UNIVERSITY OF SANTIAGO DE COMPOSTELA
DEPARTMENT OF FINANCIAL ECONOMICS AND ACCOUNTING

UNIVERSIDAD DE SANTIAGO DE COMPOSTELA
DEPARTAMENTO DE ECONOMÍA FINANCIERA Y CONTABILIDAD

Financial Crisis, Risk-taking and Early Warning Systems".

Crisis Financiera, Exposición al Riesgo y Sistema de Alerta Temprana

Dildora Karimjonovna Ibragimova

Santiago de Compostela 2014

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Tesis que, para la obtención del grado de doctor, presenta la licenciada Dña. Dildora Ibragimova, la cual fue realizada en el Departamento de Economía Financiera y Contabilidad de la Universidad de Santiago de Compostela, bajo la dirección de don Luis Alberto Otero González, profesores titulares de Economía Financiera y Contabilidad y don José Antonio Redondo López, Catedrático de Economía Financeira de la Universidad de Santiago de Compostela.

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CERTIFICAMOS que Dª Dildora Karimjonovna Ibragimova ha realizado bajo nuestra dirección el trabajo de investigación "Financial Crisis, Risk-taking and Early Warning Systems".

Santiago de Compostela a de de 2014

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For my parents Muqaddamhon Abdullaeva and Karimjon Rahimov

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Abstract

This thesis explores three important topics which contribute to the study of bank credit risk and the global financial stability. Chapter 2 "Financial Crisis: the case of Spain" focuses on the nature of the financial crises and their common characteristics. Also, it reviews the Spanish financial crisis and features that makes it distinctive. Chapter 3 "Determinants of bank excessive risk-taking behaviour" concentrates on the main reasons behind the financial crisis and empirically analyzes bank risk-taking factors for the three types of Spanish banks: commercial, saving and cooperative banks. Chapter 4 "Early Warning Model for European banks: evidence from the recent financial crisis" analyses empirically a sample of European listed banks and tests the effectiveness of Early Warning System (EWS), based on Expected Default Frequencies and accounting ratios, in forecasting the bank defaults during the recent financial crisis. The chapters are independent of each other in terms of theoretical grounding, dataset and methodology but complement each other by investigating the recent financial crisis from three different angles.

Our study suggests that the Spanish financial crisis is not an exception to the general pattern of crises. The sequences of events evident preceding the crisis have many common features with what has already been witnessed in other financial crises.

Furthermore, our findings indicate that there is a strong correlation between the bank's ownership structure and its risk-taking behaviour. The results show positive association between risk and Spanish savings banks and negative with banks with dispersed ownership. We confirm the negative influence of wholesale funding, but not in favour of deposit funding. Instead, we find adverse effect of deposit funding on bank risk. We think this may be evidence of 'excessive' competition in deposit markets prior to the crisis when banks raise their deposit rates too high to attract more depositors by increasing their cost of funding and decreasing their interest margins. Also results show the negative influence of non-traditional income such as commissions and fee income. We find that equity has stable risk reducing character while impaired loans have a strong harmful effect of on banks' risk level.

Last chapter findings reveal that EDF metrics combined with four CAMEL covariates and variable capturing adverse selection are able to predict the defaults of European banks up to 8 quarters before an event. When comparing the final model with that only including the EDF indicator the significance improves considerably, suggesting that added variables provide additional information and power to the model.

Overall, the thesis proposes preventive mechanisms to facilitate the early detection of banks' fragility in Europe and hence contributes to the study of financial stability and the prevention of banking crises.

Resumen

Esta tesis explora tres temas importantes que contribuyen al estudio del riesgo asumido por el sector bancario y la capacidad de los indicadores para anticipar crisis bancarias. El capítulo 2 " Crisis financiera: el caso de España ", se centra en la naturaleza de las crisis financieras y sus características comunes. Asimismo, se analizan las particularidades de la crisis financiera española. En el capítulo 3 " Determinantes del exceso de risk-taking por el sector bancario" se estudian los factores explicativos de la toma de riesgo para los tres tipos de bancos españoles: cajas de ahorro, cooperativas y bancos comerciales. Finalmente, en el Capítulo 4 " Modelo de Alerta Temprana para los bancos europeos: la evidencia de la reciente crisis financiera ", se pone a prueba la eficacia de los sistemas de alerta temprana (SAT) para anticipar situaciones de crisis en los bancos cotizados europeos: Para ello, se utilizan la expected default frecuency (EDF) y se evalúa el efecto de incorporar ratios contables sobre la capacidad predictiva. A pesar de que los capítulos son independientes en términos de fundamentos teóricos, bases de datos y metodología, son complementarios, siendo el objeto de estudio la reciente crisis financiera.

Nuestro estudio sugiere que la crisis financiera española no es una excepción al patrón general que subyace en general a todas ellas. La secuencia de acontecimientos que precedieron a la crisis tiene muchas características en común con lo que ya se ha visto en otras crisis financieras. Además, nuestros resultados indican que existe una fuerte relación entre la estructura de propiedad del banco y su comportamiento en la toma de riesgo. Los resultados muestran una asociación positiva entre el riesgo y las cajas de ahorro españolas y negativa con los bancos con propiedad dispersa. Confirmamos la influencia negativa de la financiación mayorista pero no del efecto positivo de la financiación de depósitos. De hecho, encontramos efectos adversos de los depósitos en el riesgo bancario. Creemos que esto puede ser el resultado del efecto de la competencia excesiva en los mercados de depósitos en los momentos previos a la crisis, llevando a los bancos a aumentar sus tasas de depósito para atraer a más clientes, con el consecuente efecto sobre el coste de la financiación y la disminución de sus márgenes de intermediación. Los resultados muestran también la influencia negativa de los ingresos no tradicionales, tales como las comisiones y tarifas cobradas. Encontramos que capital tiene un efecto reductor sobre el riesgo mientras que los préstamos de dudosa recuperación tienen un fuerte efecto nocivo sobre el nivel de riesgo de los bancos.

Los resultados del último capítulo revelan que el uso combinado de la expected default frequecy (EDF) con cuatro variables CAMEL y una adicional, que captura la selección adversa, son capaces de predecir el default de los bancos europeos con hasta 8 trimestres de antelación. Al comparar el modelo final con aquel que sólo incluye la EDF, el significado mejora considerablemente, lo que sugiere que los modelos de mercado pueden ser mejorados a través de la información contable. En general, la tesis propone mecanismos preventivos para facilitar la detección precoz de la fragilidad

de los bancos en Europa y por lo tanto contribuye al estudio de la estabilidad financiera y la prevención de las crisis bancarias.

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Abbreviations

ABS - Assets-Backed-Securities

AEICA - Association of Certified Credit Inspectors of the Spanish Banking System

AME – Average Marginal Effect

BCA - Baseline Credit Assessment (Moody's)

BDN - Boyd & De Nicolo (Authors)

BFSR –Bank Financial Strength Rating (Moody's)

BHC - Bank Holding Companies

BvD - Bureau van Dijk (owner of Bankscope software)

CAEL Ratios – Capital Asset Earnings Liquidity Ratios

CAMEL ratios – Capital, Assets quality, Management efficiency, Earning and Liquidity ratios

CEO –Chief Executive Officer

CIR- Credit Register of the Banco de España

CRA - Credit Rating Agencies

CVH - Charter Value Hypothesis

DC – Distance to Capital

DD – Distance to Default

DM - Default Mode models

DPD – Dynamic Panel Data

EDF – Expected Default Frequency

EU – European Union

EUR – Euro

EWM – Early Warning Models

EWS – Early Warning System

FE - Fixed Effect

FPM - First Passage Model

FROB - Fund for Orderly Bank Restructuring

GDP – Gross Domestic Products

GMM - Generalized Methods of Moments

GOB- Government-Owned Banks

IFRS - International Accounting Standards, International Financial Reporting Standards

IIF - Institute of International Finance

INE – Spanish National Statistics Institute

KMV - Kealhofer, McQuown and Vasicek (Part of Moody's Analytics Enterprise Risk)

LLP - Loan Loss Provisions

LLR - Loan Loss Reserve

MB - Mutual Banks

MBS - Mortgage-Backed-Securities

MoU - Memorandum of Understanding

MTM – Mark to Market

NPL- Non-Performing Commercial Loans

OLS - Ordinary Least Squares

PCA – Prompt Corrective Action

PD - Probability of Default

POB - Privately-Owned Stock Banks

RE –Random Effect

ROAA -Return on Average Assets

ROE – Return on Equity

SCB - Spanish Commercial Banks

SDM - State Dependent Models

SSB - Spanish Saving Banks

TBTF - Too-Big-To-Fail

VK model - Vasicek-Kealhofer model

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Chapter 1 INTRODUCTION

This thesis proposes two different models to analyse factors which played a role in massive bank failures during the recent financial crisis in Europe. The former model involves factors of banks' excessive risk-taking during the pre-crisis period dating 2004-2007. The latter focuses on the timely prediction of bank defaults, so called Early Warning Models. These models were blamed for failing to predict the banks' downturn in the recent financial crisis.

In presenting these two models, we have analysed the following issues: first, we have reviewed common features of financial crises evident in the world and have seen how the Spanish financial crisis fits into these characteristics and how it remains unique. Secondly, we have looked at the main risk factors which have led to excessive risk-taking among Spanish commercial, saving and cooperative banks. We test the validity of risk-taking determinants, empirically evaluating them by applying the most recent data of Spanish banks. And the third, we have proposed the modified Early Warning Model through the application of conventional techniques and combination of additional variables to predict the financial distresses of European banks.

A common feature of these three issues is that they are all exploring the recent financial crisis from different perspectives and add to the literature regarding bank credit risk. While all of these chapters focus on one common topic, each chapter is independent and not empirically interconnected to the others. Chapter 2 contains general revision and discussion of the issues while Chapters 3 and 4 have separate literature reviews, methodologies and results parts.

The purpose of this thesis is to provide some insights into the understanding of bank defaults and to propose techniques for forewarning banks' financial distress within the European banking system. The questions we addressed are as follows:

- *What is a financial crisis and how is it formed?*
- *What are the main determinants of banks' excessive risk-taking for the years 2004-2011 for Spanish banks?*
- *Are conventional models able to predict the financial distress of European banks before the onset of financial crises?*

Even though many academic studies have analysed these issues there are still many debates which demand further investigation. The current work aims to add to the literature by consolidating major factors of risk-taking and fitting them into a new model using the most recent data of Spanish banks. It also proposes a modified Early Warning Model to predict bank distress within the European market.

The thesis is organized as follows: Chapter 2 focuses on the nature of financial crises and their common characteristics. Also, it reviews the Spanish financial crisis and the features that make it distinctive. Chapter 3 concentrates on the main reason behind the financial crisis - excessive risk-taking by banks - and empirically analyzes bank risk-taking factors for the three types of Spanish

banks: commercial, savings and cooperative banks. The choice of the Spanish banking sector is not accidental; before the crisis the Spanish banking sector was believed to be one the best and safest in Europe, but following the crisis it proved to be one of the most troubled banking sectors in the EU zone. Chapter 4 empirically analyses a sample of European listed banks and tests the effectiveness of Early Warning Systems, based on Expected Default Frequencies (EDF) and accounting ratios, in forecasting the bank defaults during the recent financial crisis. EDF is the market-based credit measure developed by Moody's KMV which is based on Merton's option-pricing theory's distance to default indicator. Finally we have proposed a model with EDF and a combination of additional variables which we found to be efficient in predicting banks' defaults for the given sample of European banks.

In our analysis we applied Generalized Methods of Moments (system GMM) and model of binary choice – binomial logit model. The former method addresses the issue of endogeneity in panel data while the later model is found efficient for fitting nonlinear models with limited-dependent variable.

We conclude that the Spanish financial crisis is not an exception to the general pattern of crises. The sequences of events evident preceding the crisis have many common features with what has already been witnessed in other financial crises. The main determinants of bank excessive risk-taking in Spain found valid for our sample are bank ownership nature, the levels of ownership concentration, assets quality and equity structure. Our results suggest that the existence of risk-insensitive deposit insurance increases incentives for banks to exploit the deposit insurance system. As for predicting bank defaults the results reveal that Expected Default Frequency (EDF) metrics provide additional information to that of balance sheet ratios but is not a complete substitute for them. The addition of the variables representing the adverse selection effect showed that their marginal effects are insignificant in predicting the bank default. Our analyses have demonstrated the preponderance of the selected methods - system GMM and binomial logit in dynamic panel data modelling. Overall, we believe that our study provides important insights for regulators into setting up more efficient policies for controlling bank risk-taking factors and improving prevailing early warning models of bank distress.

Chapter 2 FINANCIAL CRISIS: THE CASE OF SPAIN

1 Introduction

Concern about the stability of financial systems - and in particular the banking system - coupled with the numerous episodes experienced throughout history, has fostered research aimed at studying the causes and consequences of financial crises. The concept of financial crisis is defined by Torrero (2008) as "*... an acute disorder that changes the normal functioning of markets, violently affects the valuation of assets, and may threaten the very existence of financial institutions, endangering the whole economic system.* "

It is a complex concept; one of the reasons for its complexity is the variety and difficulty of the various triggers that can lead to crises. There are many studies aimed at analyzing the evolution of various economic indicators that would allow us to identify a financial crisis and the consequences that flow from it to which we will refer later (Mishkin, 1991; Krugman, 1996; Allen and Gale, 2007; Reinhart & Rogoff, 2008; Rose & Spiegel, 2009; Kirmany, 2010). It should be noted that the effects of banking crises depend on the manner in which they are addressed and on the measures taken by the authorities. At this point we will refer to the spread pattern of financial crises which is known as "*contagion effect or herd behaviour*." This issue has been addressed by Eichengreen et al. (1996), Basu (2002) and Kaminsky et al. (2003) among others. Essentially it is considered that panic following a drastic reduction in investor optimism, also called overtrading, triggers a series of successive events and immediate herding (usually panic feeds itself and spreads) that increase the likelihood of intensification and extension to other areas. In this regard, Kindleberger (2012) refers to psychological connections: when an increase in euphoria or pessimism of investors in one country affects investors in other countries.

Sometimes crises happen in conjunction with changes in the economic cycle. Economic cycles are a natural and inevitable phenomenon in market economies and to some extent can be controlled or weakened (Kindleberger, 2012). In these cycles there is certain rationality between stimuli and responses - both increases and declines are gradual. In contrast, crises do not have a natural character and cannot be explained by changes in economic fundamentals i.e. the smooth running of the economy creates expectations of future earnings that are overvalued and are not sustainable over time and somewhat irrational. In general, crises are associated with speculative phenomena that are predominantly the result of certain ideological and political options. Here, we focus on a "general euphoria". According to Kindleberger (2012) the phenomenon of speculation often takes place in two stages:

1) *Period of calm:* characterized by limited and rational response of economic agents.
2) *Period of euphoria:* focus is on the forecasts of large capital gains characterized as irrational and unsustainable over time. An example would be when asset prices rise rapidly, much

faster than Gross Domestic Product (GDP) or any other measure of income. As noted by Bagehot (1873) "*the first thing they look for is the high interest investment, but then it becomes a secondary. They become interested in the large profits that they can get by selling the principal*".

Once past this stage what is referred to by Kindleberger (2012) as "*displacement*" occurs featuring some kind of external event that changes the horizon, expectations and opportunities for profit, giving rise to a "*crack"* and/or "*panic*" .

Although in our case we want to study the financial crisis that began in the summer of 2007, to better understand it we should not ignore the historical perspective. In this vein, Ferguson (2008), criticizes to some extent the lack of global vision and retrospective analysis - understanding the complexities of the financial world through the analysis of its history; a large number of financial crises have occurred throughout the history from which one could draw lessons to mitigate or prevent the current and future crises. There are numerous works which analyze the triggering causes of financial crises with a view to building early-warning systems. These works include the studies of Galbraith (1991), Kaminsky and Reinhart (1999), Schwartz (2009), Reinhart and Rogoff (2008a, 2008b and 2009) and Kindleberger (2012).

Galbraith (1991) reviews more known bubbles of history by placing emphasis on and analyzing shared characteristics to draw lessons for the future. Financial leverage is identified as a factor common to all. Moreover, the financial systems are not alien to the processes of liberalization. Kaminsky and Reinhart (1999) obtained evidence for the period post 1970 that banking crises, in both developed and emerging markets have occurred on average five years after the liberalization of the respective financial systems. They argue that the probability of occurrence of a banking crisis following deregulation of the system is much higher than the probability of a crisis occurring if the system is liberalized. For his part, Lordon (2009) considers that there are key fundamental aspects which lie behind every crisis: competition and innovation; the competition causes blindness of ex ante risk while innovation holds the imaginary negotiation of risks and their real accumulation.

Some key works on the analysis of banking crises are those of Reinhart and Rogoff (2008a, 2008b and 2009) who analyze the historical causes and consequences of financial crises, paying attention to the great crises in developed countries post World War II. Kindleberger (2012) also analyzes the best-known economic crises that hit the financial world addressing the questions: what is a financial crisis and how it is formed? The crisis of the tulips is analyzed in the Netherlands of the 16th century as well as the crash of 1929 and the “Dot-Com bubbles”.

In general, all crises follow a common pattern:

Strong capital inflows and imbalances in the current account balance. At first booming economies have large inflows of foreign capital**;** these economies have large deficits and obtain the

money to pay interest to their foreign creditors for new loans. The increase in external debt, generally, is faster than the increase in GDP.

Strong credit expansion. The crisis fuelled by bank credit expansion. Sometimes, rapid credit expansion is facilitated by financial deregulation. The arguments here favour more rigorous regulation and supervision of banks as the prevention of lending during periods of higher growth becomes more difficult. In addition, authors such as Minsky (1982) point out that changes in the supply of credit are cyclical, meaning credit increases when the economy is booming, investors become more optimistic and lenders reduce their risk aversion; credit decreases during downturns, investors and lenders become more cautious.

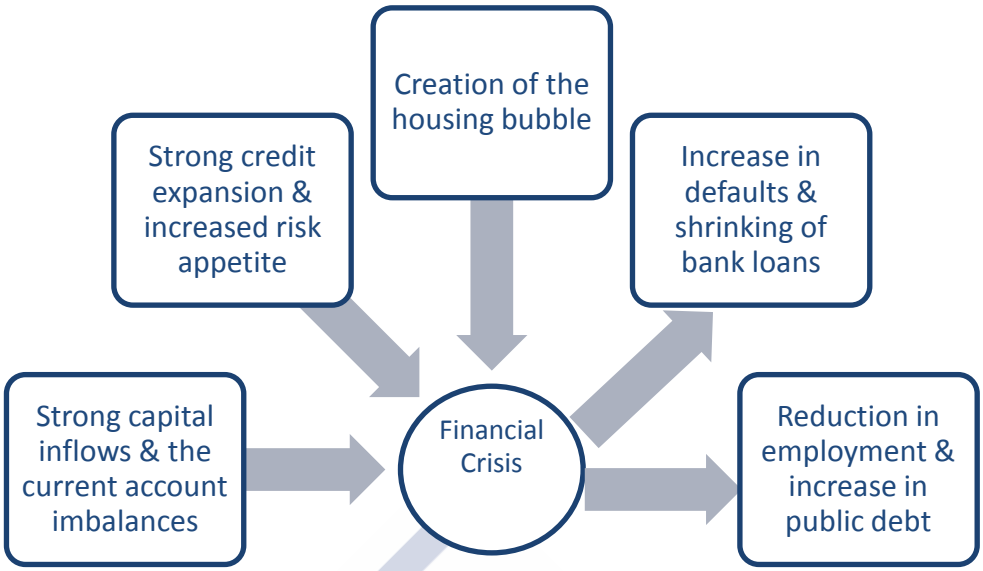
Increased risk appetite. Tends to be a period in which it prevails on a widespread basis in economic agents with a greater propensity to risk that has various causes. A psychological type exists where the smooth running of the economy and profit growth leads to a stage of euphoria: contagious optimism. Others may have their origin in the financial system itself, such as increased market liberalization, financial innovations (such as securitization) and strong competition in the sector.

Rapid increase of residential and commercial or other property or securities prices (Housing Bubble). The cycle of housing prices, similar to that which has occurred in the United States, Spain, Austria, Hungary, Italy, Iceland, the United Kingdom and other countries, is characterized by a steady increase leading to the purchase of securities or assets by investors to extract short term profit from increases in their prices. This form of buying grows exponentially through easy access to credit. Real assets (shares) reach a maximum before each banking crisis, usually a year earlier, and then decline substantially during the two or three years after. To a great degree, the increase in prices is explained by the increase of household and business income and increased spending. All agents become more optimistic and credit expansion continues to fuel price hikes.

The change in the situation leads to an increase in defaults. To take over the pessimism of the market, in this situation, the different agents are unable even to pay the interests of debts. This puts the banks in difficulty forcing them to limit the amount of available credits which, in turn, leads to a further decline in production which increases the difficulties businesses and families have in the repayment of their loans. The aforementioned rapid increase in borrowing would allow borrowers to pay interest with the money from new loans. Bankruptcy and suspension of payments exacerbate the recession and end up affecting the solvency of financial institutions, due to securities or products in the hands of financial institutions experiencing a sharp drop in value. Banks know that other banks have accounts with these same titles or products which can lead to situations where no one trusts anyone. This results in the interbank market ceasing to function triggering a severe restriction of credit to the economy as a whole.

All financial crises are accompanied by a *significant reduction in employment, public debt* increased as a result of the very significant drop in tax revenues and expansionary fiscal policies.

Figure 2-1 Common patterns of financial crises



The financial crisis that began in the summer of 2007, also known as the global financial crisis, is not an exception to the common pattern discussed above. As we can see, it is possible to identify most of the factors listed above as contributors to the majority of financial crises that have occurred so far.

Prior to the outbreak of the crisis, the financial market had been characterized primarily by increased globalization of financial transactions, the application of new information technology (allowing many transactions at once), the strengthening of links between banks and other financial firms and the implementation of various financial innovations. This caused an increase in the complexity and sometimes greater opacity of financial markets. In this new scenario, the possibility that one of the most important markets around the world, such as the United States or United Kingdom, could suffer a crash that would expand to other markets was not correctly assessed. Even during 2007 and part of 2008, prominent financial organizations such as the OECD, EC, IMF, Federal Reserve, the ECB and others considered the prospects for financial stability and economic prospects generally to be favourable, although they warned of some financial risks (Cabral, 2013).

The financial crisis was generated in the United States following the creation of market bubbles (stock, real estate, mortgage and derivatives) and was encouraged by the following factors:

a) *An expansionary fiscal and monetary policy* (Taylor, 2009, Allen & Carletti, 2010) which put interest rates at low levels.

b) A further *deregulation* tending toward greater self-regulation of the financial system which led, among other things, to higher leverage (Slow, 2009, Adrian & Shin, 2009, Pozsar et al., 2009).

c) An increase in the public deficit due to reduced revenues and increased expenses. Despite low interest rates economies continued investing in dollars (Borio & Disyatat, 2011).

There was a disproportionate increase of credit based on financial innovation mechanisms, in particular in securitization. Asset securitization means the risk of customer default is not applied to the originator resulting in abusive practices, so called "predatory lending". (Aschcraft & Schuermann, 2008). Credit growth occurred especially in the high-risk mortgage sector. Purnanandam (2009) shows how those banks that made widespread use of origination models for sale generated loans with lower credit quality. Through financial innovation financial products were created from subprime mortgages and other products. Moreover, when the housing bubble was in full swing mortgage defaults were not a problem since the growth in house prices provided a lifeline, buildings were put up for sale generating gains that allowed for debt repayment. The problem appeared when the housing market expansion ended. At this time the market value of housing started to decline making the debt value greater than the market value of homes. Borrowers then started to hand in their houses to financial institutions to cancel their debts while defaults that had been hidden thanks to the housing bubble materialized. Defaults on mortgages were transmitted to the securitized products.

2 Financial Crisis in Spain

The Spanish financial crisis is not an exception to the general pattern that has been discussed in the previous section. In fact, we could say that it is a clear example of a dramatic worldwide economic change. The sequence of events described in the above section unfortunately corresponds to situations Spain has and continues to experience. Further analysis will show that the external imbalance of the Spanish economy (one of the largest in the world), the unprecedented increase in credit, the concentration of investment in real estate resulting in what is commonly known as “the housing bubble” and the use of financial innovation to raise funds or excessive risk taking have all preceded the Spanish crisis. Spain is following the foreseeable consequences of the crisis in the shape of constant business failures, restrictions to obtain credit and an increase in public debt which have been part of the everyday life of Spain in the last years.

Therefore, in the years prior to the current crisis we were incubating a set of global imbalances that affected mainly the volume and direction of international capital flows (Andrew, 2009). In Spain, we can identify two areas directly affected by the crisis: the real estate business and the finance sector as a whole (Recarte, 2008). Consequently, this resulted on the one hand in the housing crisis and on the other the financial crisis (adjusting the construction sector to the current situation and the lack of liquidity in the financial system). Since both sectors are closely linked the connection and interrelationship between the two sectors is obvious.

Different authors suggest several different causes of the financial crisis (Recarte 2008, Andrés 2009, Jiménez et al. (2010), Otero and Ezcurra (2012) and Maudos 2012). The most important theories and the interrelationship between them will be discussed further.

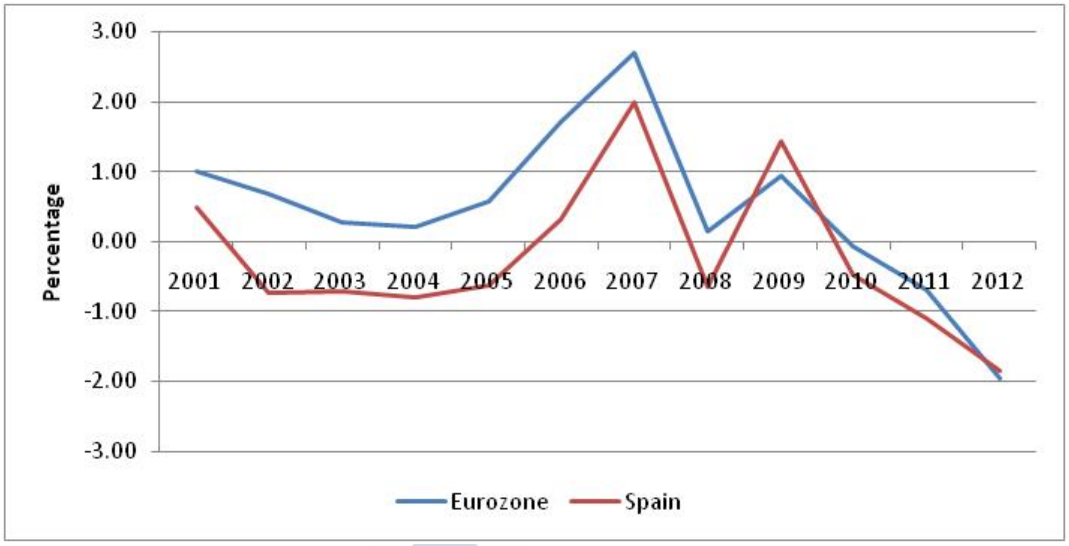
Figure 2-2 Causes of the Spanish financial crisis

2.1 External deficit and debt

The highest differential inflation rates, lower relative productivity, easy access to external financing and the European Union foreign trade policy favouring the entry of products from Asian countries have all provoked an extremely large current account deficit in Spain. It is also important to note that the previous favourable evolution of the Spanish economy, driven by domestic consumption and unprecedented construction, limited the internationalization of Spanish companies which were operating in Spain alone. Moreover, the national deficit is also related to the increased level of credit expansion due to a lack of sufficient savings in the country, which was intended to be resolved using external borrowing (European Commission, July 2012). We can say that the funding used to rescue the construction sector came mainly from external borrowing which increased the national debt.

The creation of the euro zone allowed the collection of resources from other countries without any apparent risk in fluent transactions. As it is well known, Euro-zone exchange and interest rates are given in Europe to all participants, but the evolution of prices is not the same among different member countries. Consequently, both nominal exchange and interest rates are the same for everyone unlike the real exchange rates and real interest rates (affected by inflation) and the latter variables which influenced by indebtedness, among other factors. In this sense in Spain, with higher inflation than most member countries, the real interest rate and the real exchange rate were lower, measured by the differential price experiencing steady appreciation. This caused the deterioration of Spanish terms of trade and the loss of competitiveness, leading to increase in imports and decrease in exports with a consequent expansion in the external financing needs of the Spanish economy, enlarging enormously the national debt (Jimenez et al., 2010).

Figure 2-3 Evolution of the real interest rate (Spain vs. Euro zone)[1]



Note: interbank interest rate. 12-month Euribor rate minus inflation
Source: Eurostat and National Statistics Institute (INE)

Persistent financial imbalances between countries - some of them with financing capacity, such as China, Germany, some countries in Latin America and Asia, and on the other hand countries with financial needs, as in the case of Spain or the United States - has greatly favoured the abundance of global liquidity. In Spain, borrowing need was clearly reflected in the deficit of the current account and the negative position of the financial balance of the country's economy. In this context, the Spanish banking system found facilities to capture all necessary funding in Euros from European countries with excess savings. Obviously, this resulted in a high level of external debt.

Table 2-1 Balance of payments in Spain (2003-2011)

Current account period									
Units: million Euros									
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Current account	-27.909,9	-44.163,7	-66.859,7	-84.736,3	-105.378,2	-105.973,1	-54.481,3	-47.427,3	-37.765,9
Financial Account by Net change period and liabilities, assets and balance.									
Units: million Euros									
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Financial account	18.875,8	34.851	60.818	81.471,1	101.065,5	101.975,3	54.641,1	43.174,1	33.845,9

Notes: Net Changes in Liabilities-Net Changes in Assets: a positive (negative) an inflow (outflow) of capital. Mainly loans, repos /reverse repos and deposits. Source: Spanish Central Bank

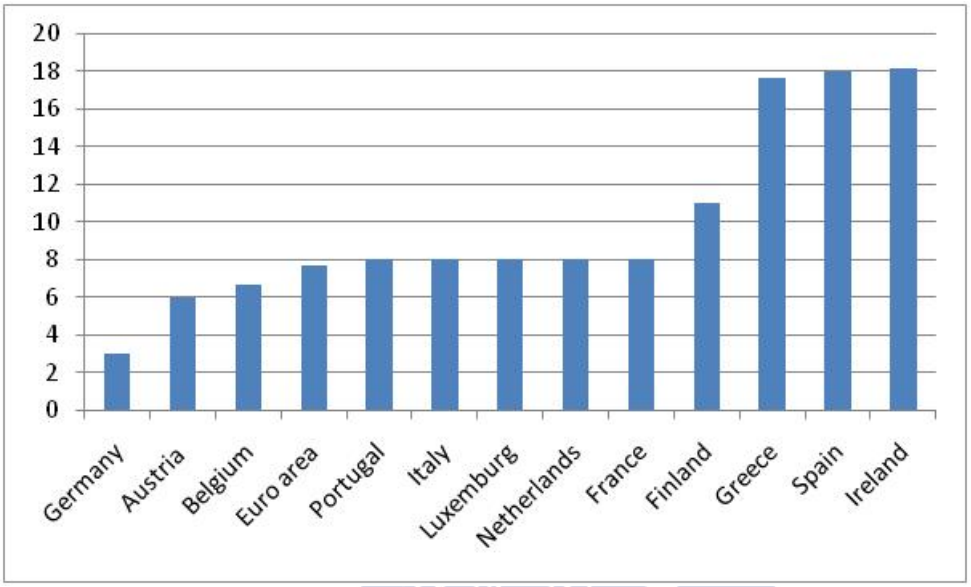
2.2 Level of interest rates and credit expansion

Expansionist monetary policies create a favourable environment for the formation of financial bubbles and excessive credit growth, thereby increasing bank risk. Bernanke, Gertler and Gilchrist

[1] Euro-zone comprises initial 11 states joined by Greece in 2001, by Slovenia in 2007, Cyprus and Malta in 2008, Slovakia in 2009 and Estonia in 2011.

(1996) argue that with low interest rates, loans or investments considered to be very risky become attractive to borrowers (Financial accelerator effect). In turn Rajan (2005) indicates that with long term low interest rates, risk investments cease to be attractive and investors look for more risky financial opportunities (Yield effect), as seen in Spain. Jimenez (2008) obtained evidence that Spanish banks lower their lending standards and grant more credit when interest rates are low. Therefore, expansionist monetary policies prove that banks assume more credit risk. As shown in the graph below, Spain, together with Greece and Ireland, was one of the countries with the highest growth in private sector credit, with rates close to 17% throughout the period 2000-2007.

Figure 2-4 Annual rate of credit growth to the non-financial private sector in the period 2000-2007



Source: Eurostat and National Statistics Institute (INE)

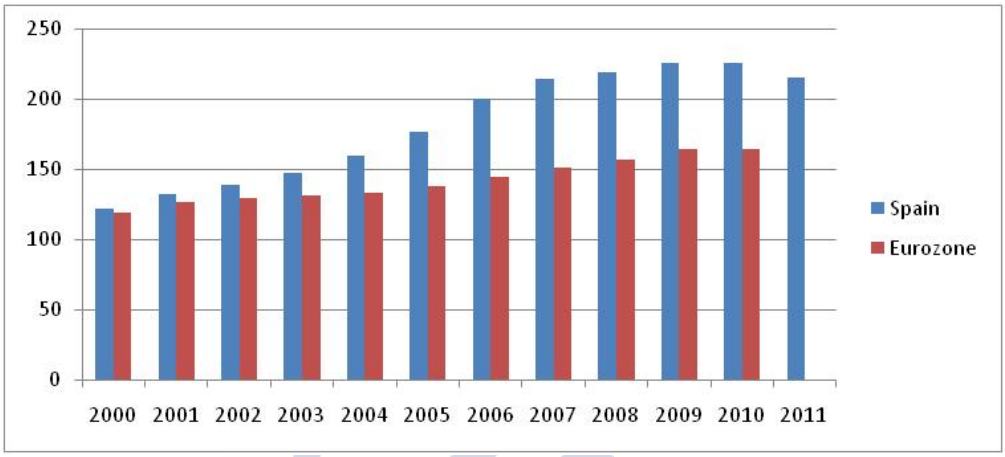
Most of the external funding was spent to rescue the private sector, so that by 2009 private debt grew enormously representing one of the highest levels worldwide. Therefore, the economic growth achieved in the boom years was mainly due to the expansion of credit oriented to the private sector, since public debt until the beginning of the crisis remained minimal. The growth of the Spanish economy favoured tax revenues and reduced financing needs of Spanish public administrations.

2.3 Strong dependence on bank credit as a source of funding

The increase in debt preceding the onset of the crisis was also encouraged by the remarkable expansion of private debt market providers in Spain, in particular those related to the financial system. Consequently, bank lending to private companies increased more strongly in Spain. As mentioned before, one of the characteristics of Spanish companies is a strong dependence on bank credit as a principle source of funding. Due to cultural, structural and normative reasons, there is a lack of diversification of funding sources for Spanish companies in general, mainly because of the predominance of Pymes (Small and Medium Enterprises -SMEs) which do not have access to financial

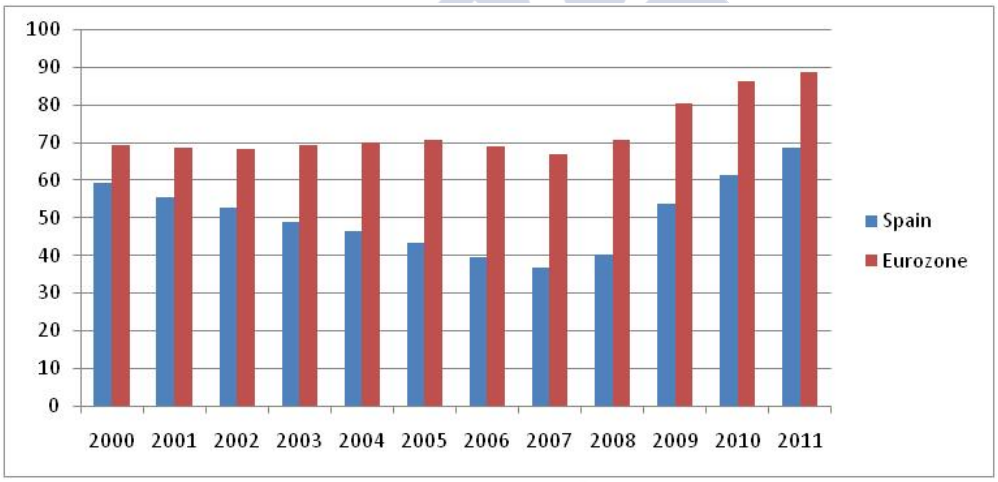
markets. Besides the high debt we also have to consider the question of the type of debt, which relies almost exclusively on credit granted by financial institutions. As seen in the chart below, in years preceding the crisis it is possible to observe that most funds and private companies' resources in Spain were held by financial institutions.

Figure 2-5 Private debt to non-financial sector: Spain vs. Euro area 2000-2011 (% of GDP)



Source: Eurostat

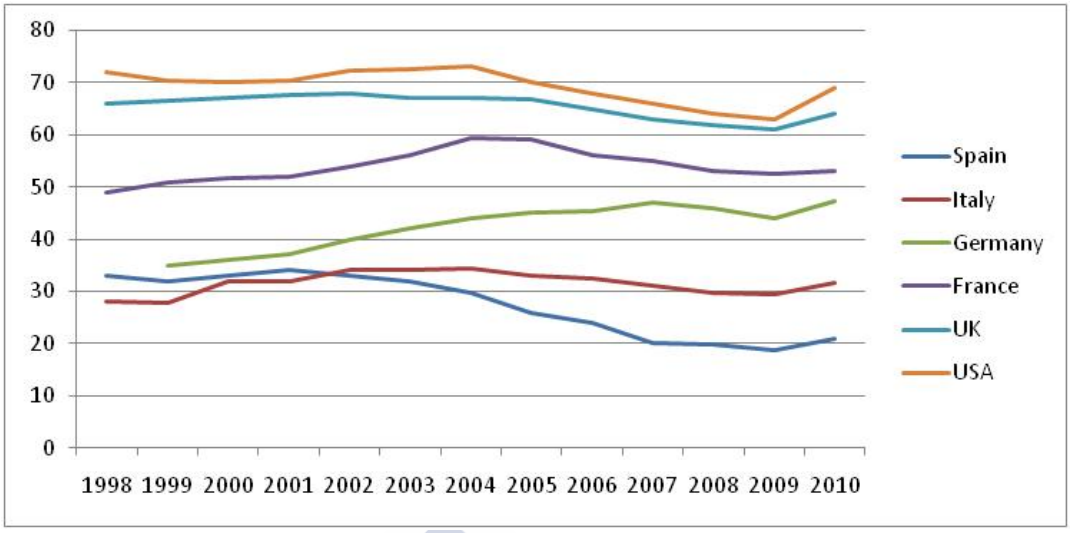
Figure 2-6 Pubic Debt: Spain vs. Euro area 2000-2011 (% of GDP)



Source: Eurostat

As it can be seen in the chart, in Spain and Italy financial institutions are the main and most important lending agents. Consequently, the economic performance of the country depends heavily on the health of the financial system until the use of other funding sources is widespread. This excessive growth of bank credit to private companies is the key factor in understanding the problems related to the crisis in the Spanish banking system.

Figure 2-7 Relationship between market based financing relative to bank credits[2]



Source: Annual report of the CNMV on the stock markets and their performance, 2010

2.4 Competition in the financial sector and the reduction of intermediation margins

There are various theories covering the responsibility of banks in the financial crisis which concentrate on the effect of competition on assuming the level of risk of financial transactions. On the one hand, less competition leads to lower risk exposure according to Allen and Gale (2000, 2004), while the approach of Boyd et al. (2006) and Boyd and Nicolo (2005) suggests the opposite. The opposed justification is based on the fact that increased competition reduces financing costs and the probability of bankruptcy, so overall more competition means less risk. Martínez-Miera and Repullo (2010) do not agree with these two suppositions, indicating that it is better for banks to have moderate levels of competition. Empirical evidence from the Spanish case shows that less competition leads to higher market power, higher margins of profit and fewer risks for banks and financial institutions (Jimenez et al., 2010). Similarly, Chambers and Saurina (2003) conclude that the liberalization of the financial sector influences the level of competition, affecting the market power of banks and their benefits. Therefore, the use of low interest rates plus increased competition among financial institutions greatly affected the behaviour of banks, which started to improve their benefits, expanding credit through the private sector.

Table 2-2 Expansion of deposit institution offices in Spain

Year	Total	Banks	% variation	Saving Banks	% variation	Cooperatives of credit	% variation
2002	38 673	14 072		20 326		4 275	
2003	39 405	14 074	0,01%	20 871	2,68%	4 460	4,33%
2004	40 230	14 168	0,67%	21 503	3,03%	4 559	2,22%

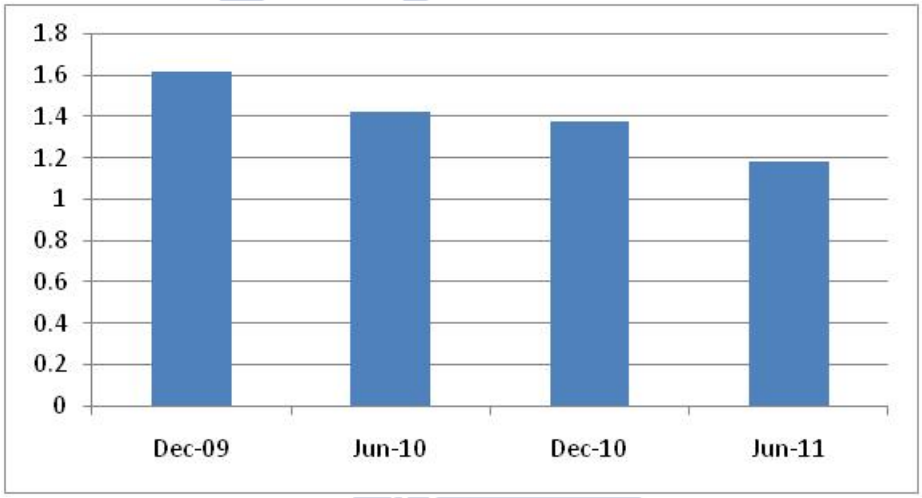
[2] The ratio of outstanding market based financing on the sum of market based funding & funding provided by credit institutions

2005	41 599	14 533	2,58%	22 410	4,22%	4 656	2,13%
2006	43 286	15 096	3,87%	23 418	4,50%	4 772	2,49%
2007	45 086	15 542	2,95%	24 591	5,01%	4 953	3,79%
2008	45 662	15 580	0,24%	24 985	1,60%	5 097	2,91%
2009	44 085	14 840	-4,75%	24 202	-3,13%	5 043	-1,06%
2010	43 453	14 670	-1,15%	23 743	-1,90%	5 040	-0,06%

Source: Bank of Spain (2010).

As we can see from the data in the table above, the highest rates of growth were achieved by saving banks, especially during the years 2004, 2005, 2006 and 2008, when their growth increased to a maximum of 5%. In addition, saving banks had the largest number of offices in the country. According to the *Financial Stability Report* of the Bank of Spain (November 2011) and as it is reflected in the graph below, the interest margin has been cut down in recent years as a result of a reduction in the difference between the average return on investments and average cost of liabilities.

