.800	21.700	3.700	3.156
$INFL_{it}$	2.441	2.500	5.500	-1.700	1.143
$DEBT_{it}$	74.852	68.000	170.300	6.100	26.984

Note: Where LLR is the loan loss reserves to total loans, CAP is the capital ratio which is defined as capital and reserves to total assets, LtD is the loans to deposits ratio, ROA is the profitability ratio: return on assets, SIZE is the bank size: the natural logarithm of total assets, GDP is the annual percentage growth rate of GDP, UNEMP is the annual unemployment rate, INFL is the annual rate of inflation and DEBT is the annual public debt as percentage of GDP. Where i corresponds to the examined bank and t to the year. All the examined variables are presented as %, apart from $SIZE_{it}$ which is the natural logarithm of total assets.

[1] Source: World Bank Indicators.
[2] All econometric models are presented extensively in the subsection 3.3.
[3] Latvia and Lithuania were not included to the sample due to data unavailability.
[4] Estonia, Latvia and Lithuania were excluded from the sample due to data limitations.
[5] Descriptive statistics for all the empirical investigations are tabulated on appendix