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Article

Credit risk determinants in the vulnerable economies of Europe: Evidence from the Spanish banking system

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CREDIT RISK DETERMINANTS IN THE VULNERABLE ECONOMIES OF EUROPE:
EVIDENCE FROM THE SPANISH BANKING SYSTEM

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Credit Risk Determinants in the Vulnerable Economies of Europe: Evidence from the Spanish Banking System

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ARTICLE INFO	ABSTRACT
<p>Article History</p> <p>Received 12th February 2017; Accepted 9th March 2017</p> <p><i>JEL Classifications</i> C32, G17, G21</p>	<p>Purpose: The purpose of this paper is to investigate the determinants of non-performing loans in the Spanish banking system over the period 1997Q4–2015Q3. This timeframe includes not only the booming period for the Spanish economy but also an extended post-crises interval which is missing from other studies for Spain.</p> <p>Design/methodology/approach: Using quarterly data from the Central Bank of Spain and from the European Central Bank, the paper employs the ARDL approach to cointegration to identify the existence of a long or short-run relationship between NPLs and a set of macroeconomic, bank-related and country-specific indicators.</p> <p>Findings: Findings from the ARDL model indicate that macroeconomic, bank-specific variables and interest rates are important determinants of non-performing loans in the Spanish banking system. Specifically, the real GDP, the Spanish long-term government bond yield, the return on equity, the total credit granted by the Spanish banks and their capital to assets ratio, explain credit risk in Spain both in the short and the long run.</p> <p>Research limitations/implications: Data on the bank-specific variables are for the whole banking industry, and not for individual banks. If such data were available, a comparison of the credit risk determinants between small/ big banks, private/public or domestic/foreign could be possibly made.</p> <p>Originality/value: These findings provide useful evidence to bank managers and policymakers in dealing with loans' defaults in Spain and in undertaking crucial reforms to stabilize the economy.</p>
<p>Keywords: Credit risk, Spain, banking system, ARDL, Global financial crisis</p>	

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1. Introduction

The strong belief that financial distress may contract economic growth, has inspired academics to investigate those factors that may trigger a banking crisis (Agnello et al 2011; Chaibi and Ftiti 2015; Islami and Kurz-Kim, 2014). According to Chaibi and Ftiti (2015), academics have considered various indicators for measuring uncertainty or stress in financial markets such as structural weaknesses in the financial systems and moral hazard. However, the authors claim that: "It seems that a banking crisis is primarily caused by banks' incapacity to satisfy their payment obligations, a situation that is essentially triggered by impaired loans on their balance sheet" (Chaibi and Ftiti, 2015, p. 2). Therefore, bringing bank credit risk problems to the forefront exceeds any other attempt to examine bank crises and their causes (Castro, 2013). Indeed, identifying those factors that

influence credit risk has been at the centre of the relevant literature over the last years. Europe is among the regions that have mostly attracted academics' attention on the issue as it was hit stunningly fast by the recent global financial crisis and since 2010 is swimming in its own Eurozone debt crisis.

This paper focuses on one of the most vulnerable economies of Europe, namely, Spain and investigates the credit risk determinants in the Spanish banking system. The choice of the focal country is not random: the 2008 collapse of the housing bubble in Spain was associated with huge defaults on loans granted to this sector and massive losses reported by banks (BS, 2014). Moreover, despite being a core EU country, the very high budget deficits and the unsustainable sovereign debt levels of Spain characterize it as a peripheral economy of Europe currently, along with other peripheral economies that were affected by the global financial crisis. Therefore, the risk of further banking distress in Spain remains

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high.

The key objective of this study is to determine whether a wide range of variables, commonly accepted by the relevant literature, affect credit risk in Spain, by employing the ARDL approach to cointegration over the period 1997Q4–2015Q3.

It adds to the existing literature, since to date similar studies on the Spanish economy have used other estimation techniques and no other investigation has covered such an extended timeframe. Empirical findings from this study generate useful insights and offer recommendations for bank managers and policymakers in the country.

The paper is organized as follows: The following section discusses the academic literature on credit risk determinants whereas Section 3 provides a brief overview of the Spanish economy and banking sector. Section 4, then, describes the dataset and the methodology employed while Section 5 discusses the empirical findings. The paper concludes with Section 6.

2. Literature review

Although investigation of the determinants of credit risk has always been an inspiring topic for researchers, the recent global financial crisis has brought renewed interest in the topic. Various financial systems have undergone several shocks and instabilities during their growth process, reflected mainly in the decreased quality of their loans, namely non-performing loans (NPLs). Thus, credit risk analysis is essential in [signalling](#) potential shocks and aiding policymakers in taking the necessary measures to prevent a possible crisis (Castro, 2013).