Figure 2-8 Difference between the average return on investments & the average cost of funds

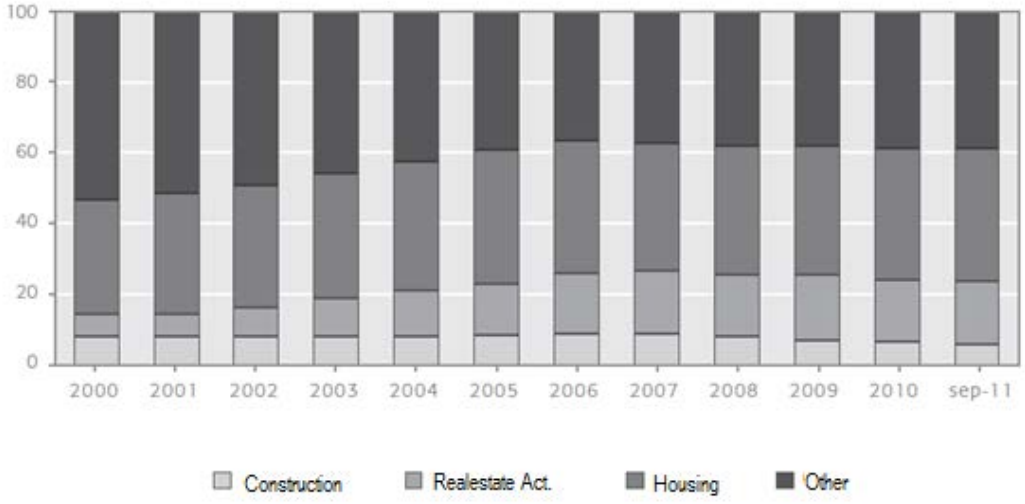


Source: Bank of Spain (2011)

2.5 Excessive risk concentration in real estate sector

According to the information provided by the Statistical Bulletin of the Bank of Spain, the Spanish financial system's exposure (commercial banks, saving banks and credit cooperative) to the construction and development sector amounts to 445,000 million Euros in December 2009, representing almost 25% in terms of credit granted in Spain to households and businesses. As stated in the Financial Stability Report 3/2010 of the Bank of Spain "*Exposure to the construction sector and property development represents a significant risk for the Spanish banking system*. In the chart below we can see that the credit granted to construction and real estate activities exceeded 25% in the years preceding the crisis, and if we add to this the credit granted in mortgages, we account for over 60% of credit granted by Spanish banks in all forms.

Figure 2-9 Structure of percentage of credit to other sectors granted by Spanish credit institutions



Source: Bank of Spain (2011)

Cuñat and Garicano (2009) show how saving banks which reported higher offence issues (delayed or overdue payments) were the ones concentrating more resources in real estate. In the tables below we can see the real estate exposure, exposure problems and insurance coverage held by major banks and saving banks.

Table 2-3 Problematic real estate exposure (2010)

Year 2010 in millions of Euros)	Exposure in construction & real estate development	% of lending except public sector	Problematic real estate exposure				
			Delinquency	Substandard (at risk of default)	Foreclosed Assets	Total	% of lending except public sector
SANTANDER	27.334	12,2%	4.636	4.932	7.514	17.082	7,6%
BBVA	16.600	8%	3.543	2.381	6.397	12.321	5,9%
BFA	41.280	19,8%	7.370	7.742	9.843	24.955	11,9%
LA CAIXA	26.284	14,9%	4.080	1.657	4.825	10.562	6%
BANCO BASE	24.264	27%	5.222	4.565	4.207	13.994	15,5%
POPULAR	17.840	18,7%	2.587	2.642	4.759	9.988	10,5%
BANCO SABADELL	10.170	14,2%	4.074	3.028	3.768	10.870	15,1%
BANESTO	10.354	15,1%	1.670	1.076	1.399	4.145	6,1%
CATALUNYACAIXA	12.774	23,7%	1.794	1.663	5.436	8.893	16,5%
NOVACAIXAGALICIA	11.150	21,8%	2.527	1.911	3.525	7.963	15,6%
BANCA CÍVICA	9.187	18,8%	1.168	2.200	2.050	5.418	11,1%
MARENOSTRUM	11.553	22,9%	n.a.	n.a.	3.854	3.854	7,6%
BANKINTER	2.452	5,8%	291	99	484	874	2,1%
BBK	3.574	10,4%	1.622	888	1.152	3.662	10,7%
ESPAÑA+DUERO	8.067	31,3%	1.677	1.338	1.083	4.098	15,9%

IBERCAJA	4.636	13,9%	580	718	962	2.260	6,8%
UNICAJA	2.948	12%	365	550	1.281	2.196	8,9%
UNNIM	3.598	19,9%	642	599	2.345	3.586	19,8%
KUTXA	1.714	11,2%	441	320	546	1.307	8,6%
CAJA TRES	3.576	27%	493	1.632	609	2.734	20,6%
CAJA VITAL	1.253	19%	162	211	289	662	10%
Total	250.608	38,4%	44.944	40.152	66.328	151.424	9,7%

Source: Bank of Spain & Author's calculations

As can be seen in the data presented in the tables the entities with greater exposure are saving banks, or financial institutions which originally were saving banks. Consequently, with an increasing delay in payments these institutions are more greatly affected by the exposure.

Table 2-4 Property risk coverage (2010)[3]

Year 2010 (in millions of Euros)	Real estate exposure					Credits to construction & development with mortgage guarantee	% of total real estate exposure	Credit to construction & development excluding mortgage guarantee
	Specific provision	% of problematic exposure	General provisions	Total	% of problematic exposure (including general)			
SANTANDER	4.956	29,0%	768	5.724	33,5%	21.210	77,6%	6.124
BBVA	3.389	27,5%	9.765	13.154	106,8%	15.272	92,0%	1.328
BFA	9.518	38,1%	1.578	11.096	44,5%	34.985	84,8%	6.295
LA CAIXA	3.962	37,5%	1.835	5.797	54,9%	24.240	92,2%	2.044
BANCO BASE	4.591	32,8%	1.012	5.603	40,0%	21.046	86,7%	3.218
POPULAR	8.548	85,6%	n.a.	8.548	85,6%	17.840	100,0%	1.552
BANCO SABADELL	3.628	33,4%	424	4.052	37,3%	9.528	93,7%	642
BANESTO	1.002	24,2%	n.a.	1.002	24,2%	5.017	48,5%	436
CATALUNYA CAIXA	3.086	34,7%	181	3.267	36,7%	10.285	80,5%	2.489
NOVACAIXA GALICIA	2.823	35,5%	359	3.182	40,0%	9.241	82,9%	1.909
BANCA CÍVICA	2.080	38,4%	n.a.	2.080	38,4%	8.438	91,8%	749
MARENOSTRUM	n.a.	n.a.	n.a.	n.a.	n.a.	10.748	93,0%	805
BANKINTER	423	48,4%	157	580	66,4%	1.369	55,8%	1.083
BBK	1.532	41,8%	418	1.950	53,2%	3.195	89,4%	380
ESPAÑA + DUERO	1.775	43,3%	126	1.901	46,4%	6.476	80,3%	1.591
IBERCAJA	776	34,3%	n.a.	776	34,3%	4.225	91,1%	412
UNICAJA	386	17,6%	n.a.	386	17,6%	2.726	92,5%	222
UNNIM	658	18,3%	106	764	21,3%	3.272	90,9%	326
KUTXA	586	44,8%	19	605	46,3%	1.262	73,6%	452
CAJA TRES	601	22,0%	n.a.	601	22,0%	3.234	90,4%	342
CAJA VITAL	161	24,3%	10	171	25,8%	1.163	92,8%	90
Total	54.481	36,0%	16.758	71.239	47,0%	214.772	85,7%	32.489

Source: Bank of Spain & Author's calculations

[3] n.a. – not available

2.6 Financial Innovation

Most authors (Carbó-Valverde et al., 2012; Maddaloni & Peydró, 2010; Martín-Oliver & Saurina, 2007; Douglas & Raghuram, 2009 and Kwan, S, 1998 among others) dealing with the international financial crisis refer to securitization as origin of it. We have already mentioned that the Spanish economy fell into debt abroad and the external credit earned ended up largely financing real estate. Part of this funding was obtained through external credit which went through a process of securitization and placement in fixed income markets. The Spanish securitization market during the pre-crisis period was one of the most important in Europe. According to data published by the European Securitization Forum, the volume of Spanish Residential mortgage-backed security (RMBS) issuance represented 14.88% of the total European RMBS emissions in the year 2006, 18.49% in 2007 and 10.43% in 2008. Spain ranked second in relation to the volume of mortgage-backed securities issued in Europe in 2007, just after the United Kingdom, while in 2008 it ranked fourth, following the United Kingdom, the Netherlands and Italy.

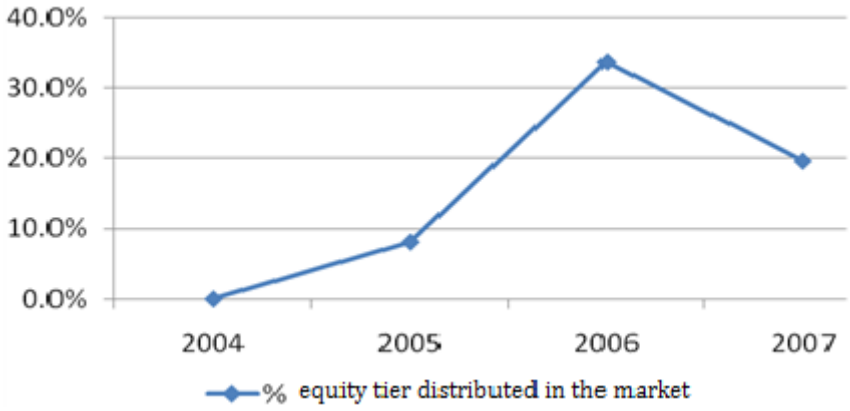
Taking into account the current outstanding asset-backed securities at the end of the third quarter of 2009, Spain is in third place with a total of 167,100 million euro (14.48% of the total), following the United Kingdom (with 458 000 million euro, representing 39.67% of the total) and the Netherlands (with 202 400 million, which account for 17.53% of the total). Diamond and Rajan (2009) argue that one of the main causes of the financial crisis was the securitization process, as it provided an excessive credit exposure related to the construction sector. Krugman (2007) summarizes the problem concluding that in the last years of growth the *"big real estate cycle"* banks - from 2000 to 2005 - issued a large number of the poor credit quality loans, although banks were aware of the situation and managed to get away from it with the help of securitization. Moreover, Purnanandam (2009) shows that those banks that made widespread use of origination model and sold loans of bad credit quality lessened their incentives as originators to generate mortgages making a rigorous credit risk analysis.

It seems reasonable to wonder about the role played by securitization in the Spanish context. Otero and Ezcurra (2012) believe that there are certain similarities with the U.S. Subprime Crisis. Almost all research studies conducted until now on the Spanish securitization market argue that one of the fundamental differences with the U.S. model is the development of various models of securitization in Spain. Also the main characteristic of the American model is "originate to distribute" while the Spanish securization market operates under the principle of "originate to maintain". Therefore, unlike the complete transfer of risk (thus freeing the entire use of capital which appears in the balance) as in the US, in Spain the technique of securitization has been used primarily as a funding mechanism. In this system, the bank providing credit has no incentive to undertake thorough analysis when providing too risky mortgages disregarding the borrower's ability to pay since the real risk is kept to a greater extent on the balance sheet of the entity which administers the loan (Losada, 2006;

Sources, 2007; Catarineu & Perez, 2008), dissimilar to the American "originate to distribute" model, where the conflict of interest is much more evident (Purnanandam, 2009)[4].

The reasons and revealed evidence leading us to talk about the subprime in Spain are:
• *the increasing trend of operations* in which the originator of the loans has been able to distribute or sell them in the market after the first loss through securitization;

Figure 2-10Origination model of sale in the Spanish securitization market



Source: CNMV[5]

- *sharp rise in mortgage loans and delinquency due to late payments* Mortgages have doubled in just five years (2004-2009), to account for 1,099,568 million Euros at the end of 2009, compared to 531.608 million euro in 2004. Regarding delinquency due to late payments, the latest official figures indicate a delinquency rate of credit for house purchase mortgage-backed securities of 2.42% at the end of the first quarter of 2011, compared with just 0.38% in mid-2006;
- *granting of increasingly riskier products with higher loan values* such as mortgage lending over the appraised estimation, mortgages for second homes or loans granted to foreigners or people without stable income. Similarly, there is a general increase in the term of loans as well as the range of products that postpone the repayment of the principal loan (by paying interest only or capital repayment deferred, hybrids, etc.).

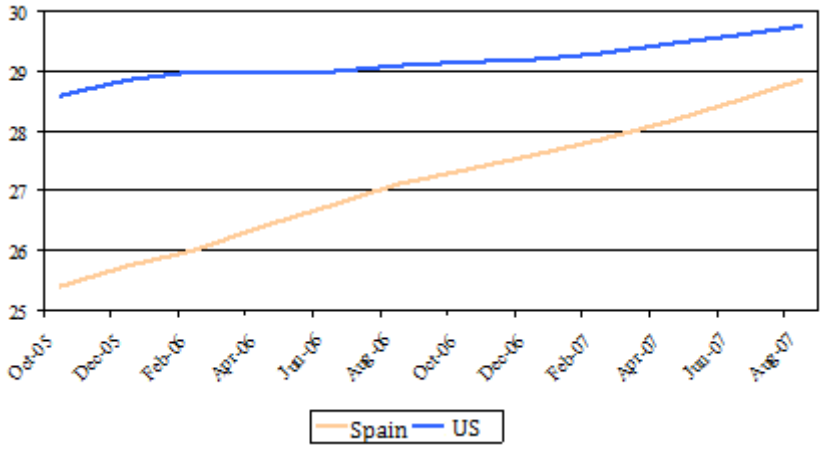
For example, mortgage loans granted to foreign residents increased substantially in recent years accounting for around 7.2% of the total mortgage loans granted by the end of 2008. These loans had a delinquency rate (late payments) of 12.5% of the total at the end of the same year, while for the national residents this figure was 1.6% of the total[6].

[4] Purnanandam (2009) shows how the "originate to distribute" model has encouraged the granting of mortgage products of lower credit quality, as the originators did not use resources to analyze the repayment capacity of the borrowers.

[5] CNMV (Comisión Nacional del Mercado de Valores) Spanish National Stock Market Commission

[6]The Bank of Spain's Financial Stability Report, 2008.

Figure 2-11 Average time of granting mortgage loans to purchase houses (years)



Source: BBVA Research Department

In this regard, the works of Jimenez et al. (2010) and Otero and Ezcurra (2012) conclude that securitization encouraged poor credit quality, increased competition between banks and led to the granting of credit in more permissive conditions. The new loans were subsequently riskier and more likely to default, suggesting that eligibility rules were relaxed in order to expand credit and, consequently, securitization has proven to have a negative impact on the financial stability of Spanish credit institutions, creating conditions for bankruptcy and increasing the delay of payments.

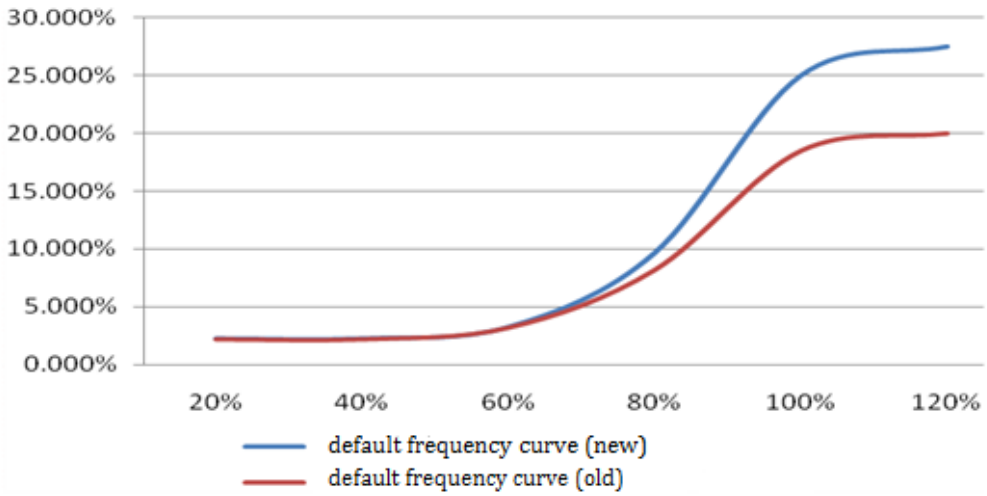
2.7 The Credit Rating Agencies

In general, in Krugman's opinion (2007) one of the most important events was the error caused by the rating agencies assigning allegedly very high credit ratings to those securities, when they were actually the equivalent to "junk bonds" or very low level. Also, Ashcraft et al. (2009) investigate whether the potential conflict of interest in rating agencies led to what is defined as "rating inflation". The results of the study show how the rating assigned to securities were gradually increasing, even immediately after adjustment according to the level of risk and the characteristics of the loan. The potential conflict of interest among rating agencies could have impacted to their work, because the main parties involved in the process - originator, issuer and rating agency - were very interested in generating short-term commissions, without taking under consideration the risk and viability of the business in the long term. As it is outlined below, fragility in the credit rating process for mortgage securities has also been demonstrated in the Spanish market.

As mortgage markets was developing, financial institutions in an increasingly more competitive environment brought about by the mobility of loans created particular mortgage products with more sophisticated characteristics and riskier profiles. But because these new products were issued in a period of economic expansion with a generalized rise in housing prices, this led to rating agencies and other market participants underestimating the risks associated. Another error found in the rating process, although not as noticeable, was the evolution or trend in housing prices. Although

rating agencies apply reductions in prices of real estate according to the different levels of rating assigned, the current crisis affecting the Spanish economy has shown that these reductions were not conservative enough. These shortcomings during the rating process have resulted in a large number of securitization transactions issued in the Spanish market (especially those collateralized by loans with a high Loan-to-value (LTV)[7] and issued in recent years) suffering severe credit downgrades, especially the junior trenches of the capital structure. As a consequence of this, Moody's and Fitch have introduced modifications in their models. In July 2008, Moody's published a series of adjustments in their rating models for the Spanish market and in the same vein Fitch updated its matrices of default probabilities in February 2010. As can be seen in the following chart, changes are stricter as the LTV of the loan increases.

Figure 2-12 Moody's default frequency curve (Aaa level)



Source: Moody's

2.8 Corporate Governance

Corporate governance, in particular in saving banks, was also critical to determine the level of risk taken by financial institutions. Thus, characteristics like acting on behalf of shareholders (Beltratti & Stulz, 2009) the composition of the Board of Directors (Pathan, 2009); the concentration of power and the participation of institutional investors in the Board of Directors, affected the level of risk assumed by banks. Laeven and Levine (2009) argue that banks with powerful shareholders tend to pressure managers to incur in more risky transactions. Moreover, Bai & Elyasiani (2013) conclude that banks with more incentive to incur in risk are those in which there is more likelihood of government support (systemic). In this type of bank shareholders are keener to encourage risk taking. In the Spanish case, saving banks have been the financial institutions which have incurred in higher levels of risk and endured the hardest part of the financial crisis. Cuñat and Garicano (2009) study the impact of corporate governance in saving banks by analyzing the composition and structure of the General

[7] LTV is loan-to-value ratio - the ratio of a loan to the value of an asset purchased

Board, the training of executives and the politicization of the general council, among others. Their work concludes that banks run by a person with postgraduate education, banking experience and no previous political activities, concentrated less credit in real estate, had fewer payment delays and credit downgrades. The majority of saving banks had a politicized management team, often without any previous banking experience and acting with unprofessional criteria. In general we can say that this sector has been damaged the most by the Spanish financial crisis.

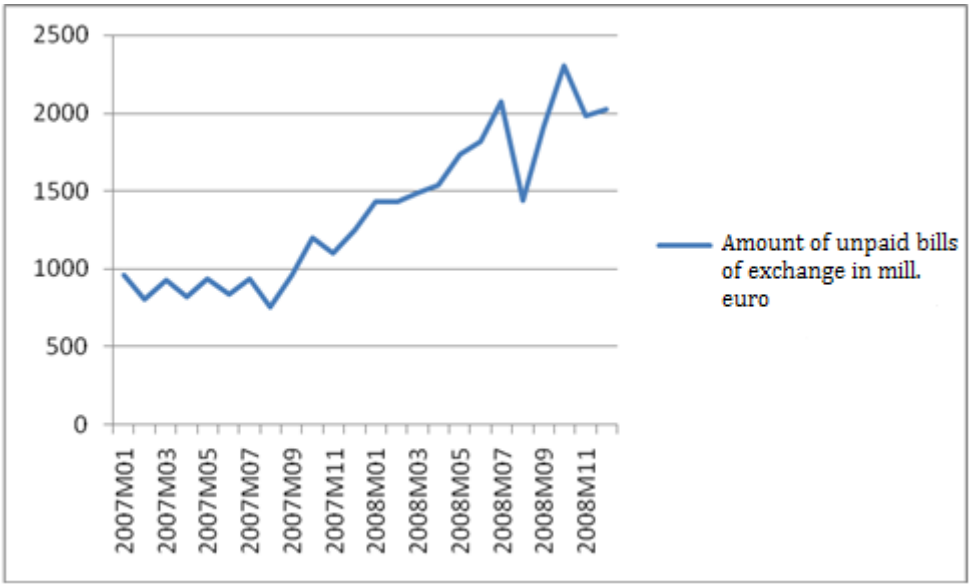
2.9 Regulation and Supervision

The implementation of Basel II, the most demanding and advanced regulation covering risk, has made assume that the financial sector was prepared to deal with potential financial crises. However, its release practically coincided with one of the most severe financial crises. Further analysis led to the conclusion that regulation tends to reduce capital levels in times of economic expansion and increase them in times of crisis (Dewatripont & Freixas, 2012). Also Dewatripont and Tirole (2012) point out that Basel II failed in the design of counter-cyclical provisions. The capital buffer incorporated in Basel III can help to alleviate this problem. Another criticism has been that Basel II relinquished supervisory activity, promoting the role of the market itself as a supervisory mechanism. Still, not all countries relaxed its supervisory function to the same extent. Moreover, the work of Beltrany and Stulz (2009) makes clear that banks in countries with a stricter monitoring system also performed better during the financial crisis. In this sense, despite the prestige of the Bank of Spain as a supervisory body, much criticism has been made of its monitoring of the Spanish financial sector. So, despite knowing that banks were expanding credit beyond wise levels, the passivity of the Bank of Spain encouraged excessive risk taking. The letter sent in 2006 by the Association of Certified Credit Inspectors of the Spanish Banking (AEICA) warns about the passivity of the Bank of Spain against excessive credit growth and its concentration in real estate.

The consequences have already been quoted in the characterization of financial crisis. In particular the bursting of the housing bubble caused very significant reductions in asset prices. The credit contracted rose sharply and the amount of late payment cases dramatically escalated, causing many bankruptcies and asset transfers to banks. Another consequence has been the significant increase in the unemployment rate.

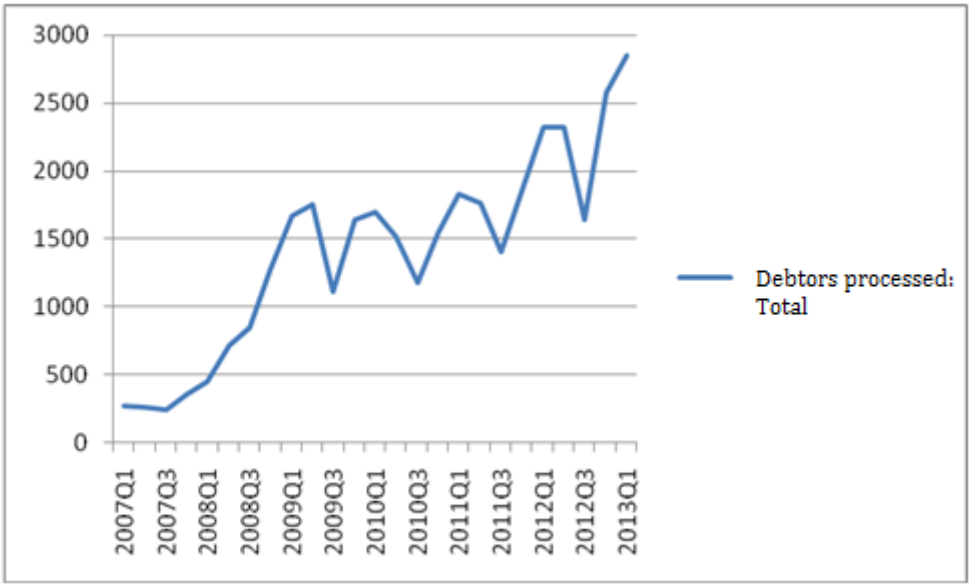
We can see clearly that as the crisis started to become worse, the unemployment rate increased, mostly affecting the younger generation.

Figure 2-13 Amount of unpaid commercial bills



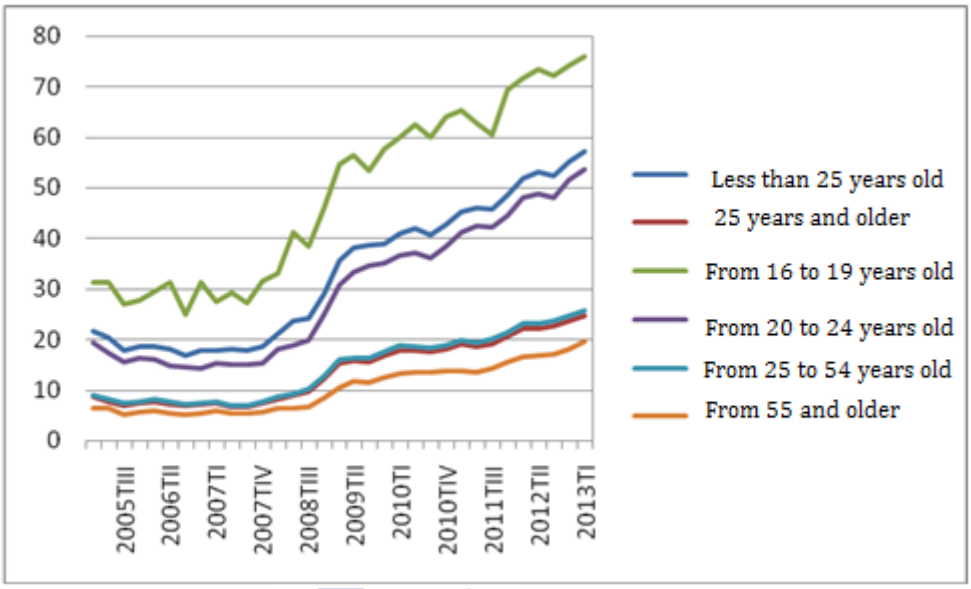
Source: *National Statistics Institute (INE)*

Figure 2-14 Number of late payment court proceedings



Source: *National Statistics Institute (INE)*

Figure 2-15Unemployment rate by age group



Source: *National Statistics Institute (INE)*

3 Restructuring process

Following the financial crisis many measures were taken both domestically (in Spain and EU) and internationally. Along with other changes there were proposed the new Basel III regulations, the carrying out stress tests of banks, improvement in supervision of financial institutions by EU and in national level and the creation of the Fund for Orderly Bank Restructuring (FROB).

In this regard, the National Reform Plan 2012[8] comprises the profound changes that have been undergoing in the Spanish financial system. To solve the problems in the financial sector and mitigate their impact on the real economy, it has been adopted a fundamental reform of the financial system that focuses on deep provisioning and restructuring of balance sheets of credit institutions to increase the efficiency and competitiveness of the sector.

The Bank of Spain, the national central bank and supervisors of the financial system, is coordinating this complex restructuring and recapitalization program as well as the Memorandum of Understanding (MoU). MoU has been developed jointly with the European authorities and agreed in July 2012 and primarily aimed to restore confidence in the Spanish economy, stabilize the financial sector and place them in a stronger position in future.

Among the measures taken by the authorities, undertaken both internationally and nationally, there are in general two courses of actions. The one is directed to undertake preventive measures

[8] While we focus on the reforms in the financial system, the reforms undertaken in Spain, as envisaged in the National Reform Programme 2012 of the Kingdom of Spain itself, have a much broader and encompass other draft lines of action such as:
- Fiscal consolidation.
- The modernization of public administrations and public services.
- Financial system reforms
- Labour market flexibility, training and education.
- Growth and competitiveness.

mitigating the severity and consequences of future crises. A clear example of these actions is found in the decisions of the Basel Committee which can be shortly expressed as the performances focused on new capital rules far more demanding than former regulations and the reconfiguration of the financial architecture internationally. The other course are the measures to directly support financial entities in order to regain the confidence of markets, mitigate liquidity pressures and facilitate the channelling of credits to the real sector. More specifically, the measures taken by the Spanish authorities are aimed at improving confidence, credibility and strength of the financial system, supporting banks' liquidity, promoting the consolidation and restructuring of the most fragile entities (mainly saving banks) and increasing the levels of capital and reserves. These actions also directed to cover the risks of real estate due to doubts about the valuation of real-estate assets, as well as the weight of the real estate assets held by the banking sector. The ultimate goal of these measures is to improve the outlook of the situation in Spanish financial sector.

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Chapter 3 DETERMINANTS OF EXCESSIVE RISK-TAKING BEHAVIOUR OF SPANISH BANKS

1 Introduction

Much research in finance attempts to explain the risk-taking behaviour of banks and identify precise indicators of banks' fragility (Achraya & Naqvi, 2012; Altunbas et al., 2010; Borio & Zhu, 2012; Boyd et al., 2006; Garcia et al., 2008; Houston et al., 2010; Iannotta et al., 2006; Jimenez et al., 2010 and Laeven & Levine, 2009 among others). This issue became especially prevalent following the recent financial crisis which has had a dramatic impact on the banking and financial sector of most countries. A number of academics and industry professionals are trying to identify factors that caused banks to take excessive risk and to ascertain if it would have been possible to forewarn or prevent the financial crisis. The current section also complements to existing literature of bank risk-taking factors but also provides an extended review of the main risk determinants along with critical examination of relevant empirical studies in this sphere. We provisionally group banks' risk-taking incentives into a few broad categories and examine their level of impact on bank fragility during the pre-crisis period dating 2004-2007 paying particular attention to the Spanish banking sector.

By revising existing theoretical and empirical literature on bank risk-taking factors, we conditionally define the following risk categories: corporate governance, bank business models, capital, financial innovations, macroeconomic factors and other regulatory and institutional factors. As it has been evidenced in previous works, these factors may have been interrelated and mutually amplifying in affecting bank risk-taking behaviour. Though we review each factor in a separate section we also present its association with other factors in shaping bank risk. Our main purpose is to identify valid risk-taking determinants, both in general and for our data of selected Spanish banks, and analyse their influence on banks' excessive risk-taking during the pre-crisis period dating 2004-2007. Our review has been organized as follows: the first section provides a critical review of recent empirical and theoretical studies of risk-taking factors; based on this review we form preliminary hypotheses on the impact of risk-taking determinants on bank fragility; using data on Spanish banks we undertake en empirical analysis of the formed hypotheses; finally we present a general conclusion on the overall effect of risk-taking determinants on bank's solvency in the Spanish banking system.

2 Determinants of Bank Risk-taking

2.1 Bank Corporate Governance

The role of bank's corporate governance is central in analysing banks risk-taking behaviour. Many academic papers attempt to explain the role of corporate governance in banks' excessive risk-taking during the recent financial crisis. In our review we focus on the impact of bank governance on

the level of bank risk from two perspectives, internal and external. Internal governance focuses on banks' internal structure and organization including board composition and its structure, CEO qualities and compensation, shareholders' structure, etc. External governance includes government regulators, credit rating agencies and other stakeholders. External factors are revised in other sections of our review.

Unlike other sectors of the economy bank corporate governance has distinctive characteristics which require a special approach in analysis. A principle feature is the multiplicity of stakeholders. Normally bank stakeholders comprise insured and uninsured depositors, the deposit insurance company, bond holders, subordinate debt holders and hybrid securities holders, shareholders, etc. Despite the fact that a large proportion of a bank's balance sheet consists of debt, it is controlled by shareholders and as practice has shown, shareholders' interests may diverge substantially from those of other stakeholders (Dewatripont & Freixas, 2012).

Other characteristics of financial firms which need to be taken into consideration are the opacity and complexity of banking operations. Remarkably, the rapid development of securitization further contributed to the opaque nature of the industry. In many academic papers increased securitization has been largely blamed as one of the contributors to the banks' excessive risk-taking. Moreover, the banking industry is more heavily regulated than other sectors of the economy so as to maintain its safety and soundness. As a consequence, market based mechanisms such as takeovers and product-market competition do not operate for banking in the same way as they do for other sectors of the economy. The recent financial turmoil demonstrates that these mechanisms are quite restricted in the banking sector due to regulatory interventions. In this section we re-examine banks' internal governance mechanisms giving special attention to the above mentioned characteristics. Specifically we review bank ownership structure, board of directors and executives compensation schemes.

2.1.1 Bank Ownership Structure

According to Laeven and Levine (2009), potential corporate governance problems associated with risk arise from bank ownership structures. The relevance of bank ownership structures to bank risk-taking has been extensively explored by many academics. Iannotta et al., (2006) define bank ownership structure in two dimensions: nature of ownership and ownership concentration. According to the property rights hypothesis, the nature of bank owners affects bank performance i.e. private banks are expected to be more efficient than public banks. On the other hand, agency theory advocates that the degree of ownership concentration also influences bank performance. Consistent with agency theory, managers of banks with dispersed ownership exhibit lower risk than is optimal for shareholders; if a bank is widely held, its risk-taking may be disciplined by market participants. Banks with large block holders are considered to have concentrated ownership; large owners can be a part of internal governance mechanisms and monitor managerial

decisions. Apparently, block holders help to reduce managerial opportunism through strong monitoring and as they can oversee managers' decisions they can also influence banks' risk-taking.

The effect of bank governance on bank performance during the recent financial crisis is investigated by Peni & Vähämaa (2012). The authors differentiate between bank performances pre-crisis vs. crisis and between bank performance vs. stock performance. Consistent with prior academic works they support the idea that the same corporate governance attributes that impact non-financial firms are also significant for bank governance. The study applies the Gov-Score corporate governance index developed by Brown and Caylor (2006, 2009) to rate the strength of banks' governance. It includes 51 different firm-specific governance attributes, which reflect both internal and external governance of the firm. Bank performance is measured by ROA and Tobin's Q ratios. The results indicate that good corporate governance practices improve the financial performance of banks and their market valuation. The hypothesis that banks with strong governance were subject to higher risk-taking at the onset of the crisis is tested by regressing leverage and stock return volatility on the Gov-Score and bank-specific control variables. Empirical results reveal that banks with stronger governance experienced higher profitability during the financial crisis but had negative effects on market valuations implying that strong corporate governance did not create shareholder value during the crisis. Nevertheless they also suggest that strong corporate governance may have moderated the adverse effect in the immediate aftermath of the financial crisis as the banks exhibited substantially higher stock returns from March 2009 onwards.

Iannotta et al. (2006) analyse the effect of ownership structure on European banks' profitability, cost efficiency and their risk level from 1999-2004. The study considers both dimensions of ownership structure – ownership nature and concentration. By comparing mutual banks (MB), privately-owned stock banks (POB) and government-owned banks (GOB) and using different risk proxies it suggests that public sector banks have poorer loan quality and higher insolvency risk than banks with other ownership types. The study explains this evidence through the role of GOBs in a country's banking system. GOBs usually pursue industrial policies directed at remedying market failures and providing loans that POBs or MBs would not grant. In other words, GOBs provide loans which are not profitable enough for the private sector. Furthermore, the findings suggest that MBs have better loan quality and lower asset risk than GOBs and POBs. As reported by Rasmussen (1988), managers of MBs cannot fully benefit from increased variability of returns and therefore they are involved in less risky activities than POBs. Regarding ownership concentration, while it does not have a significant impact on banks' profitability it is associated with lower risk and better loan quality.

Similarly, Garcia Marco et al. (2008) examine the risk-taking behaviour of Spanish commercial and savings banks from 1993-2000 and reveal major differences linked with legal forms (nature) of ownership as well as the size of the bank. Spanish Commercial Banks (SCB) are privately owned and

shareholder-oriented corporations and compete for loans and deposits in the same market as Spanish Saving Banks (SSB). SSBs, dissimilar to SCBs, are commercial non-profit organizations with no formal owner where control is shared among multiple interest groups. They found that in general SCBs exhibited a stronger tendency toward risk-taking than SSBs in the given period. Specifically, moral hazard problems indicating a stronger relation with risk-taking are found only in small commercial banks with high ownership concentration. This may indicate the small SCB owners' reliance on deposit insurance as stated by Laeven & Levine (2009). In contrast, the results for medium-size and large commercial banks suggest that the greater the ownership dispersion, the higher the level of risk-taking. This finding is in line with the results of Iannotta et al., (2006) and may indicate that managers in this category of banks increase risk-taking when they are under less control implying possible owner-manager conflicts. On the other hand, large and medium SCB managers may be less likely to increase risk with higher ownership concentration even when protected by deposit insurance. In respect to saving banks size-related risk-taking behaviour is more homogeneous.

The simultaneous examination of bank risk, ownership structure and bank regulations is proposed by Laeven & Levine (2009). In this manner it is possible to see how banks' ownership structures interact with national regulations in forming bank risk-taking. The authors form their empirical analysis based on the following theoretical keystones. First, diversified owners have stronger motivation to increase banks risk-taking than non-shareholding managers. This implies high risk-taking behaviour in banks with powerful and diversified owners. Second, the actual impact of bank regulations on risk-taking depends on the comparative power of shareholders to managers within each bank's corporate governance structure. The study used data from more than 250 privately owned banks across 48 countries with different economic regulations. The findings support the hypothesis that the same bank regulations have different effects on bank risk-taking depending on the comparative power of shareholders in the governance structure. In particular, it finds that banks with more powerful owners tend to take greater risks i.e. powerful bank owners tend to induce bank managers to increase risk taking. Furthermore, the findings suggest that the relationship between bank risk, capital regulations, deposit insurance policies and restrictions on bank activities depends on each bank's ownership structure, particularly bank ownership concentration. For instance, deposit insurance induces higher risk-taking only when banks have a large equity holder with sufficient power. Moreover, sufficiently powerful bank owners seek to compensate for utility loss from capital regulations and stringent activity restrictions by increasing the bank risk. The same capital regulations have the opposite effect in widely held banks. The primary conclusion is that ownership structure and especially ownership concentration should be taken into consideration when one analyses the impact of capital regulations, deposit insurance and activity restrictions on bank risk-taking.

Continuing with the issue of ownership concentration we acknowledge that it is very prevalent in academic literature. There is much research which analyses whether bank risk-taking varies with

the comparative power of its shareholders. Generally, the owner's power is represented as the degree of ownership concentration or as the power of shareholders rights in a bank's governance structure. It has been determined that banks operating in countries with better shareholders rights and banks with a controlling shareholder have experienced larger losses during the recent crisis than banks operating in countries with poor shareholders rights and banks without a controlling shareholder (Gropp & Köller, 2010). The research examines whether owners or managers were the driving force behind risk incurred by banks at the time of financial crisis in 2007/2008, for listed banks and unlisted credit institutions over 25 OECD countries. They estimate average bank performance from 2000-2006 and the deviation from the average performance during the crisis as a function of shareholder rights and ownership concentration. In particular, they measure the degree of shareholders' control over the bank management using two proxies: ownership concentration -a bank specific variable; shareholder rights – a country specific variable. In line with other studies (Shleifer & Vishny, 1986; La Porta et al., 1998; La Porta et al., 1999) they report that in general, majority investors and large block shareholders may have a greater ability and motivation to monitor a bank's management, while better shareholders rights may enable even dispersed shareholders to effectively control management. Specifically, Gropp & Köller (2010) suggest that owner controlled banks had a higher pre-crisis profit and larger losses at the time of the crisis implying greater risk-taking within this type of governance structure. Moreover, the profit of shareholder controlled banks in countries with strong shareholder rights declined approximately five times as much during the crisis compared to banks with widely held ownership which operated in countries with weak shareholder rights. The effect of shareholders rights on bank risk is also analysed by subdividing it into cash flow rights and voting rights. Laeven & Levine (2009) also consider cash flow rights a more direct measure of owners' risk-taking incentives compared with voting rights because banks' proceeds are distributed to owners in accordance with their cash flow rights. They conclude that the cash flow rights of shareholders impart the ability amongst owners to influence bank's risk.

Evidently, certain characteristics of bank corporate governance may engender incentives for banks' higher risk-taking. As in any non-financial firm, when owners are separated from management it leads to a conflict of interests, also referred to as the classical conflict between managers and owners. As stated in agency theory managers may have personal goals that do not coincide with the shareholders' goal of maximization of their wealth. One of the ways to resolve this conflict is managerial stock ownership. Proponents of managerial shareholding believe that it aligns the interests of management and shareholders and thus contributes to a reduction of agency costs. However, managerial shareholding is also often identified as one of the agents in increasing bank risk-taking behaviour. When managers have small ownership stakes their behaviour is more risk averse as they try to protect the value of their firm-specific human capital. But with the increase in shareholdings, they may have more incentives to raise their risk-taking within the deposit insurance system amid

decreased charter values. It is also expected that at some substantial levels of shareholdings, managers may entrench their position and no longer maximize the shareholders' value. Therefore, the relationship between management shareholdings and bank risk-taking is not expected to be upheld.

Anderson & Fraser (2000) find that in the period 1987-1989 US bank managers with substantial equity holdings took more risk than managers with similar equity holdings in the period 1992-1994 when regulatory changes were introduced to reduce bank risk-taking and improve the financial health of the US banking industry. They investigated managerial ownership together with the regulatory environment of banks from US bank stock data. They found that banks with higher franchise values were less likely to take risks than bank with lower franchise values implying the importance of banks' franchise values in determining bank risk-taking. The authors conclude that regulatory changes along with an improvement in banks' franchise values were sufficient to control management incentives to take risks from 1992-1994.

Westman (2011) examines the impact of managerial and board ownership jointly with banks' funding strategies. The study revises the impact of management and board ownership on the performance of traditional, non-traditional and diversified banks. Traditional banks are defined as banks with mainly deposit funding while non-traditional banks are those which are mainly funded by non-interest income. By differentiating banks in this way, emphasis is placed on the increased focus on non-traditional banking operations and big diversified banks which are mostly blamed for increases in bank risk during the recent financial crisis. The results from listed European banks show that management ownership has a positive impact on the profitability of non-traditional banks, since these banks are characterized as opaque, complex and difficult to monitor. Board member ownership has a positive impact on the performance of traditional banks where the existence of deposit insurance reduces the monitoring incentives of external stakeholders. However, it does not work for diversified banks as they are too complex or opaque for the board to monitor. Besides, big diversified banks are subject to a Too-Big-To-Fail safety-net, which also negatively influences the monitoring incentives of bank shareholders. By applying risk-adjusted profitability analysis, the study demonstrated that neither management nor board ownership has a robust, positive impact on the risk-adjusted profitability of non-traditional and traditional banks, implying that higher returns come with increasing bank risk i.e. there is always a risk return trade-off.

When analysing bank corporate governance, we cannot ignore the significance of institutional investors since they are generally believed to have a considerable impact on bank internal governance. These are organizations such as mutual funds, pension funds, insurance companies and other big financial institutions with large stakes in banks' ownership structures. It is also believed that institutional investors, since they can exercise significant voting power, tend to promote value-driven decisions and create shareholder wealth by monitoring managers. The evidence, however, presents controversial findings. For example Erkens et al., (2012) using data from 2007-2008 covering 296

financial firms from 30 countries which were at the centre of the financial crisis, find that increased risk-taking is associated with greater institutional ownership. In addition, Cheng et al., (2010) investigated whether residual compensation and risk are related to institutional ownership using data on executive compensation for financial firms from 1990-2008, and found evidence suggesting that there is heterogeneity in investor preferences, with institutional investors later wanting managers to take more risks and so having to give them incentives to do so.

2.1.2 Board of Directors: Size and Composition

The board of directors is a key mechanism of bank governance. Internal and external governors need to be well coordinated to achieve the shareholders' value maximization without unbalancing the safety and soundness of the whole banking system. In maintaining this balance a bank's board of directors play a crucial role. The importance of boards of directors is also stated in the second pillar of Basel II, where it is accepted as an integral part of risk management (Basel Committee on Banking Supervision, 2005). However, the opacity and complexity of the banking system are major obstacles to stakeholders monitoring bank performance, diminishing the regulators' and other stakeholders' capacity to monitor, thus increasing the importance of banks' board of directors in corporate governance issues.