In the literature, there are two distinctive sets of factors that explain credit risk: macroeconomic-cyclical factors affecting systematic credit risk and bank-specific or institutional factors affecting unsystematic risk. The first set of factors concerns the macroeconomic environment and the impact that certain economic conditions have on the borrowers' ability to service their loans. An economy in growth boosts income and therefore reduces bad debts since more money is available in the borrowers' hands. Given this, NPLs are negatively affected by GDP growth and monetary aggregates that proxy GDP (M1, M2, M3) whereas the contrary can be assumed for their relation to unemployment (Messai and Jouini, 2013). The positive effect of the latter is significant and reflected in the deteriorated ability of not only individuals to service their debts but also corporates that suffer low cash-flows due to a drop in the demand for their products (Chaibi and Ftiti, 2015). Other factors considered in the theoretical models that explain credit risk, are: the real interest rate, the inflation rate and the real exchange rate. High interest rates mean a higher debt [burden](#); thus, they have a direct effect on increasing NPLs (Nkusu, 2011). As far as the inflation rate is concerned, its effect on credit risk is ambiguous. Higher inflation rates can make debt servicing easier by reducing the real value of outstanding loans (Castro, 2013). In contrast, in countries with variable interest rates, lenders adjust rates to maintain their real returns, thus, debt servicing becomes more difficult since reduced-income customers

have to pay higher interest rates. To this extent, the relationship between inflation and credit risk can be positive or negative. The same uncertainty is also observed in the exchange rate implications for NPLs. According to Fofack (2005), a currency appreciation may directly affect the debt servicing capacity of individuals by making local products more expensive, whereas the reduced profit-margins in export-oriented industries may delay their ability to meet credit commitments. Foreign currency loans though, are aided by the local currency appreciations which make them cheaper for borrowers (Mishkin, 1996; Nkusu, 2011). Such effect is more significant in those countries with the highest percentage of foreign currency loans (e.x. South Eastern Europe). Therefore, it becomes obvious that, depending on the debt's currency, the effect of exchange rates on NPLs can be positive or negative.

Despite the heavy reliance upon macroeconomic developments to explain credit risk, recent studies also focus on banking industry-specific variables. In good times, both individuals and banks are enthusiastic to engage in excessive risk-taking projects and therefore underestimate their ability to service or collect their loans (Jimenez and Saurina, 2006). Hence, credit risk is built up during periods of economic booms when individuals have more money available to pay their debts whereas banks apply looser credit standards but it is only materialized during recessions. Given this, bank-specific features are also considered as significant contributors to credit risk. Such factors are usually captured by credit growth, bank liquidity, the leverage ratio as well as the bank's profitability. Rapid credit growth is often associated with a parallel increase of impaired loans (Castro, 2013). The moral hazard hypothesis indicates that banks with low capital tend to be riskier by undertaking excessive lending, thus, face higher loan losses (Gavin and Haussmann, 1996; Berger and DeYoung, 1997). However, Makri et al (2014), argue that both theoretical and empirical evidence have shown that the capital-credit risk relation is ambiguous. Specifically, even banks with adequate capital ratios may create tiny but high-risk portfolios and therefore report considerable stocks of bad loans. Based on the moral hazard hypothesis, banks with low liquidity will also report higher NPLs (Vogiazas and Nikolaidou, 2011). The effect of the profitability ratios such as ROA and ROE is ambiguous and is clearly explained by Louzis et al (2012) through the bad management and procyclical credit policy hypotheses. According to the first one, banks' performance is negatively associated to future NPLs since bad management related to low profitability means poor skills in credit scoring and monitoring and therefore a higher probability of default. The procyclical credit policy hypothesis though, claims that good performance is positively associated with future increases in NPLs since often, bank managers are interested not only in maximizing profit, but also in improving their reputation. Specifically, managers may attempt to boost the bank's profitability in the eyes of the market by relying on a liberal credit policy at the expense of future problem loans. Hence, current earnings may help create bigger NPLs stocks in the future.

The empirical literature that estimates credit risk (NPLs) drivers varies according to the countries

investigated, methodologies applied and variables considered. A vast majority of studies focus on a group of countries instead of analyzing individual cases. Some of them consider only macroeconomic variables, whereas others rely on both macro and microeconomic indicators for an accurate credit risk modeling. Castro (2013) concluded that GDP growth, unemployment rate, interest rates, share price indices, credit growth and the real exchange rate are crucial in determining credit risk when five countries of Europe were analyzed for the period 1997Q1-2011Q3. Ali and Daly (2010) confirmed the relevance of the macroeconomic environment to credit risk when Australia and the U.S. were investigated. GDP growth and the short term-interest rates are crucial to NPLs, although not on the same scale in each country. Similarly, Pesola (2005) found that sudden shocks on income and real interest rates contribute to the distress in the banking sector when a panel of industrial countries was analyzed whereas Kakvler and Festic (2012) unfold the importance of current account deficits on NPLs when Bulgaria and Romania were investigated over the 1997-2008 period. As the authors claim, large current account deficits caused by structural dependence on external financing may trigger financial instability. Demirguc-Kunt and Detragiache (1997) argue that a weak macroeconomic environment characterized by slow GDP growth and high inflation as well as banks' low liquidity and a high share of credit to the private sector, are at the core of the banking crises that certain developed and emerging economies experienced over the period 1980-94. According to Gavin and Hausmann (1995), excessive credit growth lay at the heart of the banking crises in Latin America, since it was accompanied by wavered loan restrictions and covenants. Makri et al (2014) investigated 14 Eurozone countries over the pre-crisis period 2000-2008; they found strong correlations between NPLs and various macroeconomic (public debt, unemployment, GDP growth) and bank-specific (capital adequacy ratio and return on equity) factors. Similar results were achieved by Mesai and Jouini (2013) for Greece, Italy, and Spain and by Louzis et al (2012) when a panel of Greek banks was analyzed.