Numerous academic works have revised the relevance of banks' board structures on risk-taking (Pathan, 2009; Adams & Mehran, 2008; Andres & Vallelado, 2008 among others). For instance, Pathan (2009) examines the relationship between bank boards and bank risk-taking from an agency theory prospective. In particular he investigates the effect of strong bank board and CEO power on risk-taking behaviour. Here, 'strong board' is defined as board effectiveness in monitoring bank managers on behalf of shareholders. The term 'CEO power' is explained as the degree of a CEO's influence on board decisions. By using a sample of 212 large US Bank Holding Companies (BHC) over the period 1997-2004 it finds that bank risk-taking is positively related to strong bank boards. These results are robust especially for small and less restrictive boards. Meanwhile, observed evidence suggests that bank risk-taking is negatively related to CEO power. Pathan (2009) proposes that the risk-averse nature of bank managers comes from a willingness to protect their non-diversifiable human capital which is mostly concentrated in their managed banks. Moreover, a negative relationship between independent directors and bank risk may imply that the former would prefer to balance between the interests of shareholders and bank stakeholders such as depositors and regulators. In general the paper suggests that bank board structure is an important determinant of bank risk taking.

Meanwhile, Andres & Vallelado (2008) study the relationship between a bank's board and its risk-taking by focusing on both the size and composition of the board since these features influence directors' ability to monitor and advise managers. The overall findings suggest a non-monotonic relationship between board size and performance. The study covers 69 large commercial banks from

six developed countries over the period 1995-2005 and applies a two-step system estimator econometric model to solve unobserved heterogeneity and endogeneity problems. The authors find that the relationship between board size and its performance describes an inverted U-shape which implies a non-monotonic relationship as when boards reach an optimal size (19 directors), performance starts to diminish. They suggest that there is a trade-off between advantages of having a larger board (monitoring, advising) and disadvantages (control and coordination problems). The same inverted U-shaped relationship is observed between the proportion of outsiders and performance. In general, the findings support the idea that outside directors improve value but when the number reaches a majority of the total directors, Tobin's Q starts to lessen. Furthermore, they argue that outside directors should hold a majority on the bank board to help minimize the conflict of interest among stakeholders through monitoring and advising in an efficient manner. And in an efficient bank board non-executive directors' ability is complemented with the presence of executive directors and their knowledge and data concerning the bank. Overall, the authors stress the significance of having an efficient board not only for a bank's shareholders and stakeholders but also for national economic systems to ensure the safety and health of financial intermediation.

Erkens et al., 2012 analyse the importance of board composition in bank performance by focusing on three corporate governance factors - board independence, institutional ownership and the presence of large shareholders during the crisis. The study analyses why during financial crisis some financial institutions were affected more than others. The authors use data from 2007-2008 covering 296 financial firms from 30 countries that were at the centre of the financial crisis and find that firms with more independent boards and greater institutional ownership had lower stock returns during the crisis. Further analysis reveals that greater risk-taking is associated with increased institutional ownership but not with independent boards, contradicting the proposition those non-executive directors encouraged managers to take greater risks before the onset of the crisis. The poor performance of firms with independent boards is explained through the increased pressure of independent directors on managers to raise equity capital during the crisis in order to ensure capital adequacy and to lower bankruptcy risk. As equity capital rising was costly during that period, it could lead to wealth transfer from shareholders to debt holders but help them to survive the crisis. To measure the effect of large shareholders, the study uses a dummy variable with a cut-off of 10% in direct and indirect voting rights. It does not find any significant association with large shareholders and firms' weakened stock returns. Finally, the study advocates that corporate governance had an important impact on firm performance during the crisis through its risk management and financing policies.

2.1.3 Executives and Compensation Scheme

Executive compensation is often referred to as one of the key contributors to bank risk-taking behaviour. The principal question raised by many academics is whether executive compensation

schemes were the origin of banks' excessive risk-taking during the recent financial crisis. According to market discipline theory, a firm's executives are monitored and disciplined by its stakeholders such as shareholders, debt holders and by regulators so that the former act in their best interests. However, the recent financial crisis has demonstrated the ineffectiveness of the disciplinary channels through which they operate. The fundamentals of the problem may arise from the nature of bank capital structure which can directly influence the level of bank executive compensation. In line with agency theory, bank stockholders prefer that the CEO is compensated with stock options as this increases the CEO's pay/performance sensitivity. In this manner, a higher level of stock options motivates the CEO to higher risk investments at the expense of banks' debt holders (Dewatripont & Freixas, 2012). In measuring the ultimate influence of CEO compensation on bank risk-taking it worth using a measure of "residual compensation" introduced by Cheng et al (2010). Residual compensation is the residuals of a regression of compensation on firm size (its market capitalisation) and sub-industry level characteristics. In other words it is the compensation unexplained by firm size. For example, firms with high residual compensation include Bear Stearns, Lehman, Citicorp, Countrywide and AIG. It is also suggested that residual compensation is strongly correlated with several measures of risk-taking and with institutional ownership of the firm. A similar risk sensitivity measure of CEO compensation – "vega" - is proposed by Bai & Elyasiani (2013). "Vega" indicates the extent of change in CEO wealth relative to a one percentage point (.01) change in bank stock return volatility. The authors have analysed the relationship between insolvency risk and the executive compensation structure for large BHCs (Bank Holding Company) from 1992-2008. The study focuses on two indicators: the risk sensitivity measure of compensation – "vega", and pay-share inequality between CEOs and other top executives. As equity based compensation became significantly more prevalent after the deregulation of markets, CEO interests became more aligned with bank stockholders' interests as their compensation was more sensitive to banks' stock risk. Meanwhile the increased "vega" of compensation has resulted in increased risk-taking among banks since CEOs have excessive incentives to take on risk and increase their wealth. The study proposes that this trend may lead to greater instability in the banking system at the expense of depositors, bondholders and deposit insurers. Moreover, it suggests that the relationship between managerial compensation structures and bank stability is bi-directional i.e. higher risk-sensitive compensation results in riskier investment policies by CEOs whilst riskier BHCs operate managerial compensation structures, which are more sensitive to stock return volatility.

As a counterbalance to increased "vega" in managerial compensation practice the study presents the positive effect of pay-share inequality to bank stability. It is measured by the share of CEO total annual compensation in the total annual compensation of the top five executives in the same BHC and indicates pay-inequality in the top management team. The use of the this measure is based on the hypothesis that when the compensation share of a CEO increases relative to other top managers, a

CEO may become more risk-averse so as to not to lose his sizeable pay in the case of failure. He therefore takes less risk to avoid a greater downside loss and to lock his current position. This results in lower risk-taking and greater bank stability. The study uses natural logarithms of Z-score as a measure of bank stability. Moreover, the authors investigate whether BHCs use noninterest income activities as a channel to raise their risk-taking behaviour caused by increased "vega". The obtained results exhibit that BHCs with higher level of "vega" have greater levels of non-traditional banking and support the hypothesis brought by the authors. It is also important to notice the relationship the authors find between the Too-Big-To-Fail effect and the level of bank's "vega" since many large banks attempt to maximize the value of the implicit government guarantees. For this they divide BHCs into five quintile groups by the size of total assets. The empirical results confirm the effect of bank size on risk-taking behaviour through compensation. The findings show that the second largest BHCs increase "vega" more than other groups in order to encourage CEOs to take on more risk to achieve Too-Big-To-Fail status and to take advantage of government guarantees.

Executives are compensated for outputs such as bank performance as well as inputs such as the skills and experience they invest in the bank in so-called human capital. In fact, compensation schemes are designed to attract and retain skilful managers and it is natural to expect that higher compensation cultivates skilled corporate leaders, with significant upsides to their future earning power. However, debates over the origins of the ongoing financial turmoil are often related to the issue of a lack of human capital in banks' management. In particular the professionalism of banks' CEOs is repeatedly put under question. The work of Cuñat & Garicano (2010 investigates this issue of executive professionalism in a sample of Spanish savings banks known as Cajas. The authors intend to explain heterogenity in the performance of these banks from the prespective of corporate governance and human capital. The choice of Spanish Cajas is not accidental;they are characterized as an unusual segment of the Spanish financial sector which does not formally have shareholders and is heavily politicized. Moreover, shares of Cajas are not quoted on the stock market and thus major external disciplinary governance mechanisms do not work. The extended board of Cajas is formed by representatives of the local political authorities, representatives of the founders of the bank, relevant social institutions, workers and other stakeholders. Also, a substantial proportion of board members is directly appointed by local and regional governments. Considering the special features of Cajas the authors try to determine if it is beneficial to have knowledgeable chairmen through assessing their performance in portfolio allocation decisions and loan risk-taking. These decisions require relatively profound knowledge and experience while chairmen of Cajas are mainly retired politicians; their lack of required knowledge and inexperience in banking could be reflected in the CEOs key decisions. The study also analyses how corporate governance impacts on bank performance by examining the board composition and its effect on loan losses, rating changes and the composition of the loan portfolio. The authors created a synthetic index of the Chairman's human capital for most saving banks over the last

9 years from 2001 onward. Their findings exhibit clear and significant patterns in governance and the human capital of the Chairman. Specifically, the human capital level of the Chairman is closely correlated with the loan portfolio of the Caja before the Crisis (in 2007) and with the loan performance of the Caja during the crisis. In particular, a Caja run by a chairman with a post-graduate education, with previous banking experience, and with no previous political appointments is expected to have significantly less real estate lending in its portfolio, or a larger share loans to individuals ratio (loan concentration), a lower rate of non-performing loans, and a lower downgrade in its bank's rating. In general Cajas with fewer politicized board members had less exposure to real estate risks suggesting that CEO professionalization played a role in bank performance during the crisis. On the contrary, with respect to the governance of Cajas, the authors do not find a high correlation between governance and the composition of the loan book at time of the financial crisis.

In practice, bank executives' payments are also provided in the form of bonus payments to high-ability workers. The study of Bannier et al., (2013) addresses the rationale of why bonuses are paid by banks even at the expense of profit and social welfare. It presents a theoretical model of managerial talent's remuneration where agents of differing talent (or ability) have to decide on the allocation of funds between safe and risky projects. The type of agent (ability of manager) affects bank returns received both from safe and risky investments but it is unobservable i.e. private information. In the presence of competition for talented workers, the model is characterized by hidden information on agent ability and moral hazard with respect to choice of investment (safe/risky). In a model equilibrium, only high-ability workers receive bonuses, and excessive risk-taking is deliberately accepted in order to reduce low-ability workers' information rents. Consequently, authors suggest that rising competition for workers induces banks to offer higher compensation including bonuses to be able to attract skilful workers. Moreover, it leads to higher risk-taking and higher inefficiencies both from society's and the bank's point of view. Therefore legal restrictions on bonuses have a positive impact on bank profits and stability as well as social welfare.

Along with changes in compensation, executive turnover is also considered as an efficient internal managerial control mechanism to control top management. Schaeck et al., (2012) investigates the role of different stakeholders in disciplining bank executives through the application of two dimensions of market discipline: the ability of stakeholders to monitor and evaluate bank conditions, and their ability to influence a bank's actions. They primarily examine the monitoring roles of stakeholders and how they influence the likelihood of an executive dismissal in small and medium-sized unlisted US banks from 1990-2007. Consequently, the study evaluates changes in post-turnover bank soundness by looking at risk-taking, losses, and profitability to examine whether executive replacements have affected a bank's financial state. The results show that the probability of forced turnovers is robustly increasing with banks' increasing risk-taking. But further findings reveal that debt holders or regulatory actions do not contribute to this disciplinary mechanism since in those

banks where debt holders have a larger stake, or in banks where the regulator is aware of the distress, the frequency of turnover does not increase with bank risk. With respect to improvements in bank performance following turnovers, the results are not supportive. The preliminary findings show weak evidence that dismissals leads to reduced losses over three years following the event, but do not reduce risk or improve profitability. Further analyses demonstrate that, on the contrary, turnovers lead to higher risk levels with greater losses, and a sustained negative impact on profitability. The study therefore put in question the effectiveness of market disciplinary mechanisms for small and medium-sized banks notwithstanding their shareholders which are also not found to have an influence on bank soundness.

The experience and background of CEOs and their impact on bank risk/return efficiency is further analysed by Jonghe et al., (2012). They estimate an efficient risk/return frontier for Turkish commercial banks with the use of a stochastic frontier approach for the period 1988-2009 which includes the Turkish banking crisis of 2000-2001. The paper merges two aspects of risk/return trade-off studies: off-balance sheet banking activities and the impact of governance mechanisms – internal and external on risk/return efficiency. Unlike other research it investigates risk and return simultaneously by relating the risk of a bank portfolio to the returns that portfolio generates. Moreover, it sets apart internal governance, which involves the attributes of the strategic decision-making process, from external governance which relates to market and stakeholder oversight trying to impact and control decisions. The findings suggest that a more experienced CEO in most cases increases risk/return efficiency. In relation to size, larger banks tend to be risk/return, efficient possibly due to their wider opportunities and market power. However, the political background of bank chairmen is likely to have a negative effect on risk/return. The same negative effect is observed with respect to non-interest income. Moreover, their results are in favour of CEO non-duality i.e. when the CEO is not the chair of the bank board. They find that, in general, CEO non-duality helped to achieve a higher efficiency in risk/return trade-off, especially post crisis. Overall the work sheds light on the impact of corporate governance on bank risk/return efficiency in conditions of opaque bank activities, economic, regulatory and supervisory environments.

2.2 Bank Business Models

The financial crisis has highlighted a significant variability of performance and risk-taking across different banks. Academics and policymakers raise the question of if this variability could be explained through specific bank characteristics originating from their different business models. Prior to the crisis, many banks had moved away from traditional retail banking activities to “new” bank business models with complex securities, non-interest generating activities and wholesale markets funding structures. The shift towards new business models was mainly caused by financial innovations in credit markets as well as deregulation of the banking sphere. Extensive bank crashes

fosters debate over the characteristics of bank business models which have greater financial efficiency and stability.

A cohort of academic studies has investigated the relationship between bank business models and risk-taking behaviour. The research intends to identify whether there is any association between certain business model characteristics such as bank asset structure, capital structure, income source and funding strategy and excess risk-taking, and whether bank business models can help to identify the hidden risks which could materialize in long run or cause macroeconomic shocks. Altunbas et al., (2011) using a large sample of listed banks in the EU and US, observe banks' financial indicators before and during the crisis and investigate whether the variability across bank business models is related to their realized risk during the financial crisis. In general, the results reveal a non-linear relationship between bank business models. Specifically, a strong deposit base and income diversification are associated with lower risk, while less capital, large size, greater reliance on short-term money market funding and rapid credit growth correlate with higher risk. In general, the study encourages bank supervisors to distinguish the impact of different business models on bank risk to explain the divergence in risk realisation during the crisis.

Similarly, Köhler (2012) analyses the effect of loan growth and business models on bank risk level and revealed considerable heterogeneity in risk-taking across banks and countries. He suggests that banks with high loan growth rates are riskier. Also, he finds evidence that if banks increase their non-interest income share it positively affects stability while this effect decreases with bank size. Excessive credit growth is associated with high bank risk. Overall, the study summarizes that differences in lending activities and business models facilitate the identification of bank risk.

In this section we revise the selected characteristics of bank business models such as capital, assets, income sources and funding strategy and examine how these factors affected the risk-taking of banks during the crisis. Although we present them in separate sections, in practice it is impossible to disentangle their individual impact from other macroeconomic effects; hence in many cases we present the joint impact of the factors on bank risk-taking behaviour.

2.2.1 Capital Structure

The role of capital is prominent in analysing bank risk. Among other factors, insufficiency of bank capital is also extensively discussed among academics and policymakers as a contributor to the on-going financial turmoil. A strand of literature supports the hypothesis that lax regulation of banks including oversight of bank capital, restriction on bank activities and weak monitoring led banks to take excessive risks during the crisis. In fact, Basel's recommendations on capital level served as a cornerstone of prudential regulations for banks. However, it is believed that the Basel II Accord lowered the degree of regulator and supervisor involvement and promoted financial markets as a supervisory disciplinary device. Banks are allowed to undertake internal risk assessment models in identifying their capital requirements. As a consequence, coupled with other factors it led to the

problem of procyclicality. Procyclicality, stemming from Basel II, is blamed for bank excessive lending, the emergence of bubbles and a financial accelerator effect during the crisis. It is also supposed that Basel II capital regulation tends to reduce capital requirements in good times and increase capital requirements in bad times (Dewatripont & Freixas, 2012). The effect of procyclicality could be particularly important in downturns when banks could face a 'capital crunch' that would further restrict their lending. The regulatory proposal of Basel III on countercyclical buffers is intended to solve this issue. Meanwhile, empirical literature presents contradictory results on the relationship between capital and risk-taking.

Demirgüç-Kunt et al., (2010) research the role of bank capital in withstanding a shock such as the financial crisis. In particular, they investigate whether better capitalized banks had higher stock returns during the financial crisis. Also they examine which concept of capital is more relevant in stock valuation during the crisis and what items are counted as capital for regulatory purposes. The baseline model measures bank performance with a change in bank stock prices between quarters and relating it to change in its level of capital. It uses dummy variables which account for any possible omitted country-level effects such as macroeconomic shocks, systematic components, etc. and a matrix of bank-level control controls for bank-specific features (such as bank liquidity, reliance on deposits for funding, etc.) The results obtained from a large sample of international banks suggest that during the crisis banks with higher capitalization were better valued than undercapitalized banks though this trend is not observed before the crisis. Moreover, they find that big banks' stock returns are more sensitive to the leverage ratio as a capital measure than to the risk-adjusted Basel ratio. This may be explained by a lack of reliability to Basel risk-weighted indicators by market participants at the time of the crisis. Finally, it concludes that "higher quality capital" – Tier 1 and tangible common equity are more relevant.

Berger & Bouwman (2012) also examine the effect of capital on bank performance and whether it varies across financial crises and periods of economic stability. Here bank performance is measured in terms of survival and market share. Moreover, they test the joint effect of capital and size on bank performance during the crisis. The research has two baseline regressions which empirically measure the effect of capital on banks' survival and on market share in different time periods. Potential omitted variables are covered by a broad set of control variables. The main findings of the study support in general the hypothesis that capital helps banks to survive in line with Altunbas et al., (2011), Demirgüç-Kunt et al., (2010) and others. In addition to the findings of other similar research, it reveals that for small banks capital is essential for survival at all times and for medium and large banks only during banking crises. With respect to market share and bank size, capital helps small banks to improve their market share at all times, while for medium and large banks it is helpful only during banking crises.

The importance of Tier 1 capital for large banks is also supported by Beltratti & Stulz (2012). By analysing the relative stock return performance of large banks across the world during the crisis they find that that large banks with more Tier 1 capital, more deposits, less exposure to US real estate, and less funding fragility performed better than banks financed with short-term funds raised in the money markets and with more exposure to US real estate.

The outline of the interaction among bank capital regulation, the business cycle and the transmission mechanism is presented by Borio and Zhu (2012). In light of the evolution of the financial system, it explains the potential impact of minimum capital standards on the transmission mechanism by revising two issues: the influence of minimum capital standards on bank behaviour and their effect at the interest margin on the impact of monetary policy (Borio & Zhu, 2012). Two ways of how capital regulation effects bank behaviour are identified – through the capital minimum thresholds effect and through the capital framework effect. The former focuses on the costs associated with breaching the minimum threshold and on actions needed to prevent this. The latter looks at the broader influence of the capital framework on how a bank conducts its business. The authors suggest that with the evolution of minimum capital regulation from Basel I to Basel II the influence of prudential regulation and supervision on bank behaviour has been raised, with respect to both the threshold and framework effects. Consequently, the minimum threshold could have a greater variance over the business cycle. Obviously, risk measures tend to vary procyclically i.e. to be comparatively low during economic expansion and to be comparatively high during economic contraction. They argue that changes in the financial system and prudential regulation highlighted the importance of the risk-taking channels and that existing macroeconomic concepts and models are not sophisticated enough to capture these changes.

Dewatripont and Tirole (2012) also report the negative effect of micro prudential banking regulations leading to increased bank vulnerability. They argue that Basel I/II capital regulations fail to account for macro shocks and that countercyclical capital buffers recommended by Basel III help to deal with these shocks. The authors propose a model which departs from Modigliani–Miller in that outside equity and capital requirements matter and in where they analyse banking regulation in the presence of macroeconomic shocks. They note the desirability of self-insurance mechanisms such as countercyclical capital buffers or dynamic provisioning, as well as "macro-hedges" such as CoCos and capital insurance.

A number of empirical studies show that under the influence of banking competition, capital regulation may destabilize the banking sector and cause increased risk-taking. Hakenes & Schnabel (2011) present evidence on the presumed trade-off between competition and bank stability. They suggest that capital regulation may not always prevent banks' excessive risk-taking. They develop a model where banks first solve a portfolio problem by assessing the riskiness of projects from an available portfolio, and with given limited liability and deposit insurance banks are subject to a risk-

shifting problem. In the second model banks solve an optimal contracting problem by extending loans to entrepreneurs who determine the risk of their projects. In this case, the entrepreneurs are subject to a risk-shifting problem. The later model is based on a paper by Boyd & Nicolo (2005) where banks compete for loans and deposits but with added portfolio problems, costly bank equity and capital regulation. The authors analyse the impact of capital requirements on the risk of loans, bank correlation and bank default rate. They suggest that stricter capital requirements weaken competition for loans and lead to higher loan rates, increasing risk-taking by entrepreneurs by raising the risk of individual loans. Moreover, strict capital requirements may induce banks to choose a more correlated portfolio by increasing the probability of default. In general, the research summarizes that the ambiguous effect of competition on banks' risk-taking results in an ambiguous effect on capital regulation, and that capital regulation acts as a stabilizer when competition has a destabilizing effect and vice versa.

Schaeck & Cihak, (2012) also examine the impact of competition on bank capital ratios. They analyse why banks maintain capital levels above regulatory requirements although it is costly and may impede banks' ability to compete. The authors report that the observed capital ratios tended to significantly exceed minimum capital requirements in the period prior to the recent financial crisis and they seek explanations for this phenomenon. The study involves a large sample of European banks including commercial, savings and cooperative banks. Hypothetically, it is based on the theories of Allen et al., (forthcoming) which state that banks have excessive capital holdings due to market discipline arising from the banks' assets. In other words, increased competition encourages banks to have higher capital ratios because it demonstrates their commitment to monitoring. Besides, it attracts creditworthy borrowers despite a countervailing effect of deposit insurance. They also supposed that capital ratios are higher when shareholder rights are strongly protected, and that deposit insurance lowers capital ratios. In line with Allen et al(forthcoming)., Schaeck & Cihak (2012) find robust evidence that competition motivates banks to increase capital holdings and this evidence holds true prior to the financial crisis. This result is valid mainly for commercial banks but holds true even for not profit maximizing financial institutions such as savings and cooperative banks. A 1% increase in competition raises the average bank's capital ratio in the sample by up to 3.9%. Regarding bank size they also find that the increase in capital is greater for the average large European bank (4.2%) than for the average small bank in Europe (3.6%) supporting the view that smaller banks use different types of lending technologies than large banks, because smaller banks lend more to information-sensitive borrowers that require intensive monitoring mentioned by Berger et al., (2005). Stronger shareholder rights (or less dispersed ownership structures) are associated with higher capital ratios while agency problems and deposit insurance decreases capital ratios by reducing incentives to monitor.

2.2.2 Assets composition

Prior to the financial crisis there was a significant increase in the scale and scope of financial institutions. To some extent, the existence of a flat rate deposit insurance system contributed to the size and growth of banking assets. Many large banks were often perceived as "Too-Big-To-Fail" (TBTF effect), and thus deemed more likely to be rescued by their state authorities (Huang, et al., 2011; Demirgüc-Kunt and Huizinga, 2010; Tarashev et al., 2009). Consequently, investors and other market participants expected that systemically important financial institutions (SIFIs) would eventually be bailed out. This led to a lower level of effort in screening and processing information regarding these institutions by market participants. Moreover, flat rate deposit insurance encouraged banks to take on more risk. Each of these effects reduced the sensitivity of bank investors to bank risk-taking and led to a severe attenuation of market discipline.

Altunbas et al., (2011) find that ex-post bank risk is associated with ex-ante bank size and the degree of credit expansion in the years preceding the crisis. The realized bank risk is measured by several indicators such as likelihood of bank rescue, systematic risk and intensity of recourse to central bank liquidity. Probit and linear regression is applied to three measures of risk and to a group of independent variables. To measure bank distress during a crisis the study employs regression quantile techniques where the riskiest banks belong to the higher quantiles and less risky banks belong to the lower quantiles of the distribution. Regarding bank size, the empirical evidence suggests it has a different impact on the upper and lower quantiles. In other words, size is indeed associated with higher levels of risk during the crisis. The analyses also reveal that the level of loans to total assets is not significant in the lower part of the conditional distribution, but statistically significant for the upper quantiles, i.e. for most distressed banks. It suggests that rapid expansion contributes to an increase in distress for the riskiest institutions but has no effect on less risky banks. They conclude that loans are likely correlated with broad macroeconomic variables such as house price developments and strongly influenced by national factors.

Since the Too-Big-To-Fail" (TBTF) status of financial institutions implies greater government support and insurance coverage when it is in distress, depositors of these banks have little monitoring incentives. On the other hand, their shareholders have greater incentives to encourage management to take greater risks through risk sensitive compensations. Based on this hypothesis, Bai & Elyasiani (2013) examine whether managers in the largest BHCs received compensation packages encouraging them to take greater risk. They applied a measure of CEO compensation sensitivity to risk –"vega" - and analysed managerial compensation between different sized BHCs. To examine the TBTF effect, they divide BHCs into five quintile groups by the size of total assets. The first quintile group includes the smallest BHCs in the sample while the fifth comprises the largest ones. The results indicate that vegas vary considerably across different BHC sizes. Vegas of the large BHCs are several times higher than those of the small BHCs; the BHC group ranked second in terms of size displays the strongest

effect from size on vega. These findings are in line with TBTF effect. Moreover, they suggest that the managers of the BHCs in the group ranked second in terms of size are given the greatest incentives to take risks. It may be explained by BHCs in this quintile having the highest probability of achieving the TBTF status and benefiting from increased government guarantees, hence their shareholders are keen to reach this status.

As we stated earlier the joint impact of macroeconomic and institutional factors makes it difficult to disentangle the individual effects of risk-taking factors. Many academics hypothesise that monetary policy has a significant effect on bank assets, particularly on the growth of bad loans. Lowering interest rates by improving borrowers' net worth may result in banks lending to borrowers that were in the past deemed too risky (Bernanke, Gertler & Gilchrist, 1996). As a result many banks had to write down substantial portions of their loan portfolios during the crisis.

Jimenez et al., (2008) investigate how short-term interest rates influence credit risk-taking using a dataset of Spanish bank loan contract information -The Credit Register of the Banco de España (CIR). They use the German and Euro overnight interest rates as a measure of the status of monetary policy and analyse their impact on the riskiness of bank loans. They reveal that lower interest rates prior to the origination of the loans precede more lending to borrowers with either a bad or no credit history. Apparently, lower short-term interest rates induce banks to soften their lending standards and grant more loans to borrowers with a bad or no credit history. They argue that banks grant loans with a higher hazard rate explained as default probability normalized per time (a normalization that is desirable as loan maturity may also be affected by overnight rates). Therefore the authors conclude that the better a borrowers' net worth and the higher appetite for liquidity risk are not the only reasons for such banking behaviour; they also want to take more credit risk. Overall, monetary expansion reduces interest rates lowering the credit risk of outstanding loans and encouraging banks to take more credit risk. The empirical analyses show that small banks, banks that are flush with liquidity and commercial banks take on extra risk when interest rates are low. The authors suggest considering banks' balance-sheet strength, investment opportunities, moral hazard and type of bank ownership in shaping the impact of monetary policy on bank credit risk-taking.

Furthermore, Köhler (2012) also supports the proposition that banks with high rates of loan growth are more risky. His work identifies the effects of loan growth and banks' business models on bank risk for listed and unlisted European banks. Analysing banks during the period 2003-2006, he reports considerable heterogeneity in risk-taking across banks and banks types. To measure banks' lending activity, he uses a bank's abnormal loan growth rate and shows the difference between a bank's loan growth rate and the median loan growth rate of all banks from the same country and year. He finds that high rates of loan growth are associated with high bank risk. The reason may be that banks set low lending standards and collateral requirements in order to increase loan growth. Besides, banks that exhibit significantly higher rates of loan growth than their competitors may attract

customers who have not been granted a loan by other banks because of their credit quality. Applying various indicators to characterize periods of excessive lending growth, Köhler analyses whether high rates of aggregate credit growth led to an increase in individual bank risk. Results indicate that banks become more risky if aggregate credit growth is excessive, even in banks with lower rates of individual loan growth. Overall, the results indicate that differences in the lending activities and business models of banks help to identify risks, which would only materialize in the long-term or in the event of a shock.

The other great influence on assets structure is the securitization process. The development of securitization has contributed to a change in the nature of banks' assets structures. Basically, securitization let banks turn traditionally illiquid claims (overwhelmingly in the form of bank loans) into marketable securities (Altunbas, Manganelli, & Marques-Ibanez, 2011). Prior to the crisis banks were highly involved in securitization as it allowed to speed up the process of lending at the origination stage and in interbank markets, thereby increasing opacity via merging large amounts of information. Consequently, securitization contributed to the growth of the shadow banking sector since most of the assets held in the shadow banking sector immediately before the crisis were bank-originated loans, transferred to the shadow banks via securitisations. Consequently, securitization has been largely blamed as one of the contributors to excess risk-taking in the academic literature. We do not revise the impact of securitization on bank risk-taking in this section but examine the issue in the section on Financial Innovations.

2.2.3 Income Structure

Over the past two decades, banks have widened the range of products they offer to their clients by increasing the share of non-interest income in their profit. This caused a dramatic change in bank income structure in both US and European banking practices. The combination of traditional and non-interest activities results in a reduction of risk via diversification benefits, as claimed by some studies (Boyd et al., 1980; Kwan, 1998; Gallo et al., 1996 among others) while another strand of literature argue the opposite (De Young & Roland, 2001; Stiroh, 2004; Stiroh & Rumble, 2006 and Lepetit et al., 2008 among others). De Young & Roland (2001) cite three reasons why expending into non-interest income adds to bank risk: the high volatility of non-interest income - it is easy for borrowers to switch banks for this type of activity than from traditional lending activities; non-interest income might augment the bank's fixed costs such as the cost of hiring additional staff which could increase the operational leverage of banks; dissimilar to lending activities, regulators do not require banks to hold capital against non-interest income activity and this causes higher financial leverage. According to Stiroh, (2004) and Stiroh & Rumble, (2006) when banks expand to non-interest income activity this does not lead to increased diversification since interest income and non-interest income are highly correlated. In fact, this happens due to cross-selling of different products to the same customer.

Lepetit et al. (2008) revise the effect of expending into non-interest income on the risk-taking of the European banking industry. They state that in the framework of past financial deregulation, European banks as well as US banks faced significant changes in their operating environment. More European banks became engaged in new commercial activities such as non-interest income activities. The work analyses 734 European banks from 1996-2002 to see how these changes affected their risk-taking behaviour. Unlike previous works, the study splits non-interest income into commission and fee activities and trading activities and involves both small and large banks. The findings demonstrate that banks with expanded non-interest income activities exhibit higher risk-taking than banks performing traditional activities. The results are more robust for small banks with total assets of less than €1 billion. Furthermore, a higher share of commission and fee income signifies a higher risk and a higher insolvency risk while a large share in trading income exhibits a lower risk exposure and lower default risk.

When talking about the income structure of banks we cannot ignore its interrelation with other macroeconomic and institutional factors. Jonghe et al., (2012) investigate the relationship between corporate governance factors and non-traditional bank activities through a sample of Turkish banks before and after the Turkish banking crisis of 2000–2001. The work analyses the extent to which banks deviate from the best practice risk/return trade-off, given their particular set of assets and liabilities. Empirical evidence shows that CEO non-duality, staff education level, and an educational background in business of the CEO and/or the chairman improved risk/return efficiency post-crisis for banks that were actively involved in noninterest-income activities. They stress that for noninterest-opaque bank activities, CEO non-duality did not lead to more risk/return efficiencies pre-crisis, while it clearly did improve efficiency post-crisis. This is in line with theory of Hermalin and Weisbach (1998) model which predicts much monitoring by independent boards after a negative shock. Overall, the study advises that the relationship between corporate governance traits and risk/return efficiency is conditional on product complexity and the economic, regulatory, and supervisory environments.

2.2.4 Funding Strategy

The importance of funding strategy in defining the level of bank risk is now quite popular among academics. The implications of a bank's funding strategy for bank risk and return is investigated by Demirgüç-Kunt & Huizinga (2009) among others. The study examines how bank activity and short-term funding strategies affect risk and return trade-off. The sample was taken from the years 1995-2007 and comprises international banks with stock exchange listings. The study first intends to explain the variation in income and funding share through a range of bank level, bank environment variables. Next, the relationship between fee income and non-deposit funding on bank risk and return is tested. With the purpose of testing robustness it tests two alternative measures of bank risk and return. The possibility endogeneity of bank's risk and return is also revised. Research

findings support the idea that a higher non-interest income or non-deposit funding level contributes to higher bank risk though the impact of both variables on bank return is difficult to explain due to endogeneity concerns. The study concludes that overall, traditional banks – with heavy reliance on interest income and deposit funding - are safer.

Alternatively, Huang & Ratnovski (2010) also research the effect of bank funding strategies, specifically wholesale funding impact. In this work, they present two alternative models: "bright side" and "dark side" of wholesale bank funding. As a benchmark of "bright side" wholesale funding the CK (Calomiris & Kahn, 1991) model is used. It is then contrasted with an alternative "dark side" model with the introduction of costless and noisy signals of bank project quality. The results reveal that wholesale funding is beneficial when providers are informed, but with the presence of noisy public signals the incentives of fund providers to monitor banks and impose market discipline could be distorted and may lead to inefficient liquidation of a bank. The negative effects of wholesale funding relate to banks with extended exposures to standardized and tradable arm's length assets, with readily available public information and when wholesale funds are senior claimants.

2.3 Financial Innovations

In seeking the origins of the financial crisis, many studies refer to financial innovations as one the key factors. There has been a considerable amount of papers studying the effect of secondary market instruments such as credit derivatives, securitization, loan sells and credit default swaps on banks risk taking, liquidity and stability. In light of the on-going financial crisis, debates have intensified as to whether the use of these financial instruments is beneficial or harmful to bank risk level. It is also supposed that low interest rates preceding the crisis might have induced a search for higher yield from financial intermediaries. Securitization of loans offers attractive returns and low screening and monitoring of securitized loans or easier standards for new loans because of improved bank liquidity position (Rajan, 2005). The persistence of low rates for long periods of time might further amplify the securitization of bank assets.

Kero (2010) investigates the effect of financial innovation together with changes in the structure of macroeconomic risk in the U.S. economy. The study develops a model to explain the connection between macroeconomic risk and new financial instruments to banks' portfolio decisions. The model shows that the existence of credit derivatives induces banks to invest in more risky assets and credit derivatives. Though credit derivatives help to hedge the banks' idiosyncratic risk, they encourage the acquisition of more risky assets which eventually results in the rise of banks' portfolio variance. Different results are obtained in the study of European markets (Otero González et al., 2012).

The study shows that European banks using credit derivatives for hedging experience demonstrate improvement in their level of financial stability, while banks which opt for a speculative position negatively impact their financial stability. However, they do not find evidence to support the

hypothesis that banks exploit coverage to undertake more risky strategies. Their empirical evidence demonstrates that the use of credit derivatives does not affect the position of leverage of banks, signifying that banks would not take advantage of improving solvency caused by hedging to increase their level of leverage. This result is supported by the use of Z-score - a measure of distance to insolvency. The authors conclude that credit derivatives may not be a cause of the recent financial crisis with regards to Europe.

At this point it is natural to question the reasons why banks securitize. The study of Martín-Oliver & Saurina, (2007) sheds light into this issue through the study of selected Spanish banks – commercial, savings and cooperative banks. The research covers the period 1999-2006 when local banks started to actively participate in securitizing their assets. Fundamentally, securitization serves for reasons of liquidity. It allows banks to obtain liquidity from assets that otherwise cannot be sold in liquid markets. However, the authors point to significant differences across securitization products. For example, covered bonds are used only to refinance operations while ABS might also allow for risk reduction and regulatory capital arbitrage. After securitizing their assets, banks may issue funds and further increase their lending. Evidently, some banks are increasingly becoming mere originators of loans and distributors of their risk – the so called "originate to distribute" model. As soon as the loan has been granted, it is packaged into a bundle of other mortgages, receives risk assessment by a rating agency and is sold out. Banks involved in this type of operation are considered risky since their main income comes from fees and commissions from these transactions. In addition these banks dilute their incentives to monitor their borrowers since they transfer the credit risk to a third party. Another problem with these types of banks is their excessive reliance on the wholesale market to fund their lending growth. Authors distinguish between these two different products: covered bonds and ABS. In the case of covered bonds, they expect that liquidity is the only reason to securitize since risk or capital requirements are unchanging, while in the case of ABS banks they consider transferral of risk and/or arbitrage of capital requirements. The results of Martín-Oliver & Saurina (2007) suggest that for Spanish banks the main motivation behind loan securitization was liquidity needs. Those banks with more rapid credit growth, less interbank funding and a higher loan to deposit gap have a higher probability of both issuing covered bonds and resorting to the ABS, including RMBS. In general they don't find evidence of the originate-to-distribute model in Spain for the given period.

In contrast, later studies undertaken in Spain report a negative impact of securitization on banks' risk-taking. Carbó-Valverde et al., (2012) through analyzing changes in the quality of MBS and ABS securitization from 2000-2010 claim that securitazation may have deteriorated credit quality standards and led to higher loan defaults, ultimately worsening overall financial stability. They build a model in which loan growth, on balance-sheet credit quality and rating changes are estimated simultaneously. Since there were a significant number of rating changes during this period, the study

also analyses ratings of securitized deals by identifying factors which are considered by rating agencies and the sequence of ratings provided.

As stated earlier, Spain's market is characterized by very significant loan growth in pre-crisis years, in particular during 2006 where annual loan growth was above 25% on average. Securitization activity grew dramatically, mostly together with large increases in bank credits to the private sector, from being almost insignificant in the late 1990s to financing a large portion of loan growth in the years running up to the crisis. Unlike securitization in the U.S. market, in Spain the originating bank also acts as the servicer of the loan portfolio while borrowers are not typically aware of whether their loans have been securitized or not (Martín-Oliver & Saurina, 2007).

The findings of Carbó-Valverde et al. (2012) suggest that bank characteristics such as solvency, cash-flow generation and cost efficiency (on top of loan performance) affect ratings considerably. They reveal that these characteristics have a greater impact on the rating changes of savings banks compared with commercial banks. Moreover, banks located in regions with increased housing price growth in the years before the crisis also have higher impact ratings of securities issued by saving banks, suggesting their close link to regional territories. The sequence of ratings show that loan growth significantly affects loan performance with a lag of at least two years, and balance-sheet loan performance a lag of four quarters. Analyses of other factors suggest that the role of competition in stimulating loan growth has been more intense in savings banks.

The general evidence from the Euro Area and the U.S. is also in line with the findings in Spain. Maddaloni & Peydró (2010) undertake a broader study of inter-relations between bank risk-taking, interest rates, securitization and bank capital supervision pre-crisis terminating in 2008:Q3. They state that low short-term rates of monetary policy –too low for too long period – led to a softening of lending standards resulting in an accumulation of risk on banks' assets. At the same time, increased securitization activity and weak supervision of bank capital further amplified the impact of low monetary policy rates. The study supposes that low interest rates prevailing in economies for a long period of time may make riskless assets less attractive and may lead to a search-for-yield by banks (Rajan, 2005). Since the securitization of loans offered assets yielding attractive returns for investors at a time of abundant liquidity, it became widely used as an investment decision. Moreover, by securitizing their assets, bank could enhance their lending capacity, especially when the capacity constraint is binding (in times of high credit growth, partially stemming from low monetary policy rates) and grant more loans. Securitization may therefore intensify the impact of low interest rates on the softening of lending standards.

2.4 Impact of Competition on risk-taking

Many academic works concentrating on factors affecting banks' risk-taking hold the opinion that competition has a strong influence on bank risk. Since competition has traditionally been considered a source of excessive risk-taking it has been continually regulated in order to prevent bank

runs and instability in the banking system. These regulatory measures, as believed by many academics, gave rise to a long period of stability within the banking system. After the intense deregulation in the US and European banking sectors, banks were faced with intense competition in both national and international spheres. Consequently, there is an increasing concern that competition erodes banks' market power and monopoly profit leading to a decrease in banks' charter values. As there is less to lose, banks start to increase their risks which could eventually lead to bankruptcy or bank runs and contribute to overall economic distress.

Salas & Saurina (2003) argue that when markets are liberalised and regulations are relaxed, competition decreases profit and banks' charter value. In their study they have analysed 21 Spanish commercial banks within the years 1968-1998 to reveal the effects regulatory changes have on banks' market power. The data covers 31 years, involving the principle steps to deregulation which contributed to key changes in the Spanish financial market. It analyses banks' risk-taking behaviour in response to reduced economic profits caused by deregulation. The central question of the research is whether there is a trade-off between market efficiency and banks' solvency in the context of financial intermediation. The study advocates that in deregulated markets such as Spain, competition may eliminate external constraints to risk-taking, as well as internal constraints assumed to be voluntary, by the banks possessing market power. The results generally confirm that the measures of liberalization have influenced bank competition resulting in reduced market power and a decrease in banks' economic profits. Furthermore, lower economic profits caused by deregulation and increased competition fostered banks' risk-taking as their charter values decreased and they had less to lose.

Matutes & Vives (2000) have also investigated a relationship between banks' market power and risk-taking incentives but in the presence of limited liability and the social cost of failure. The study analyses the link between imperfect competition for deposits and bank risk-taking subject to limited liability, and tries to identify whether 'excessive' competition for deposits exist. According to the authors, limited liability is introduced with a standard debt contract between bank and depositor. Since banks' portfolios are not perfectly diversified, in the case of bank failure there is a social cost not borne by the bank. The paper makes the following suggestions concerning the social cost of failure, under different regimes: 1) assuming a lack of deposit insurance, where there is intense competition, banks tend to set inflated deposits rates resulting in a high social cost of failure. Under this regime banks do not internalize the cost of failure. In this case, the introduction of a proper deposit rate ceiling induces minimal risk taking; 2) flat premium deposit insurance tempts banks to engage in the highest possible risk-taking. Since investors do not have incentives to punish excessive risk-taking by the banks this induces banks to undertake maximal asset risk positions. In this case, the introduction of fair and risk based deposit insurance decreases excessive risk-taking on the deposit side because banks are fully liable for any consequences. The study summarises that high risk-taking incentives exist with flat-premium deposit insurance and could be minimized with the use of risk-based

insurance. It also emphasizes the role of limited liability, imperfect competition and the social cost of failure in analysing banks' risks.

The belief that more competition in banking causes a greater level of instability tends to focus on competition in deposit markets. However, far too little attention has been paid to loan markets. The study of Boyd et al. (2006) and Boyd & Nicolo (2005) argue that the conclusions of previous theoretical research are fragile since they allow competition only for deposits and not for loans, while in fact banks are simultaneously involved in both markets. The study compares two banking models, CVH (Charter Value Hypothesis) and BDN (Boyd & De Nicolo) and examines whether there is a trade-off between bank competition and stability. CVH is based on earlier work by Allen & Gale (2000, 2004) and allows for competition in deposit markets, but not for loans and it assumes that there is no contracting problem between bank and borrower. Unlike CVH, the BDN model allows for competition in both deposit and loan markets and assumes that banks solve an optimal contracting problem with their borrowers. CVH predicts a positive relationship between competition and risk of failure whereas the opposite is predicted by BDN. Both models have an important implication in that the relationship between bank competition and profitability can easily be non-monotonic. Empirical tests conducted on 2500 cross sectional US banks' data and a large set panel data collected from non industrialized countries find that more competition is *ceteris paribus* associated with a lower probability of failure. In other words, there is a positive relationship between competition and bank stability. Furthermore, the test reveals a positive link between bank competition and willingness to lend. As competition declines, banks earn more income in their loan markets through charging higher loan rates. This implies a high bankruptcy risk for borrowers due to a moral hazard problem i.e. borrowers faced with high interest costs choose higher risk-higher return projects. Consequently, the CVH model is rejected while the results are still consistent with the BDN model's predictions.