The main body of the empirical literature uses VAR models instead of cointegration analysis, although several methods are available for conducting cointegration tests such as the Engle-Granger approach, the maximum likelihood based Johansen test and the Autoregressive Distributed Lag approach to cointegration (ARDL) (Nikolaidou and Vogiazas, 2014). Through the use of VAR, Nkusu (2011) concludes that slow GDP growth and unemployment positively affected credit risk in a large group of advanced economies from 1998 to 2009. Using the same approach, Marcucci and Quagliariello (2008) conclude that macroeconomic cyclical indicators affect NPLs in Italy over the period 1990-2004. However, no strong evidence of a feedback effect between the two was found. Bofondi and Ropele (2011) found that over the period 1990-2010, NPLs in Italy are explained by a small number of macroeconomic variables such as economic growth, the cost of borrowing and the burden of debt. Berger and DeYoung (1997) studied the causal relationship between loan quality, cost efficiency and bank capital. They found a negative feedback relationship between cost efficiency

and problematic loans and that capital reduction in low capitalized banks causes problematic loans. Similarly, Diamond and Rajan (2005) suggest that liquidity and solvency problems interact and can cause each other. By applying the VAR approach, Klein (2013) found that the level of NPLs in Central, Eastern and South-Eastern Europe (CESEE) is influenced by GDP growth, unemployment and inflation as well as from the profitability, level of equity and excessive risk taking of the banks. Moreover, a feedback relationship between NPLs and macroeconomic downturns was noted, meaning that countries that face loan crisis are condemned to economic recessions. A Monokroussos et al (2016) study concluded a negative bi-directional causality between GDP growth and NPLs and employment and NPLs in Greece over the period 2005-2015.

Among the few studies that apply cointegration techniques to study the short-term and long-term relationship between a set of macro and microeconomic variables and NPLs, Yurdakul (2014) applied the Engle-Granger approach to investigate Turkey over the period 1998-2012. Findings suggest that GDP growth and the Istanbul Stock Exchange index reduce credit risk in the long run, whereas money supply, the foreign exchange rate, unemployment, the inflation rate and the interest rate have the adverse effect. Similar results were also achieved by Delgado and Saurina (2004) for Spain. The ARDL approach to cointegration is relatively new in the credit risk determinants literature and therefore studies applying it are limited in number. Greenidge and Grosvenor (2009) employed the ARDL approach to investigate NPLs in Barbados over the period 1996-2008 and conclude that they are significantly affected by interest rates in the long run while Nikolaidou and Vogiazas (2013) following the same approach concluded that lending growth, jointly with money supply and unemployment, have a significant long-run impact on Romania's credit risk over the period 2001-2010. Consistently, Nikolaidou and Vogiazas (2014) found that NPLs in the Bulgarian banking system are explained by both macroeconomic and industry-specific variables as well as by exogenous factors such as the recent global financial crisis.

As far as Spain is concerned, Salas and Saurina (2002) compared credit risk determinants among savings and commercial banks in the country over the period 1985-1997. Their findings suggest that credit growth, inefficiency, the portfolio composition, the net interest margin and the capital ratio jointly with GDP growth, explain credit risk of savings and commercial banks - although not in the same scale - confirming the relevance of the institutional form in credit risk management. Jimenez and Saurina (2004) focus on a loan by loan basis, analyzing more than 3 million loans granted by all Spanish banks during the period 1988-2000. Findings suggest that collateralized loans and a good bank-customer relationship increase the probability of default. Blanco and Gimeno (2012) explained the dynamic behavior of the default rates of loans granted to households by using a dynamic panel data model (50 provinces) for the period 1984-2009. They found that unemployment, credit growth and the interest debt burden affect loan default rates in Spain. The effect of unemployment though, is asymmetric since

an increase in the unemployment rate has a sharper effect on defaults than its decrease. Messai and Jוני (2013) investigated the credit risk determinants of 85 banks of Italy, Greece and Spain over the period 2004-2008. They found that NPLs are negatively affected by GDP growth and the profitability of banks' assets, whereas NPLs are positively related to the unemployment rate, the loan loss reserves to total loans and the real interest rate. Castro (2013) confirmed as well the role of GDP growth, unemployment rate, and real interest rates on credit risk when Spain was investigated along with four other European countries.

The surveyed literature on credit risk determinants highlights the most common finding in the literature: the negative relationship between credit risk and economic growth. Other than that, diverse interactions between other macroeconomic/bank-specific factors and NPLs are found. The main body of the literature consists of panel data/cross-country studies, and thus, lacks the incorporation of country - specific features. Moreover, the single country analyses are limited in terms of the variety of credit risk drivers estimated or the short time intervals investigated. To this extent, the proposed study for Spain contributes to the international debate

Table 1. Key Economic indicators

	1991-2000	2001-2010	2008	2009	2010	2011	2012	2013	2014
GDP growth (%)	2.81	2.25	1.10	-3.6	0.0	-1.0	-2.6	-1.7	1.40
Inflation (%)	3.89	2.80	4.10	-0.3	1.80	3.20	2.40	1.40	-0.1
Investment (% of GDP)	23.5	28.2	30	25	24	22	20	19	20
Unemployment (%)	19.77	12.11	11.5	18.1	20.2	21.7	25.2	24.6	25.1
GG debt (% of GDP)	51.48	41.54	33.9	46.1	53.6	61.8	83.5	96.5	98.06

Source: World Bank

Note: GDP and investment growth rates are calculated from constant 2005 USD.

As outlined in Table 1, economic recovery was achieved during the period 1991-2000 with an average GDP growth of 2.8% and an average inflation rate of 3.9%. However, a decade of healthy economic upturn began during the 2000s, characterized mostly by a real estate boom and massive flows of foreign investment. The average GDP growth of the decade was 2.3% while the average inflation rate was further reduced to 2.8% and unemployment dropped from 19.8% in the 1990s to 12.1%. Compared to that of the other core EU countries, it was among the highest-performing economies. The initiation of the global financial crisis in conjunction with the Spanish property crash, accelerated extreme unemployment levels in the country over the last seven years, with a peak of 25% in 2012 and 2014, the second highest in the EU after Greece. As the economic growth switched to negative digits, and banks reported huge losses due to the collapse of the construction industry, in June 2012 Spain received a bail-out package of Euro 100 billion, following Ireland, Greece and Portugal. Consequently, government debt rose rapidly almost equalling the country's GDP by the end of year 2014. According to the BS (2015) stability report, a positive growth rate (1.4%) was seen in 2014, following tough austerity measures and major reforms. Besides, the financial position of the Spanish economy has improved in structure and is expected to last over time as a result

on credit risk by covering a longer post-crisis interval, considering a variety of macroeconomic and banking-industry specific variables and using the ARDL approach to cointegration, which explained later, has certain advantages in comparison to other approaches applied in the relevant literature. A brief overview of the Spanish economy and banking system is outlined in the next session.

3. Overview of the Spanish economy and banking system

Located in southwestern Europe, Spain is a core EU member since 1986. Following 35 years of social and economic isolation under the dictatorship of General Franco, in the beginning of the 1980s Spain became more involved with European integration. As such, during the 1980s several reforms were undertaken to soothe the high unemployment rate of 18% and to bring the Spanish economy up to the standards of Western neighbours.

of the application of a highly expansionary monetary policy by the ECB, as well as domestic reforms. However, the country's external debt still remains high and far exceeds that of the core Euro area nations.

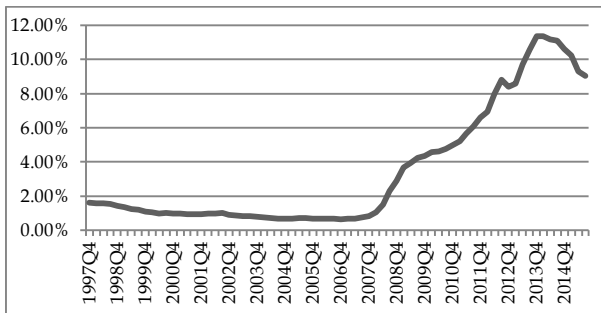
As far as the Spanish banking system is concerned, up till the death of Dictator Franco in 1975, it was dominated by seven privately owned banks with an extensive equity stake in the Spanish industry (Dymski, 2013). In 1977, financial deregulation initiated along with other measures that intended to free the monetary authority from interference with other branches of the state (Deeg and Perez, 2000). However, it took more than a decade after the 1977 reforms for the modernization of the Spanish stock market to entice foreign banks into the Spanish credit market. Despite the increased competition accelerated by the foreign banks entry and the relaxation of the geographic restrictions on Spanish banks expansions, various large banks strengthened their positions by merging domestically (Dymski, 2013). As a result of such consolidation, the big seven commercial banks of the Franco's era, were reduced to three large banks and a smaller one in the 1990s. As reflected in the pie charts on Figure 1, domestic banks still own the crucial stake in the Spanish banking system.