The debate continues regarding the type of relationship between competition and bank risk. The paper by Martinez-Miera & Repullo (2010) supports the Boyd and Nicolo (2006) proposition that bank competition reduces a loan's probability of default due to reduced loan rates. This effect is referred to as the risk-shifting effect. However, they argue that increased competition may also reduce the interest payments from performing loans, which serves as a buffer to cover loan losses. This effect is referred to as the margin effect. Unlike the above mentioned models, the study suggests a U shaped relationship between competition and banks' risk of failure where risk first decreases before starting to increase in a very competitive market. At some point, more competition leads to lower loan rates and reduces banks' interest income from non defaulting loans used as buffer for loan losses. Consequently, in highly concentrated markets the risk-shifting effect dominates and more competition reduces bank risk, whereas in very competitive markets the margin effect dominates and the increased competition erodes banks' franchise values and so increases risks. Accordingly, the probability of bank failure is lowest in moderate levels of competition.

The relationship between bank competition and risk-taking is further analysed within the Spanish national banking system by Jimenez et al., (2010). The authors support the franchise value paradigm in limiting bank risk taking. They advocate that bank managers and shareholders tend to limit and reduce their risk exposure to preserve the bank's franchise value. The source of franchise value is assumed to be the market power of a bank and a decrease in competition among banks diminishes their appetite for risk. Conversely, an increase in competition erodes their quasi-monopoly rents and the value of the charters and may lead to greater bank risk-taking and greater financial instability. The paper examines the impact of various measures of competition in loan and deposit markets and constructs measures of market power based on Learner indexes. The Learner index is commonly used to measure the market power of a firm and indicates the degree to which it can increase its marginal price beyond its marginal cost. The dependent variable for a bank's risk is a ratio of Non-Performing Commercial Loans (NPL) obtained from the credit register maintained by Banco de Espana. The results of loan market Learner measures indicate a negative relationship between banks' market power and risk-taking. Similar but weaker results are shown for deposit markets, although the joint loan and deposit Learner indexes indicate a negative and very significant impact on NPL ratios. Hence, the findings based on the Spanish Banking system support the franchise value paradigm while disproving Boyd and Nicolo's risk shifting effect i.e. the BDN model. Also, they find little evidence of a U shaped relationship between competition and risk suggested by Martinez-Miera & Repullo, (2010).

Furthermore, an inverted U-shaped relationship between regional bank competition and stability is found by Liu et al. (2013). The study examines the joint impact of competition and regional economic conditions on the risk and stability of European banks from 2000 – 2008. They argue that many studies of competition and risk-taking apply national measures of competition and/or national economic activity though the majority of banks have a regional customer focus. National measure may therefore be inadequate in certain market segments like retail deposits or small business loans, in which banks operate mainly at a regional level. Consequently, the authors advocate that regional competitive and economic conditions may be more relevant in analysing the risk-taking behaviour of these kinds of banks. By analysing the relationship between regional economic conditions and competition and their subsequent impact on bank risk in European banking they confirm the prevalence of a U shaped relationship between regional competition and banks. Particularly, risk-shifting effects appear to dominate in concentrated markets while margin effects appear prevalent in competitive banking markets as suggested by Martinez-Mirea and Repullo, 2009. Moreover, they advocate that regional economic conditions play a significant role in determining the stability of banks as banking risks may increase in regions with high unemployment. With regard to individual bank characteristics they find evidence that diversified banks are less stable than their smaller and more focused counterparts, whilst mutual banks seem to be more stable than their commercial banking counterparts.

Hakenes & Schnabel (2011) examine the joint impact of banking competition and capital regulation on bank risk-taking behaviour and find that capital regulation may destabilize the banking sector through its effect on banking competition. Specifically, evidence suggests that stricter capital requirements weaken competition for loans and lead to higher loan rates and so to higher risk-taking by entrepreneurs increasing the risk of individual loans. Moreover, strict capital requirements may induce banks to choose a more correlated portfolio by increasing the probability of default. They also find that capital regulations act as a stabilizer when competition has a destabilizing effect through the "charter value effect". In general, the research summarises that the ambiguous effect of competition on banks' risk-taking results in an ambiguous effect of capital regulations.

Tabak et al. (2012) investigate the effects of bank competition on the risk-taking behaviours of banks in 10 Latin American countries between 2003 and 2008. In particular, they examine how size and capitalization change the relationship between competition and stability. The study applies an innovative Boone indicator method (Boone, 2008) to measure the competition by assessing the impact of efficiency on performance. Specifically, the Boone indicator within the loans market measures the intensity of the effect of the earning market share of more efficient banks. They find supporting evidence that competition influences banks' risk-taking behaviour in a non-linear way and both high and low competition levels enhance financial stability, while they find the opposite effect for average competition. The authors suggest that the non-linearity of the effect supports both the concentration-stability (anti competition views) and the concentration-fragility (pro competition views) theories. They advocate that banks facing both high and low competition are, on average, lower level risk-takers than banks experiencing average competition. Also, the study reveals the importance of bank size and capitalization in analysing the impact of competition on bank risk. In particular, they find that the larger banks may reap greater benefits from competition since their size makes them less vulnerable. Similarly, greater capital ratio is beneficial for banks that operate in collusive markets, though capitalization only seems to have a positive impact on financial stability for larger banks. In other words, in collusive markets, banks with a larger capital ratio are more stable as shareholder capital disciplines banks under low competition. In general, the study proposes that average competition is not high enough to benefit large banks or low enough to trigger the advantages of capitalization.

Another study undertaken in non-European markets analyses the effects of competition on banks' risk- taking behaviour in four South East Asian countries comprising Indonesia, Malaysia, Philippines and Vietnam from 1998-2004 (Liu et al., 2012). The results are somehow contradictory: it supports the pro competition view suggesting that competition does not increase bank risk-taking behaviour while it also asserts that concentration is inversely related to bank risk, implying a positive relationship between competition and concentration. The received evidence casts some doubt on the traditionally expected inverse link between concentration and competition. However, as is noted by the authors, Claessens and Laeven (2004) examined the drivers of competition in 50 countries

applying H-statistic to measure competition and found that concentration tended to be positively related to competition. Liu et al., (2012) suggest that regulatory restrictions positively influence bank risk-taking. Reductions in restrictions on banking activities, particularly on foreign bank operations, appear to lead to higher levels of competition while increases in competition reduce bank risk-taking. The results seem robust for different model specifications, estimation approaches and variable construction.

2.5 The Risk-taking Channel of Monetary Policy

There are several studies which concentrate on the impact of monetary policy on bank risk. All these works intend to answer one question: how monetary policy affects risk-taking and what risk-taking channels it applies. It is widely believed that banks take more risk when monetary policy is expansive. This view supports the risk-taking channel theory suggested by Borio and Zhu (2008) and identifies the transmission mechanism as the risk-taking channel. In fact the theory studies the impact of changes in monetary policy rates on either risk perceptions or risk-tolerance and so on the degree of risk in the portfolios.

Extensive empirical evidence has been found suggesting that monetary policy could have a significant impact on banks' incentives to take on risks. Besides, it has been suggested that there is a strong link between monetary policy looseness and bank risk taking (Altunbas et al., 2009). This study finds a strong connection between relatively low interest rates and bank risk supporting the idea that monetary policy can have a strong impact on banks' balance sheet conditions and that loose monetary policy contributed to bank risk-taking. They undertake analysis of listed banks operating in the European Union (EU15) and the United States during and prior to the financial crisis using both the Taylor rule and the natural rate method. They note that changes in the financial system have contributed to strengthening this link. Moreover, the development of financial innovations and changes in the capital regulatory framework (Basel II) may further increase the risk attitude of banks. However, they admit that the mechanisms through which monetary policy may influence market participants' risk-taking are complex and at least need to be viewed in two dimensions: through amplification of the "financial accelerator", when monetary policy may influence the evaluation of collateral, asset prices and cash flows, thereby amplifying risk-tolerance of loan providers; through the "search for yield" process where market participants in conditions of low interest rates decide to take on riskier assets in order to increase their expected returns. The authors state that these two dimensions may be amplified if agents perceive that monetary policy will be relaxed in the case of decreasing asset prices in a financial downturn (the so-called "insurance effect" i.e. moral hazard problem). Overall, the study concludes that monetary policy is not fully neutral from a financial stability perspective

Similarly, Jimenez et al. (2008) investigate the effect of monetary policy on the appetite for credit risk in banks within the Spanish banking industry. Particularly, they investigate the effect of

short-term interest rates on banks' credit risk levels. Based on data from Spanish banks, the findings suggest that lower short-term interest rates motivate banks to soften their lending standards and provide more loans to borrowers with a bad or no credit history. An expansionary monetary policy is therefore most likely associated with higher credit risk. This view is widely supported by academics (Diamond and Rajan, 2006(Douglas & Raghuram, 2005); Dell'Ariccia & Marquez, 2006 and Delis & Kouretas, 2011 among others) and in general proposes that banks take more risk when monetary policy is expansive. Jimenez et al. (2008) advocate that as bank finances illiquid long-term projects with liquid demand deposits this causes a mismatch making bank reluctant to grant risky loans in times of liquidity shortages.

A negative relationship between interest rates and bank risk-taking is analysed by Delis & Kouretas (2011). The study is based on data from 16 euro area countries over the period 2001-2008. The empirical findings suggest a strong negative relationship between interest rates and bank risk taking; the negative relationship is stronger for banks which have higher levels of non traditional activities i.e. with higher volumes of off-balance sheet items, while for banks with higher levels of capitalization the relationship is weaker. Therefore, the study concludes that banks' involvement in non traditional activities and their level of capitalization is central in defining risk-taking behaviour, especially at a time of low interest rates. This paper is in line with the findings of Lepetit et al. (2008) discussed earlier in our review, stating that banks that expanded into non-interest income activities in general exhibit higher risk-taking than banks performing traditional activities.

Furthermore, Achraya & Naqvi (2012) argue when there is abundant liquidity, banks' managers may have an incentive to under-price the risk of investments; especially when managers are hedged from downside risks the risk-taking incentives amplify. This in turn induces an excessive demand for assets in the real sector and leads to asset price inflation i.e. price bubble. The authors state that when macroeconomic risk is high and investors switch from direct investment to savings in bank deposits, banks face excessive liquidity. This aggravates the risk taking moral hazard, giving rise to credit booms and asset price bubbles. Here, the situation worsens through expansionary monetary policy which results in flushing banks with even more liquidity. According to Achraya & Naqvi (2012), a central bank should adopt a contradictory monetary policy in times of excessive bank liquidity to limit banks' risk-taking incentives. Dell'ariccia & Marquez (2006) also have found that banks' incentives to screen depend on their cost of financing which is determined by the level of short-term interest rates. If interest rates decrease, banks' incentives to screen borrowers also lessen.

An extensive discussion of monetary transmission mechanisms are presented by Borio & Zhu, 2012. They state that more attention should be paid to the characteristics of the transmission mechanism in light of the recent evolution of the financial system. The paper examines the nexus between capital regulation and supervision, business fluctuations and traditional channels of the transmission mechanism. The authors define risk-taking channels as the transmission mechanisms

which provide the link between monetary policy and the perception and pricing of risk by economic agents. Based on the related literature they identify at least three ways in which such risk-taking channels may operate: through the impact of interest rates on valuations, incomes and cash flows (financial accelerator effect); through the relationship between market rates and target rates of return (search for yield effect); and through aspects of the characteristics of communication policies and the reaction function of the central bank (Borio & Zhu, 2012). In this channel the role of the regulator is very central; by increasing the degree of transparency it can decrease uncertainty resulting in a reduction in risk premium (transparency effect). By "censoring" the distribution of future outcomes, the regulator can imply that changes in rates have an asymmetric impact on behaviour, with reductions encouraging risk-taking by more than equivalent increases would curtail it (insurance effect). The study emphasizes that liquidity and risk-taking are tightly interconnected. It develops the concept by exploring the mutually reinforcing link with "liquidity" (defined as the ease with which perceptions of the value can be turned into purchasing power) and analyses its interaction with monetary policy reaction functions. The study concludes that changes in the financial system and prudential regulation elevate the importance of the risk-taking channel and that prevailing macroeconomic paradigms and related models are not well suited to fully capture it. These concepts may therefore have reduced effectiveness as prudent guides to monetary policy.

2.6 Regulatory and Institutional contexts

A number of academic papers studying bank risk taking concentrate on analysing the institutional and regulatory environment of the issue. For example, Houston et al (2010) examine the links between the level of creditor's rights, information sharing and bank risk-taking using a sample of 2400 banks in 69 countries. The study explores how these two factors affect the likelihood of a financial crisis and the overall banking system. The paper argues that the strength of creditors' rights and the level of information sharing have an effect on the contracting environment , on creditors' ex ante incentives as well as the recovery rates in cases of default. In particular, strong creditors' rights make creditors more willing to grant funds since their risk is reduced with higher recovery rates. On the other hand greater protection in the event of default may induce creditors to lend to borrowers with poor credit ratings. Meanwhile, the level of information sharing among creditors may also have an important influence on bank risk-taking since it helps to reduce costly information asymmetries. The study uses a number of variables to measure information sharing and suggests that stronger creditor rights are correlated with higher bank risk-taking and therefore increase the likelihood of financial crisis. Alternatively, better information sharing among creditors reduces the risk-taking incentives of banks and significantly weakens the positive link between creditor rights and banking crises. Specifically, it serves as a post lending diciplinary or monitoring tool for borrowers by enhancing banks' regulatory environment. In general, the study concludes that greater information

sharing results in greater bank profitability and lower bank risk leading to a reduced likelihood of financial crisis, and higher economic growth.

2.7 The Role of Market Discipline

Lately, much emphasis has been placed on market forces by the Basel Committee on Banking and Supervision (Basel II, Accord). It suggests bank supervisors use market information to improve the assessment of banks' financial safety and soundness. Under market discipline, the market correctly reflects individual bank risk levels as investors require a risk premium for any additional risk. This mechanism may increase banks' cost of funding and so banks will be discouraged from taking additional risk. Therefore, market information could be used by bank supervisors as a signal and also to complement accounting data in the design of early warning systems. In the meantime, the principal question raised is whether market prices convey additional information which is not already included in accounting data or whether the benefits from employing market information outweigh the cost of using market information (Curry et al., 2002). Empirical research of US banks supports the idea that market variables improve the assessment of bank financial health when added to standard call report financial data (Curry et al., 2002; Evanoff & Wall, 2001). Additionally, it is shown that the prediction of a CAMEL (supervisory) rating downgrade to the lowest levels can be significantly improved by adding market variables to a set of accounting indicators, although the predictive power is found to be significant only for banks in great financial distress (Curry et al., 2002). Empirical findings from a sample of EU banks analysed by Gropp et al. (2002), and Distinguin et al. (2005) suggest that equity market based indicators deliver earlier signal of fragility than debt based indicators. Overall, with rapidly changing financial markets, determinants of banks' excessive risk-taking need to adjust to a changing environment.

2.8 The Role of Credit Agencies

The credibility of the Credit Rating Agencies (CRA) has been shaken in the recent financial meltdown. As financial markets became more opaque and complex, the expertise of CRAs in assessing credit-worthiness have been increasingly demanded by investors. However, CRAs have been blamed for contributing to the creation of those market conditions which led to financial turmoil (Bahena, 2010). Since credit instruments originate from a pool of many loans it is difficult to assess their credit-worthiness for individual investors. Therefore, many investors used CRAs ratings which had been overoptimistic and experienced delays in reacting to changing market conditions.

CRAs have also been criticized for conflicts of interest as most ratings are solicited and paid for by the firm which is rated. Many banks issuing securities have maintained a close relationship with CRAs and due to this it is unclear whether the CRAs serve the interests of public or the paying entity. Moreover, CRAs provide paid consulting to entities which want to improve their ratings which are ultimately rated by the same CRA, thus creating other conflicts of interest (Bahena, 2010).

Evidence regarding the dynamics of rating changes and the objectivity of credit ratings assigned during the crisis raise a number of issues on the role of credit rating agencies in the economy. For instance Carbó-Valverde et al., 2012 report a delay in rating changes of four quarters for credit derivatives in Spain. They note a considerable delay before CRAs reassess their credit views though their involvement should go beyond providing passive credit quality certification and theoretically include a more active approach over the economic cycle.

Similarly, Ogut, et al., (2012) argue that the rating of a bank's financial strength can be very misleading and investigate whether the forecast of the rating of a bank's financial strength using the publicly available data is consistent with those of the credit rating agency. They build models to determine the significant factors that have an impact on bank financial strength ratings reported by Moody's. Data is comprised of 26 bank ratios – both financial and proxies of qualitative data, as independent variables. Banks' financial strength ratings by Moody's serve as dependent variables. The period of observation covers 2003-2009 and includes only Turkish banks. The empirical findings suggest that the most important factors are efficiency, profitability (ROE), and the proportion of loans in the assets. It is observed that the rating agency assigns a higher rating to those banks that generate high net income for shareholders, use resources efficiently, and channel funds as loans to households and businesses. The authors suppose that rating agencies find it less profitable for banks to place a high proportion of their funds (mainly deposits) in government debt securities indicating that the rating of a bank is higher if its risk is shared with different groups. The results are in general consistent with those of Moody's financial strength ratings.

The study by Ashcraft et al., 2010 analyses credit ratings on subprime and Alt-A mortgage-backed-securities (MBS) deals issued between 2001 and 2007 in the US market. The study covers 3,144 MBS deals differentiated into security and loan-level data representing around 60,000 securities and 12.1m loans, and covering nearly 90% of deals issued during this period. It investigates how well initial credit ratings summarized the variation in MBS default risk across this sample of deals in period leading to crisis. In particular, it analyses the consistency of MBS ratings in two dimensions: through time, and across deals from a given vintage backed by different types of loans. Furthermore, it examines how well credit ratings order relative risks across MBS deals from within a given cohort. The empirical evidence suggests that ratings are in general informative, hence it rejects the simple story that credit rating standards deteriorate uniformly over the pre-crisis period. However, it also reveals significant time-series variation in subordination levels i.e. it finds a significant decline in risk-adjusted subordination levels between the start of 2005 and mid-2007. Moreover, the study advocates the theory that MBS ratings did not fully reflect publicly available data which reported that high-risk deals, measured by a simple ex-ante model, considerably underperform relative to their initial subordination levels. Meanwhile deals with a high share of low-documentation mortgages also perform disproportionately badly compared to other types of risky deals. The authors do not present final

conclusions on the role of explicit agency conflicts in the ratings process but note the following observations: poor performance relative to ratings of deals backed by opaque low-documentation loans; the observed decline in risk-adjusted subordination around the peak of MBS issuance, when incentive problems are likely most severe.

2.9 Spanish Banking Sector

This section focuses on the Spanish banking sector and provides a brief review of country-specific and individual characteristics of banks operating in Spain. It also reviews the principle changes experienced by Spanish banks over the last three decades by analysing how these changes could have affected the overall risk position of banks. Finally, it intends to gather recent empirical findings on Spanish banks' risk-taking and draw general conclusions on their relative risk behaviour pre-crisis.

According to Garcia Marco & Roblez Fernandez (2008), there are several types of financial firms with different organizational forms and ownership structures which compete in the same market in Spain. Banks are primarily subdivided into commercial and savings banks, though in some literature three different organizational forms are used such as independent commercial banks, savings banks and subsidiaries (Crespi et al., 2004). Spanish commercial banks, also referred to as independent commercial banks, are shareholder oriented corporations owned by families, individual investors and institutional investors. Spanish savings banks (also known as "Cajas de Ahhoros"), unlike commercial banks do not have either formal owners or capital, and are considered to be a mix of mutual companies and public institutions. In terms of ownership Spanish savings banks are private foundations with a board of trustees represented by public authorities, depositors, employees, and the founding entities. Savings banks control about half of the Spanish retail banking market. Their earnings are either retained or invested in social and cultural programs. Subsidiaries are dependent banks and have another bank as a controlling shareholder. Though they are legally independent firms, they have a hierarchical relationship with their parent bank.

Over the last three decades the Spanish banking sector has experienced many changes in its operating environment. This has mainly been initiated by the waves of deregulation and liberalization aimed at harmonizing the national regulatory structures imposed by the European Monetary Union. As mentioned above, these changes have also triggered increased competition between commercial and savings banks due to narrowed performance gaps among banks' organizational forms.

Jimenez et al. (2008) point up that Spanish banks continue to play a key role in the country's economy and in the financing of the corporate sector. For instance in 2006 their deposits (credits) to GDP reached 132% (164%). Since the majority of non-financial firms had no access to bond financing, the securitization of commercial and industrial loans is still very low (4.8% in 2006). Integration with Europe began in 1989 when Spain formally joined the European Monetary Mechanism. But Spain had implicitly been part of it since 1988 after joining the European Union in 1986. After joining the EU

"monetary conditions consequently became fairly exogenous and basically "set in Frankfurt"" (Jimenez, et al., 2008: 11).

According to Tortosa-Ausina (2003), Spanish savings banks were previously subjected to more severe restrictions in specializing in territorial expansion than commercial banks. As a result of deregulation, saving banks began gaining greater market share which occurred principally at the expense of private commercial banks (Kumbhakar et al., 2001). The same comparative advantage was observed in consolidation processes. Commercial banks cannot acquire savings banks due to their ownership form, but the opposite is possible. Therefore, savings banks are able to expand by opening new branches and through consolidation regardless of their ownership form, whilst commercial banks are allowed to acquire only other commercial banks.

Numerous empirical studies of the Spanish banking system show that the liberalisation measures which increase the level of competition have a significant impact on reducing the market power and economic profits of Spanish banks. For instance Crespi, et al. (2004) found a continued erosion of the financial intermediation margins. In 1990, the spread between interest paid on deposits and interest earned on loans showed 5.5% points. In 2000 it had reduced to 3%. They argue that increased competition and lower profit margins fostered a number of mergers and acquisitions among banks. Alternatively, Jimenez et al. (2010) tested the relationship between bank competition and bank risk using data for the Spanish banking market and found that there is a trade-off between competition and financial stability.

Our review of the empirical literature showed that the risk-taking behaviour of a bank is generally affected by a bank's corporate governance (its ownership structure, the degree of ownership concentration, degree of owners' power), a bank's business model, financial innovations, general macroeconomic state, competition in the banking industry and other regulatory and institutional factors. In terms of the nature of these relationships the findings are somehow contradictory. Corporate governance factors demonstrate very controversial impacts on risk-taking. Particularly they suggest that:

- risk taking drivers may originate from the legal organization form of the bank;
- high ownership concentration may be associated with better loan quality and lower asset and insolvency risks which may decrease banks risk-taking incentives;
- widely held banks may not increase their risks in response to deposit insurance and banks with more powerful owners may be predisposed to take greater risks;
- banks with large and powerful owners have a tendency to take more risks than banks controlled by managers.
- widely held banks and banks with higher CEO control may exhibit less risk-taking than banks with a controlling owner

Regulatory and institutional incentives focus on the impact of financial market deregulation and liberalization which leads to increased competition among banks and eventually may result in increased risk-taking. It is argued by many academics and policymakers that restricting competition in banking helps to achieve sounder banking systems by preventing the erosion of a bank's charter value.

Also, the importance of monetary policy and knowledge of its risk-taking channels to better predict the risk behaviour of financial institutions has been emphasised. We also note the role regulators took in the recent crisis. Policymakers impose regulatory requirements on minimum levels of capital to prevent high levels of leverage and to reduce incentives for high risk-taking. The study also considers the role of rating agencies as they are deemed to be one of the contributors to the crisis for failing to predict the banks' downturn.

Bank business models are also referred to as an important determinant of bank risk behaviour. As studies suggest ex-post bank risk is associated with ex-ante bank size and the degree of credit expansion in the years preceding the crisis. Moreover, it is found that banks with more deposit base funding are less risky than banks with a higher market funding. Some academics argue that knowing the impact of different business models on bank risk helps to explain the divergence in risk realization during the crisis.

It is also believed that a higher level of capital decreases the bank risk because the higher the capital reserves, the stronger the buffer to withstand losses especially during a crisis (Demirgüç-Kunt, Detragiache, & Merrouche, Bank Capital, 2010), (Berger & Bouwman, 2012), (Beltratti & Stulz, 2012). Moreover, evidence suggests that less leverage reduces risk-shifting incentives from shareholders towards excessively risky projects at the expense of debt holders especially in conditions of quasi-flat deposit insurance. A number of studies advise that a higher level of capital motivates a more intensive screening of borrowers and negatively affects risk. On the other hand, some studies find a positive relationship between bank capital and risk due to regulators or market pressure to raise capital or because banks with more capital have a greater risk absorption capacity and thus take on more risk (Berger and Bouwman, 2010,). Lastly, there is a non-linear relationship where both very low and very high levels of capital induce banks to take on more risk (Altunbas, Manganelli, & Marques-Ibanez, 2011) .

3 Data and Methodology

The on-going global financial crisis has further intensified interest in understanding the causes of excessive risk-taking within banks. Many academic studies attempt to explain banks' risk taking behaviour and to ascertain if it would have been possible to predict or prevent the financial crisis. The purpose of our study is to empirically evaluate risk-taking determinants of the Spanish banking sector and to summarize their overall effect on the risk-taking behaviour of Spanish banks between 2004 and 2011. Based on empirical studies undertaken so far we have provisionally classified bank risk drivers

into a number of factors. Although we have reviewed these factors in distinct sections, we found them to be interrelated and mutually amplifying in affecting bank risk-taking behaviour. The choice of the Spanish banking sector is not accidental; before the crisis the Spanish banking sector was believed to be one the best and safest in Europe, but following the crisis it proved to be one of the most troubled banking sectors in the EU zone. Our study applies dynamic panel data and Generalized Methods of Moments (GMM) to avoid endogeneity problems, and explains why some banks experienced greater problems during the crisis than others.

Our main research question is: *What were the main determinants of banks' excessive risk-taking during the financial crisis for a representative sample of Spanish banks*.

By revising existing theoretical and empirical literature, we conditionally classify bank risk-taking factors taking into the following categories: corporate governance, business models (with special emphasis on capital), competition, financial innovations, monetary policy and other regulatory and institutional factors. Since we do not have access to all types of data, our empirical work focus only on those risk determinants for which we are able to collect data. Our sample comprises 91 Spanish banks, selected by applying the following criteria (Table 3-1):

Table 3-1 Criteria of the search strategy

World Region/Country	Spain
Accounting standards	International Accounting Standards, International Financial Reporting Standards (IFRS)
Specialisation	Commercial banks, Savings banks, Cooperative banks
Listed banks	Listed and unlisted banks
Total Assets	2007, min 1,000,000 (thousand EUR)
Time Period	2004-2011

The data is taken from the BankScope International Bank Database provided by Fitch/Bureau Van Dijk and includes listed and unlisted Spanish commercial, savings and cooperative banks from 2004-2011. In Spain commercial banks, savings banks and cooperative banks compete under equal conditions in the loan, deposit and financial service markets. Regulations, accounting practises, external reporting and credit-risk management standards are practically identical for all. The time period over which we have chosen to conduct this study allows us to see changes in banks' data prior to the crisis as well as the extent of the impact of the crisis in later years.

3.1 Dependent Variables

In our research we use several alternative risk measures. In this way our results do not depend on specific definitions of bank risk and take into consideration different aspects of risk realization.

Table 3-2 Dependent variables

Variables	Definition	Source
Z-score	Measure of Insolvency risk Zscore=(ROAA+Equity/Total Assets)/σ ROAA	Bankscope
NPL	Impaired Loans(NPLs)/ Gross Loans	Bankscope
Loan Loss ratios	Loan Loss Reserve / Gross Loans Loan Loss Provisions/Net Loans	Bankscope

Our main dependent variable is Z-score. It is used frequently in many of the research papers discussed in our literature review as a measure of bank insolvency risk and serves to determine the financial stability of an entity. It is determined in the following way:

$$Z \equiv \frac{\mu + k}{\sigma}$$

where:

μ is the ROAA (Return on Average Assets)

k is the balance of capital relative to total assets of the entity (Equity / Total assets)

σ is the standard deviation (volatility) of ROAA.

By applying Z-score we estimate the level of exposure to insolvency risk for each of the financial institutions in the sample and in each of the years studied (2004-2011). The Z-scores indicate the number of standard deviations that the return of the assets of a particular entity would have to decrease below its expected value to cause the consumption of all available capital. Therefore, the ratio Z-score measures "the distance to insolvency of an entity"; a higher Z-score implies a lower probability of default risk (or higher financial stability) and vice versa. We also use alternative measures of bank risk such as non-performing loans (Impaired Loans/ Gross Loans), loan loss reserves (Loan Loss Reserve / Gross Loans) and loan loss provisions (Loan Loss Provisions/Net Loans).

3.2 Hypotheses and Explanatory variables

According to Iannotta et al., (2006) bank ownership structure can be measured in two aspects: nature of ownership and ownership concentration. Consistent with the property rights hypothesis, private (commercial) banks are expected to be more efficient than public banks (savings and cooperative banks). However, high ownership concentration i.e. banks with large block holders exhibit greater risk-taking behaviour compared to banks with dispersed ownership. At the same time large block holders can be part of a bank's internal governance mechanisms and are able to monitor managerial decisions. Also, if a bank is widely held, its risk-taking may be disciplined by market participants. Laeven & Levine (2009) also conclude that the comparative power of shareholders in a

bank's governance structure affects its level of risk-taking; they find that powerful bank owners tend to induce bank managers to increase risk taking. Moreover, Gropp & Köller (2010) suggest that owner controlled banks had higher pre-crisis profit and larger post-crisis losses.

Based on these propositions we suggest the following hypotheses regarding ownership structure

H1: Privately owned banks (Commercial banks) have higher risk than other forms of ownership (savings and cooperative banks)

H2: Higher ownership concentration causes greater risk-taking

H3: When a bank is widely held it results in lower risk-taking

The opaque and complex nature of the banking system makes stakeholder monitoring of bank performance difficult, increasing the importance of a bank's board of directors in corporate governance issues. However, when a bank's board is strong i.e. it can effectively monitor bank managers on behalf of shareholders; its risk-taking also increases (Pathan, 2009). These results are robust especially for small and less restrictive boards. Bank composition and size are also found to be related to bank risk-taking behaviour (Erkens et al., 2012; Andres & Vallelado, 2008). We therefore examine the following hypotheses:

H4: Bank risk-taking is positively related to a strong bank board (small board with more independent directors)

H5: Bank risk-taking is inversely related to 'CEO power' (when CEOs have significant influence on board decisions)

We analyze the relationship between bank business models and risk-taking behaviour to identify any associations between certain business model characteristics (asset structure, capital, source of income or funding strategy) and excess risk-taking. Altunbas et al., (2011) find that a strong deposit base and income diversification are associated with lower risk while less capital, large size, greater reliance on short-term money-market funding and rapid credit growth correlate with higher risk. Köhler (2012) finds that banks with high loan growth rates are riskier. Moreover, he reports that if banks increase their non-interest income share it positively affects stability, although this effect decreases with bank size.

In relation to capital, it has been observed that during the crisis banks with higher capitalization were better valued than undercapitalized banks, though this trend is not apparent before the crisis (Demirgüç-Kunt et al., 2010). Regarding the joint impact of capital and bank size, we expect that for small banks capital is always essential to ensure their survival while for medium and large banks it is essential only during banking crises. We therefore test the following hypotheses in respect to capital and risk-taking:

H6: Higher levels of capital lead to lower bank risk

H7: A stronger capital position (higher Tier 1 capital) achieves a better market value during crises

H8: Capital enhances the banks' probability of survival during financial crises and periods of economic stability

H9: The capital of small banks helps them to survive at all times, for medium and large banks only during banking crises

Altunbas et al., (2011) find that ex-post bank risk is associated with ex-ante bank size and the degree of credit expansion in the years preceding crises. During the financial crisis many large banks were often perceived as "Too Big To Fail" (TBTF effect), and thus deemed more likely to be rescued by state authorities (Huang, et al., 2011; Demirgüc-Kunt and Huizinga, 2010; Tarashev et al., 2009). Moreover, lower interest rates prior to the origination of loans gave rise to more lending to borrowers with either a bad or no credit history (Jimenez et al., 2008). Köhler (2012) finds that high rates of loan growth are associated with high bank risk. The development of securitization has also contributed to changes in the nature of the bank asset structures by allowing banks to turn traditionally illiquid claims (overwhelmingly in the form of bank loans) into marketable securities (Altunbas, Manganelli, & Marques-Ibanez, 2011). Based on empirical studies, our hypotheses in respect to bank assets are:

H10: Bank size and loan ratio are positively related to risk

H11: Securitization increases the overall risk of default of banks measured by Z-score and other risk-taking proxies.

Another determinant of bank business models is income structure. Banks with expanded non-interest income activities exhibit greater risk-taking behaviour than banks performing traditional activities (De Young & Roland, 2001; Stiroh, 2004; Stiroh & Rumble, 2006 and Lepetit et al., 2008). The effect of non-interest income activities can be further analyzed by splitting said activities into commission and fee income and trading income. A higher commission and fee income share of non-interest income indicates increased risk and a greater risk of insolvency (Lepetit et al., 2008). Our expectations regarding bank income structure are as followings:

H12: Banks with high non-interest income have higher level of risk than banks with traditional income.

H13: Banks with more fee-based income exhibit higher risk

The final component of bank business models is funding strategy. Huang & Ratnovski (2010) argue that with the presence of noisy public signals, fund providers' incentives to monitor banks and impose market discipline may be distorted and lead to inefficient liquidation of a bank with higher wholesale funding. Altunbas et al., (2011) also suggest that banks with a broader deposit base were more resilient during the financial crisis. Hence we expect the following:

H14: Non deposit funding shares increase bank risk

H15: Short-term marketable securities increase risk

Table 3-3 Variables and hypotheses considered

Variable		Prediction		Definition	Source
		Z-Score	Credit Risk		
Total Risk of default [Z-Score]		Dependent variable		Return on average assets plus the balance of capital-to-total-assets over the volatility of ROAA	Bankscope
Credit Risk	NPL ratio % [Imparedloans]	Dependent variable		(non-performing loans / total gross loans)	Bankscope
	Loan loss reserve % [Loanlossres]	Dependent variable		Loan loss reserve / gross loans %	Bankscope
	Loan loss provision % [LoanLossPtoloans]	Dependent variable		Loan loss provision / gross loans %	Bankscope
Nature of ownership [Savdummy], [Comdummy] & [Coopdummy]		+/-	+/-	Dummy variable for Saving banks, Commercial banks and Cooperative banks respectively.	Bankscope
Ownership concentration [BvDdummy]		+	-	Proxy BvD Indep. Indic. With cut-off rate 25%. If widely held=1 (with the largest owner no more than 25% of share), otherwise 0.	Bankscope
Capital [Capitrat]		+	-	Total Capital Ratio/Capital Adequacy Ratio: Tier 1 + Tier 2 as a percentage of risk weighted assets and off balance sheet risks	Bankscope
Tier 1 Capital [Tier1]		+	-	Shareholder funds plus perpetual non cumulative preference shares as a percentage of risk weighted assets and off balance sheet risks measured under the Basle rules	Bankscope
Loan ratio [Netloantoas]		-	+	Net loans/Total assets -percentage of the assets of the bank tied up in loans	Bankscope
Level of securitization [RMBS]		-	+	Outstanding balance of securitized assets / total assets	Annual report and Pillar III disclosures
Bank size [Logtotassets]		-	+	Natural logarithm of total assets	Bankscope
Non-interest income [NonIntIn]		-	+	Non-Interest Income/ Gross Revenues %	Bankscope
Fee-based income [FeesCommtoOpProf]		-	+	Net Fees & Commissions/ Operating Profit %	Bankscope
Trading Income [TradingfeestoOpprof]		+	-	Net Trading fees/Operating Profit %	Bankscope
Non-deposit funding [Moneymarkfunding]		-	+	Other Deposits & Short-term borrowings/Total Deposits, Money Market Instrument & Short-term Funding	Bankscope
Short-term Marketable Securities [otherdeptototal]		-	+	Other Deposits and Short-term Borrowings/Total Assets	Bankscope
Deposits [DepostoAssets]		+	-	Total Customer Deposits/Total Assets	Bankscope
Loan growth rate [Growthloans]		-	+	Annual growth rate of Gross Loans	Banksope

3.3 Descriptive analysis

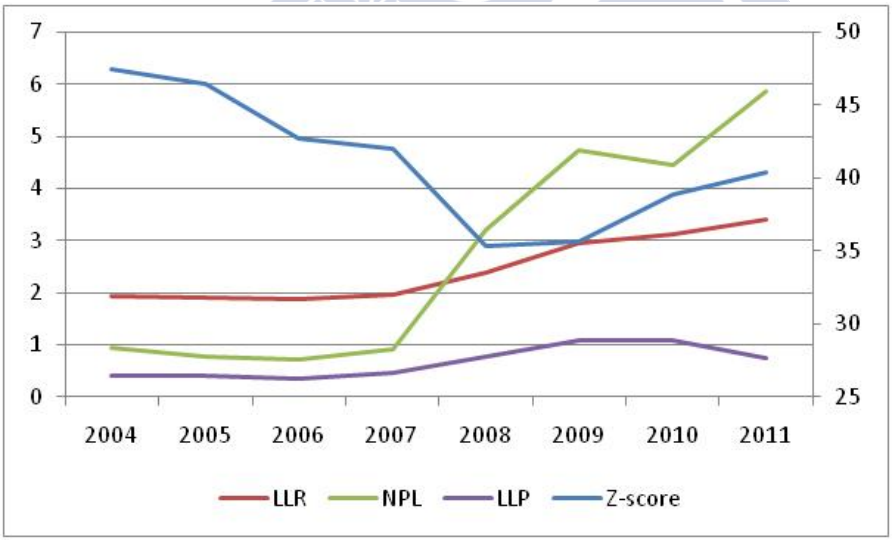
Our data includes three types of banks: commercial, savings and cooperative. Table 3-4 shows the quantity of each type of bank and their percentage weight in sample Total Assets for the year 2007. As one can see from the table, even though commercial banks comprise 27 entities they hold more than half of the total assets of the sample in the given period. Cooperative banks have the lowest weight both in terms of quantity and total assets.

Table 3-4 Sample characteristics

Bank ownership nature	Number of banks	% in Sample Total Assets
Commercial banks	27	58.6%
Saving banks	46	38.8%
Cooperative banks	18	2.6%
Total	**91**	**100%**

The evolution of bank risk over the observed period (See Figure 1), represented by 4 dependent variables (Z-score, LLP, LLR &NPL), shows the evident impact of the crisis indicated primarily by a rapid increase in NPL (Net Performing Loans) starting from 2007 and a decrease in Z-score over the same period. Loan Loss Reserves (LLR) and Loan Loss Provisions (LLP) act relatively similarly and also exhibit higher levels of credit risk from mid-2007 onward with a slight decrease in 2010 when massive bank reconstructions were implemented.

Figure 3-1 Evolution of bank risks over 2004-2007



We also review the evolution of Z-score and NPL for each bank type (See Figure 2 & 3). In 2004 commercial banks have the highest Z-score and lowest NPL but show a downward trend in Z-score until 2008, remaining stable thereafter. Unsurprisingly, savings banks exhibit the highest level of risk in both charts, with a dramatic increase in the level of nonperforming loans from 2007 onwards.

Figure 3-2 Evolution of Z-score by bank type

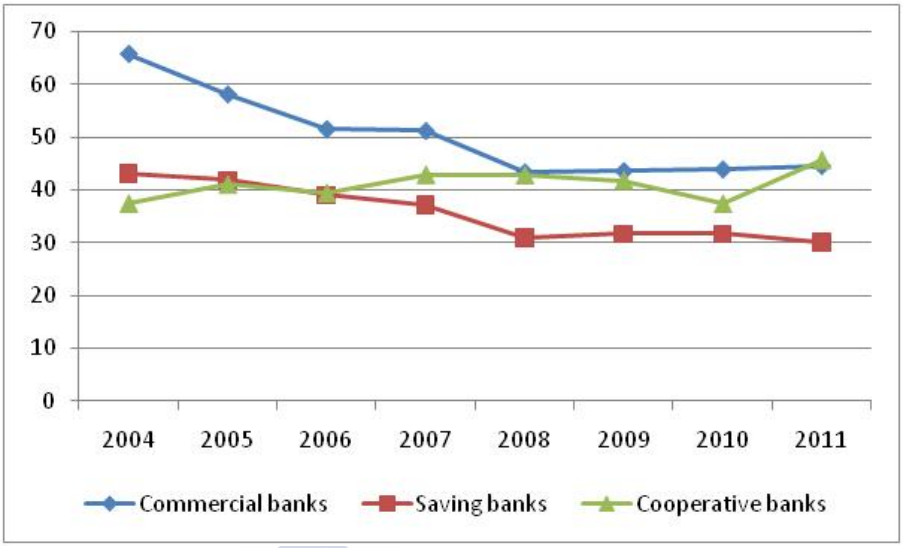
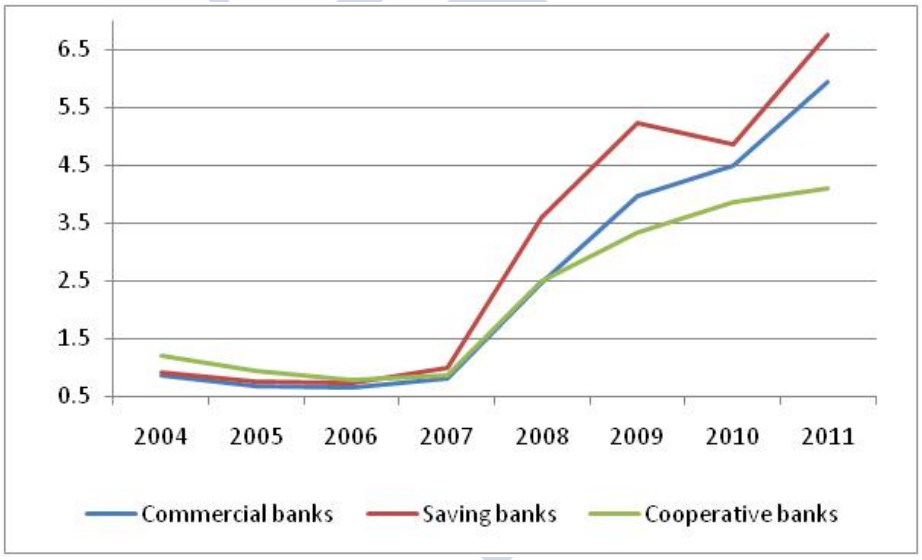


Figure 3-3 Evolution of Impaired Loans by bank type



The summary of descriptive statistics for dependent variables is subdivided into pre-crisis (2004-2007) and post-crisis (2008-2011) periods. Table 3-5presents variations of coefficients- mean and standard deviations in two periods. Before the crisis the mean Z score was higher and standard deviation lower implying lower pre-crisis insolvency risk. Consequently, credit risk variables exhibit lower mean and lower dispersion from 2004-2007 than from 2008-2011.

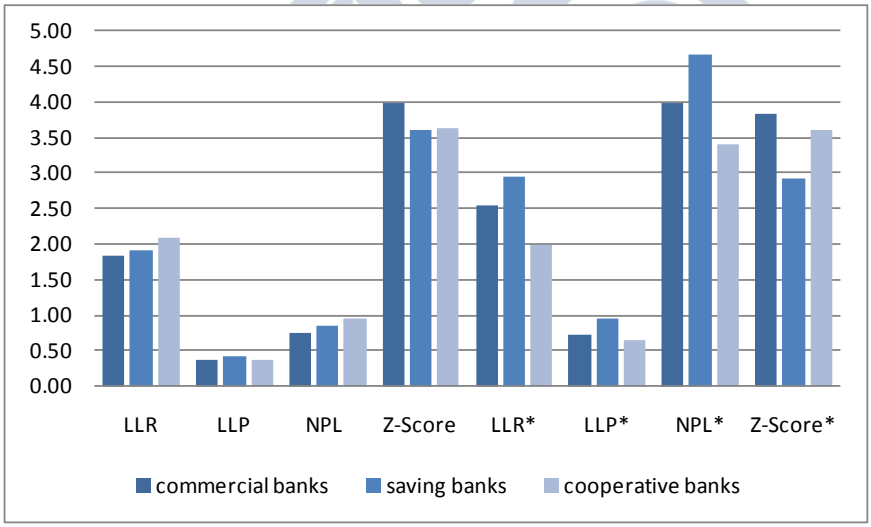
Table 3-5 Descriptive statistics for dependent variables before and after crisis

Variable	Obs	Mean	Std. Dev.	Min	Max
2004-2007					
Total Risk of default [Z-Score]	364	41.976	54.050	0	437.486
Loan loss reserve % [Loanlossres]	282	1.909	0.362	0.23	3.144

NPL[9] ratio % [Imparedloans]	277	0.834	0.453	0.13	3.02
Loan loss provision % [LoanLossPtoloans]	321	0.390	0.242	-1.391	1.725
2008-2011					
Total Risk of default [Z-Score]	364	30.550	68.460	-1.335	789.286
Loan loss reserve % [Loanlossres]	219	2.655	1.387	0	7.802
NPL ratio % [Imparedloans]	207	4.259	2.597	0	16.1
Loan loss provision % [LoanLossPtoloans]	254	0.804	1.299	-13.621	9.837

To reveal further differences we look at the statistics across different bank types over the same periods. Figure 3-4 Mean comparison by bank type presents results for commercial banks, savings banks and cooperative banks respectively. As it can be seen in tables, statistical indicators worsen after the financial crisis. Before the crisis commercial banks show less exposure to risk than savings and cooperative banks, exhibiting higher Z-score value and lower credit risk indicators. Conversely, credit risk variables of cooperative banks show the highest exposure to credit risk in the sample with an average of 2.09 in LLR and 0.93 in NPL. From 2008-2011, all three bank types' indicators deteriorate with lower mean and higher standard deviations. Savings banks Z-score reduces by half while the mean NPL value increases by over 500% to 4.6. Savings banks' maximum NPL level is 16.1, which is the highest in the sample. Mean NPL of commercial banks also increases by over 500% indicating an average of 3.9 with an increased dispersion of 2.7.

Figure 3-4 Mean comparison by bank type



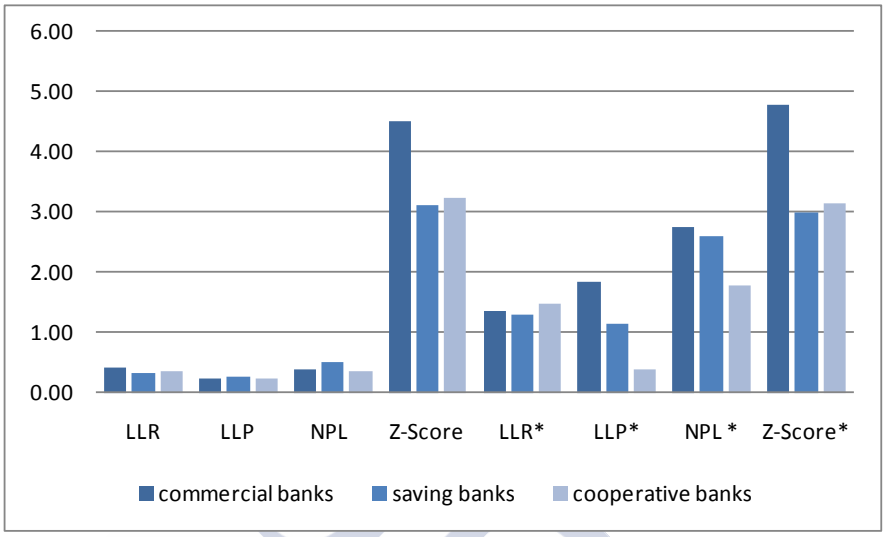
Note: * shows values for post-crisis period (2008-2011), all values are shown in % except Z-score values which are shown in natural logarithm to facilitate comparison

Descriptive statistics of independent variables for all bank types before and after the crisis are given in Table 3-7. Independent variables generally exhibit similar changes as dependent variables with decreased mean and dispersed standard deviation. The most significant changes are observed in loan growth rates which drop from an average of 22.08 to 2.4 and non-deposit funding from an average of 7.2 to 4.2. Non-deposit funding, practiced by the majority of banks before crisis, later

[9] NPL – Nonperforming Loan

becomes unpopular because of changes in market perceptions regarding the quality of market sources. ROAA also decreases by more than half post crisis though the standard deviation is not affected. Tier 1 average value increases post crisis to 9.6 reflecting banks' adjustments to new capital requirements.

Figure 3-5 Standard deviation comparison by bank type



Note: * shows values for post-crisis period (2008-2011), all values are shown in % except Z-score values which are shown in natural logarithm to facilitate comparison

Table 3-6 Mean and Standard deviation by bank types

Variable	Mean			Std. Dev.		
2004-2007	Commercial	Saving	Cooperative	Commercial	Saving	Cooperative
Total Risk of default [Z-Score]	53.65	36.85	37.58	91.75	22.39	25.735
Loan loss reserve % [Loanlossres]	1.83	1.90	2.09	0.41	0.33	0.338
NPL ratio % [Imparedloans]	0.74	0.86	0.94	0.37	0.50	0.348
Loan loss provision % [LoanLossPtoloans]	0.36	0.41	0.37	0.22	0.25	0.237
2008-2011						
Total Risk of default [Z-Score]	46.55	18.71	36.80	119.70	19.99	23.408
Loan loss reserve % [Loanlossres]	2.54	2.96	1.98	1.36	1.29	1.488
NPL ratio % [Imparedloans]	3.98	4.67	3.39	2.76	2.60	1.777
Loan loss provision % [LoanLossPtoloans]	0.71	0.96	0.65	1.84	1.16	0.374

Table 3-7 Descriptive statistics for independent variables before and after the crisis

Variable	Obs		Mean		Std. Dev.		Min		Max	
	before	after	before	after	before	after	before	after	before	after
Loan ratio [Netloantoas]	90	80	72.04654	67.58026	22.28932	22.62452	2.744	0.58	99.432	96.179
Loan growth rate [Growthloans]	66	78	17.83258	3.968205	11.6679	15.41529	-20.65	-53.44	53.92	88.73
Bank size [Logtotassets]	93	83	16.42201	16.86035	1.658263	1.725138	13.59312	14.17031	20.63215	20.94763
Liquid Assets/Total Assets [Liquidtototassets]	93	83	18.48633	18.3881	24.90652	26.49303	0.004205	0.013175	98.373	99.33522
Deposits [DepostoAssets]	93	83	37.51503	38.89839	17.73386	18.67572	0	0	97.21867	96.18442
Non-deposit funding [Moneymarkfunding]	93	83	8.536654	4.225763	9.25969	6.052308	0	0	34.35599	33.45022
Short-term Marketable Securities [otherdeptototal]	90	80	13.02882	6.929541	13.92997	9.361293	0	0	49.0931	48.29235
Operating Profit ratio [Opproftototearnass]	93	83	1.132035	0.511976	0.998138	0.862901	-0.65797	-3.962	5.855005	3.77572
Operating Income ratio [OpInctoearningass]	93	83	2.569445	2.334398	1.277762	1.168178	0.014359	0.020369	6.535847	5.66448
Equity/Total Assets [EqtotAssets]	93	83	6.589366	6.362048	4.495273	4.892315	1.05	1.289	27.82	26.809
Standard deviation of ROAA [var9]	93	83	0.914796	0.444084	1.16768	0.856614	-1.186	-3.993	9.239	3.477
Operating Expenses [OperExpensestoass]	93	83	1.300393	1.300333	0.707736	0.729124	0.005385	0.001852	2.884047	3.045607
Non-interest income [NonIntIn]	93	81	32.04763	28.45185	14.10629	18.07261	-6.67	-70.95	79.38	85.49
Fee-based income [FeesCommtoOpProf]	93	83	65.48755	-562.888	72.6931	6933.576	-201.835	-62700	325.3414	4240
Trading Income [TradingfeestoOpprof]	93	83	-5.04634	-31.2814	86.86801	548.3045	-825.714	-4766.67	23.63232	975
Tier 1 Capital [Tier1]	55	51	8.938182	10.04412	3.047946	3.268181	5.62	2.02	19.6	22.4
Capital [Capitrat]	46	52	11.55457	12.14231	2.202132	2.776718	8.8	3.35	19.6	22.4
Equity / Liabilities [Eqtoliab]	93	83	7.430441	7.232578	6.09944	6.68525	1.069	1.306	38.542	36.63
Securitization [RMBS]	85	34	718707.7	1123997	1881083	3363788	0	0	1.54E+07	1.85E+07

Table 3-8 Correlation matrix between dependent and independent variables

	Zscore	LLR	NPL	LLP	Loans/TA	Loans Growth	LnTA	Liquid Assets/TA	Deposits/TA	Wholesale funding	Operating Profit/TA	Equity/TA	ROAA	Non-int Income	Fees&Com/OP	Tier1	Equity/Liabil.	RMBS	Board size	Recordsharh
Zscore																				
LLR	-0.1378*	1																		
NPL	-0.1743*	0.8035*	1																	
LLP	-0.1008*	0.3751*	0.4732*	1																
Loans/TA	0.1025*	0.1381*	0.0356	0.0858*	1															
Loans Growth	0.0174	-0.2172*	-0.4841*	-0.1356*	-0.0627	1														
LnTA	-0.2155*	0.1701*	0.2066*	0.1369*	-0.2189*	0.0191	1													
Liquid Assets/TA	0.3485*	-0.2639*	-0.1962*	-0.1969*	-0.8494*	0.1553*	-0.0168	1												
Deposits/TA	-0.1838*	-0.0073	-0.0435	-0.1154*	0.2518*	-0.0624	-0.4795*	-0.2378*	1											
Wholesale funding	-0.0837*	-0.0527	-0.1217*	0.0274	-0.1689*	0.2139*	0.3755*	0.007	-0.3266*	1										
Oper. Prof/TA	-0.0047	-0.3575*	-0.5267*	-0.2659*	0.1301*	0.1062*	-0.0027	-0.1042*	0.1122*	0.0108	1									
Equity/TA	-0.0479	-0.0231	-0.2056*	-0.0362	0.2087*	0.0133	-0.1413*	-0.2998*	0.3467*	-0.0315	0.5618*	1								
ROAA	-0.0373	-0.2600*	-0.4483*	-0.1770*	0.0894*	0.1589*	0.043	-0.1190*	0.0930*	0.0908*	0.8362*	0.6615*	1							
Non-int Income	-0.0636	-0.0157	-0.0226	0.0619	-0.3097*	0.1304*	0.2774*	0.1773*	-0.0693	0.2181*	0.1521*	0.0983*	0.1647*	1						
Fees&Com/OP	0.0216	-0.1721*	-0.1468*	-0.1696*	-0.0169	0.0118	-0.0355	0.0138	0.0285	0.031	0.031	0.051	0.0259	-0.1860*	1					
Tier1	0.1799*	-0.0177	-0.0285	-0.0741	-0.2569*	-0.1238*	-0.1102*	0.2448*	0.0316	-0.2606*	0.2920*	0.5297*	0.3148*	0.1819*	0.0408	1				
Equity/Liab.	-0.0454	-0.0126	-0.1857*	-0.0285	0.1681*	0.011	-0.1144*	-0.2673*	0.3020*	-0.0192	0.5667*	0.9937*	0.6829*	0.1171*	0.0446	0.5300*	1			
RMBS	-0.0637	-0.0479	-0.0467	0.0194	-0.031	0.0809	0.4184*	0.0284	-0.2666*	0.1488*	0.0549	-0.1242*	0.0591	0.1998*	-0.0026	-0.0922	-0.1091*	1		
Board size	-0.0192	-0.0243	-0.0156	0.0449	-0.1257*	0.035	0.2525*	-0.0264	-0.0639	0.0922*	-0.0202	0.0498	0.0127	0.1242*	0.0169	0.0373	0.0448	0.1442*	1	
Record. sharh	-0.029	-0.0172	0.001	0.0594	-0.1366*	-0.0299	0.4967*	0.1092*	-0.1359*	0.1480*	0.1371*	-0.1166*	0.0537	0.1943*	0.0094	-0.039	-0.1108*	0.2880*	0.1123*	1

legend: * p<.1; ** p<.05; *** p<.01

4 Methodology and Results

The global financial crisis of 2007-2009 has further intensified interest in understanding its possible causes. Many academics and observers blame banks' excessive risk-taking as the core cause of the global financial crisis. This study aims to test the validity of this argument through analysis of the Spanish banking sector.

Our research question is: *What are the main determinants of banks' excessive risk-taking for the years 2004-2011 for a sample of Spanish banks which practically represents the whole Spanish banking sector?*

In empirical analysis the baseline models are first tested and then a regressor representing a certain risk factor is added to each baseline model. In so doing, we are able to observe the individual effect of each factor in a number of parsimonious models. We build as many parsimonious models as risk determinants with each risk definition. While we revised each factor in separate models, we acknowledge that they are interrelated in affecting bank risk-taking behaviour. Their combined effect on banks' risk-taking is, therefore, hard to predict.

We establish the following objectives in answering our research question: 1) to measure the influence of a range of risk determining factors on banks' insolvency risk – Z score; 2) to assess the effect of the same risk factors on alternative risk measures – banks' credit risk measures represented by Impaired Loans, Loan Loss Provision and Loan Loss Reserves; 3) to draw inference as to the nature of the factors which caused excessive risk-taking for Spanish banks from 2004-2011.

For this we apply dynamic panel data modelling and the system Generalized Methods of Moments (GMM) method of estimation. By applying dynamic modelling we not only take into account temporal autocorrelation in the residuals, but we are also able to reduce the amount of potential spurious regression, which may lead to incorrect inferences and inconsistent estimation in static models. Besides, the coefficient of the lagged dependent variable itself is of interest to us.

DPD models contain one or more lagged dependent variables, allowing for the modelling of a partial adjustment mechanism. According to Wooldbridge (2012?), models with lagged dependent variables are hard to estimate when heterogeneity and other sources of endogeneity are present. The problem of endogeneity usually appears when explanatory variables are not fully exogenous. When one applies Fixed Effect and Random Effect methods to dynamic models in the presence of unobserved heterogeneity and endogeneity, estimators are inconsistent and biased. A serious difficulty arises when using the one-way fixed effects model in the context of a DPD model when the number of years is small while the number of individual units is large -"small T, large N" data (Baum, 2012?). This happens because of a demeaning process which subtracts the individual's mean value of y and each X from the respective variable creating a correlation between regressor and error. The resulting correlation creates a bias in estimating the coefficient of the lagged dependent variable which is not

mitigated by increasing N. Similar problems affect the one-way random effects model where the lagged dependent variable cannot be independent of the composite error process. Since each bank has its own culture and its own way of managing risk, and considering the possibility of an endogenous relationship between variables, we have opted for a methodology based on dynamic panel data, making estimates using the system generalized method of moments (GMM). System GMM is designed for dynamic models and is well suited to tackle the endogeneity problem. By applying Generalized Method of Moments (GMM), we believe we can construct more efficient estimates of the dynamic panel data model.

The difference and system GMM estimators developed by Holtz-Eakin et al., (1988); Arellano & Bond (1991); Arellano & Bover (1995) and Blundell & Bond (1998) are designed for situations with "small *T*, large *N*" panels such as ours. They deal well with independent variables that are not strictly exogenous i.e. correlated with past and possibly current realizations of the error, with fixed effects, heteroskedasticity and autocorrelation within individuals (Roodman, 2009). In difference GMM all regressors are usually transformed by differencing (also referred to as Arellano–Bond estimation). System GMM is an extension of difference GMM (also referred as the Arellano–Bover/Blundell–Bond estimator) which augments Arellano–Bond by building a system of two equations -the original equation and the transformed equation - and making an additional assumption that first differences of instrument variables are uncorrelated with the fixed effects. System GMM was invented to tackle the weak instrument problem and allows for the introduction of more instruments and the improvement of the models' efficiency.

Our model is as follows:

$$Y_{it} = \alpha_{it} + \beta_1 Y_{it-1} + \beta\,[X]_{it} + \gamma[C]_{\mathrm{it}} + \sum_{t=1}^{8} Year_t + \varepsilon_{it} \qquad [1]$$

Where Y_{it} is a dependent variable representing alternative risk measures of a particular entity i in period t and Y_{it-1} is its one period lag. $[\mathrm{X}]_{\mathrm{it}}$ is a set of independent variables and $[C]_{\mathrm{it}}$a set of control variables which we have already presented above. ε_{it} represents the error term, whereas α, β and γ denote the parameters to be estimated. We have built separate baseline models for each dependent variable based on theories and empirical literature. For Z-score (measure of bank insolvency risk) our baseline model is:

Equation 1 Baseline model for Insolvency risk - Z-score

$$[logZscore]_{it} = \alpha_{it} + \beta_1[logZscore]_{it-1} + \beta_2\,[\mathrm{logGrowthloans}]_{it} + \beta_3\,[\mathrm{logEqtoliab}]_{it} + \\ +\gamma_1[\mathrm{Logtotassets}]_{\mathrm{it}} + \gamma_2[\mathrm{Netloantoas}]_{\mathrm{it}} + \ + \gamma_3[\mathrm{Netloantoas}]_{\mathrm{it-1}} + \sum_{t=1}^{8} Year_t + \ \varepsilon_{it} \qquad [2]$$

Where: $logZscore_{it}$ - log of Z-score of bank *i* in period *t* and $logZscore_{it-1}$ is its one period lag

$logGrowthloans$ - Logarithm of annual loan growth rate

$logEqtoliab$ - log of Equity/Liability ratio

Logtotassets – control variable for bank size

$Netloantoas$ and $Netloantoas_{it-1}$ - control for extent of bank's involvement in lending activity for the current period and one period before.

For credit risk models we use the following baseline models:

Baseline model for Credit risk – Net Performing Loans:

$$[logNPL]_{it} = \alpha_{it} + \beta_1[logNPL]_{it-1} + \beta_2\,[Growthloans2]_{it} + \beta_3\,[logEqtoliab]_{it} + \gamma_1[Logtotassets]_{it} + \gamma_2[Netloantoas]_{it-1} + \sum_{t=1}^{8} Year_t + \varepsilon_{it} \quad [3]$$

Baseline model for Credit risk – Loan Loss Reserves

$$[logLLR]_{it} = \alpha_{it} + \beta_1[logLLR]_{it-1} + \beta_2\,[logGrowthloans]_{it} + \beta_3\,[logEqtoliab]_{it} + \gamma_1[Logtotassets]_{it} + \sum_{t=1}^{8} Year_t + \varepsilon_{it} \quad [4]$$

Baseline model for Credit risk – Loan Loss Provisions

$$[logLLP]_{it} = \alpha_{it} + \beta_1[logLLP]_{it-1} + \beta_2\,[Growthloans2]_{it} + \beta_3\,[logGrowthloans]_{it} + \gamma_1[Netloantoas]_{it-1} + \gamma_2[Logtotassets]_{it} + \sum_{t=1}^{8} Year_t + \varepsilon_{it} \quad [5]$$

We start estimation with baseline models before adding, step by step, a regressor representing an additional risk determining factor to see its individual effects in a parsimonious model. We aim to build as many parsimonious models as risk determinants.

4.1 Results

We start by applying classical linear estimation OLS (pooled OLS) and linear models which are mostly used with panel data estimations such as Fixed Effect and Random Effects to our models. Accordingly, we can see why simpler methods are not appropriate in our case by demonstrating the preponderance of the selected method - system GMM.

We make sample estimates using pooled OLS regression and ignore the dynamic nature of our data. We are aware that OLS does not address the potential impact of unobserved heterogeneity on the conditional mean which gives rise to 'Nickell bias', and the lagged dependent variable will be correlated with the fixed effects in the error term (Nickell, 1981). This positive correlation between a regressor and the error violates an assumption necessary for the consistency of OLS estimation.

We use fixed effect estimation, assuming that something within the entities may impact or bias the predictor or outcome variables and the need to control for this i.e. assuming the correlation between the entity's error term and predictor variables. Fixed effect (FE) removes the effect of those time-invariant characteristics from the predictor variables enabling assessment of the predictors' net effect. According to Kohler et. al., (2005) fixed-effects models cannot be used to investigate time-

invariant causes of the dependent variables as time-invariant characteristics of the individuals are perfectly collinear with the entity dummies.

Nickell states (Nickell, 1981) that in pooled OLS regression, the lagged dependent variable is positively correlated with the error, biasing its coefficient upward. In contrast, in the fixed effects model, the coefficients are biased downward due to the negative sign in the transformed error. Given the opposite directions of bias present in these estimates, these two estimations may provide us with a coefficient range also referred to as a "credible range" by Roodman (2009) with consistent GMM estimates supposed to lie between these values. As Bond (2002) noted, these bounds may provide a useful check on results from theoretically superior estimators. However, in the presence of endogeneity we think the reliance on this range is questionable.

We also apply Random Effect estimation by assuming that differences across entities have some influence on our dependent variable. Unlike the fixed effects model, in the random effect (RE) model the variation across entities is assumed to be random and uncorrelated with the predictor or the independent variables included in the model. Baum (2013) states that Nickell bias also affects the one-way random effects model when applying DPD and the lagged dependent variable cannot be independent of the composite error process. Estimates may be biased because we are not controlling for omitted variables; we therefore believe that we may construct more efficient estimates by applying system GMM model.

4.1.1 Z-score (Insolvency risk)

The preliminary results of the baseline model with pooled OLS regression (see Table 3-9Table 3-9 Baseline model estimations with dependent variable Z-score) show that banks 'Z score decreased with the *growth of loans*, with the *size* of the bank and with lagged *loan ratio* while it positively affected the *Equity/Liability* ratio and current *Net loans/Total Assets*. In general all signs are consistent with what we expected, but as we mentioned above, the problem in applying OLS is that $logZscore_{it-1}$is correlated with the fixed effects in the error term which causes "dynamic panel bias" (Nickell, 1981) violating an assumption necessary for the consistency of OLS.

In the fixed effect model we see that the estimates are mostly insignificant, regressors' signs are ambiguous and the F test is also poor. The random effect model shows mostly significant coefficients fairly consistent with the pooled OLS model and in line with our hypothesis.

The baseline model GMM results are significant and consistent with our hypothesis, coefficients' consistent with OLS and RE models and test statistics are robust. The results of the estimates suggest that *growth of loans* negatively influences Z-score congruous with the findings of Altunbas et al., (2011), Köhler (2012), Martín-Oliver & Saurina, (2007) & Jimenez et al. (2008) among others signifying that banks might have softened their lending standards prior to the crisis and provided more loans to borrowers with a bad or no credit history. Bank size also has a negative effect on Z-score.

Table 3-9 Baseline model estimations with dependent variable Z-score

logZ	PoolOLS	FE within	RE	sysGMM
L1.logZ	0.977***	0.015	0.851***	0.981***
logGrowthloans	-0.020***	0.000	-0.015**	-0.024*
logEqtoliab	0.048***	0.858***	0.327***	0.062*
Logtotassets	-0.009**	0.01	-0.029**	-0.020*
Netloantoas	0.010***	0.000	0.007***	0.008***
L1.Netloantoas	-0.011***	-0.001	-0.010***	-0.010***
_cons	0.173*	1.472***	0.474*	0.375
R2_within		0.9474	0.6051	
corr(x_i,mu_i)		-0.2593		
sigma_u		0.050471	0.050471	
sigma_e		0.031782	0.031782	
Rho		0.716064	0.716064	
F	1082.53	409.67		
Wald chi2(12)			2195.97	
Diff AR(2)				0.768
Hansen test				0.782
No. of instruments				90
No. of groups				90
No. of observations	375	375	375	375

NOTE: Table reports the panel data estimates for Pooled OLS, Fixed Effect, Random Effect and the system Generalized Method of Moments where the dependent variable is the Log of Z-score [logZ] and GMM style lag limits (2 2) and estimates are robust. Year dummies are included. Hansen is a test for over-identifying restrictions, asymptotically distributed. Legend: * p<.1; ** p<.05; *** p<.01

This is referred to in the literature as "size effect" and is supported by Garcia Marco et al., (2008), Bai & Elyasiani (2013) and Altunbas et al., (2011) among others. In particular, Altunbas et al., (2011) suggested that ex-post bank risk may be associated with ex-ante bank size and the degree of credit expansion in the years preceding the crisis. Banks may intend to maximize the value of implicit government guarantees and disregard risky transactions Bai & Elyasiani (2013).

In contrast, capital [logEqtoliab] has a positive influence on Z-score; a 1% increase in Zscore is associated with 0.06 % in equity/liability ratio. Demirgüç-Kunt et al., (2010) state that during the crisis banks with higher capitalization were better valued than undercapitalized banks, though this trend is not observed before the crisis. Since our data includes more crisis and post-crisis data, our findings reflect the importance of capital in the estimated period. The importance of capital in reducing risk is also supported by Berger & Bouwman (2012) Altunbas et al., (2011), Demirgüç-Kunt et al., (2010), Garcia Marco et al., (2008) and others. Berger & Bouwman (2012) also stress that for small banks capital is essential for survival at all times (crisis and non-crisis) and for medium and large banks only during crises. Loan ratios [Netloantoas] are introduced to control banks' level of involvement in loan activity.

Turning to test statistics of GMM estimation, we can see that it is a well-fitting model with statistically insignificant test statistics for both second order autocorrelation and Hansen J-statistics of overidentifying restrictions. To summarize, we are able to construct more efficient estimates of the dynamic panel data model by using the system GMM method.

The next step is to use the baseline model to inspect our possible risk determinant factors by adding them one by one and observing their influence on the model. The results of parsimonious models of all significant risk factors are reported in Table 3-10.

As can be observed from the results of ownership nature in parsimonious models, savings banks [Savdummy] have a strong negative effect on Z-score. Iannotta et al. (2006) argue that private banks are expected to be more efficient than public banks as the latter provide loans which are not profitable enough for the private sector i.e. loans which are politically motivated. Cuñat & Garicano (2010) also find evidence in support of this hypothesis within the Spanish market arguing that saving banks with higher politicized board members had more exposure to real estate risks. They state that Spanish savings banks do not have formal shareholders and are usually heavily politicized. Furthermore, their shares are not quoted in the stock market and therefore major external bank disciplinary governance mechanisms do not work for this type of bank. As was observed post crisis, most Spanish banks which were found to be in trouble were savings banks. The Spanish central bank undertook numerous mergers, primarily between savings banks, and implemented complex restructuring and recapitalization programs including amendments to savings bank law to improve the stability of the banking sector. Our findings contradict those of Garcia Marco et al., (2008) as their analyses indicate that Spanish commercial banks exhibit a stronger tendency toward risk-taking than saving banks. But their work is based on an earlier period, namely 1993-2000. In this sense, we can conclude that the traditional attitude towards risk in Spanish saving banks has shifted towards other more aggressive characteristics contributing to the build-up of excess risk concentration in this type of bank ownership.

Regarding ownership concentration, the widely held bank proxy [*Recordshar*] which represents the number of recorded shareholders shows positive and highly significant effects on banks' Z score. This corresponds to agency theory that states managers of banks with dispersed ownership exhibit lower risk than is optimal for shareholders, and is consistent with the findings of (Iannotta et al., 2006; Laeven & Levine 2009). In particular, Laeven & Levine (2009) find that powerful bank owners (i.e. banks with concentrated ownership) tend to induce bank managers to increase risk-taking. They argue that when banks have a large equity holder with sufficient power they seek to compensate for utility loss from capital regulations and stringent activity restrictions by increasing bank risk. The same capital regulations have the opposite effect in widely held banks.

In terms of funding structure, we have twofold results: wholesale funding [*Moneymarkfunding*] as it is expected negatively influences Z-score in line with Altunbas et al.,(2011), Beltratti & Stulz

(2012) and Huang & Ratnovski (2010). Huang & Ratnovski (2010) argue that wholesale funding is beneficial when providers are informed but with the presence of noisy public signals the incentives of fund providers to monitor banks and impose market discipline could be distorted. Martín-Oliver & Saurina, (2007) using a sample of Spanish banks, find that they exhibit excessive reliance on the wholesale market to fund their lending growth. The authors argue that some banks are increasingly becoming mere originators of loans and distributors of their risk – the so called "originate to distribute" model. As soon they grant a loan, it is packaged into a bundle of other mortgages, receives risk assessment by a ratings agency and is sold off. They suppose that banks involved in this type of operation are considered risky since their main income arises from fees and commissions from these transactions.

On the other hand the results show the negative effect of deposit funding though the coefficient is rather small. Traditional deposit funding is widely considered to be a safe funding source; the negative sign could be the effect of deposit market competition which is deemed a risky source as it raises the cost of bank liabilities (Craig & Dinger, 2013). The positive correlation between risk and competition in deposit markets is also supported through data from the Spanish banking sector by Jimenez et al., (2010). We have also checked nonlinear associations of deposit funding with Z-score but the results remain negative.

Regarding non-income sources our findings are in line with Lepetit et al., (2008) who report from a sample of European banks that those with higher shares of commissions and fee income experience higher risk than banks with traditional income sources. The negative influence of non-traditional income is also found by De Young & Roland, (2001); Stiroh, (2004); Stiroh & Rumble, (2006).

The coefficients of equity ratios such as [*EqtotAsset*], [*logEqtoliab*] positively affects bank Z-score while the Tier 1 ratio is insignificant. The positive influence of most capital ratios is in line with the findings of Berger & Bouwman(2012); Altunbas et al.,(2011), Demirgüç-Kunt et al.,(2010), Garcia Marco et al.,(2008), Tabak et. al.,(2012) and others. All these papers report that during the crisis banks with higher capitalization were better valued. Moreover, Demirgüç-Kunt et al., (2010) find the strongest effect for the leverage ratio rather than risk-adjusted capital ratio.

The *securitization* proxy [*logRMBS*] is negative but insignificant which we explain by a lack of data for banks' securitization level within our sample. We also note that the effect of size remains negative in all three parsimonious models where it is significant suggesting its negative effect on bank insolvency.

Bank insolvency risk is traditionally measured by Z-score and it is widely applied by many research papers. It is calculated by using Return on Average Assets (ROAA), balance of capital relative to total assets and standard deviation of ROAA. When we observe the sensitivity of ROAA of Spanish banks for the period in question we see no large fluctuations within the observed period resulting in

small standard deviation and hence a greater Z-score. We suppose that banks may intend to maintain their ROAA and capital ratios via "manipulation" of components (net income and/or average total assets or equity) for different purposes.

Table 3-10 Parsimonious Models with Z-score & with additional independent variables

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
L1.logZ	0.9587***	0.9767***	0.9450***	0.9141***	0.9904***	0.9752***	0.9890***	0.9995***
logGrowthloans	-0.0384***	-0.0019	-0.0194	-0.0155	-0.0195	-0.0144	-0.0169	-0.0345**
logEqtoliab	0.1188*	0.0777***	0.1875**	0.1076*	0.1137*		0.1381*	
Logtotassets	-0.0064	-0.0252*	-0.0739***	-0.0427**	-0.0281	-0.0388**	0.0248	0.01
Netloantoas	0.0076	0.0104***	0.0095*	0.005	0.0094	0.0123***	0.0132***	0.0042
L1.Netlaontoas	-0.0102*	-0.0093***	-0.0110**	-0.0068	-0.0115*	-0.0136**	-0.0105**	-0.0041
Savdummy	-0.1566**							
Recordshar		0.0007***						
DepostoAssets			-0.0042**					
Moneymarkfunding				-0.0499**				
FeesCommtoOpProf					-0.0000*			
EqtotAssets						0.0165**		
L1.logRMBS							-0.0244	
Tier1								-0.0021
_cons	0.3425	0.1971	1.3322***	0.9251**	0.3992	0.6616*	-0.5307	-0.0837
Diff AR(2)	0.635	0.831	0.998	0.33	0.311	0.912	0.766	0.969
Hansen test	0.238	0.924	0.226	0.47	0.47	0.311	0.741	0.836
No. of instruments	46	88	46	46	56	56	54	69
No. of groups	90	90	73	90	90	90	44	69
No. of observations	375	375	375	276	374	375	131	260

NOTE: Table reports the panel data estimates for the system Generalized Method of Moments where the dependent variable is the Log of Z-score [logZ] and GMM style lag limits (2 2) in Model 1-4, (3 3) in model 5-8 and all estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Model1 to Model 5 are parsimonious estimates with addition of one independent variable to baseline model. Legend: * p<.1; ** p<.05; *** p<.01

In order to check for the robustness of our Z score findings and to identify trends within other banks' risk determinants we include three alternative measures of risk in our analysis. In particular, we estimate risk determinant factors against credit risk indicators such as Impaired Loans, Loan Loss Provisions and Loan Loss Reserves. We take credit risk as an alternative bank risk measure since credit risk is considered one of the principle bank risks and has a direct influence on bank solvency.

Non Performing Loans (Impaired Loans) ratio**¡Error! La autoreferencia al marcador no es válida.** reports the baseline model results of our second dependent variable - Impaired loan ratio/Net Performing Loans (NPL). Signs are consistent across all estimation methods and their effect on dependent variable is as we hypothesized. Squared growth of loans has a positive sign and is statistically significant in all estimation methods except fixed effect. The inconsistency of the fixed effect method could be associated with the drawbacks of the model mentioned above.

Table 3-11 Baseline model estimations with NPL

Variable	PoolOLS	FE	RE	SysGMM
L1.logNPL	0.8111***	0.5088***	0.8050***	0.8959***
Growthloans2	0.0001**	0.0000	0.0001**	0.0001**
logEqtoliab	-0.1248***	-0.4545***	-0.1299***	-0.3545***
Logtotassets	0.0309***	0.4880**	0.0318***	0.0339
L1.logNetloantoas	0.1184***	0.383	0.1215***	0.1941*
_cons	-0.2605	-7.9031**	-0.2689	-0.9274
R2_within		0.9325	0.917	
corr(x_i,mu_i)		-0.5706		
sigma_u		0.6650594	0.0333496	
sigma_e		0.2561225	0.2561225	
rho		0.8708439	0.0166719	
F	401.33	377.96		616.08
Wald chi2(12)			4321	
diff AR(2)				0.274
Hansen test				0.685
No. of instruments				70
No. of groups				83
No. of observations				395

NOTE: Table reports the panel data estimates for Pooled OLS, Fixed Effect, Random Effect and the system Generalized Method of Moments where the dependent variable is the Log of NPL [logNPL] and GMM style lag limits (3 3) and estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Legend: * p<.1; ** p<.05; *** p<.01

The effect of equity ratio is consistent with earlier discussions - negative and strongly significant in all models. In system GMM estimation the size of the bank is no longer significant whilst one period lag of the total landing ratio is significant and has a positive effect. The diagnostic tests of GMM estimation show that it is a well-fitting model with statistically insignificant test statistics for both second order autocorrelation and Hansen J-statistics of overidentifying restrictions. To summarize, the results of alternative risk definitions (Z-score and NPL) in general are consistent, suggesting that the estimates do not depend on a specific definition of bank risk.

Next, we test additional explanatory variables by adding them to the baseline model one by one. Table 3-12 presents the results of our estimations. Unlike the Z-score model, our NPL model exhibits more sensitivity in response to increased risk factors.

Ownership Nature & Concentration

In Model 1 we found that commercial banks exhibit less risk than two other types (savings and cooperative banks) which is in line with our Z-score model and Iannotta et al., (2006) who suggest that private banks are more efficient than public banks (savings banks).

Moreover, Model 2 exhibits its sensitivity to the ownership concentration proxy [Recordshar] which used for widely held banks and in line with Z score model results. These findings may provide evidence that banks with concentrated ownership exhibit higher risk than widely held banks. Consistent with agency theory, managers of banks with dispersed ownership exhibit lower risk than is optimal for shareholders (Iannotta et al., 2006). Moreover, Laeven & Levine (2009) argue that banks with concentrated ownership seek to compensate for utility loss from capital regulations and stringent activity restrictions by increasing the bank risk.

Table 3-12 Parsimonious Models with NPL & with additional independent variables

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
L1.logNPL	0.8565***	0.8732***	0.9032***	0.4389**	0.6830***	0.7433***	0.8613***
Growthloans2	0.0001*	0.0001**	.0001***	-0.0009*	0.0001***	0.0001***	0.0001**
logEqtoliab	-0.3536**	-0.3884***	-0.3523***	-0.451	-0.6372**		
Logtotassets	0.0457	0.0645	0.0250	-0.1424	0.0438	0.0639	0.0616
L1.logNetloantoas	0.2085*	0.2043	0.2164**	-0.2318	0.5607***	0.2613***	0.1557*
Comdummy	-0.1338*						
Recordshar		-0.0013**					
L1.logNonintIn			0.2425*				
L1.logRMBS				0.1547**			
Tier1					0.0077		
Capitrat						-0.0547***	
EqtotAssets							-0.0504**
_cons	-1.1621	-1.3872	-1.6966**	2.6263	-2.2041*	-1.8649**	-1.5755*
diff AR(2)	0.254	0.231	0.456	0.234	0.256	0.351	0.339
Hansen test	0.66	0.67	0.761	0.978	0.283	0.739	0.737
No. of instruments	70	71	78	55	42	68	70
No. of groups	83	83	83	42	69	72	83
No. of observations	395	395	394	130	332	337	395

NOTE: Table reports the panel data estimates for the system Generalized Method of Moments where the dependent variable is the Log of NPL [logNPL] and GMM style lag limits (3 3) and all estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Model1 to Model 7 are parsimonious estimates with addition of one independent variable to baseline model. Legend: * p<.1; ** p<.05; *** p<.01

In Model 3, the past percentage change of non-interest income has a positive, significant coefficient on bank risk confirming the findings of Jonghe et al., (2012), De Young & Roland, (2001), Stiroh, (2004), Stiroh & Rumble, (2006) and Lepetit et al., (2008).

The positive sign for *securitization* proxy [logRMBS] is significant and suggests that banks may use securitization to acquire more risky assets eventually resulting in a rise in bank risk (Kero, 2010 and Carbó-Valverde et al., 2012). Our findings are congruous with those of Otero González *et al.* (2012), Kero, (2010) and Carbó-Valverde et al., (2012) and contradict those of Altunbas et al (2011) and Martín-Oliver & Saurina, (2007) who do not find evidence that banks exploit securitization to undertake riskier strategies.

With regard to *capital ratios*, Tier1 capital is insignificant whilst capital ratio and equity to assets ratio are significant and have a negative influence on the level of credit risk. These findings are supported by Berger & Bouwman (2012) Altunbas et al., (2011), Demirgüç-Kunt et al., (2010), Garcia Marco et al. and Demirgüç-Kunt et al., (2010). They state that during the crisis more focus is given to components of capital that is able to absorb losses and Tier1 ratio may not be viewed as informative in capturing the true risk in bank portfolios at this time.

4.1.2 Loan Loss Reserves

Loan Loss Reserves (LLR) reflects banks' estimated losses on loans due to defaults and non-payment. It indicates a bank's sense of how stable its lending base is and its approach in estimating its reserves. On the one hand an increase in LLR may indicate an increase in the level of credit risk. On the other hand banks may vary when it comes to deciding how much of a loan to write off and when increased LLR may constitute evidence of prudent bank behaviour i.e. a conservative approach. Moreover, increased LLR is not always the result of bad lending decisions or risky lending decisions because macroeconomic changes may also increase banks' expected loan losses by hitting responsible borrowers. In summary, a higher provision could mean higher expected losses and more risk exposure but at the same time indicate prudent behaviour of managers, while lower LLR could be an indication of risky behaviour if there are not enough provisions set relative to the risk they bear.

The regressions with LLR are presented in Table 3-13. The baseline models demonstrate consistency of signs of explanatory variables across different regression methods, and system GMM estimates of lagged dependent variable lies within the "credible range" referred by Roodman (2009). As in previous models capital has a negative and size has a positive effect on risk though the latter does not demonstrate consistency in significant levels.

Table 3-13 Baseline model estimations with dependent variable LLR

Variable	PoolOLS	FE	RE	SysGMM
L1.logLLR	0.9707***	0.5311***	0.9373***	0.9523***
Growthloans	-0.0033***	-0.0031***	-0.0035***	-0.0046***
logEqtoliab	-0.1161***	-0.4755***	-0.1633***	-0.3257***
Logtotassets	0.0291**	0.1833	0.0394**	0.0619
_cons	-0.1737	-1.6401	-0.1941	-0.2071
R2_within		0.4403	0.3766	
corr(x_i,mu_i)		-0.1002		
sigma_u		0.4858954	0.1226651	
sigma_e		0.28408	0.28408	
rho		0.7452572	0.1571489	
F	125.98	24.62		163.59
Wald chi2(12)			1009.4	
diff AR(2)				0.425
Hansen test				0.334
No. of instruments				82

No. of groups				85
No. of observations	408	408	408	408
NOTE: Table reports the panel data estimates for Pooled OLS, Fixed Effect, Random Effect and the system Generalized Method of Moments where the dependent variable is the Log of LLR [logLLR] and GMM style lag limits (2 3) and estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Legend: * p<.1; ** p<.05; *** p<.01				

The most interesting findings are the negative effect of loan growth on banks' loan loss reserves. We originally expect a positive association with bank risk as rapid loan growth is generally blamed for an increase in bank risk by many academics (Altunbas et al., 2011; Köhler, 2012; of Martín-Oliver & Saurina, 2007 & Jimenez et al. 2008). Nevertheless, the results contradict the logic of prudent bank behaviour which implies reserving more loan provisions during periods of rapid credit growth. Since the provision of loan reserves involves a high degree of subjective judgement it could be used by bank managers as a tool to present a bank's earnings in a better than realistic light. Despite the fact that loan loss reserves must be estimated looking forward it seems that this does not happen in practice; this could be evidence for the validity of income smoothing practices among Spanish banks. Laeven & Majnoni (2003), by analysing large commercial banks around the world, find that banks appear to have increased provisions during periods of positive profits whilst being less prudent during periods of rapid credit growth.

Table 3-14 Parsimonious Models with LLR & with additional independent variables

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
L1.logLLR	0.9335***	0.9221***	0.9597***	0.9738***	0.9057***	0.9386***	0.8694***	0.9111***
Growthloans	-0.0047***	-0.0047***	-0.0045***	-0.0048***	-0.0042***	-0.0051***	-0.0041***	-0.0042***
logEqtoliab	-0.3094***	-0.3386***	-0.3092***	-0.3189***	-0.4778***	-0.3493***		
Logtotassets	0.0582	0.1156**	0.0511*	0.0544	0.0719**	0.0614*	0.0082	0.0024
Savdummy	0.1489**							
Recordshar		-0.0022**						
FeesCommtoOP			-0.0000*					
TradingfeestoO				-0.0001*				
Liquidtotoasset					-0.0064**			
logOperatexpe						0.1917**		
Tier1							-0.0303***	
Capital ratio								-0.0339***
_cons	-0.2585	-0.9888	-0.0706	-0.1089	0.0422	-0.2036	0.2866	0.51
diff AR(2)	0.475	0.381	0.76	0.897	0.801	0.302	0.274	0.191
Hansen test	0.386	0.304	0.326	0.832	0.359	0.749	0.587	0.533
No. of instruments	88	83	80	80	80	99	68	66
No. of groups	85	85	85	85	85	85	69	72
No. of observations	408	408	408	408	408	408	340	345
NOTE: Table reports the panel data estimates for the system Generalized Method of Moments where the dependent variable is the Log of LLR [logLLR] and GMM style lag limits (2 3) and all estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Model1 to Model 7 are parsimonious estimates with addition of one independent variable to baseline model. Legend: * p<.1; ** p<.05; *** p<.01								

As a result, banks on average create insufficient provisions in good times and are then forced to increase them during cyclical downturns, magnifying losses and the size of negative capital shocks.