Source: Bank of Spain

Figure 1: Structure of credit institutions' ownership and asset size in 2014

The following years up to the spark of the global financial crisis, witnessed rapid credit growth. Indeed, the private sector's indebtedness grew aggressively during the pre-crisis period as a result of extraordinary demand for housing in Spain between 1997 and 2007 (Carballo-Cruz, 2011). The latter was accelerated by the economic boom of those years, flat interest rates in the post- Euro integration era and the growth in the number of households due to the massive immigrant flux. Such aggressive demand for housing was associated with a rise of 115% in the average housing price in Spain between 1997 and 2007, compared to a 40% average in the Eurozone (Carballo-Cruz, 2011). To this extent, the sharp decrease of real estate prices that began in 2008 had a significant effect not only in shrinking further housing but also in expanding the bad loans' stock.



Source: Bank of Spain

Figure 2: NPLs ratio in the Spanish banking system

At the time, the BS (2002) financial stability report had warned of the possibility of credit risk problems in the Spanish banking system. It appeared that despite the low level of interest rates, the number of non-performing loans had increased slightly in 2002 due to the uncontrolled credit appetite of banks and their massive expansion in the real estate sector. However, as observed in Figure 2, the non-performing loans ratio saw a sharp rise at the beginning of 2008, thus, in parallel with the outbreak of the global financial crisis. Despite a short stabilization in the first quarter of 2010, the loans' quality further deteriorated as the European sovereign debt crisis emerged. Several domestic reforms undertaken by the Spanish Government taken effect in the year 2014, since the non-performing loans ratio finally started to drop. Indeed, the BS (2016) stability report highlights that credit risk in Spain improved significantly during 2015, sustained by the growth of

economic activity. Specifically, the NPLs ratio fell below 10% in December 2015, from 10.6% in the same month of the previous year. Such improvement was observed among all types of loans granted to the private sector. However, further structural reforms are needed to boost investor confidence in the financial stability of the Spanish economy.

The following section presents the data used and the methodological framework employed.

4. Data and methodology

4.1. Data

A survey of the literature on credit risk clearly highlights the relevance of the macroeconomic environment, financial markets and bank-specific variables in explaining credit risk. Using data spanning from the last quarter of 1997, to the third quarter of 2015, the purpose of this study is to investigate the relationship between a wide range of the above-mentioned variables and a selected proxy of credit risk for the Spanish banking system. Specifically, to measure the latter, this paper has chosen the ratio of doubtful loans¹ to total loans (NPL) whereas the used explanatory variables are specified below.

In line with relevant academic literature, the main macroeconomic variables selected in this study are: the real GDP, the unemployment rate, the consumer price index, the trade balance, the current account, the General Government debt and the foreign direct investment stock. Furthermore, gross fixed capital formation, total consumption and monetary aggregates (M1, M2 and M3) are included in this study to enable some flexibility in estimating the GDP effect on the NPL ratio. The above-mentioned variables are expected to negatively affect credit risk in Spain except for the

¹ According to the BS (2004) doubtful loans include: 1) exposures with arrears of more than 90 days on payments of interest or capital on which arrears of +/- 90 days exceed 25% of the outstanding loan (unless already written off) and 2) exposure which, while not falling into the above category or that of written-off loans, presents reasonable doubt as to respect for the terms of the loan contract (deterioration of the borrower's solvency). Loans falling into the previous category but not reaching the 25% threshold.

unemployment rate, whose effect is expected to be positive.

Interest rates such as the Spanish 10-year bond and the 3-month Euribor are introduced in this study considering the positive effect that they may have on non-performing loans due to the increased debt burden associated to their rise. The real effective exchange rate (REER), with reference to the 27 EU members, is also included in the equation. Its effect on NPLs is expected to be positive since an increase in this variable means an appreciation of the local currency, making the goods and services produced in that country relatively more expensive. The volatility of the oil price significantly influences economies of the world whereas the dramatic decrease of property prices in Spain in the year 2008 negatively affected the demand for housing as well as the bad loans' stock. To this extent, the oil price and the property prices in Spain have joined the dataset. On the other hand, the S&P 500 Chicago Board Options Exchange Market Volatility Index (VIX) has gained acceptance as an indicator of global uncertainty or financial stress and as such is considered also in this study. It is expected to have a negative impact on the quality of the Spanish bank loans.