The risk factor analysis presented in Table 3-14 reveals the significant effect of the following variables:

the savings banks dummy shows a positive association with LLR suggesting a higher credit risk in this type of bank or, at least, a higher level of funds in expectation of higher future losses or a conservative behaviour applied by this type of banks. The recorded shareholders variable which is the proxy for widely held banks has a negative influence on bank risk, consistent with our results for the NPL model;

fee and commission income along with Trading income exhibit a weak negative influence on LLR which may prove evidence of the positive effect of income diversification also found by Altunbas et al.,(2011) and Köhler (2012), although Köhler (2012) finds that the positive effect of income diversification decreases with bank size. This could explain the small magnitude of coefficient for our sample as it comprises principally of large banks;

Liquid assets have a negative association with LLR as we expected and *operating expenses* are positively associated with credit risk. This could be explained through the fact that banks encountered high operating expenses in periods of rapid credit growth and increased involvement in non-interest activities. As it is argued by De Young & Roland (2001), non-interest income might augment the bank's fixed costs, such as the cost of hiring additional staff, which could increase the operational leverage of banks along with its risk-taking;

capital negatively affects bank risk level and is highly significant and consistent across all models and across different capital ratios (Tier1, Capital ratio, and Equity to Liability ratio).

4.1.3 Loan Loss Provisions

Our last dependent variable representing bank credit risk is Loan Loss Provision (LLP). LLP is a key accounting indicator which directly influences the volatility and cyclicality of bank earnings. In banks' financial reports it reflects the risk of loan portfolios. Table 3-15 presents the results of the baseline regressions. Unlike other models, here the lagged dependent variable exhibits lesser dependence on its one period lag. The log of loan growth rate is insignificant [logGrowthloans] while its squared value [Growthloans2] is highly significant and positive across all regression methods. Total loan ratio and its lagged value are added to control the bank's involvement in loans activity. They both show their influence on LLP, with the same period loan ratio having a negative effect and one period lagged value having a positive effect. Size (*logtotassets*) was significant and the sign indicates a positive relationship to the level of bank credit risk. Again, our system GMM lagged dependent variable lies within the "credible range" of pooled OLS and FE coefficients. The diagnostic tests of GMM estimation show that it is a well-fitting model with statistically insignificant test statistics for both second order autocorrelation and Hansen J-statistics of overidentifying restrictions.

The addition of risk determining factors into the baseline model reveals that LLP has positive associations with savings banks within other risk definitions. However, the result of widely held banks is insignificant indicating a lack of association between Loan Loss Provisions and the bank ownership concentration.

Table 3-15 Baseline model estimations with dependent variable LLP

Variable	PoolOLS	FE	RE	SysGMM
L1.logLLP	0.6644***	0.1898***	0.6644***	0.5636***
logGrowthloans	-0.0373	0.0358	-0.0373	-0.0638
Growthloans2	0.0002***	0.0002***	0.0002***	0.0002**
logNetloans	-0.7566*	-2.0896***	-0.7566*	-1.8530*
L1.Netloans	0.7550*	1.1071*	0.7550*	1.8561*
Logtotassets	0.0532***	-0.7158	0.0532***	0.0990**
_cons	-1.1784***	14.4712	-1.0297**	-1.9147*
R2_within		0.436		
corr(x_i,mu_i)		-0.9107		
sigma_u		1.3168	0	
sigma_e		0.4274	0.4274	
Rho		0.9047	0	
F	30.9515	16.5588		22.2701
Wald chi2(12)			371.4175	
diff AR(2)				0.467
Hansen test				0.831
No. of instruments				78
No. of groups				88
No. of observations	357	357	357	357

NOTE: Table reports the panel data estimates for Pooled OLS, Fixed Effect, Random Effect and the system Generalized Method of Moments where the dependent variable is the Log of LLP [logLLP] and GMM style lag limits (2 2) and estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Legend: * p<.1; ** p<.05; *** p<.01

Similar to Loan Loss Reserves, Loan Loss Provisions exhibit a positive association with Operating Expenses and the log of Operating Expenses. As in LLR, this is explained through high operating expenses in periods of rapid credit growth as can be seen before the crisis. Therefore operating expenses increased relative to the extent of loan activities and size of banks.

Remarkably, we find a positive association between LLP and deposit funding as observed in the Z –score model. This association is quite odd since we hypothesized that deposit funding is safer than its alternative wholesale funding and would be expected to reduce bank risk. We suppose that this result is not coincidental and could be evidence of 'excessive' competition in deposit markets prior to the crisis as mentioned by Matutes, C & Vives, X (2000) and Craig & Dinger, (2013). They argue that in response to intense deposit competition banks raise their deposit rates too high. By doing so, they attract more depositors by increasing their cost of funding while decreasing their net interest margin. Moreover, banks may use deposits for risky investments since they do not internalize the cost of

failure thanks to the existence of deposit insurance. This also lessens the monitoring incentives of depositors and other stakeholders. As a result banks may have higher levels of bad debts leading to increased loan loss provisions though banks use mainly deposit funding.

Positive and significant effects of fee and commission income were observed as in our LLR model. This we again relate to the positive effect of income diversification found by Altunbas et al., (2011). As in the case of LLR, the significance of operating expenses may be associated with banks' increased operational leverage referred by De Young & Roland (2001).

Table 3-16 Parsimonious Models with LLP & with additional independent variables

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
L1.logLLP	0.4865***	0.5004***	0.5394***	0.5391***	0.4398***
logGrowthloans	-0.0159	-0.0005	-0.0144	-0.0156	0.011
Growthloans2	0.0002**	0.0002	0.0002	0.0003**	0.0002**
logNetloans	-1.8688*	-2.0487**	-1.8149*	-2.3327**	-2.7724**
L1.Netloans	1.8850*	2.0068*	1.8654*	2.3886**	2.7809**
Logtotasse~_	0.054	0.1457***	0.0521	0.1204**	0.1140**
Savdummy	**0.3441****				
DepostoAss~_		**0.0107****			
FeesCommto~_			**-0.0000****		
OperExpens~_				**0.2687***	
logExpens					**0.3897*****
_cons	-1.6835	-3.3125***	-1.5046	-3.1281***	-2.7348***
diff AR(2)	0.515	0.698	0.595	0.547	0.629
Hansen test	0.877	0.822	0.922	0.738	0.697
No. of instruments	84	88	88	86	86
No. of groups	88	88	88	88	88
No. of observations	357	357	357	357	357

NOTE: Table reports the panel data estimates for the system Generalized Method of Moments where the dependent variable is the Log of LLR [logLLR] and GMM style lag limits (2 2) and all estimates are robust. Year dummies are included. Hansen is a test for overidentifying restrictions, asymptotically distributed. Model1 to Model 5 are parsimonious estimates with addition of one independent variable to baseline model. Legend: * p<.1; ** p<.05; *** p<.01

Table 3-17 Results of parsimonious models consolidated

Risk Factors	Z-score	Impaired Loans	Loan Loss Reserves	Loan Loss Provisions
Ownership nature	Risk increase with saving banks	Risk decrease with commercial banks	Risk increase with saving banks	Risk increase with saving banks
Ownership concentration	Risk decrease with widely held banks	Risk decrease with widely held banks	Risk decrease with widely held banks	-
Bank size	Risk increase with bigger size banks	-	Risk increase with bigger size banks	Risk increase with bigger size banks
Securitization	-	Risk increase with higher level of securitization*	-	-
Liquid Assets	-	-	Risk decrease with higher level of Liquid Assets	-
Loan growth	Risk increase with higher loan growth	Risk increase with higher loan growth	Risk decrease with higher loan growth	Risk increase with higher loan growth *
Deposit funding	Risk increase with higher deposit ratio	-	-	Risk increase with higher deposit ratio
Wholesale funding	Risk increase with higher proportion of wholesale funding	-	-	-
Non-Interest income	-	Risk increase with higher proportion of non-interest income	-	-
Fee-based income	Risk increase with higher proportion of fee-based income	-	Risk decrease with higher proportion of fee-based income	Risk decrease with higher proportion of fee-based income
Trading income	-	-	Risk decrease with higher proportion of trading income than income from commissions	-
Tier I ratio	-	-	Risk decrease with higher level of Tier I ratio	-
Leverage ratio	Risk decrease with higher leverage ratio	Risk decrease with higher leverage ratio	Risk decrease with higher leverage ratio	-
Capital ratio	-	Risk decrease with higher capital ratio	Risk decrease with higher capital ratio	-
Equity to Assets ratio	Risk decrease with higher Equity-to-Assets ratio	Risk decrease with higher Equity-to-Assets ratio	-	-
Operating expenses	-	-	Risk increase with higher level of operating expenses	Risk increase with higher level of operating expenses

NOTE: Table reports the associations of factors with alternative risk based on baseline and parsimonious models presented in tables and do not necessarily show the sign of the factor but its effect on risk (Z-score, NPL, LLR and LLR). '–' indicates there is no significant coefficient for this factor. * signifies non linear relation

Chapter 4 EARLY WARNING MODEL FOR EUROPEAN BANKS: EVIDENCE FROM THE RECENT FINANCIAL CRISIS

1 Introduction

The on-going financial turmoil evident in European financial markets and the rest of the world re-emphasizes the economic importance of banks' stability. Since the banking system is the main mechanism of financial stability, monitoring the appetite for risk within banks has become a central issue for regulators. Many economical models have been developed to forewarn regulators about the possible vulnerabilities of banks at both the systemic and bank-specific levels. These models were broadly classified as Early Warning Systems of bank fragility. However, the most recent banking turmoil has demonstrated that the majority of existing EWS models cannot fully capture the growing complexities of current financial markets. For this reason existing approaches should be reassessed critically and, where required, extended or modified to incorporate the latest changes in financial markets and risk factors.

This chapter critically reviews existing approaches and models of EWS by placing more emphasis on market indicators of bank fragility. The paper undertakes a proper study of European banks and proposes possible directions for the extension or modification of existing EWS models.

EWS models are widely considered as important complementary tools for bank regulators as off-site detection means. Recent empirical studies have advocated that bank supervisors should devote more attention to equity securities issued by banks. However, there has been proportionally less discussion regarding the role of equity market indicators in predicting bank distress, especially within the context of European markets. The majority of research is performed primarily in the US market and focuses on bond market indicators - subordinated debt spreads. But bond spreads are difficult to calculate in the European context due to market illiquidity and problems in constructing appropriate risk free benchmarks, especially for smaller European countries (Gropp, Vesala, & Vulpes, 2002). In contrast, market data of bank equities are available in a high frequency and the European market is itself quite efficient in processing available information. Nevertheless, relatively few empirical works focus on the predictive ability of equity market indicators for European banks. For this reason, in our literature review we concentrate mainly on bank vulnerability indicators based on equity prices and on empirical research undertaken in the scope of EU market. Our review is noteworthy as these days more European banks are downgraded by ratings agencies leading to a greater availability of data for the empirical implementation of our research. Besides, it may positively contribute to the statistical power of our estimates.

Our literature review has been organized in the following way: first, we give a brief theoretical overview of the main approaches of credit risk measuring models; next we examine in more detail an option theoretical structural approach in the opposition to existing alternative viewpoints and also focus on existing conflicts and debates within the approach; we then discuss the latest empirical studies on bank fragility undertaken within the European market and other international markets; finally we present our general conclusions and propose approaches to conducting our research.

2 Literature review

2.1 Brief theoretical background of default risk modelling techniques

While we focus on EWS models of bank fragility we would first like to mention the concepts of Early Warning Systems in general and their assumptions. EWS are defined as functional, data-driven approaches which concentrate on variables related to past crises in order to forewarn policy makers of possibilities of future crises (Gramlich et al., 2010). EWS are based on economic theories of financial crises and make two fundamental assumptions: 1) there is causality between crisis and crisis-driving factors and 2) crisis-driving factors can be identified ex ante. Since financial markets and risk factors change rapidly, neither type of EWS is considered static and are subject to continuous reassessment and upgrading. EWS may be tailored to user objectives, model complexity and data availability. However, in light of the latest crisis there is increasing concern that existing EWS models are not sophisticated enough to capture the rapid change and growing complexity of the banking industry and financial markets. King, Nuxoll and Yeager (2005) argue that prevailing EWS models can be adjusted to those changes through the adoption of forward-looking approaches and/or by addressing various types of bank risk individually.

Much emphasis has recently been placed on market forces by the Basel Committee on Banking and Supervision (Basel II). It suggests bank supervisors use market information to improve the assessment of banks' financial safety and soundness. Under market discipline, the market correctly reflects individual bank risk levels as investors require a risk premium for any additional risk. This mechanism may increase banks' funding costs meaning banks will be discouraged from taking additional risk. Therefore, market information could be used by banks' supervisors as a signal and also to complement accounting data in the design of EWS. In the meantime, the principal question raised is whether market prices convey additional information which is not already included in accounting data or whether the benefits from employing market information outweigh the cost of its use (Curry et al., 2002). Empirical research of US banks supports the idea that market variables improve the assessment of banks' financial health when added to standard call report financial data (Curry et al., 2002; Evanoff & Wall, 2001). Additionally, it is shown that the veracity of predicting a CAMEL (supervisory) rating downgrade to the lowest levels can be significantly improved by adding market variables to a set of accounting indicators, though the predictive power is found to be

significant only for banks in great financial distress (Curry et al., 2003). Empirical findings in a sample of EU banks analyzed by Gropp et al., (2002) and Distinguin et al., (2005) suggest that equity market based indicators deliver earlier signals of fragility than debt based indicators. Overall, with rapidly changing financial markets, Early Warning Models also need to adjust to a changing environment. For this reason, EWS models need to be continually revised and modified where necessary. The proposed approaches to EWS modifications suggested by academics are discussed in a separate section of our literature review.

Allen L (2005) has revised both traditional and modern approaches of credit risk measurement. The review states that traditional models are characterized as estimators of probability default. In contrast, modern approaches measure an extent of potential loss/gain following downgrades/upgrades in credit quality. This feature of modern models is called "Mark to Market" (MTM). The following table demonstrates a broad classification of credit risk models suggested by L. Allen (2005)

Table 4-1 Relative Classification of Credit Risk Measuring Models

Classifications of the existing models	Main characteristics
1.Traditional models of credit risk measurement	
a. Expert system 5 C's i. Artificial neural networks b.Rating system (external and internal) c. Credit scoring models (Z score) d.Linear probability model i. Logit model ii. Probit model iii. The multiple discriminant analysis model	Estimate Probability of Default (PD), so called Default Mode (DM) models
2.Modern credit risk measurement models	
a.Option-theoretic structural approach i. Merton option pricing model ii. KMV's Credit Manager(now Moody's KMV) b.Reduced form approach or intensity based models (fundamentally empirical) i. KPMG and Kamakura Corporation	Loss Given Default (LGD) or Loss In the Event of Default (LIED) models. Estimate magnitude of potential losses in the event of default.
c. Value at Risk models (proprietary VaR Models of Credit Risk measurement) i. Credit Metrics (mark-to-market) ii. Algorithmic (mark-to-future) d.Mortality rate models (Credit Risk Plus by CSFP)	

Traditional models are broadly subdivided into three main categories: expert system, rating system and credit scoring models. Expert system is based on the so called 5 C's of credit quality: Character, Capital, Capacity, Collateral and Cycle. Later, it was supported by artificial neural network to increase objectivity. The disadvantage of a neural network besides the cost of execution is that it

quickly exceeds a particular database if excessive training has taken place, resulting in poor out of the sample estimates.

Rating system, which is another traditional model, is sub-divided into external and internal credit ratings. The first is carried out by entities specializing in credit ratings such as Moody's. Internal ratings are required by bank regulators to rank the credit quality of banks' portfolios of loans. The system is implemented by the majority of banks to fit the New Capital Accord proposed by the Basel Committee on Banking Supervision. One of the deficiencies of the internal rating system is its inconsistency with regard to the estimated relative importance of each factor across individual banks.

The next method classified as a traditional modelling technique is credit scoring models. Credit scoring models were pioneered by Beaver (1966) and Altman(1968) and have various methodological forms. Generally, they identify financial variables which statistically estimate the creditworthiness of an entity based on Z-score. The lower the Z score, the more likely the company is to fail. The advantages of these models lie in the fact that they are not costly to implement and do not suffer from subjectivity and discrepancy evident in the previously listed systems. However, they have their own limitations which are the assumption of linearity and data limitations (balance sheet data). Moreover, these models are not well grounded in economic theory.

Modern methods can be broadly classified into two alternative schools of thought in the asset pricing literature of academic finance: an *options-theoretic structural approach* pioneered by Merton (1974) and a *reduced form approach* based on intensity-based models to estimate stochastic hazard rates, pioneered by Jarrow and Turnbull (2000), Jarrow, Lando and Turnbull (1997), and Duffie and Singleton (1998, 1999). The two approaches offer differing methodologies in the estimation of default probabilities. The structural approach models the economic process of default, while the reduced form approach models the decomposition of risky debt prices in order to estimate the random intensity process underlying default. Both are primary models that attempt to describe default processes in credit risk modelling. Since structural models are our main interest, detailed descriptions of the models and their extensions are presented in the next part of our literature review.

Numerous researchers have come up with so called modified versions of the structural model that depart from the original Merton model and relax many of its assumptions. One of the widely used versions of the structural model is KMV- Kealhofer, McQuown and Vasicek (also known as MKMV – Moody's KMV) developed by the KMV Corporation in late 1980s. KMV is essentially a commercial version of the VK model (Vasicek-Kealhofer model) which values corporate securities based on implicit corporate default risk free rate, time varying market risk premium, liquidity premium and time varying expected recovery amount. Moreover, it uses a historical database of firms' default rates to estimate an appropriate EDF (Expected Default Frequency). This model appears to produce unbiased robust predictions of corporate bond credit spreads (Bohn, 2000), (Agrawal, Arora, & Bohn, 2004). KMV departs from the traditional structural model in various aspects. The firm is treated as a

perpetual entity that is continuously borrowing and retiring debt; the model treats different classes of liabilities - short term and long term liabilities, convertible debt, preferred and common equity; the method of calculating interim asset volatility and final asset volatility differs, which will be discussed broadly in our methodology.

Another example of modern credit measuring theories is the reduced form approach. In structural models default occurs when the market value of a firm's assets falls below the value of its liabilities i.e. it argues that default is an outcome of worsening asset values. In contrast, reduced models explain default as a sudden or unexpected event. Moreover, reduced models (also known as intensity based models) view default as a point process occurring randomly with a probability determined by the intensity or "hazard" function. Unlike in structural models, there is no structural explanation of why default occurs. Intensity based models are fundamentally empirical using observable risky debt prices such as spreads to estimate the stochastic default intensity function.

It is argued that reduced models better explain complex term structures of default than structural models. However, many international bond markets are vast and not transparent as trades are conducted over the counter markets. The prices of debts are therefore often inaccurate and contain considerable noise. It is also claimed that most structural models assume complete information while a modeller only has as much information as the market, making the reduced-form approach more realistic (Jarrow & Potter, 2004). In practice, proponents of structural models state that the assumption of complete information is an approximation which facilitates the capture of various economic nuances in how a firm operates. Furthermore, the reduced model also has a principal weakness of not having a clear economic rationale to define the nature of default processes (Arrora, Bohn, & Zhu, 2005). Also, the reduced model's flexible structure of functional form may result in a model with strong in-sample fitting properties, but poor out of the sample results. As for empirical testing of the reduced model, it is not widely employed because of the difficulty with results interpretation (especially with a large cross section of debt instruments) and a lack of theoretical guidance.

The empirical work by Agrawal, Arora, & Bohn (2004), compares the three above dicussed models: the HW reduced form model (Hull & White, 2000), basic Merton structural model, and MKMV with a sample of 542 firms. Their research is one of the first attempts at testing these models on a broad cross section of credit default swap data. The power of the two structural models is tested based on information from equity markets, while for the reduced model bond market information is used. The research concludes that in general the reduced form model largely underperforms compared to a sophisticated strucural model like MKMV model. The MKMV model consistently outperformed the other two models in terms of default predictive power. Moreover, its performance is more consistent with large and small firms, while the performance of the HW and basic Merton models deteriorates considerably across large firms. However, the HW reduced form model outperforms the structural

model when a firm issues a large number of bonds in the market. A basic Merton model requires appropriate modification to the framework.

The final classification of credit risk modelling approaches is VAR models. These models are considered as complementary since they use either a structural or reduced form approach to find the PD of each asset. Each loan in the portfolio can then be valued to derive a probability distribution of portfolio values. In the next stage, a loss distribution is calculated permitting the computation of Value at Risk measures of unexpected losses where it specifies the minimum losses that will be exceeded with a certain probability.

In 2000, ISDA (International Swap Derivative Association) and IIF (Institute of International Finance) published the results of their joint research where they tested the performance of 4 credit risk models (KMV, Credit Risk Plus, Credit Portfolio View, CreditMatrics) across 25 commercial banks of varying size and specialties from 10 countries (IIF/ISDA, 2000). One of the main conclusions of the study is that the models show directionally consistent outputs when given similar inputs. Discrepancies are attributed to differences in module inputs, pre-processing and valuation errors of model usage during testing and participants misunderstanding the application of standardized parameters. In addition, substantive differences in results across models can be caused by different approaches of valuations and correlation calculation methods (Allen, 2002).

Structural literature on credit risk starts with the first structural model presented by Merton (1974) who applies option pricing theory developed by Black and Scholes (1973) to model a firm's debt. The classical Merton model implies a relationship between the unobservable variable (Asset) and observable variables (Equity and Debt). It supposes that a firm's equity value is equivalent to a European call option on the firm's asset with the strike price equal to the debt's face. The model assumes a very simple and unrealistic capital structure and implies that a firm's default can only occur at maturity. It also assumes risk neutrality and that the firm's asset value follows geometric Brownian motion. In other words, the firm's equity is as a call option on the firm's assets (denoted *A)* with a strike price equal to the liabilities of the firm *(*denoted *D)*. If at expiration (coinciding with the maturity of the firm's liabilities, where the firms liabilities are assumed to be comprised of pure discount debt instruments) the market value of the firm's assets is greater than the value of its debt, then the firm's shareholders will exercise the option to repurchase the company's assets by repaying the debt. When the market value of the firm's assets is less than the value of its debt ($A<D$), then the option may not be exercised and the firm's shareholders may default. Consequently, the probability of default (PD) until expiration (set equal to the maturity date of the firm's pure discount debt, typically assumed to be one year) is equal to the likelihood that the option will expire unexercised.

To determine PD, the value of the call option is calculated by using an iterative method. It estimates the unobserved variables that determine the value of the equity call option, in particular A (the market value of assets) and σ_A (the volatility of assets). These values for A and σ_A are combined

with the amount of debt liabilities *D* that have to be repaid at a given credit horizon in order to calculate the firm's Distance to Default (DD):

$$DD = \frac{A - D}{A * \sigma_A} \quad [1a]$$

The preceding formula can be worded as:

$$Distance\ to\ Default = \frac{(Market\ Value\ of\ Assets) - (Debt)}{(Market\ Value\ of\ Assets)\ x\ (Volatility\ of\ Assets)} \quad [1b]$$

DD calculates the number of standard deviations between current market asset values and the debt liabilities. The higher the DD, the lower the PD. To convert the *DD* into a probability to default estimate, Merton (1974) assumes that asset values are lognormally distributed.

A number of empirical tests of the model (Jones, Mason, & Rosenfeld, 1984) show that it systematically underestimates observed spreads. Ogden(1987) proved this finding and estimated that the Merton model under predicted spreads over US treasury bills by an average of 104 basis points. The original Merton model suffers primarily from unrealistic assumptions; to make it more realistic many extensions have been introduced. Here we provide the major limitations of Merton's model and how these limitations have been addressed in later extensions of the model.

There are number of limitations of Merton's model. Firstly, there is a restriction of default time to the maturity date i.e. there is no possibility of an early default before the maturity of the debt. Besides, capital structure of a firm is a simple zero-coupon bond which is not realistic. It also assumes constant and flat term structure of interest rates and predictability of defaults.

Black and Cox (1976) offer a modified model where default happens the first time the asset value goes below a certain lower threshold. This is a so called First Passage Model (FPM) which allow default to take place at any time, not only at the maturity of the debt. This change moves the model closer to reality since firms may, for example, have a safety covenant - a protection mechanism for firm's bondholders against unsatisfactory corporate performance. Here, the default threshold would be deterministic, although possibly time dependent, and exogenously fixed when the firm's debt is issued. Black and Cox (1976) consider a default barrier equal to the face value of the debt discounted at the risk free interest rate. This can make the default barrier stochastic if the model considers a stochastic process for the interest rate (Briys & Varenne, 1997). The default threshold can also be chosen endogenously by the stockholders to maximize the value of the equity (Mello & Persons, 1992).

Obviously, the above mentioned extensions have made the modified model more realistic, but at the same time FPMs have become more analytically complex and their empirical implementations in general have not been very successful (Anderson & Sundaresen, 2000). Moreover, since according to FPM the firm is liquidated immediately after the default event, the models still suffer from predictability of defaults which also implies suffering from predictability of recovery.

In contrary to FPMs, in the new set of models the default event does not immediately cause liquidation but rather represents the start of the liquidation process which might or might not lead to liquidation depending on completion. These models are so called Liquidation Process Models (LPM). LPMs make a distinction between the terms *default event* and *liquidation.* A default event takes place when the firm assets go below the lower threshold (which can be constant, exogenous, time dependant, stochastic or endogenous). Default also indicates the beginning of a period of financial distress which does not necessarily lead to liquidation. Liquidation of a firm takes place when the firm is actually liquidated i.e. when its activity stops and its remaining assets are distributed among its claimholders. While LPMs have extended FPMs to account for the fact that liquidation takes place following a default, these models have not been empirically tested (Elizalde, 2005).

Another direction within the structural approach consists of extending standard models with regime switching: some of the model parameters are state dependent. These models are called State Dependent Models (SDM) and, similar to LPMs, they attempt to incorporate into the structural model different real-life phenomena. In SDMs states can represent the state of the business cycle or a firm's external rating. Consequently cash-flow, bankruptcy costs, and funding costs are considered as state-dependent. SDMs are able to reduce the problem of predictability of defaults since they imply that the firm is subject to exogenous changes in parameters which affect its ability to generate cash flow or its funding costs. These two factors are the main drivers of default probability.

SDMs have been developed through a number of papers. For example, Elizalde (2005) presents a structural model originally applied to banks where the firm's asset value is assumed to be unobserved by debt holders. According to the model, the debt holders rely on the ratings published by ratings agencies to set the debt's coupon for their bonds based on those ratings. This causes the firm's funding costs to be dependent on its external ratings. Duffie (2005) explains it as "*rating-based step up*" where more bond issuers link the size of the coupon rate on their debt to their credit ratings. Like LPMs, SDMs have not been empirically tested and their future success in credit risk modelling depends on their empirical capability.

2.2 Previous research of EWS based on structural models

To our knowledge (change) Gropp el al. (2002) and Tarazi et al. (2005) are the first authors who study EWS for EU banks based on security data. Much research studies the properties of subordinate debt spreads to predict banks failure but we will concentrate on equity market indicators since we believe they are more available and less problematic to measure in the European framework. Debt signals have some major drawbacks: since banks usually issue several bonds with different profiles and time-to-maturity, it is unclear what type of data to collect; another difficulty arises in finding a general risk free rate applicable for the European market to calculate spreads; finally, the liquidity of European bond markets can often be questioned.

Grop et al. (2002) argue that the negative distance to default measure is both complete and unbiased and may prove a useful leading indicator of bank fragility. It was compared to the standard bond spreads indicator; overall these two indicators were found to provide complementary information by reducing Type I errors. By estimating logit and proportional hazard models it was found that both indicators could predict bank distress up to 18 months prior to an event even taking into account the safety net effect. However, the predictive power of the indicators is different: negative DD shows poor predictive power close to the default while spread signals come only close to the event. Based on their findings, spreads signals predict defaults of only smaller banks with uninsured securities. Using a synthetic measure of the financial situation of banks based on accounting data it can be demonstrated that DD provides supplementary information relative to accounting information.

Another test, developed for European banks through a specifically designed logit econometric model (Distinguin, Rous, & Tarazi, 2006), investigates how well stock market prices contribute to the improvement of predicting a bank's distress. It has been Since European markets generally suffer from insufficient liquidity in bond markets, the work only considers a great variety of equity market indicators. It focuses only on the prediction of any downgrading of banks credit ratings (by Fitch, Standard & Poors, and Moody's) to test the actual information content of stock prices, not on bank failure/severe financial distress. As accounting indicators and equity market data are not available at the same frequencies, the study departs from each date at which accounting data information is available (31 December) and then considers events which take place in four subsequent quarters following this date. The sample comprises 64 European banks listed on the stock market and which have at least one rating from three major ratings agencies through the period 1995-2002. Accounting indicators are ratios which are commonly used to assess a bank's financial state and are presented in their time changes. Market indicators are constructed from daily equity prices to capture: 1) the effect of shocks or presence of abnormal returns; 2) risk changes and 3) changes in the probability of failure. The research findings confirm that the market information can act as a substitute to accounting information and conveys additional information regarding the probability of bank's being downgraded. The accuracy of the predictive power depends on the extent to which bank liabilities are traded in the market. For those banks which rely heavily on insured and non-market priced deposits, larger subordinate debt issues do not improve prediction and the market seems to be unable to convey useful information. Size and opacity effects, at odds to the study of Gropp at al. (2002), show that they may undermine the ability of stock prices to transmit useful information on banks' future financial health. For instance, a higher degree of opacity tends to weaken the existing link between equity market indicators and the probability of future downgrading.

Earlier we debated that recent regulatory changes, financial and technological innovations have changed the existing banking environment and the causes of financial distress both in US and European markets. To capture these changes, the introduction of more risk focused and growth

focused indicators has been suggested so that to adapt risk measuring models to the new banking environment (King et al., 2005). This implication is empirically tested using a sample of 82 EU banks observed from 1991-2005 by Brossard et al (2007). The study constructs DD indicators to test the predictive power of bank failure, similar to the test implemented by Gropp et al (2005), while introducing a variable detecting the adverse selection effect of rapid growth strategies in their model. This indicator accounts for problems arising from banks undertaking aggressive growth strategies where they might employ lower standards in the selection and monitoring of their new assets. This is considered in the FDIC Growth Monitoring System, but its significance is still not well evidenced in EU markets. Their empirical findings confirm the robustness of DD as an early indicator of banks' failure supporting the study of Gropp et al (2002) though a more restrictive definition of the "failure" is used. To define credit events the Individual Ratings from Fitch/ICBA are used. They also include a Support Rating from the same agency to explain the extent of the safety net a bank might benefit from in case of financial difficulties controlling "To-Big-To-Fail" effect. DD remains significant when it is joined with CAMEL accounting indicators and after the introduction of the "Too-Big-Too-Fail" effect. Another important finding is that the new indicator of the adverse selection effect improves the predictive power of the model.

As we mentioned above, Merton's model is subject to various modifications and additions. Since it uses market signals as a primary input, the model may suffer from potential shortcomings associated with the accuracy of market indicators. Well-known factors which influence data accuracy are opacity, option value effect, and moral hazard due to the safety net. These factors have been extensively discussed in academic literature. The work Auvray and Brossard, forthcoming focuses on another factor which may have a negative effect on the reliability of share prices in predicting bank distress. This factor is referred to as the level of ownership dispersion suggesting that too much ownership dispersion may impair the information content of share prices due to weaker monitoring. The study tests a sample of 76 European banks applying Merton-KMV DD and investigates whether dispersed ownership leads to weaker monitoring from shareholders and consequently a poor power of predictability of the DD indicator. The study also examines the quality of information gathered by banks' shareholders and how well it is incorporated into banks' share prices. The sample only contains data from the biggest and most actively traded European banks which have individual ratings from Fitch/IBCA agency between the years 1997-2005. First EWM are built using five accounting variables (CAMEL) and the DD indicator. A dummy variable is introduced to take into account the possible impact of the degree of public support. In the second step, DD is multiplied with another dummy variable which captures ownership type (dispersed or not dispersed). The test confirms that ownership dispersion of a bank's shareholders clearly reduces the effectiveness of distance-to-default as a predictor of bank distress and bank recovery. In contrast, when ownership is concentrated it raises the predictive power of the indicator.

Empirical findings in emerging markets also are favourable towards equity market signals in predicting banks' financial distress. Chan-Lau, Jobert, & Kong (2004) in their study of emerging markets'banking vulnerabilities follow Merton's option-based structural model of credit risk (Merton, 1974) by deriving normalized distance-to-default as a risk neutral indicator of bank vulnerability. The sample period covers July 1997 to July 2003 comprising 38 banks from 14 different emerging countries. Their findings show that indicators can forewarn bank distress, defined as ratings downgrades to CCC or below, up to nine months in advance within the sample. Correspondingly, out of the sample results prove that the indicator could have signalled bank failures in Argentina by the end of 2001. The authors suggest using these indicators in real time as a policy maker's toolkit to forecast bank crises. However, the distance to default indicator is considered to have an inherent weakness which stems from the fact that it is only a "risk neutral" measure, thus making it difficult to apply it as a "real world" objective measure of financial distress.

The concept of using distance to default as a pre-default regulatory action was further developed through a number of pieces of research and case studies. Chan-Lau and Sy (2006) offer an alternative risk measure named Distance-to-Capital (DC) to serve as the regulatory purpose of bank supervisors in intervening well ahead of a bank's default, since it involves substantial welfare costs. They argue that the original definition of DD may understate the likelihood that a bank may be required to undertake corrective actions by regulators and thus the DD may be "a bridge to far" for regulatory purposes. In contrast DC incorporates triggers embedded in the prompt-corrective-action (PCA) frameworks providing better signals as to when a bank would be required to take corrective actions or require regulatory intervention. The study suggests DC as a tool for policy makers to monitor the stability of the financial system as a whole, but it emphasizes its limitations in its application such as the existence of numerous capital thresholds and problems with the aggregation of individual bank data.

Another test of the predictive power of DD for eight failed Japanese banks is proposed by Harada et al (2010). DD is calculated by a structural model of credit risk assessment based on Merton's (1974) option pricing theory. Banks are placed into two groups based on their asset size: 3 large banks and 5 smaller regional banks. DD becomes smaller in predicting banks' failure in many cases. They find that DD is generally a reliable measure, but a lack of transparency in financial statements and disclosed information deteriorates its predictive power. The DD spreads, defined as DD of failed banks minus DD of sound banks is also found to be a helpful indicator in predicting bank failures.

Given that here we discuss bank fragility indicators based on publicly observable information, most surveys refer to a central question: to what extent market signals of bank fragility are reliable. This question is addressed by a study of the South East Asian crisis countries over the years 1996-1998 with collective data from 246 financial institutions (Bongini, Laeven, & Majnoni, 2002). They explore the performance of three publicly available indicators of bank fragility namely accounting

data, stock market prices and credit ratings by means of three different tests. First, they investigate the degree of market discipline imposed by credit ratings and stock prices before and during the onset of the financial crisis. The results confirm that neither rated nor listed banks were subject to a significant degree of market discipline. The next test is referred to as a horse race since it investigates which of the three indicators of bank fragility has more power in predicting actual bank distress. A balance sheet indicator is constructed using CAMEL ratios, by transferring them into dummy variables whenever their value is worse than that of 75% of all the sampled banks and zero otherwise. Market signals are built by using deposit insurance premiums via the implementation of Merton's model (1977) suggested by Ronn and Verma (1986). Two key assumptions of the model are (1) that the bank's asset values follow geometric Brownian motion and (2) that all bank debt is insured. East Asian countries governments are found to implicitly fully guarantee depositors funds. Credit ratings are taken from Moody's ratings. The results of the second test suggest that after controlling for country specific and size factors none of the three indicators exhibits a significant amount of information with regard to discriminating distressed banks from non-distressed ones. Among these three indicators implicit deposit insurance premiums demonstrate a relatively higher power, followed by the balance sheet indicator. In general, the investigation revealed that all three indicators of bank fragility did not demonstrate common behavioural characteristics during the onset of the East Asian Crisis and did not provide considerable predictive power in the forecast of bank failure. From a dynamic perspective, stock market based indicators proved to react faster than the other two. The work concludes that in less developed financial systems it is important to use simultaneously a plurality of indicators to assess bank fragility.

Though the revised empirical research has applied different approaches and methods of EWS, we can draw the following conclusions:

- Distance to default indicator may prove useful for banks monitoring purposes though it suffers from its restrictive assumptions and other limitations
- Majority of studies advocate paying more attention to the equity market and to information embedded in the market prices of bank's securities
- Many studies present evidence in favour of using market price based measures as early indicators of bank fragility
- Stock market based information responds more quickly to changing financial conditions
- The accuracy of market based indicators can deteriorate as a result of a number of factors
- Further extensions of the bank fragility indicator should capture the increasing complexity and transmission of changes in financial markets.

In the following table we have made a comparison of the main characteristics of some of the revised EWS studies.

Table 4-2 Comparison of the selected EWS studies and their main characteristics

Author(s)	Data analyzed	Period of study	Type of bank's fragility measure	Predictive power, time span	Limitations
Gropp, Vesala, & Vulpes, 2002	European banks	1991-2001	Equity-based distance to default	6-8 months, up to 24 months	Fails to predict close to event
			Subordinate bond spread	3-6 months	Predicts only in short run
Chan-Lau & Sy, 2006	Japanese banks	2001-2003	Distance-to-Capital	-	Cannot be applied system wide due to existence of numerous capital thresholds
Chan-Lau, Jobert, & Kong, 2004	Emerging market banks	1997-2003	Normalized DD (derived from Merton's formula)	Up to 9 months	1) Risk neutral measure 2) It assumes that default barrier remains constant during the period
Brossard, Ducrozet & Roche, 2006	European banks	1991-2005	DD with CAMEL (accounting ratios) and adverse selection effect variable	Up to 24 months	Could be further improved with bank sensitivity to contagion effects and systematic risks.
Distinguin, Rous, & Tarazi, 2005	European banks	1995-2002	Accounting indicators: CAEL ratios and market indicators (11 indicators including Z-score and DD)	Up to 4 quarters before downgrade	Depends on extent to which bank liabilities are market traded
Auvray & Brossard, (2012)	European banks	1997-2005	EWS using five accounting variables (CAMEL) and DD (Merton's KMV model)indicator	2- 4 quarters	If bank's ownership is dispersed this diminishes predictive power of DD

3 Other indicators of bank's fragility

Some academic papers do not focus on a set of indicators as a part of EWS models but rather concentrate on specific factors such as capital structure, funding structure, business models, etc. and investigate their power in predicting bank distress. Similarly, a number of studies concentrate on analyzing how well certain indicators performed in reflecting financial soundness/ fragility of banks during the recent financial crisis. In this section we review a few of these studies and discuss the validity of the proposed factors.

Demirgüç-Kunt et al., (2010) research the role of bank capital in withstanding shocks such as the financial crisis. In particular, they investigate whether better capitalized banks have higher stock returns during financial crises. Also, they discuss which concept of capital is more relevant in stock valuation during crises and what items are counted as capital for regulatory purposes. The baseline model measures bank performance through changes in a bank's stock prices between quarters relating it to changes in its level of capital. It uses dummy variables which account for any possible omitted country-level effects such as macroeconomic shocks, systematic components, etc. and a matrix

of bank-level control controls for bank-specific features (such as bank liquidity, reliance on deposits for funding, etc.) The results obtained from a large sample of international banks suggest that during the crisis banks with higher capitalization were better valued than undercapitalized banks, though this trend is not observed before the crisis. Moreover, they find that big banks' stock returns are more sensitive to the leverage ratio as a capital measure than to the risk-adjusted Basel ratios. This may be explained by a lack of reliability of later indicators by market participants at the time of the crisis. Finally, it concludes that "higher quality capital" – Tier 1 and tangible common equity are more relevant.

The role of bank capital is analysed by Berger & Bouwman (2012). The study examines the effect of capital on bank performance and whether it varies across financial crises and periods of financial stability. Here bank performance is measured in terms of survival and market share. The research has two baseline regressions which empirically measure the effect of capital on bank survival and on market share over different time periods. Potential omitted variables are covered by a broad set of control variables. The main findings of the study support the general hypothesis that capital helps banks to survive. It demonstrates that for small banks capital is essential for survival at all times while for medium and large banks it si essential only during banking crises. Capital helps small banks to improve their market share at all times, while for medium and large banks it is helpful only during banking crises

Similar analysis has been performed by Altunbas et al., (2011) for a large sample of listed banks in the EU and US. They observe complex financial indicators before and during the crisis and investigate whether the variability across bank business models is related to their realized risk during the financial crisis. Realized bank risk is measured by several indicators such as the likelihood of bank rescue, systematic risk and intensity of recourse to central bank liquidity. Probit and linear regressions are applied to three measures of risk and a group of independent variables. To measure bank distress during a crisis the study employs regression quantile techniques. The results reveal that higher levels of capital decrease bank risk, though this is argued to be a non-linear relationship. They also find that ex-post bank risk is associated with ex-ante bank size and the degree of credit expansion in the years preceding a crisis. Moreover, they argue that banks with more deposit base funding are less risky than banks with a higher market funding. In general, the study encourages bank supervisors to distinguish the impact of different business models on bank risk to explain the divergence in risk realization during crises.

The idea of the importance of funding stragegy in defining the level of bank riskiness is now quite popular among academics. The implications of a bank's funding strategy for bank risk and return is investigated by Demirgüç-Kunt & Huizinga (2009) among others. The study examines how bank activity and short-term funding strategies affect risk and return trade-off. The period covered is 1995-2007 and comprises international banks with stock exchange listings. The study first intends to

explain variations in income and funding share through a range of bank level, bank environment variables. Next, the relationship between fee income and non-deposit funding on bank risk and return is tested. For the purpose of robustness two alternative measures of bank risk and return are tested. The possibility of endogeneity in bank risk and return is also revised. Research findings support the idea that a higher non-interest income or non-deposit funding level contributes to higher bank risk, though the impact of both variables on bank return is difficult to explain due to endogeneity concerns. The study concludes that, overall, traditional banks – with heavy reliance on interest income and deposit funding - are safer.

Alternatively, Huang & Ratnovski (2010) also research the effect of bank funding strategies and specifically wholesale funding impact. They present two alternative models: "bright side" and "dark side" of wholesale bank funding. As a benchmark of "bright side" wholesale funding the CK (Calomiris & Kahn, 1991) model is taken. It is then contrasted with an alternative "dark side" model with the introduction of costless and noisy signals of bank project quality. The results reveal that wholesale funding is beneficial when providers are informed. But with the presence of noisy public signals the incentives of fund providers to monitor banks and impose market discipline may be distorted and lead to inefficient liquidation of a bank. The negative effects of wholesale funding relate to banks with extended exposures to standardized and tradable arm's length assets, with readily available public information and when wholesale funds are senior claimants.

4 Data and Empirical Methodology

Despite the fact that the sphere of credit risk measurement has been well explored, the fundamental techniques still have the same objective - that is to identify factors, using a common set of variables and/or financial ratios that differ in a systematic way between failed and non-failed banks.

We measure European banks' default predictability using Moody's Analytics' Expected Default Frequency (EDF). EDF is the market-based credit measure developed by Moody's KMV which is based on Merton's option-pricing theory's distance to default indicator. It calculates distance to default of an entity through mapping it to MKMV's empirical default database and provides with the regularly updated probabilities that a company defaults within a given time horizon, where default means the failure to make scheduled debt payments. EDF has two distinctive characteristics: it is grounded on corporate theory unlike reduced models and incorporates market information unlike structural credit risk models. Moreover, it incorporates more realistic assumptions which better adjusts it to reflect real-world default dynamics. EDF metrics range from 1 basis point to 35% and provides with absolute default probability estimates. It is argued by number of empirical works (Bohn, 2000 & Agrawal, Arora, & Bohn, 2004) as being efficient measure of firms' defaults which generally outperforms the basic Merton structural model and Hull and White's reduced form models.

Our methodology is based on using 1 year and 5 years EDFs of European banks and test whether they discriminate distressed banks from non-distressed ones. We take Moody's credit ratings as a "default" variable. Whenever the bank's rating falls to D+ or below it is accepted as "default" event. We add other variables suggested by previous studies such as adverse selection effect variable and accounting variables to test if the efficiency of our baseline model increases with their addition. Our final model comprises of the combination of the variables which is found efficient in predicting banks' defaults for the given sample of European banks.

Our main research question is: *Are conventional models able to predict the financial distress of banks before the onset of financial crises?*

By answering this question we also examine if EDF is a good measure for distinguishing fragile banks from not fragile ones? If so, what parameters can be improved and how can the model be improved so as to make a robust estimator of EU bank defaults?

Our sample comprises of 93 European[10] banks which are selected by applying the following selection criteria (Table 4-3):

Table 4-3 Criteria of the search strategy

World Region/Country	European Union of 15
Accounting standards	International Accounting Standards, International Financial Reporting Standards (IFRS)
Specialisation	Commercial banks, Savings banks, Cooperative banks, Real estate &mortgage banks, Investment banks, Bank holdings & Holding companies, Private banking / Asset management companies
Listed Banks	Listed Banks
Moody's EDF data	Expected Default Frequency for 1 year and 5 years
Time Period	2005 1st quarter – 2011 4th quarter

We start our sample selection process from a list of European banks which have the Expected Default Frequency (EDF) data for the selected time period. The Accounting and Moody's rating data is taken from the BankScope International Bank Database provided by Fitch/Bureau Van Dijk. Since downgrades are announced in an irregular manner and do not occur at equally spaced intervals, we decided to use quarterly data to better match the announcement times.

4.1 Dependent Variable

Our dependent variable should indicate the occurrence of bank default. However, among European banks formal defaults are very rare. Prior to actual default there is no way to explicitly discriminate between banks that may default and those that may not. We can, therefore, only use proxies which are based on the probabilistic likelihood of default. In the majority of previous studies academics use credit agencies' ratings as a proxy. The credit ratings discriminate between sound banks and fragile ones by assigning them a particular score indicating the financial state of an entity.

[10] List of analysed banks are provided in Appendix C

In our research we use Moody's Bank Financial Strength ratings as a default indicator. The rating reflects a bank's intrinsic financial strength and ranges from A to E including '+' and '-' qualifiers, where A is assigned to the strongest banks. In line with Gropp et al. (2002) and Brossard et al. (2006) we consider a bank's downgrade to D+ or below as a proxy for being "defaulted" as it reflects a substantial weakening of a bank's financial strength. Banks with a D rating display modest intrinsic financial strength and may require external support. BFSR D+ ratings are mapped to the Baseline Credit Assessment (BCA) rating as baa3-ba1. BCA ratings reflect opinions of issuers' standalone intrinsic strength, notwithstanding any extraordinary support from an affiliate or a government. Banks which have a rating lower than baa3 are characterised as having speculative intrinsic, or standalone, financial strength and are considered as having substantial credit risks.

Table 4-4 shows the total number of observations for each group in our sample. Defaulted banks account for 90 observations in the sample. These are banks which were downgraded by Moody's agency to D+ or lower levels (D+, D, D- & E) within the observed quarters. Not rated banks signify banks which did not receive Moody's ratings for the observed period.

Table 4-4 Statistics of the "default" events in the sample

	Freq.	Percent	Cum.
Not defaulted Banks	669	8.31%	8.31%
Defaulted Banks	90	1.12%	9.42%
Not rated Banks	7296	90.58%	100%
Total	8055	100%	

A general statistics table of the sample shows that about 12% of all rated banks have experienced a downgrade event, with a frequency of 90 out of 759 rated banks. It comprises only 1.12% of the overall sample. Only 9.4% of the banks in the sample received Moody's ratings in the observed period (from 2005 1st quarter to 2011 4th quarter). As we mentioned above, formal bank bankruptcy is a rare event for European banks. We are aware that rare events could bring bias to model estimations, though with the given sample size and the proportion of positive outcomes we believe there is no bias in maximum likelihood estimation.

4.2 Independent Variables and hypothesis

Our main independent variable is Expected Default Frequency – EDF. Essentially, EDF is based on Merton's option-based structural model of credit risk. The first structural model presented by Merton (1974) applies option pricing theory developed by Black and Scholes (1973) to model a firm's debt. The classical Merton model implies a relationship between the unobservable variable (Asset) and observable variables (Equity and Debt). It supposes that a firm's equity value is equivalent to a European call option on the firm's asset with the strike price equal to the debt's face value. The model measures the creditworthiness of an entity through the "distance to default" indicator. Distance to

default denotes the number of standard deviations of assets' volatility to an entity's default point. The higher the distance to default, the lower is the default risk. Vasicek and Kealhofer have extended the Black-Scholes-Merton framework to produce a model of default probability known as the Vasicek-Kealhofer model (VK model). KMV (Moody's KMV) is a commercial version of the VK model which provides commercially available EDF measures for firms and financial institutions. EDF, unlike the distance to default measure, represents the probability of default i.e. the likelihood of a bank being insolvent within a specified period of time. Here, default is an event when a company is not able to meet its debt obligations or when the market value of the firm's assets is less than the book value of the firm's liabilities by the time the debt matures (Crosbie & Bohn, 2003). To calculate the probability of default one needs to determine the distance to default value first. Distance to default measures the difference between the asset value of a firm and the face value of its debt, scaled by the standard deviation of the firm's asset value:

$$DD = \phi\left[\frac{\ln(A_t) - (\mu - \frac{\sigma^2}{2})(T-t) - \ln L}{\sigma\sqrt{T-t}}\right] \quad [2]$$

Consequently, the probability of default or EDF can be defined as the cumulative normal distribution of the distance to default:

$$PD = \phi[-DD] \quad [3]$$

As can be seen from the equation [2], the probability of default (PD)/EDF are inversely proportional to the distance to default measure where the higher PD/EDF values indicate lower distance to default.

Despite being well grounded in economic theory, EDF is a forward looking measure based on market information. It uses the asset value of entities based on information from equity prices, and these prices reflect current and future estimates of market participants. EDF is measured in regular base and provides a continuous credit monitoring process that is difficult and expensive to duplicate. Its values are estimated based on Moody's historical database identifying the proportion of entities with particular distance to default who actually defaulted within a particular time period. It is believed by many practitioners that using such a database improves default predictions enormously. Considering all the above, we believe that EDF is a reliable measure of banks' credit quality and thus an appropriate measure for our analysis.

We use both the bank ratings and EDF of Moody's Analytical Services in our estimates; it is logical to question whether these two measures replicate each other. EDF does not correspond fairly to default probabilities mapped to agencies' ratings. Moody's explanation is that these discrepancies reflect the difference in nature of the measures. Ratings represent long-term views of credit risk and

are not continuously reviewed, while EDF values fluctuate continuously because of frequent revaluation of EDF inputs.

In line with the previous literature we test the validity of the supervisory CAMEL ratios for our Early Warning Models. CAMEL ratios are standard balance sheet and income statement financial ratios which are widely used by supervisory agencies around the world. They include capital, asset quality, management, earnings, and liquidity ratios and are often combined with other early warning indicators to detect the financial vulnerability of banks. We use CAMEL covariates together with EDF and see if they imbue our models with additional power.

Another variable we test together with EDF is an indicator of adverse selection effect. The variable captures the effect of aggressive growth strategies undertaken by many banks before the outbreak of financial crises. According to Brossard *et al.* (2006) this indicator improves the predictive power of the EWM. Together with other variables it enables the prediction of bank failure up to 24 months prior to the event. Similarly, we also introduce variables which account for adverse selection effect. We take moving averages of year-on-year growth rates of total assets or gross loans, using quarterly data. A more detailed explanation of how we calculate adverse selection variables is provided in the next section.

Based on previous studies and our analyses we form the following hypotheses with regards to our measures:

H1: The higher the bank's EDF of the bank the more likely it will be downgraded to D+[11] *and below*

H2: CAMEL variables bring additional predictive power to the EDF measure

H2a: Higher capital ratios enhance banks' probability of survival during financial crises

H2b: Impaired loans ratio is positively related to likeliness of default

H2c: Increased costs is positively related to bank downgrade

H2d: Higher bank earnings decrease the probability of default

H2e: Higher bank liquidity position is negatively associated with default probability

H3: Banks undertaking aggressive growth strategies prior to crises have a higher probability of being downgraded to D+ and below.

Table 3-3 summarizes definitions and sign predictions of variables we use in our estimation.

Table 4-5 Variables and expected signs

Variable	Prediction Default=1	Definition	Source
Bank Financial Strength Rating [bfsr]	Dependent variable	Dummy variable equals 1 when Moody's BFSR rating is C and below	Moody's Analytics
Expected Default Frequency 1 year [edf1year]	+	Expected Default Frequency for 1 year	Moody's Analytics

[11] Hereafter we use bank ratings only with the reference to Moody's Bank Financial Strength Ratings

Variable	Prediction Default=1	Definition	Source
Expected Default Frequency 5 years [edf5years]	+	Expected Default Frequency for 5 years	Moody's Analytics
CAMEL ratios:			
Capital ratios [equitytototassets]	-	Equity/Total Assets	BankScope, Fitch/Bureau Van Dijk
Assets quality [imploanstogrossloans]	+	Impaired Loans/Gross Loans	
Management [costtoincome]	+	Cost to Income ratio: operating costs divided by operating income	
Earnings ratio [roae]	-	Return on Average Equity	
Liquidity ratio [liqassettotdepbor]	-	Liquid Assets/Total Deposits & Borrowings	
Adverse selection effect ratios [ma4totassets] [ma4growthgl]	+	Moving average of assets growth for 4 consecutive quarters ; moving average of Gross Loan growth for 4 consecutive quarters	BankScope, Fitch/Bureau Van Dijk

4.3 Empirical Methodology

In our analyses we apply the model of binary choice – binomial logit model. We estimate pooled/simple logit and panel structure of logit. The panel specification allows us to better exploit the panel structure of our dataset. The binary model assumes that entities belong to either one of two states. In our case it is either being downgraded to D+ and lower – a proxy for "default" - or not. Linear models are not constrained to valuing models with binary choice dependent variables, thus we do not consider them in our estimates. In binary models an increase in X corresponds to an increase in probability of outcome 1. The equation of the logit model is:

$$\Pr(y_i = 1|x_i) = F(x'\beta) = \Lambda(x'\beta) = \frac{\exp(x'\beta)}{1+\exp(x'\beta)} \quad [3]$$

The logit model uses the cumulative logistic probability distribution for the cdf (cumulative distribution function). The baseline logit model is as following:

$$\Pr(\text{Default} = 1) = F(\beta_0 + \beta_1 \text{EDF}) \quad [4]$$

where F(.) is the cumulative logistic distribution and EDF is a bank's 1 year and 5 years EDF. The signs of the regression results are interpreted as follows: a positive sign denotes an increase the likelihood that $y_i = 1$ (default event) i.e. makes the default probability more likely; a negative sign denotes a decrease in the likelihood that $y_i = 1$ i.e. makes the default probability less likely. It is important to interpret the sign of the coefficient but not the magnitude. The magnitude can be interpreted through the marginal effect, which in this case is equal to:

$$\frac{\partial F(x'\beta)}{\partial x_j} = \Lambda(x'\beta)[1 - \Lambda(x'\beta)]\beta_j = \frac{exp(x'\beta)}{(1+exp(x'\beta))^2}\beta_j \quad [5]$$

To estimate the marginal effects at a specific value of x (usually at the means), we use the following formula:

$$\frac{\partial F(x'\beta)}{\partial x_j} = F'(\bar{x}'\beta)\beta_j \quad [6]$$

where $\bar{x}$ represents the average bank in the sample. But there may not be such a bank in a sample and thus we also report average marginal effect which shows the average of the individual marginal effects by using the following equation:

$$\frac{\partial F(x'\beta)}{\partial x_j} = \frac{\sum F\prime(x\prime\beta)}{n}\beta j \quad [7]$$

The equation [7] is believed to better estimate of marginal effects and gives more sense in interpreting the result.

We calculate odds ratio also interpreted as relative risk measure. It shows the probability that y=1 relative to the probability that y=0. Odds ratios are estimated with logistic model. Statistically, they are exponentials of the logit coefficients and range from 0 to +infinity, with the values for "no effect" if equal to 1, "negative effect" if lower than 1 and "positive effect" if greater than 1.

$$p = \frac{\exp(x'\beta)}{1+\exp(x'\beta)} \quad [8a]$$

$$\frac{p}{1-p} = \exp(x'\beta) \quad [8b]$$

$$\ln\frac{p}{1-p} = (x'\beta) \quad [8c]$$

As we use panel data in our estimates, we expect that the independence of errors across individual banks over time is likely be violated. To avoid biased estimates, the standard errors are adjusted using the Hubber/White/Sandwich method in both pooled logit and its panel version. This adjustment produces a heteroscedasticity robust variance-covariance matrix allowing for the possibility of correlated errors within estimated banks.

To analyse whether the baseline models have more predictive power when combined with CAMEL ratios and/or variables of adverse selection effect, we introduce two groups of additional variables. In the first group we have 5 CAMEL ratios which are widely used by investors. If the information of CAMEL covariates is already incorporated into EDF, we expect that coefficients of CAMEL components are not significant and test statistics of model not improved. But if we find evidence that they improve the predictive power of the models we can argue that they are a good complement of EDF.

Concerning adverse selection effect Brossard et al., (2006) report that it has a strong and very significant positive impact on banks' default probability even at the 2 year horizon. We test the impact of this factor in our dataset by applying two alternative measures: the average growth of total assets and the average growth of gross loans. To calculate we take moving averages of assets growth for four

consecutive quarters (for the assets growth variable) and moving averages of gross loans for 4 consecutive quarters (for the loan growth variable). We also use lags of these variables to see if more distant growth of assets/loans affects the likelihood of bank defaults. In Chapter II, when analysing Spanish banks we find evidence that past asset growth is associated with higher risk-taking and subsequent deterioration of a bank's financial state. This evidence could be applied to the rest of European banks too. If adverse selection effect is valid for our models this may indicate that greater risk-taking caused by rapid assets/loan growth is related to higher subsequent bank default rate and hence the variable must be included in EWS.

4.4 Descriptive analysis

Table 4-6 presents average indicators of main explanatory variables for downgraded and non-downgraded banks. The table compares expected default rates with a 1 year horizon for both types of entities: downgraded and not downgraded. The mean and standard deviation of EDF for downgraded banks are much higher than for non-downgraded banks.

Table 4-6 Summary statistics for EDF 1

Not downgraded		Mean	Std. Dev.	Min	Max	Observations
edf1year	Overall	0.330	0.641	0.010	5.375	N = 462
	Between		0.589	0.045	2.595	n = 36
	Within		0.492	-1.797	4.085	T = 12.83
Downgraded						
edf1year	Overall	0.849	0.703	0.116	2.838	N = 33
	Between		0.572	0.299	1.960	n = 7
	Within		0.438	0.267	2.263	T = 4.71

Two-sample t test on the equality of means with unequal variances (see Table 4-7) shows that the means are statistically and significantly different even with 6 quarters lag. The differences between the means of non-downgraded and downgraded banks are persistently negative implying a higher default probability in downgraded banks.

Table 4-7 EDF 1: two-sample t test with unequal variances

EDF1	Status	N	Mean	Difference	T
1-quarter lag	0	484	0.300	-0.572	-5.116***
	1	41	0.873		
2-quarter lag	0	506	0.274	-0.614	-5.673***
	1	50	0.887		
3-quarter lag	0	528	0.257	-0.586	-5.962***
	1	59	0.843		
4-quarter lag	0	551	0.237	-0.591	-6.015***
	1	69	0.828		

5-quarter lag	0 1	574 79	0.224 0.784	-0.560	-6.210***
6-quarter lag	0 1	596 90	0.212 0.080	-0.531	-6.422***

Note: Status 0 is Not downgraded banks, Status 1is Downgraded banks; Difference is mean (Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0; legend: * p<.1; ** p<.05; *** p<.01

Table 4-8 Summary statistics for EDF 5

Not downgraded		Mean	Std. Dev.	Min	Max	Observations
edf5years	Overall	0.753	1.116	0.018	9.318	N = 462
	Between		0.991	0.090	4.348	n = 36
	Within		0.845	-2.432	6.804	T = 12.8333
Downgraded						
Edf5years	Overall	1.808	1.441	0.327	7.285	N = 33
	Between		0.964	0.579	3.195	n = 7
	Within		1.044	0.002	5.899	T = 4.71429

Table 4-9 EDF 5: two-sample t test with unequal variances

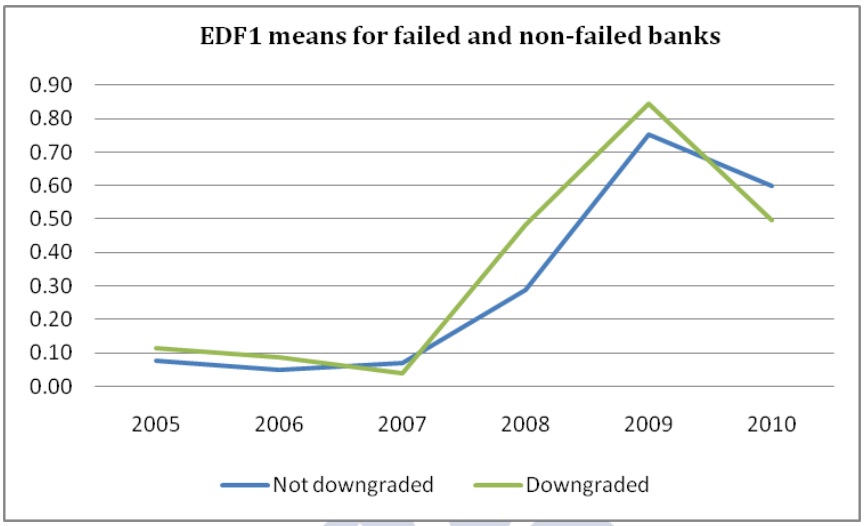
EDF5	Status	N	Mean	Difference	T
1-quarter lag	0 1	484 41	0.697 1.838	-1.141	-5.294***
2-quarter lag	0 1	506 50	0.645 1.839	-1.194	-5.970***
3-quarter lag	0 1	528 59	0.609 1.751	-1.142	-6.348***
4-quarter lag	0 1	551 69	0.570 1.695	-1.124	-6.586***
5-quarter lag	0 1	574 79	0.541 1.602	-1.061	-6.756***
6-quarter lag	0 1	596 90	0.517 1.519	-1.003	-6.230***
7-quarter lag	0 1	593 90	0.469 1.376	-0.907	-6.250***
8-quarter lag	0 1	590 90	0.443 1.259	-0.816	-5.560***

Note: Status 0 is Not downgraded banks, Status 1is Downgraded banks; Difference is mean (Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0; legend: * p<.1; ** p<.05; *** p<.01

The review of expected default frequencies for 5 years horizon reveals similar characteristics exhibiting higher mean and standard deviations for downgraded banks and strong and significant difference in means between two status groups.

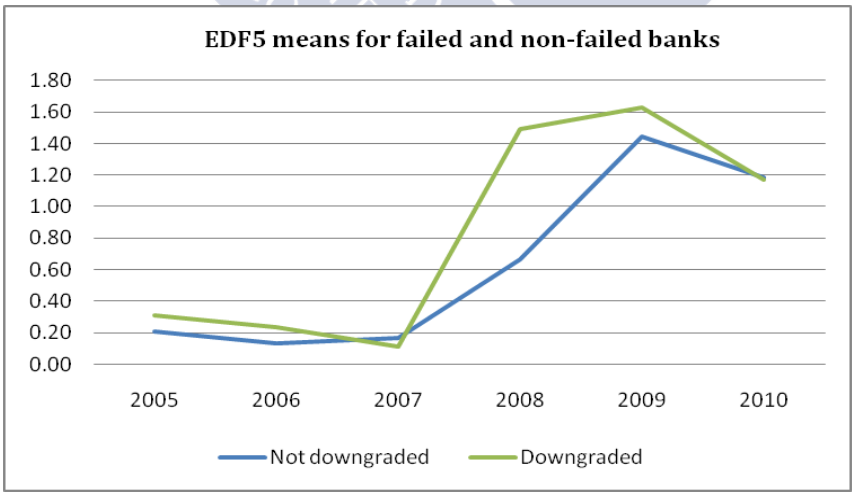
Evolution of EDF means over time in Figure 4-1 demonstrates the evident impact of the crisis on banks' EDF values: a rapid increase of default expectations from 2007 reaching a peak in 2009 with a slight decrease afterwards. The graphs reveal two main structural break periods: in 2007 and 2009. These are the breakpoints denoting the start of the financial crisis in the third quarter of 2007 and its apogee in 2009.

Figure 4-1 Evolution of EDF 1



The evolution graph of EDF 5 years exhibits steeper rise of default expectations in period 2007-2008 when it was almost impossible to foresee the further unfold of the crisis and its further growth up to 2009.

Figure 4-2 Evolution of EDF 5



5 Results

We start with the estimation of our baseline model with *edf1year* variable only. The signs of the coefficients exhibit general direction between dependent and independent variables.

It is worth mentioning, except dependent variable, when there are missing values in quarterly data, in line with study of Brossard et al. (2006) we duplicate the previous quarter value until end of the calendar year. In doing so we are able to keep more observations while not stretching out financial information of one year to another. To avoid supplementary autocorrelation which could arise with duplication of data we use robust standard errors adjusted for clustering between banks. Consistent with our a *priori* expectations all lagged EDF signs are positive in all estimations suggesting positive correlation between bank defaults and 1 year EDF. The results are significant at 99% level in all 8 lags. The highest Pseudo R is observed in lags 4, 5 & 6 lags.

Table 4-10 EDF 1: Baseline Model

	Pooled logit 1 lag	**Pooled logit 2 lags**	**Pooled logit 3 lags**	**Pooled logit 4 lags**	**Pooled logit 5 lags**	**Pooled logit 6 lags**	**Pooled logit 7 lags**	**Pooled logit 8 lags**
edf1year								
L1.	0.635***							
L2.		0.963***						
L3.			1.012***					
L4.				1.138***				
L5.					1.186***			
L6.						1.235***		
L7.							1.205***	
L8.								1.068***
_cons	-2.968***	-2.773***	-2.645***	-2.560***	-2.456***	-2.355***	-2.285***	-2.209***
N	495	556	587	620	653	686	683	680
$Pseudo\ R^2$	0.048	0.087	0.087	0.098	0.096	0.095	0.081	0.065
$Wald\ \chi^2$	14.064	12.051	11.441	11.949	11.607	11.282	8.322	7.849
Log likelihood	-115.381	-153.497	-174.74	-195.349	-217.668	-241.388	-244.678	-248.413

edf1year is EDF for one year; L1.- L8. are EDF values lagged for 1-8 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01

Table 4-11 presents average marginal effect (AME), marginal effect at means (ME) and odds ratios of the baseline model with 4 quarter lags. Both marginal effect methods show almost the same magnitude of EDF variable - about 10%. AME represents the average of each bank's marginal effect while ME is computed at the average bank. The ME implies that one unit change in EDF from the average 0.303 is associated with 10.1% increase of likeliness of default.

Odds ratios represent odds of being defaulted when EDF increases by one unit. In other words, for one unit increase in *edf1year* value, the expected change in log odds is 3.121 i.e. more than 3 times more likely to be defaulted.

Table 4-11 EDF 1: average marginal effect, marginal effect at the means & odds ratios

	AME	ME (Mean)	Odds ratios
edf1year L4.	0.100***	0.101*** (0.303)	3.121***
Cons			0.077323

Note: AME – Average Marginal Effect, ME- Marginal Effect at means,
Mean values of ME are given in brackets; legend: * p<.1; ** p<.05; *** p<.01

Table 4-12 presents the results of baseline regression with EDF 5 years. The coefficient of the variable is positive and highly significant in all lags. Comparing test statistics to EDF with 1 year horizon, the 5 year EDF exhibit slightly higher pseudo R squared results in respective models (4, 5 and 6 lags).

Table 4-12 EDF 5: baseline model

	Pooled logit 1 lag	Pooled logit 2 lags	Pooled logit 3 lags	Pooled logit 4 lags	Pooled logit 5 lags	Pooled logit 6 lags	Pooled logit 7 lags	Pooled logit 8 lags
edf5years								
L1.	0.499***							
L2.		0.581***						
L3.			0.609***					
L4.				0.663***				
L5.					0.682***			
L6.						0.703***		
L7.							0.686***	
L8.								0.613***
_cons	-3.016***	-2.922***	-2.793***	-2.698***	-2.586***	-2.480***	-2.403***	-2.312***
N	525	556	587	620	653	686	683	680
Pseudo R^2	0.084	0.101	0.102	0.108	0.105	0.102	0.09	0.074
Wald χ^2	18.103	15.647	14.512	14.015	13.549	13.102	11.257	10.993
Log likelihood	-131.866	-151.076	-171.998	-193.125	-215.615	-239.408	-242.233	-246.031

edf1year is EDF for one year; L1.- L8. are EDF values lagged for 1-8 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01

Table 4-13presents average marginal effect (AME), marginal effect at means (ME) and odds ratios of the baseline model with 6 quarter lags. We take deeper lag than in *edf1year* case because we want to test if edf5years may predict bank defaults for more than one year in advance. The marginal effect of EDF 5 years is about 7%. Odds ratio reports that the likeliness of being downgraded with one unit increase in EDF value is more than two times.

Table 4-13 EDF 5: Average marginal effect, marginal effect at the means & odds ratios

	AME	ME (Mean)	Odds ratios
edf5years L6.	0.070***	0.073 (0.648)	2.021***
Cons			0.084

Note: AME – Average Marginal Effect, ME- Marginal Effect at means,
Mean values of ME are given in brackets; legend: * p<.1; ** p<.05; *** p<.01

5.1 Baseline model and CAMEL covariates

We follow the existing literature and add CAMEL covariates to our baseline model. Before showing the regression results we review each CAMEL ratio with two-sample t-tests on the equality of means with unequal variances. The tests show whether the value of ratios for two groups of banks are different from those observed before the onset of the crisis, signalling the deterioration of the bank's financial state.

Table 4-14 ROAE, two-sample t-test with unequal variances

ROAE	Status	N	Mean	Difference	T
1-quarter lag	0	323	9.358	7.567	3.893***
	1	51	1.792		
2-quarter lag	0	321	9.490	7.483	4.320***
	1	60	2.008		
4-quarter lag	0	327	9.674	6.381	4.378***
	1	76	3.293		
6-quarter lag	0	282	10.319	7.294	4.676***
	1	73	3.024		
8-quarter lag	0	244	10.694	6.790	3.894***
	1	66	3.904		

Note: Status 0 is Not downgraded banks, Status 1is Downgraded banks; Difference is mean (Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0; legend: * p<.1; ** p<.05; *** p<.01.

Table 4-15 Assets quality, two-sample t test with unequal variances

Impaired loans/ Gross Loans	Status	N	Mean	Difference	T
1-quarter lag	0	200	3.074	-2.222	-4.445***
	1	41	5.296		
2-quarter lag	0	200	3.025	-2.144	-4.289***
	1	46	5.169		
4-quarter lag	0	205	2.907	-1.981	-4.552***
	1	57	4.888		
6-quarter lag	0	169	2.666	-1.641	-3.457***
	1	50	4.307		
8-quarter lag	0	141	2.480	-0.948	-2.046**
	1	42	3.428		

Note: Status 0 is Not downgraded banks, Status 1is Downgraded banks; Difference is mean (Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0; legend: * p<.1; ** p<.05; *** p<.01.

As can be observed from the table the differences between non-defaulted and defaulted banks are positive in all lagged periods suggesting that non-defaulted banks have higher equity ratios than defaulted banks. The 1, 6 and 8 quarter lags exhibit 99% significance, unlike CAMEL's capital ratio assets quality indicator which shows no significance at any lagged period with a positive difference up

to 1 year and a negative difference afterwards. The t-tests of the rest CAMEL's covariates are provided in Appendix C.

EDF is market based indicator and we expect that it reflects past balance sheet information as well as future expectations about the bank's financial state. Nevertheless we test the predictive power of the model with addition of all CAMEL covariates lagged up to 4 quarters.

Table 4-16 EDF 1 with CAMEL covariates

Variable	Pooled logit CAMEL	Pooled logit 4 lags	Pooled logit 5 lags	Pooled logit 6 lags
edf1year				
L4.		1.070***		
L5.			1.058***	
L6.				1.162***
equitytototassets L4.	-0.236***	0.012	-0.004	0.01
imploanstogrossloans L4.	0.347***	0.256***	0.275***	0.276***
costtoincome L4.	0.038***	0.042**	0.045***	0.043**
roae L4.	-0.081***	-0.095**	-0.095***	-0.094***
liqassettototdepbor L4.	-0.073***	-0.068***	-0.070***	-0.072***
_cons	-1.645	-3.579**	-3.573**	-3.401**
N	262	204	229	252
Pseudo R^2	0.279	0.382	0.372	0.362
Wald χ^2	61.554	42.473	52.747	59.046
Log likelihood	-98.969	-63.238	-74.652	-85.942
edf1year is EDF for one year; L1.- L6. are variable values lagged for 1-6 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01				

Table 4-16 shows the results of regressions with both CAMEL ratios only and a combined model with EDF1 and CAMEL. When we regress CAMEL covariates without EDF, all variables' coefficients become significant at the 99% level. Moreover, they are also in line with our hypothesis. The results show that bank defaults are negatively associated with capital ratio, earning and liquidity ratios. Defaults are positively associated with impaired loans ratio and management efficiency measure. When we combine edf1 with 4, 5 and 6 lags and CAMEL components, edf1 demonstrates high level of significance in all three specifications. The test statistics of the combined models are also improves in comparison with their earlier specifications. Pseudo R increases to 38.2%. All CAMEL components except capital ratio remain significant. Brossard et al., 2006 also combine distance-to-default measure with CAMEL covariates. They explain lower insignificance of capital ratios with the relative homogeneity of European banks' capital indicators. They argue that European banks maintain their capital ratios in accordance with the Basel II regulatory framework and thus do not vary to a great extent similar to US banks' capital ratios. This fact may reduce the signalling power of equity

ratio in our model too. Our t-test on the equality of means also reveals that there is no significant difference between defaulted and non-defaulted banks' equity indicators.

We combine CAMEL covariates with EDF 5 years (see regression results in Appendix C). In general the results are similar to what we received for 1 year EDF. All CAMEL ratios are significant except equity ratio. The EDF 5 variable remains significant at 99% in all 3 models. In general the test results for both 1 year EDF and EDF 5 years suggest that they convey additional information to that already provided by CAMEL ratios, and that such a combination of variables improves the predictive power of the models.

Table 4-17 EDF 5 with CAMEL covariates

Variable	Pooled logit 6 lags	Pooled logit 7 lags	Pooled logit 8 lags
edf5years			
L5.			
L6.	0.865***		
L7.		0.790***	
L8.			0.757***
equitytototassets L4.	0.077	0.054	0.052
imploanstogrossloans L4.	0.258***	0.258***	0.267***
costtoincome L4.	0.047***	0.049***	0.052***
roae L4.	-0.088**	-0.090**	-0.098***
liqassettototdepbor L4.	-0.074***	-0.077***	-0.083***
_cons	-4.333***	-4.069***	-4.090***
N	252	252	252
Pseudo R^2	0.38	0.37	0.378
$Wald\ \chi^2$	59.917	60.539	58.893
Log likelihood	-83.541	-84.91	-83.864
Edf5 year is EDF for five years; L1.- L8. are variable values lagged for 1-8 quarters _cons – constant; legend: * p<.1; ** p<.05; *** p<.01			

We remove equity ratio from our models and run the regression with EDF and 4 CAMEL components. The marginal results are provided in Table 4-18. Average magnitude of EDF 1 year ranges from about 10% to 15%. Average marginal effect of impaired loans is between 2.4%-3.6%. Conditional means which are computed at the average bank show that one unit change in NPL ratio from the average 3.1%-3.3% is associated with 2.8%-3.6% increase of likeliness of default.

Marginal effect of the combined mod with EDF 5 years and selected CAMEL variables are provided in Appendix C. Similar to EDF 1 year *edf5years* is significant at 99% level in all three models. Its average margin ranges from 7.5% to 9.7% which is slightly lower than one of *edf1year.* Magnitudes of CAMEL covariates are similar to that of EDF 1 year.

Table 4-18 EDF 1 & selected CAMEL ratios, marginal effect

	4 lags		5 lags		6 lags	
edf1year	**AME**	**ME (Mean)**	**AME**	**ME (Mean)**	**AME**	**ME (Mean)**
L4.	0.099***	0.116**				
		(0.476)				
L5.			0.106***	0.126**		
				(0.456)		
L6.					0.122***	0.149***
						(0.439)
imploanstogrossloans L4.	0.024***	0.028***	0.027***	0.032***	0.029***	0.036***
		(3.051)		(3.192)		(3.304)
costtoincome L4.	0.004**	0.005**	0.004***	0.005**	0.004**	0.005**
		(63.188)		(62.943)		(62.799)
roae L4.	-0.009***	-0.010***	-0.009***	-0.011***	-0.010***	-0.012***
		(8.154)		(8.118)		(8.083)
liqassettototdepbor L4.	-0.006***	-0.007***	-0.007***	-0.008***	-0.008***	-0.009***
		(23.797)		(23.695)		(23.737)

Note: AME – Average Marginal Effect, ME- Marginal Effect at means,
Mean values of ME are given in brackets; legend: * p<.1; ** p<.05; *** p<.01

We also test the validity of adverse selection effect for our models, similarly to Brossard *et al* (2006) and other studies. This test demonstrates whether aggressive growth undertaken at an earlier time affects a bank's subsequent default. We examine two alternative measures of adverse selection effect: moving averages of annual growth - total assets and gross loans - with different time lags. To estimate we add an adverse selection variable to models with the selected CAMEL components, producing two different results for each definition of adverse selection effect. The addition of the assets growth variable with no lag (moving average of assets growth in the same year when the default happens) does not give significant results. After some iteration of the process we find that 4 quarter lagged moving average of assets growth has a more apparent effect. The results for 1 year EDF with past assets growth are given in Table 4-19.

In line with other studies, our results suggest that past assets growth is positively associated with the probability of bank default and is significant at 95%. It suggests the perilous consequences of banks' rapid/aggressive growth strategies that may trigger asset quality deterioration and lead to severe downgrades of bank ratings.

Table 4-19 EDF 1 with CAMEL components & adverse selection effect: assets growth

	Pooled logit 4 lags	Pooled logit 5 lags	Pooled logit 6 lags
edf1year			
L4.	1.256**		
L5.		1.257***	
L6.			1.466***
ma4growthtotas L4.	0.119**	0.096**	0.088**
imploanstototalassets L4.	0.241***	0.270***	0.283***
costtoincome L4.	0.035*	0.040**	0.038**
roae L4.	-0.104**	-0.100***	-0.098***
liqassettototdepbor L4.	-0.067***	-0.068***	-0.071***
_cons	-0.067***	-0.068***	-0.071***
N	198	223	246
Pseudo R^2	0.41	0.394	0.383
Wald χ^2	35.254	55.368	61.267
Log likelihood	-59.61	-71.132	-82.128
edf1year is EDF for one year; L1.- L6. are variable values lagged for 1-6 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01			

The results for EDF 5 years are provided in Table 4-20. Similar to 1 year EDF, the signs of past assets growth are positive and significant in all three specifications. The addition of the new variable does not weaken the significance of EDF but brings more predictive power to the models.

Table 4-20 EDF 5 with CAMEL components & adverse selection effect: assets growth

	Pooled logit 4 lags	Pooled logit 5 lags	Pooled logit 6 lags
edf5years			
L6.	1.022***		
L7.		0.902***	
L8.			0.728***
ma4growthtotas L4.	0.093**	0.081**	0.052
imploanstototalassets L4.	0.279***	0.272***	0.279***
costtoincome L4.	0.043**	0.045**	0.050***
roae L4.	-0.092**	-0.093***	-0.099***
liqassettototdepbor L4.	-0.078***	-0.080***	-0.085***
_cons	-4.116***	-3.913***	-3.780***
N	246	246	246
Pseudo R^2	0.403	0.387	0.381
Wald χ^2	62.279	61.22	61.235
Log likelihood	-79.483	-81.643	-82.472
Edf5years is EDF for five years; L1.- L8. are variable values lagged for 1-8 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01			

The test statistics are also improved: pseudo R increases to 38.3%-41% and the probabilities of $Wald\ \chi^2$, which tests if all the coefficients are different than zero, are less than 0.05. In general, the

addition of 4 quarter lagged average assets growth supplement to the models' overall test statistics and significance of the variables. Surprisingly, our alternative measure for adverse selection effect - the past growth of gross loans exhibits negative relation with the bank defaults. The sign does not change with a variation of lags of the added variable for both EDF 1 year and 5 years. The following tables show the results of the combined models with loan growth.

Table 4-21 EDF 1 with CAMEL components & adverse selection effect: loan growth

	Pooled logit 4 lags	**Pooled logit 5 lags**	**Pooled logit 6 lags**
edf1year			
L4.	0.830**		
L5.		0.977**	
L6.			1.345***
ma4growthgrossloans	-0.060***	-0.063**	-0.070***
imploanstototalassets L4.	0.254**	0.231**	0.223*
costtoincome L4.	0.063***	0.065***	0.069***
roae L4.	-0.079**	-0.081**	-0.085**
liqassettototdepbor L4.	-0.115***	-0.114***	-0.124***
_cons	-4.291***	-4.398***	-4.517***
N	159	159	159
Pseudo R^2	0.467	0.477	0.498
Wald χ^2	36.931	36.892	32.084
Log likelihood	-38.578	-37.912	-36.335
edf1year is EDF for one year; L1.- L6. are variable values lagged for 1-6 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01			

As it is seen from results, the test statistics of the all models improved with the addition of loan growth variable. The EDF is significant in 95% and 99% confidence levels in 1 year and 5 years models respectively. Variable accounting for loan growth has negative sign and significant. Pseudo R squared is raised up to 50% and 51% approximately for one year and five-year EDF respectively.

Table 4-22 EDF with CAMEL components & adverse selection effect: loan growth

	Pooled logit 6 lags	**Pooled logit 7 lags**	**Pooled logit 8 lags**
edf5years			
L6.	0.855***		
L7.		0.955***	
L8.			1.717***
ma4growthgrossloans	-0.069**	-0.075***	-0.069***
imploanstototalassets L4.	0.228*	0.233*	0.236*
costtoincome L4.	0.072***	0.083***	0.085***
roae L4.	-0.076*	-0.078*	-0.069
liqassettototdepbor L4.	-0.128***	-0.144***	-0.140***

_cons	-4.960***	-5.203***	-5.533***
N	159	159	159
Pseudo R^2	0.503	0.506	0.495
Wald χ^2	32.57	34.165	30.699
Log likelihood	-35.999	-35.751	-36.604
Edf5years is EDF for five years; L1.- L8. are variable values lagged for 1-8 quarters; _cons – constant; legend: * p<.1; ** p<.05; *** p<.01			

Table 4-23 and Table 4-24 report the marginal effect of models with adverse selection variables: with asset growth and with growth of loans. The average marginal effect of 1 year EDF in models with asset growth is 11.3%, meaning a one-unit increase in EDF on average leads to an increase in probability of default of 11.3%. The alternative measure - marginal effect at means for average bank - reaches 13.7%. The impaired loans ratios have magnitudes of 2.2% and 2.6% with a significance of 99% in both methods. There is a positive association of past assets growth with the likelihood of bank default with marginal effects of 1.1% and 1.3% in the two alternative methods. Marginal effects of EDF in the loan growth model are lower than in the assets growth model, 5.9% and 5.6% respectively in the two alternative methods. Past loan growth has a negative sign suggesting favourable influence on banks' ratings although with a marginal effect of less than 1%.

Table 4-23 EDF 1 Average marginal effect and Marginal effect at the mean

	Assets growth		**Loan growth**	
	AME	**ME (Mean)**	**AME**	**ME (Mean)**
edf1year L4.	0.113**	0.137** (0.490)	0.059**	0.056* (0.460)
ma4growthtotas L4.	0.011**	0.013** (2.592)		
ma4growthgrossloans			-0.004***	-0.004** (-1.960)
imploanstogrossloans L4.	0.022***	0.026*** (3.070)	0.018**	0.017** (2.761)
costtoincome L4.	0.003*	0.004 (63.317)	0.005***	0.004*** (63.993)
roae L4.	-0.009***	-0.011*** (7.954)	-0.006**	-0.005** (8.107)
liqassettototdepbor L4.	-0.006***	-0.007*** (23.627)	-0.008***	-0.008*** (24.750)

Note: AME – Average Marginal Effect, ME- Marginal Effect,
(Mean)-mean values of ME; legend: * p<.1; ** p<.05; *** p<.01

Table 4-24 EDF 5 Average marginal effect and Marginal effect at the mean

	Assets growth		Loan growth	
	AME	**ME (Mean)**	**AME**	**ME (Mean)**
edf1year L4.	0.092***	0.117*** (0.894)	0.064***	0.062** (0.741)
ma4growthtotas L4.	0.008**	0.011** (3.136)		
ma4growthgrossloans			-0.005***	-0.005** (-1.960)
imploanstogrossloans L4.	0.028***	0.035*** (3.326)	0.016*	0.015** (2.761)
costtoincome L4.	0.005**	0.006** (62.893)	0.006***	0.005** (63.993)
roae L4.	-0.009***	-0.012*** (7.920)	-0.005**	-0.005* (8.107)
liqassettototdepbor L4.	-0.008***	-0.010*** (23.599)	-0.010***	-0.009*** (24.750)

Note: AME – Average Marginal Effect, ME- Marginal Effect,
(Mean)-mean values of ME; legend: * p<.1; ** p<.05; *** p<.01

The average marginal effect of 5 year EDF in the assets growth model suggests that a one-unit increase in EDF on average leads to an increase in probability of default of 9.2% and 11.7% respectively in the two alternative methods. Past assets growth has a positive association with magnitudes of 0.8% and 1.1% with a significance of 95%. The 4 quarters lagged NPL ratio demonstrates marginal effects of 2.8% and 3.5% in the respective methods. In contrast, the model with loan growth exhibits a negative correlation with defaults but with a relatively lower marginal effect – 0.5%. In the second model we observe lesser impacts of the 5 year EDF variable which decrease to about 6.4% and 6.2% respectively.

5.2 Prediction

Using our two alternative models – selected CAMEL covariates adverse selection variables - we predict the probability of default for two EDF categories. The predicted probability indicates the likelihood that the bank defaults. We compare our predictions with the actual results of our final models in Table 4-25 and Table 4-26 below. The tables present the sensitivity to Type I and Type II errors. A Type I error is when the model fails to identify the defaulted banks. A Type II error is when the model falsely identifies sound banks as defaulted. The cut-off value specifies whether an observation has a predictive positive outcome or not. A higher cut-off results in fewer banks determined to have a positive outcome i.e. being defaulted, hence Type I errors increase. A lower cut-off conversely leads to an increase in Type II errors by identifying sound banks as failed ones. Poghosyan & Cihak (2009) suggest putting a larger weight on Type I errors in analysing bank defaults

as supervisors are mainly concerned about overlooking potential bank defaults. Thus we will use a lower cut-off value for prediction though providing graphs for sensitivity vs. probability cut-offs.