The bank-specific variables considered in the study include: credit growth, the loans to deposits ratio, the capital to assets ratio, profitability ratios such as the return on assets (ROA) and the return on equity (ROE), the ratio of loans granted for house purchase and renovation to total loans and the ratio of loans granted to the construction sector to total loans. The overall credit growth is among the widely used indicators since its high levels usually indicate that more risky loans are approved thus, its effect on NPLs is expected to be positive. The loans to deposits ratio measures the portion of deposits which is utilized in loans by the bank, thus, is an important indicator of the latter's liquidity as well as risk undertaking. Consistently, a low capital to assets ratio indicates excessive risk-taking. However, as supported also by the relevant literature, its effect on NPLs may be either positive or negative, since adequately capitalized banks may also engage in high-risk activities. ROA and ROE are introduced in the study as measures of profitability which, in accordance with the literature, are expected to positively or negatively affect NPLs. Lastly, considering that bank credit in Spain ended badly following a decade of massive flow to housing and the construction sector, it is believed that the ratio of loans granted for house purchase and renovation to total loans and the ratio of loans granted to the construction sector to total loans may play an important role in explaining credit risk in the Spanish banking system.

A summary of the explanatory variables considered in this study is outlined in the Appendix, Table A1. Quarterly observations that span from the year 1997 to 2015 are used. This timeframe covers the stable economic period, the big crash as well as an extended post-crisis time interval compared to that analysed in previous studies. This is particularly important considering the ongoing economic and financial disturbances in Spain, as well as the recent challenges to the European integration. The deepening of the debt crisis in the Eurozone peripheral countries since 2010 has accelerated the interaction between banking and the

sovereign debt crisis, and therefore provides a suitable environment for further financial distress in the area.

4.2. Methodology

This study has chosen the ARDL bounds approach to identify the existence of a long-term relationship between NPLs and the set of macroeconomic, bank-related and country-specific indicators. In contrast to other cointegration techniques, the ARDL approach to cointegration can be applied irrespective of the order I(0) or I(1) of the variables' integration and corrects for residual serial correlation and the problem of endogenous variables (Shahbaz and Islam, 2011). Therefore, the first step of the empirical work is to verify that no variable included in the dataset is of order I(2), using the ADF and Philip Perron (1988) tests but also the test that allows for an endogenous determination of a break, namely, Perron (1997). Despite being relatively new in the credit risk determinants literature, the ARDL approach to cointegration was firstly introduced by Pesaran and Smith (1998) and Pesaran and Shin (1999) and holds other advantages as well over typical cointegration techniques. Specifically, the ARDL approach allows using a sufficient number of optimal lags, on the basis of standard criterion such as Akaike Information Criteria (AIC) and Schwarz Bayesian Criteria (SBC) (Mallick and Agarwal, 2007). Specifically, in our study, a maximum order of 4 lags is selected based on quarterly observations usage whereas the Schwarz Bayesian Criterion determines the optimal lag length of each variable. Furthermore, the error correction version of the ARDL equation determines both the short and the long-run relationship between the variables in the model since it uses both the variables' differences and the lagged long-run solution. Based on the above, the following equation is proposed to explain credit risk:

$$NPL = f(NPL_{t-1}, \text{Macro}, \text{Banking}, \text{Other}, \text{Crisis}),$$

where NPL is the ratio of non-performing (doubtful) loans to total loans, NPL_{t-1} is the lagged value of NPL, Macro stands for the macroeconomic cyclical indicators explained above, Banking stands for the banking industry-specific indicators explained above, Other comprises interest rates or other country-specific factors which as explained above are considered relevant in determining credit risk in Spain whereas Crisis is a dummy variable that captures the effect of the global financial crisis on the NPLs of Spain; this takes the value of 1 for the period 2008Q1 to 2013Q4 and 0 elsewhere.

5. Empirical results

The standard ADF tests for unit roots suggest that all variables appear to be I(0) or I(1) (see Table A2 in the Appendix). The estimates of the ARDL regression are outlined in Tables 2 and 3 along with the respective diagnostic tests whereas Figure A4 in the Appendix provides both the CUSUM and CUSUM square test results which suggest that the model is stable.

It appears that credit risk in the Spanish banking system is affected by the macroeconomic environment as well as by bank-specific variables and interest rates. Specifically, among all variables included in the model,

the real GDP (LGDP), the Spanish long-term government bond yield (LTGB), the total credit granted by the Spanish banks (LCRE), the return on equity (ROE) and the capital to assets ratio (CAP) affect non-performing loans in the Spanish banking system. As observed in Table 3, such effect is significant in the long-term at the 5% and 1% level of significance. Consistently, the error correction model of the ARDL

regression outlined in Table 3, confirms that all the above-mentioned variables determine credit risk also in the short-term. As observed, the error correction coefficient (Ecm) is highly significant and bears the correct sign. Specifically, it shows that approx. 16.2% of deviation of the non-performing loans ratio from its equilibrium in the previous period gets corrected in the current one.

Table 2. The long-run estimates of the ARDL regression. NPL is the dependent variable

Regressors	Coefficient	t-ratio
LGDP	-0.091	-2.93
LTGB	0.005	2.17
ROE	0.002	2.24
LCRE	0.065	3.85
CAP	1.549	17.26
C	-0.376	-3.12
D08	0.024	3.74

Table 3. The error correction model of the ARDL regression. NPL is the dependent variable

Regressor	Coefficient	t-ratio
dNPL1	0.271	3.16
dLGDP	-0.014	-2.64
dLTGB	0.001	2.60
dROE	0.001	5.55
dROE1	0.001	2.74
dLCRE	0.010	3.31
dCAP	0.250	4.93
C	-0.061	-2.98
D08	0.003	4.13
Ecm(-1)	-0.162	-4.90
R²=0.828; F(9,58)= 30.54		

Diagnostic Tests

Test Statistics	LM Version	F Version
A: Serial Correlation	CHSQ(4)= 2.2762[.685]	F(4, 53)= 0.4588[.766]
B: Heteroscedasticity	CHSQ(1)= 2.7112[.100]	F(1, 66)= 2.7407[.103]

All coefficients bear the expected sign; the global financial crisis (captured by the dummy) has a negative effect in the credit quality of the Spanish banking system. The real GDP has the expected negative effect on non-performing loans, indicating that economic booms stimulate sustainable debt services. The finding is in consensus with the study by Salas and Saurina (2002) performed for several Spanish commercial and savings banks. The Spanish long-term government bond yield seems to be the sole interest rate (among the ones considered in the dataset) that significantly affects credit risk. Specifically, the latter increases in line with the rising bond yield, confirming the link that exists between higher risk associated to heavily indebted countries and the asset quality of their banking system. As suspected, the actual sovereign debt crisis in Spain adversely affects the stability of the financial system by particularly hitting its Achilles heel: the non-performing loans. The effect of the return on equity on credit risk is positive and in line with the procyclical credit policy hypothesis, showing that the most profitable banks are the riskier ones. Credit expansion is associated with more neglected and less restricted loan granting

processes and therefore has a positive effect on the non-performing loans ratio. Such effect was also suggested in two other studies performed for Spain (Salas and Saurina 2002; Blanco and Gimeno 2012). The capital to assets ratio has a positive effect on NPLs implying that high capitalized banks report high NPLs in Spain. Indeed, Godlewski (2006) argues that minimum capital requirements can be costly for banks and put pressure on their profits therefore they are incited to generate additional revenues by increasing risk taking. Specifically, for Spain, Oliver et al (2012) found that high capital ratios are associated with an increase in the cost of bank loans which causes a contraction in the demand for credit. It may be assumed that higher lending rates will also negatively impact the existing borrowers' capacity to service their debts.

To summarize, it may be concluded that a positive economic performance improves credit quality in Spain whereas the high risk associated with the country's considerable level of indebtedness has the adverse impact. On the other hand, extreme banking-industry regulation incentives may increase credit risk. Inadequate risk policy and insufficient supervision aid

massive credit expansion and thus positively affect the accumulation of bad loans among Spanish banks; an extreme discipline in capital adequacy though, may have the same accelerating effect considering that it drives banks to seek higher profits from excess risk incentives.

6. Conclusions

The recent global financial crisis unfolded the fragility of certain financial systems towards shocks, mostly reflected in the liquidity and insolvency problems that banks incurred as a result of an increased default rate of their loans. Spain was among the core European countries whose banking system reported huge stocks of non-performing loans immediately after the start of the crisis, a phenomenon that jointly, with the extremely high unemployment rate in the country, brought economic stagnation and classified Spain among the peripheral countries of Europe. Despite the fact that since 2014, credit quality started to improve and economic growth moved into positive digits, the extremely high indebtedness in the country may become the means of sovereign debt crisis transmission to the banking sector and the whole financial system of Spain. This paper investigated the factors that lie behind the bad credit quality in the Spanish banking system over the period 1997Q4-2015Q3 by employing the ARDL approach to cointegration. In accordance with the main body of literature, a wide range of variables from the macroeconomic and the banking-industry environment

are considered in the study so as to capture any potential effect that the latter's may have on credit risk.

The results suggest that Spanish non-performing loans are significantly affected by the global financial crisis, the real GDP, the Spanish long-term government bond, the return on equity, the total credit granted by the Spanish banks and their capital to assets ratio, both in the short and the long term. In other words, the loan portfolio quality in the Spanish banking system appears to be strongly affected by the economic outlook, the actual debt crisis in the country as well as bank-specific variables. The latter may be used by bank managers and regulators as early warning indicators of credit default. The levels of indebtedness though, along with the overall economic performance represent challenges for policymaking, not only in Spain but in other Eurozone countries considering that they are part of a major debt crisis that sparked among the peripheral counties of the region in 2010.

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APPENDIX

A1. The dataset

Indicators		
NPL	Non-performing loans/Total loans	Bank of Spain
CPI	Consumer Price Index annual rate (%)	Bank of Spain
UNE	Unemployment rate (%)	CBOE
CA	Current Account	Bank of Spain
GD	Total General Government Debt	Bank of Spain
GDGDP	General Government Debt as % of GDP	Bank of Spain
FDI	Foreign direct investment, quarterly flow	Bank of Spain
TB	Trade Balance	Bank of Spain
GDP	GDP at constant terms	Bank of Spain
GFCF	Gross fixed capital formation at constant terms	Bank of Spain
TCONS	Total consumption at constant prices	Bank of Spain
REER	Real effective exchange rate	Bank of Spain
PROP	Property prices in Spain, in Euro/sqm	Bank of Spain
M1	Narrow money. Comprises currency in circulation plus overnight deposits	Bank of Spain
M2	Intermediate money. Comprises M1 plus highly liquid deposits	Bank of Spain
M3	Broad money	Bank of Spain
OIL	Brent crude oil price fob in Euro per barrel	Bank of Spain
VIX	The CBOE Volatility Index	CBOE
LTGB	Spanish long term government bond rate	CBOE
EURI	Euribor 3-month rate	CBOE
CRE	Gross loans granted by the Spanish banks	Bank of Spain
ROA	Return on Assets	Bank of Spain
ROE	Return on Equity	Bank of Spain
Cap	Capital to Assets ratio	Bank of Spain
LDEP	Loans to deposits ratio	Bank of Spain
LASS	Loans to assets ratio	Bank of Spain
MORT	Mortgage loans/Total loans	Bank of Spain
CONST	Loans granted to the construction sector/ Total loans	Bank of Spain

A 2. Unit root tests

Indicators	ADF		PP	
	Level	First difference	Level	First difference
NPL	0.848	-3.740*	-0.144	-3.470**
CPI	-1.923	-10.480*	-1.638	-10.634*
UNE	0.689	-3.540*	-0.893	-3.416**
CA	-1.425	-9.290*	-1.769	-9.743*
LGD	2.566	-3.848*	1.235	-3.988*
GDGDP	2.506	-3.050**	0.474	-2.914**
FDI	-6.393*		-6.625*	
TB	-1.889	-8.561*	-1.895	-9.146*
LGDP	-2.223	-33.225*	-3.814	-17.784*
LGFCF	-2.817	-23.723*	-2.719	-18.279*
LTCONS	-2.058	-17.044*	-3.877	-15.883*
REER	-1.449	-10.190*	-1.552	-10.679*
LPROP	-4.518*		-2.464	-3.433**
LM1	-1.459	-8.511*	-1.637	-8.957*
LM2	-3.121	-6.545*	-2.148	-7.875*
LM3	-3.588	-6.172*	-1.916	-7.226*
OIL	-1.887	-6.595*	-1.568	-6.770*
VIX	-4.041*		-4.389*	
LTGB	-1.189	-8.868*	-1.372	-9.052*
EURI	-0.710	-4.418*	-1.450	-4.468*
LCRE	-3.870	-3.740*	-2.147	-3.627*
ROA	-6.110*		-6.381*	
ROE	-5.460*		-5,648*	
CAP	0.707	-5.915*	-0.297	-6.044*
LDEP	-0.429	-6.602*	-1.257	-6.908*
LASS	0.413	-6.284*	-0.084	-7.149*
MORT	-2.242	-3.763*	-2.240	-3.846*
CONST	-0.329	-9.873*	0.365	-9.981*

- 1) ** and * denote stationary of the residuals at 5% and 1% level of significance.
- 2) The respective critical values are 2.9048 and 3.53 at 5% and 1% level of significance
- 3) ADF stands for the Augmented Dickey-Fuller test, PP for the Phillips-Perron test

A 3. ARDL (2,0,0,2,0,0) selected based on Schwarz Bayesian Criterion

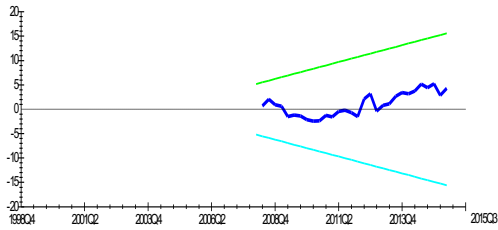
Regressor	Coefficient	t-ratio
NPL(-1)	1.109	11.27
NPL(-2)	-0.271	-3.16
LGDP	-0.015	-2.64
LTGB	0.001	2.60
ROE	0.001	5.55
ROE(-1)	0.002	1.51
ROE(-2)	-0.001	-2.74
LCRE	0.010	3.31
CAP	0.250	4.93
C	-0.061	-2.98
D08	0.003	4.13

$R^2=0.996$; $F(10,57)= 3611.4$

*All variables are significant at 5% and 1% significance level.

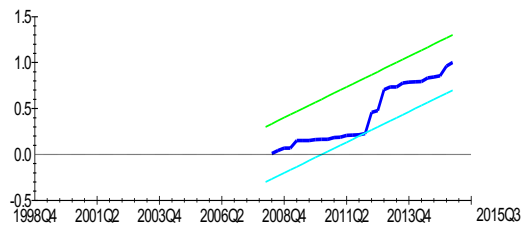
A 4. Structural stability tests

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level