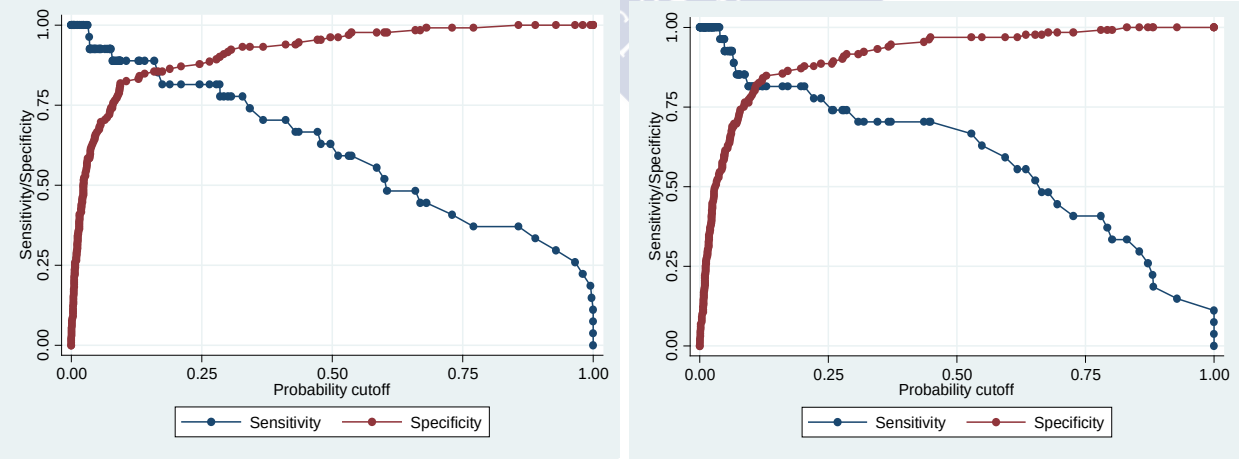
The predictions of EDF 1 year lagged for four quarters and with asset growth indicate that the final model correctly classifies 37 out of 41 default events, and 120 out of 157 non-default events with a 15% cut-off rate. The overall rate of correct classification is estimated to be 80%, with 90% of the defaulted banks correctly classified and 76% of the sound banks correctly classified. The prediction of the model with loan growth correctly classifies 22 out of 27 defaulted banks and 113 out of 132 sound banks. The accuracy of prediction is 82% for defaulted banks and 86% for non-defaulted. As we mentioned above, this classification is sensitive to the relative sizes of each component group and to the cut-off value. The sensitivity of the two models is evident in the graph provided below (see

Figure 4-3).

Table 4-25 EDF 1- Comparing predicted values vs. actual values, 15% cut-off rate

	Final model with assets growth			Final model with loan growth		
Classified	**Actual Defaults**	**Actual Non-defaults**	**Total**	**Actual Defaults**	**Actual Non-defaults**	**Total**
Predicted defaults	37	37	74	22	19	41
Predicted non-defaults	4	120	124	5	113	118
Total	41	157	198	27	132	159

Figure 4-3 EDF 1 year - Sensitivity of prediction to probability, cut-offs 15%



Note: Sensitivity/Specificity denotes the percentage of correctly classified sound banks to the percentage of correctly classified defaulted banks.

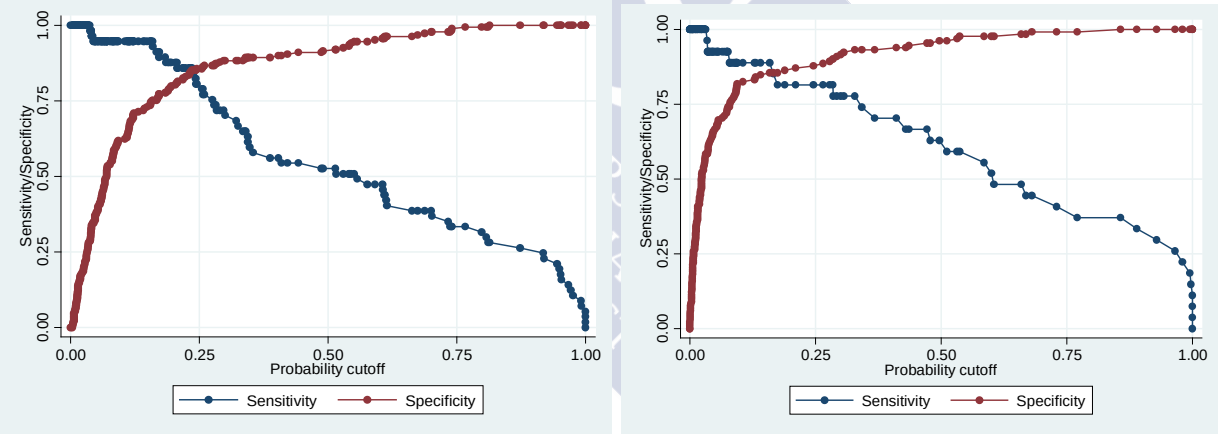
Prediction results of *edf5years* model with assets growth and loan growth are given in the table below. The cut-off rate for two models is 20%.

Table 4-26 EDF 5 - Comparing predicted values vs. actual values, 20% cut-off rate

	Final model with assets growth			Final model with loan growth		
Classified	**Actual Defaults**	**Actual Non-defaults**	**Total**	**Actual Defaults**	**Actual Non-defaults**	**Total**
Predicted defaults	50	37	87	22	17	39
Predicted non-defaults	7	152	159	5	115	120
Total	57	189	246	27	132	159

The predictions of the model with 5 year EDF lagged 7 quarters, and with asset growth lagged four quarters, accurately classifies 50 out of 57 default events, and 152 out of 189 non-default events. The overall rate of correct classification is estimated to be 82% with 88% of the defaulted banks correctly classified and 81% of the sound banks correctly classified. The prediction of the model with 5 year EDF lagged 7 quarters and average loan growth correctly classifies 25 out of 27 defaulted banks and 115 out of 132 sound banks. The accuracy of prediction is 82% for defaulted banks and 86% for non-defaulted. The graph of sensitivity for cut-off rate is provided below.

Figure 4-4 EDF 5 years - Sensitivity of prediction to probability, cut-offs 20%



Note: Sensitivity/Specificity denotes the percentage of correctly classified sound banks to the percentage of correctly classified defaulted banks.

Chapter 5 CONCLUSION

The recent global financial crisis has further intensified interest in understanding the possible causes of excessive bank risk-taking and early warning mechanisms to predict bank fragility. The current work aims to understand how changes in financial environments of the banking sector have affected banks' risk-taking behaviour and predicting power of early warning models of bank fragility. To do so, we explored the following three issues:

What is a financial crisis and how it is formed and what are similarities and distinctions of the Spanish Financial Crisis from other financial crises?

We found that the Spanish financial crisis is not an exception to the general pattern of crises. The sequences of events evidenced in preceding crises have many common features with what it has already been witnessed in other financial crises. The external imbalance of the Spanish economy, the unprecedented increase in credit, the concentration of investment in real estate resulting in what is commonly known as "the housing bubble" and the use of financial innovation to raise funds or excessive risk taking have all preceded the Spanish crisis. The measures that have been taken at the national and international levels seem to go the right direction, to the extent that strengthen capital levels, seeking a more strict supervision, trying to limit credit expansion and the problems of perverse incentives. Based on previous studies and own analysis we conclude that the excessive time-span of the crisis is fuelled by the large dependence of the Spanish economy from the construction sector. The loose monetary policy, a very competitive market and the performance of banks which were overly concentrating their risks through credit expansion aided by financial innovation and the lack of adequate supervision shaped the enabling environment for excessive risk-taking of financial institutions. Responsiveness also appears to be critical. For that reason, recognition of the crisis and the reaction time - the faster restructuring of financial institutions was crucial. When main financial problems emerged with Dexia, RBS, UBS and ING in 2008, Spain seemed more concerned with persuasion that restructuring would not be a cost to society and greatly delayed action plans until 2012.

The measures that have been taken at the national and international levels seem to go the right direction, to the extent that strengthen capital levels, seeking a more strict supervision, trying to limit credit expansion and the problems of perverse incentives. However, the dilemma exists between stability and financial credit needs. The new environment of reduced competition and higher capital requirements would result in less and more expensive credits, which would further limit the economic growth. Therefore, the complex measures should be taken to not endanger financial stability but also allocating enough credits necessary for economic recovery.

What were the main determinants of banks' excessive risk-taking for the years 2004-2011 for a Spanish Banks?

To address this question we set three definite research objectives:

- to measure the influence of self-defined risk determining factors on bank's insolvency risk – Z score
- to assess the effect of the same risk factors on alternative risk measures – credit risk measures (Impaired Loans, Loan Loss Provision and Loan Loss Reserves)
- to draw inference as to the nature of the factors driving banks' excessive risk-taking.

In accomplishing our research objectives we have utilised data taken from the BankScope International Bank Database provided by Fitch/Bureau Van Dijk which contains information regarding listed and unlisted commercial, savings and cooperative Spanish banks from 2004-2011. This period includes the years of financial crisis giving us the chance to use the crisis as a test bed where latent bank risks previously not apparent were observed. We apply system GMM as an estimation method. This method is designed for dynamic models and is well suited to tackle the endogeneity problem which we believe is present in our data. The following tendencies in relation to risk determinants have been revealed:

- We found that there is a strong effect of bank's ownership nature to its risk-taking behaviour. With this factor we have the most consistent results signifying the association between higher risk and public banks i.e. Spanish savings banks. This result is in agreement with most empirical studies and supports the idea of Iannotta et al. (2006) that public banks (or bank with majority of government ownership) usually pursue industrial policies and provide loans which may not be profitable enough for the private sector. As we mentioned in Chapter 2, Spanish savings banks are institutions exhibiting unusual ownership structures lacking a formal owner and characterized by high levels of politicization. Their shares are not quoted in the stock market preventing the effective use of major external bank disciplinary governance mechanisms (Cuñat & Garicano, 2010). Numerous defaults of the saving banks led to the Spanish Central Bank conducting a massive restructuring process including changes in their legal frameworks following years the crisis.
- In line with Laeven & Levine (2009), Gropp & Köller (2010) and Iannotta et al., (2006) we conclude that levels of ownership concentration have also an effect on banks' risk-taking behaviour, where the banks with concentrated ownership stimulate the higher risk-taking. This corresponds to agency theory stating that the managers of banks with dispersed ownership exhibit lower risk than is optimal for shareholders. Similar to Laeven & Levine (2009) we support the hypothesis that powerful bank owners tend to induce bank managers to increase risk-taking.

As evidenced by many empirical studies and other observers, prior to the crisis many banks have moved away from traditional retail banking activities to "new" bank business models with complex securities, non-interest generating activities and wholesale markets funding structures.

The shift towards new business models is primarily caused by financial innovations in credit markets as well as the deregulation of the banking sector. Some of these innovations have positive effects on bank performance but later abuse use and manipulation may have adverse effect on banks' solvency.

- Our results on effect of funding source on bank risk level are twofold. We have confirmed the negative influence of wholesale funding, but not in favour of deposit funding. We found that there is negative effect of deposit funding on bank risk. We think this may be evidence of 'excessive' competition in deposit markets prior to the crisis, also mentioned by Matutes, C & Vives, X (2000) and Craig & Dinger, (2013). In response to intense deposit competition banks raise their deposit rates too high and by doing so, they attract more depositors by increasing their cost of funding while decreasing their interest margins. We also suppose that there could be manipulation of LLP and Z-score indicators. Traditionally creditors, investors and other bank external stakeholders refer to these indicators to identify the probability of bankruptcy or default. They may therefore have become the 'victims' of possible earning manipulations and may not properly reflect the real financial situation of a bank.
- Non traditional income source shows a negative influence with Z score (fee based income) and NPL. However, with LLR and LLP it exhibits a positive effect implying risk reduction. Previous empirical studies found both positive and negative effects of non-traditional income on banks' risk level. Lepetit et al. (2008) state that banks with expanded non-interest income activities exhibit higher levels of risk-taking than banks performing traditional activities. The negative influence of non-traditional income is also found by De Young & Roland, (2001); Stiroh, (2004); Stiroh & Rumble, (2006). Köhler (2012) finds evidence of the positive effect of non-interest income on banks' stability although this effect decreases with bank size. When non-interest income is further classified into categories we find that higher risk-taking is associated with high shares of commissions and fee income. We conclude that not all sources of non-traditional income rise bank risk-taking.
- The results of banks' equity measures demonstrate their stable risk reducing character. At the time of intense competition observed within the Spanish banking sector prior the crisis, capital was essential and helped banks to withstand financial turmoil which came afterwards. This is in line with Tabak et al., (2012) Berger & Bouwman (2012) and many other studies supporting the importance of bank capital as a risk-reducing mechanism. In line with Demirgüç-Kunt et. al., 2010; Berger & Bouwman, 2012; Beltratti & Stulz, 2012 we believe that increased capital decreases bank risk because the higher the capital reserves, the stronger the buffer to withstand losses, especially in crises. We think that policymakers should further impose regulatory requirements on minimum levels of capital to prevent high levels of leverage and to reduce incentives for risk-taking.

- Concerning bank assets quality, there is strong harmful effect of impaired loans on banks risk level. This result supports the use of NPL ratio as one of efficient determinants of bank's risk-taking behaviour. We also find that larger bank size is related to higher risk-taking. This may imply that high asset growth comes at the cost of lower asset quality; at least in the case of high banking competition. To increase their size banks may set low lending standards and collateral requirements and increase their loan growth, or may attract customers which have not been granted a loan by other banks because of poor credit quality (Köhler, 2012). As we mentioned in Chapter 2 the Spanish market is characterized by very significant loan growth in pre-crisis years, in particular during 2006 where annual loan growth was above 25% on average. In addition the existence of flat rate deposit insurance systems could contribute to the size and growth of banking assets. Many large banks were often perceived as "Too Big To Fail" and therefore deemed more likely to be rescued by their state authorities (Huang, et al., 2011; Demirgüc-Kunt and Huizinga, 2010; Tarashev et al., 2009). We strongly believe that the existence of the risk-insensitive deposit insurance rise incentives for banks to exploit the deposit insurance system.

What are the parameters which have to be added to EWM so as to make robust predictions of the European bank defaults?

To discriminate defaulted banks from sound ones we use the probability of default metrics - EDF (one-year and five-year EDF) - as the main explanatory variable. For EDF - Expected Default Frequency - the most widely used version of the structural model is essentially the Vasicek-Kealhofer model and was acquired by Moody's Corporation in 2002 and subsequently renamed MKMV (Moody's-KMV). We employ Moody's Bank Financial Strength ratings as a dependent variable where the downgrade to D+ or below is taken as a proxy for default. In line with the previous literature we examine CAMEL supervisory ratios together with EDF. The addition of these ratios enables us to check whether these ratios convey additional information to EDF. Another variable tested is adverse selection affect by two alternative measures: past asset growth and gross loans growth. These variables are expected to capture the effect of aggressive growth strategies applied by many banks before the crisis. In our analyses we apply models of binary choice – pooled binomial logit model and its panel structure. The estimated models are analysed using different lags of the independent variables to see at which horizon the models have the highest predictive power.

Our results reveal that EDF metrics combined with four CAMEL covariates and variable capturing adverse selection are able to predict the defaults of European banks up to 8 weeks before an event. When comparing the final model with that only including the EDF indicator the significance improves considerably, suggesting that added variables provide additional information and power to the model.

Our tests reveal that all CAMEL components except capital ratio exhibit significance in predicting bank defaults. As argued by Brossard et al., 2006 equity ratios may weaken their signalling power because of the relative homogeneity of European banks' capital assets. They argue that European banks maintain their capital ratios in accordance with the Basel II regulatory framework and thus they do not vary much like in US banks' capital ratios. Since our data comprises that of European banks, equity ratio may not be valid as one of the default predictors.

As for adverse selection effect, both definitions contribute to the predictive power of the model, although their marginal effects are not very high in all models' specifications. Past asset growth exhibits a positive association with defaults, while loan growth persistently displays a negative sign. At first sight these are contradictory results, but we suppose that this inconsistency is brought about by the following issues:

- The measure of bank assets is broader in definition than gross loans and includes bank loans as well as other items. As was evident in the recent financial crisis, many loans were securitized and transferred by use of Mortgage-Backed Securities (MBS). By doing so, a bank may not exhibit excessive growth of loans but may still have risky MBS and other derivatives in its assets which will have a negative effect on its solvency
- The timing of loan loss may also influence regression results. Usually the peak of delinquency on loans comes between two to four years after their origination. Since in our model we do not include time intervals for more than two years the negative effect of rapid loan growth may not yet be apparent
- During the financial crisis credit rating agencies have been criticized for delaying banks' downgrades. This was especially relevant to big banks. Since we use downgrades as a proxy for default and our sample comprises of mainly big banks this could bring some bias to our model.
- Large banks may also have implicit government guarantees and thus deemed to be guaranteed rescue by state authorities. This effect is referred as implicit safety nets in the academic literature. Banks may therefore not receive significant downgrades from rating agencies.

To summarize, in Early Warning Models it is beneficial to use both market based indicators and balance sheet indicators as they mutually complement each other. It also implies that EDF provides additional information to that of balance sheet ratios but is not a complete substitute for them.

There are some issues which need to be taken into account in generalizing the thesis findings:

- We estimate our models in Chapter 4 based on the data of EU banks which is perhaps not representative of the entire universe of European banks. As such, our conclusions apply mainly to the EU-15 banks with specified specializations and with market traded securities. Also we use the downgrade of banks' ratings as a proxy for bank default, thus it may bear some bias to the estimated models.

- Since the financial environment of banks is changing rapidly and more financial innovations are introduced, the statistical models of predicting bank failures and explaining bank risk-taking behaviour need to be re-estimated periodically in order to adjust them to fit new conditions prevalent in the economy.
- It is important to stress the importance of general macroeconomic states which have a huge impact on the bank-specific risk factors we have analysed. Though our aim in this study is not to estimate their influence we acknowledge that we cannot ignore the prevailing macro-environment when looking to understand the effect of bank-specific factors. The impact of the general macroeconomic state of the country, competition in the banking industry, regulatory and institutional factors, macroeconomic shocks etc. inevitably play a role in bank risk-taking and in predicting bank distress. However, we would like to leave this issue for future studies.

Our main intention in this thesis is to reveal risk-taking factors contributing to an excess of bank risk and to show how these risks can be foreseen or predicted in order to prevent the future realization of financial crises. In so doing we believe we can put our own contributions toward understanding the causes of the Spanish financial crisis and suggesting possible improvements to early warning models for European banks. The work could provide important insights for regulators into setting up more efficient policies for controlling bank risk-taking factors and improving prevailing early warning models of bank distress.

One possible direction for further research in modelling bank credit risk may be the inclusion of macroeconomic variables accounting for macroeconomic conditions in the observed market, as well as the addition of variables for realized and/or expected bank bail-outs.

Another interesting topic for further research can be the use of a dataset with actual bank defaults, not its proxies, as it can better discriminate between sound and fragile banks and improve the predictive quality of the model.

Our empirical work can be expanded by using the research framework employed in Chapter 3 and Chapter 4 to study smaller size banks and/or the broad nature of bank ownership.

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APPENDIX A Summary of revised papers for Chapter 3

Author(s) &year of publishing	Summary of Findings
	Corporate Governance
Garcia Marco, T & Robles Fernandez, D (2008)	The study analyses how the difference in ownership forms and legal structures between Spanish Saving Banks (SB) and Commercial Banks (CB) translates into risk taking behaviour. It also examines how risk taking behaviour is affected by significant board turnover and the size of the entities. It includes 1030 observations made during 1993-2000 years. The results reveal that CBs exhibit a stronger tendency toward risk taking than SBs. Higher risk-taking are found in only small CBs with high ownership concentration. The results of medium-size and large CBs suggest that the greater the ownership dispersion, the higher the level of risk-taking. Higher risk-taking likely occurs in large and medium-size CBs.
Pathan, S (2009)	The study investigates whether bank board structure and CEO power are relevant to bank risk-taking performance by using a sample of 212 large US Bank Holding Companies (BHC) over 1997-2004. it finds that bank risk-taking is positively related to strong bank boards. The results are robust especially for small and less restrictive boards. Other findings suggest that bank risk-taking is negatively related to CEO power. A negative relation between independent directors and bank risk measures implies that independent directors would prefer to balance between the interests of shareholders and bank stakeholders such as depositors and regulators. The paper suggests that bank board structure is an important determinant of bank risk-taking.
Laeven, L & Levine, R (2009)	The research examines whether the bank risk taking varies with the comparative power of shareholders within the bank's corporate governance structure. It also analyses how national regulations affect various bank ownership structures. They argue that the same bank regulations have different effects on bank risk taking according to the comparative power of shareholders in the governance structure; banks with more powerful owners tend to take greater risk implying that bank owners tend to induce managers to increase risk taking. Ownership structure should be taken into consideration when analysing the impact of capital regulations, deposit insurance and activity restrictions on bank risk

	taking.
Iannotta, G, Nocera, G & Sironi, A (2006)	A study analyses the effect of ownership structure on European banks' performance and on their risk level from 1999-2004. It compares mutual banks (MB), privately-owned stock banks (POB) and government-owned banks (GOB). By using different risk proxies it argues that POBs have poorer loan quality and higher insolvency risk than others. MBs have better loan quality and lower asset risk. Higher ownership concentration is associated with better loan quality, lower asset risk and lower insolvency risk.
Gropp, R & Kohler, M (2010)	The study examines whether owner controlled banks or manager controlled banks incurred larger losses during the recent financial crisis. Data used is OECD listed banks and many unlisted credit institutions. The results suggest that owner controlled banks had higher profits before the crisis and larger losses at the time of the crisis implying greater risk-taking in this type of governance. The profit of shareholder controlled banks in countries with strong shareholder rights declined about five times as much during the crisis compared to banks with widely held ownership operating in countries with weak shareholder rights. The findings suggest that if managers are better controlled by shareholders, this will positively correlate with bank risk-taking.
Peni & Vähämaa, (2012)	The study investigates the effect of bank governance on bank performance during the recent financial crisis by applying the Gov-Score corporate governance index. The results indicate that good corporate governance practices improve the financial performance of banks and their market valuation during the financial crisis but had negative effects on market valuations implying that strong corporate governance did not create shareholder value during the crisis. They also suggest that strong corporate governance may have moderated the adverse effects in the immediate aftermath of the financial crisis as the banks exhibited substantially higher stock returns from March 2009 onwards.
Westman (2011)	The study revises the impact of management and board ownership on the performance of traditional, non-traditional and diversified banks. The results from listed European banks exhibit that management ownership has a positive impact on the profitability of non-traditional banks since these banks are characterized as opaque, complex and difficult

	to monitor. Board member ownership has a positive impact on the performance of traditional banks where the existence of deposit insurance reduces the monitoring incentives of external stakeholders. But it does not work for diversified banks because they are too complex or opaque for the board to monitor. Big, diversified banks are subject to the Too-Big-To-Fail safety-net, which also negatively influences the monitoring incentives of bank shareholders. The author concludes that higher returns come with increased bank risk i.e. there is always a risk return trade-off.
Andres & Vallelado (2008)	The study covers 69 large commercial banks from six developed countries over the period 1995-2005. The authors find that between board size and its performance is an inverted U-shape relation which implies non-monotonic relation as when board reaches an optimal size (19 directors), its performance starts to diminish. They suggest that there is a trade-off between advantages in having a larger board (monitoring, advising) and disadvantages (control and coordination problems). The same inverted U-shaped model is observed between the proportion of outsiders and performance. They argue that outside directors improve value but when the number reaches a majority of the total directors, Tobin's Q starts to lessen.
Erkens, Hung, & Matos (2012)	The study analyses why during the financial crisis some financial institutions were affected worse than others by focusing on board independence, institutional ownership and the presence of large shareholders. They find that firms with more independent boards and greater institutional ownership experienced lower stock returns during the crisis. They argue that more risk-taking is associated with more institutional ownership but not with independent boards, contradicting the proposition those non-executive directors encouraged managers into higher risk-taking before the onset of the crisis. Poor performance of firms with independent boards is explained through increased pressure from independent directors on managers to raise equity capital during the crisis to ensure capital adequacy and to lower bankruptcy risk. As equity capital rising was costly at that period, it could lead to wealth transfer from shareholders to debt holders but help them to survive the crisis.
Dewatripont & Freixas, (2012)	The study analyses the influence of CEO compensation on bank risk-taking by using a measure of "residual compensation". They argue

	that the recent financial crisis has demonstrated the ineffectiveness of the disciplinary channels through the compensation of CEOs. In line with agency theory, bank stockholders prefer that CEOs are compensated with stock options as this increases the CEO's pay/performance sensitivity. In this manner, a higher level of stock options motivates the CEO to higher risk investments at the expense of bank's debt holder.
Bai & Elyasiani (2013)	The paper analyses the relationship between insolvency risk and executive compensation structures for large BHCs (Bank Holding Company) from 1992-2008. It focuses on two indicators: the risk sensitivity measure of compensation – "vega", and pay-share inequality between CEOs and other top executives. They argue that CEO interests became more aligned with bank stockholders' interests because of equity based compensation by making CEO compensation more sensitive to a bank's stock risk. Increased "vega" of compensations has resulted in higher risk-taking among banks since CEOs have excessive incentives to take on risk and increase their wealth. They also suggest the positive effect of pay-share inequality to bank stability. The results indicate that BHCs with higher level of "vega" have greater levels of non-traditional banking using noninterest income activities as a channel to raise their risk-taking.
Cuñat & Garicano (2010)	The paper researches if it pays to have knowledgeable chairmen by assessing their performance in portfolio allocation decisions and loan risk-taking in the case of Spanish Cajas (savings banks). They suggest that a Caja run by a chairman with a post-graduate education, with previous banking experience, and with no previous political appointments is expected to have significantly less real estate lending in its portfolio of total lending, or a larger share loans to individuals (loan concentration), a lower rate of non-performing loans, and a lower downgrade in its bank's rating. Cajas with lower politicized board members had less exposure to real estate risks suggesting that CEO professionalization played a role in banks' performance during the crisis.
Schaeck, Cihak, Maechler & Stolz (2012)	The work investigates the role of different stakeholders in disciplining bank executives through the application of two dimensions of market discipline: the ability of stakeholders to monitor and evaluate bank conditions, and their ability to influence a bank's actions. They argue that the probability of forced turnovers is robustly increasing with bank's

	increasing risk-taking. Analyses demonstrate that higher turnovers lead to higher risk levels with greater losses, and a sustained negative impact on profitability. The study puts in question the effectiveness of market disciplinary mechanisms for small and medium-sized banks, except through their shareholders, which are also not found to influence bank soundness.
Jonghe, Disli & Schoors (2012)	The authors estimate an efficient risk/return frontier for Turkish commercial banks with the use of a stochastic frontier approach over the period 1988-2009 which includes the Turkish banking crisis in 2000-2001. The paper merges two aspects of risk/return trade-offs studies: off-balance sheet banking activities and the impact of governance mechanisms – internal and external on risk/return efficiency. They suggest that a more experienced CEO in most cases increases risk/return efficiency. Larger banks tend to be risk/return efficient possibly due to their wider opportunities and market power. The political background of bank chairmen is likely to have a negative effect on risk/return. CEO non-duality helps to achieve a higher efficiency in risk/return trade-off, especially post crisis.
	Business Models
Altunbas, Manganelli, & Marques-Ibanez, 2011	The paper revises European and US banks and analyses whether the variability across bank business models is related to their realized risk during the financial crisis. The results reveal that a higher level of capital decreases the bank risk though this is argued to be a non-linear relationship. Ex-post bank risk is associated with ex-ante bank size and degree of credit expansion in the years proceeding to crisis. Moreover, it finds that banks with more deposit base funding are less risky than banks with a higher market funding. The study encourages bank supervisors to distinguish the impact of different business models on bank risk to explain the divergence in risk realization during the crisis.
Berger & Bouwman, 2012	The study examines the effect of capital on bank performance and whether it varies across financial crises and periods of economic stability. Here bank performance is measured in terms of survival and market share. The work shows that capital helps small banks to survive at all times and for medium and large banks only during banking crises. Capital helps small banks to improve their market share at all times, while for

	medium and large banks it is helpful only during banking crises.
Demirgüç-Kunt & Huizinga, 2009	The study examines how bank activity and short-term funding strategies affect risk and return trade-off. The sample period is 1995-2007 and comprises international banks with stock exchange listings. Results argue that a higher non-interest income or non-deposit funding level contributes to higher bank risk though the impact of both variables on bank return is difficult to explain due to endogeneity concerns. The study concludes that, overall, traditional banks – with heavy reliance on interest income and deposit funding - are safer.
Demirgüç-Kunt, Detragiache, & Merrouche, 2010	The paper investigates whether better capitalized banks have higher stock returns during financial crises using data from a big sample of international banks. The work discusses which concept of capital is more relevant in stock valuation during the crisis and what items are counted as capital for regulatory purposes. The results suggest that during the crisis banks with higher capitalization were better valued than undercapitalized banks though this trend is not observed before the crisis. Moreover, the strongest effect is observed for the leverage ratio rather than risk-adjusted capital ratio supporting the view that a stronger capital position is important during periods of crisis. This especially relates to "higher quality capital" – Tier 1 capital.
Lepetit, L, Nys, E, Rous,P & Tarazi, A (2008)	The work analyses 734 European banks from 1996-2002 and concludes that banks with expanded non-interest income activities, namely with higher shares of commission and fee income, present higher risk and higher insolvency risk than banks with traditional income sources. Conversely, large shares in trading income exhibit a lower risk exposure and lower default risk. The results are more robust for small banks with total assets less than €1 billion.
Köhler (2012)	The paper analyses the effect of loan growth and business models on bank risk level and reveals considerable heterogeneity in risk-taking across banks and countries. Kohler suggests that banks with high loan growth rates are riskier. Also, he finds evidence that if a bank increases its non-interest income share it positively affects its stability while this effect decreases with bank size. Excessive credit growth is associated with high bank risk. Overall, the study summarizes that differences in the lending activities and business models facilitate in the identification of bank risk.

Beltratti & Stulz (2012)	The paper analyses the importance of Tier 1 capital for large banks by analysing the relative stock return performance of large banks across the world during the crisis. They find that that large banks with more Tier 1 capital, more deposits, less exposure to US real estate, and less funding fragility performed better than banks financed with short-term funds raised in the money markets and with more exposure to US real estate.
Borio and Zhu (2012)	The study focuses on the interaction among bank capital regulation, the business cycle and the transmission mechanism. Authors suggest that with the evolution of minimum capital regulation from Basel I to Basel II the influence of prudential regulation and supervision on bank behaviour has been increases. The minimum capital threshold could vary more over the business cycle. Risk measures tend to vary procyclically i.e. to be comparatively low during economic expansions and to be comparatively high during economic contractions. Existing macroeconomic concepts and models are not sophisticated enough to capture the changes in the financial system.
Huang & Ratnovski (2010)	The paper researches the effect of bank funding strategies - the impact of wholesale funding on the performance of banks. The results reveal that wholesale funding is beneficial when providers are informed. But with the presence of noisy public signals the incentives of fund providers to monitor banks and impose market discipline could be distorted and may lead to inefficient liquidation of a bank. Negative effects of wholesale funding relate to banks with extended exposures to standardized and tradable arm's length assets, with readily available public information and when wholesale funds are senior claimants.
	Financial Innovations
Otero González, Rodríguez Gil, Cantorna Agra & Durán Santomil (2012)	The study researches the effect of credit derivatives on bank risk for European banks. They argue that the use of credit derivatives for hedging experience demonstrates improvements in banks' levels of financial stability while banks which opt for a speculative position experience a negative impact on their financial stability. However, they do not find evidence to support the hypothesis that banks exploit coverage to undertake more risky strategies. The empirical evidence suggests that the use of credit derivatives does not affect the position of leverage of banks, signifying that banks would not take advantage of improving solvency

	caused by hedging to increase their level of leverage. The authors therefore conclude that credit derivatives may not be a cause for the recent financial crisis within Europe.
Martín-Oliver & Saurina (2007)	The paper analyses the reasons behind bank securitization within selected Spanish banks – commercial, savings and cooperative banks from 1999 – 2006. The results suggest that for Spanish banks the main motivation behind loan securitization was liquidity needs. Those banks with more rapid credit growth, less interbank funding and a higher loan to deposit gaps have a higher probability of both, issuing covered bonds and resorting to the ABS, including RMBS. In general they don't find evidence of the so called "originate-to-distribute" i.e. when banks are becoming mere originators of loans and distributors of their risk via securitizing them.
Carbó-Valverde, Marques-Ibanez & Rodríguez-Fernández (2012)	The study reports the negative impact of securitization on banks' risk-taking by analyzing the changes in quality of MBS and ABS securitization over the period 2000-2010 in Spain. It claims that securitazation may have deteriorated credit quality standards and led to higher loan defaults ultimately worsening overall financial stability. The findings suggest that bank characteristics such as solvency, cash-flow generation and cost efficiency (on top of loan performance) affect ratings considerably. It also reveals that bank characteristics have a greater impact on the rating changes of savings banks as compared with commercial banks. Banks located in regions with increased housing price growth in the years before the crisis have also have higher impact ratings of securities issued by saving banks suggesting their close link to regional territories.
Maddaloni & Peydró (2010)	The study focuses on interrelations among bank risk-taking, interest rates, securitization and bank capital supervision pre-crisis. Low short-term rates of monetary policy –low monetary policy rates prevailing for too long period– led to a softening of lending standards resulting in an accumulation of risk on banks' assets. Increased securitization activity and weak supervision for bank capital further amplified the impact of low monetary policy rates. Since securitization of loans offered assets yielding attractive returns for investors at time of abundant liquidity, it became widely used as an investment decision. Hence, securitization may intensify

	the impact of low interest rates on the softening of lending standards.
	Competition
Boyd, J, Nicolo, G & Jalal, A (2006)	The study focuses on two banking models, CVH (Charter Value Hypothesis) and BDN (Boyd & De Nicolo) and examines whether there is a trade-off between bank competition and stability. CVH predicts a positive relationship of competition and risk of failure whereas the opposite is predicted by BDN. Empirical tests done on 2500 cross sectional US banks' data and a large set panel data collected from non-industrialized countries find that more competition is *ceteris paribus* associated with a lower probability of failure. In other words, there is positive relationship between competition and bank stability. Furthermore, the test reveals a positive link between bank competition and its willingness to lend. Therefore the CVH model is rejected while the results are still consistent with BDN model's predictions.
Salas, V & Saurina, J (2003)	The paper undertakes the empirical analysis of 21 Spanish commercial banks within the period of 1968-1998 to reveal the effects of regulatory changes in the market power of Spanish banks. Besides, it examines banks' risk-taking behaviour in response to reduces economic profits. The obtained results suggest that the measures of liberalization influenced on the level of competition in each market and resulted in reduced market power and economic profits of Spanish banks. Furthermore, lower economic profits caused by deregulation and increased competition increased banks' risk-taking behaviour as their charter values decreased and they have less to lose.
Matutes, C & Vives, X (2000)	The study analyses the links between imperfect competition for deposits and bank risk-taking subject to limited liability and tries to identify whether 'excessive' competition for deposits exist. The research concludes that when the social cost of failure is high, with intense competition, banks tend to set deposit rates too high. Here, the introducing a proper rate ceiling induces minimal risk taking. Besides, it argues, that flat premium deposit insurance tempts banks to highest possible risk-taking. In this case, the introduction of fair and risk based deposit insurance decreases banks excessive risk-taking on the deposit side. In overall, the study summarises that high risk-taking incentives exist with flat-premium deposit insurance and could be minimized with the use of

	risk-based one.
Martinez-Miera, D & Repullo, R (2010)	The paper re-examine the relationship between competition and the risk of the bank failure. It supports the proposition of Boyd and Nicolo (2006) where banks competition reduces loan's probability of default due to reduced loan rates. This effect is referred as risk-shifting effect. But unlike BDN model, the study suggests U shaped relationship between competition and bank's risk of failure where risk starts increasing in very competitive market. It argues that more competition leads to lower loan rates and reduces the banks' interest income from non-defaulting loans used as buffer for loan losses. This effect is referred as margin effect. Hence, the probability of bank failure is lowest in moderate level of competition.
Jimenes G, Lopez J, Saurina J (2010)	Authors support franchise value paradigm in limiting bank risk-taking stating that banks managers and shareholders tend to limit and reduce their risk exposure to preserve the bank's franchise value where the source of franchise value is assumed to be the market power of a bank. Therefore it suggests that the decrease of competition diminishes the risk appetites of banks. Using data of Spanish banks the study finds a negative relationship between bank's market power and risk. It takes bank's ratio of Non-Performing commercial Loans (NPL) as a dependent variable. The results suggests that with increase in market power/or decrease of competition, bank risk-taking declines. The study tests the impact of competition both the loan and deposit markets using Lerner indexes for market power and finds negative and very significant impact on NPL i.e. clear evidence in support of franchise value paradigm. It disproves the Boyd and Nicolo's risk shifting effect of BDN model and finds little evidence of U shaped relationship between competition and risk (suggested by Martinez-Miera & Repullo, 2010).
Hakenes & Schnabel (2011)	The study presents evidence on the presumed trade-off between competition and bank stability. They suggest that stricter capital requirements weaken competition for loans and lead to higher loan rates and hence increase risk-taking by entrepreneurs by raising the risk of individual loans. Moreover, strict capital requirements may induce bank to choose more correlated portfolio by increasing its probability of default. In general, the research summarizes that the ambiguous effect of competition

	on banks' risk-taking results in an ambiguous effect of capital regulation. And that capital regulation act as a stabilizer when competition has destabilizing effect and vice versa.
Schaeck & Cihak (2012)	The work investigates why banks maintain capital levels above regulatory requirements although it is costly and may impede bank's ability to compete. They suggest that increased competition encourages banks to have higher capital ratios because it demonstrates their commitment to monitoring. Also it attracts creditworthy borrowers despite a countervailing effect of deposit insurance. They also supposed that capital ratios are higher when shareholder rights are strongly protected, and that deposit insurance lowers capital ratios. They find robust evidence that competition motivates banks to increase capital holdings and this evidence holds prior to the financial crisis period. This result is valid mainly for commercial banks but holds even for not profit maximizing financial institutions such as saving and cooperative banks.
Tabak, Fazio & Cajueiro (2012)	The paper analyzes the effects of bank competition on the risk-taking behaviours of banks in 10 Latin American countries between 2003 and 2008 by examining how size and capitalization change the relationship between competition and stability. The authors advocate that banks facing both high and low competition are, on average, lower level risk-takers than banks experiencing average competition. They find that the larger a banks may more benefit from competition since size makes them less vulnerable. Similarly, greater capital ratio is beneficial for banks that operate in collusive markets, though capitalization only seems to have a positive impact on financial stability for larger banks. In other words, in collusive markets, banks with a larger capital ratio are more stable as shareholder capital disciplines banks under low competition.
	Monetary Policy
Acharya, V & Naqvi, H (2010)	The paper develops a theory which explains why access to abundant liquidity increases the risk-taking in banks and induces asset price bubbles. It states that when macroeconomic risk is high and investors switch from direct investment to savings in bank deposits, banks face to excessive liquidity. In this case banks' managers may have an incentive to under-price the risk of the investments. Especially when managers are hedged from downside risks risk-taking incentives amplify.

	This in turn induces an excessive demand for assets in the real sector and leads to asset price inflation i.e. to price bubble.
Delis, M & Kouretas, G (2011)	Authors suggest that low level of interest rate has negative effect on bank risk-taking. They empirically tested 3628 banks operating euro area during the period of 2001-2008 and concluded that there is a strong negative relationship between the level of interest rate and bank risk-taking. Moreover, the negative relationship is stronger for banks which have higher level of non-traditional activities, while for banks with higher level of capitalization the relationship is weaker.
Jimenez G, Ongena S, Peydro J & Saurina J (2008)	The study focuses on the impact of short-term interest rates on credit risk-taking by analysing Spanish banks during the period of low interest rates, prior to financial crisis. The results reveal that lower overnight rates prior to loan origination lead banks to lend more to borrowers with a worse credit history and to make more loans with a higher probability of default. Lower overnight rates during the life of the loan reduce this probability. Bank, borrower and market characteristics determine the impact of overnight rates on credit risk-taking. Besides, it argues that smaller banks' incentives and ability for risk-taking are more affected than larger banks' incentives. The effect of monetary policy on credit risk-taking also depends on bank liquidity and ownership type, as well as on the level of banking competition and new borrower entry in the local area.
	Regulatory and Institutional Contexts
Bongini, Laeven, & Majnoni, 2001	The study investigates to what extent market signals of bank fragility are reliable upon. The data consists of South East Asian crisis countries with the investigated time period of 1996-1998. By exploring three publicly available indicators of bank fragility (accounting data, stock market prices and credit ratings) it tries to identify which of them has more power in predicting actual bank distress. The study takes balance sheet indicators by using CAMEL ratios, market signals - by deposit insurance premiums applying Merton's model (1977) and credit ratings from Moody's ratings. The result suggests that none of the three indicators exhibits a significant amount of information with regard to discriminating distressed banks from non-distressed ones. From these three indicators implicit deposit insurance premiums demonstrate a relatively higher

	power, followed by the balance sheet indicator.
Distinguin, Rous, & Tarazi, 2005	The paper investigates how well stock market prices contribute for the improvement of prediction of a bank's distress by applying specifically designed logit econometric model for European banks. The findings suggest that the market information can be a substitute to accounting information and convey additional information regarding probability of bank downgrade. Besides, they argue that accuracy of the predictive power depends on the extent to which bank liabilities are traded in the market. For those banks which rely heavily on insured and non-market priced deposits, larger subordinate debt issues do not contribute for the improvement in prediction and the market seems to be unable to convey useful information. Regarding size and opacity effects, research shows that they may undermine the ability of stock prices to transmit useful information on future bank financial health.
Houston J, Lin, C, Lin P & Ma Yue (2010)	The paper examines the links between creditor's rights, information sharing & bank risk-taking using a sample of 2400 banks in 69 countries. It also explores how these two factors affect the likelihood of financial crisis and the overall banking system. The findings suggest that the stronger creditor rights are correlated with higher bank risk-taking and therefore increase the likelihood of financial crisis. Better information sharing among creditors reduces risk-taking incentives of banks and significantly weakens the positive link between creditor rights and banking crisis. In general, the greater information sharing results in higher bank profitability, lower bank risk hence a reduced likelihood of financial crisis, and higher economic growth.
Ogut, Doganay, Ceylan & Aktas (2012)	The work investigates whether the forecast of the rating of bank's financial strength using the publicly available data is consistent with those of the credit rating agency. The findings suggest that the most important factors are efficiency, profitability (ROE), and the proportion of loans in the assets. It also suggests that the rating agency assigns a higher rating to those banks that generate high net income for shareholders, use resources efficiently, and channel funds as loans to households and businesses. The authors suppose that rating agencies find it less profitable for banks to place a high proportion of their funds (mainly deposits) in government debt securities indicating that the rating of a bank is higher if its risk is

shared with different groups. The results are in general consistent with those of Moody's financial strength rating.

Ashcraft, Goldsmith-Pinkham & Vickery (2010)

The study analyses credit ratings on subprime and Alt-A mortgage-backed-securities (MBS) deals issued between 2001 and 2007 in US market. The study covers 3,144 MBS deals. Particularly, it analyses the consistency of MBS ratings in two dimensions: through time, and across deals from a given vintage backed by different types of loans. Furthermore, it examines how well credit ratings order relative risks across MBS deals from within a given cohort. The empirical evidence suggests that ratings are in general informative, hence it rejects a simple story that credit rating standards deteriorate uniformly over the pre-crisis period. It reveals significant time-series variation in subordination levels i.e. it finds a significant decline in risk-adjusted subordination levels between the start of 2005 and mid-2007.

Others

Allen (2005)

The work reviews and compares both traditional and modern approaches of credit risk measurement by giving emphasis on credit risk exposure of middle market firms. It estimates credit risk models (both academic and proprietary models) by using hypothetical portfolio of middle market credit obligations. The paper concludes that credit models exhibit directionally consistent outputs if are used with similar inputs. The discrepancies in results are mainly associated with differences in module inputs, pre-processing or valuation errors.

Elizalde, (2005)

The study reviews the structural approach of credit risk modelling for single firm and for default dependences between firms. It discusses both criticism and extensions of the revised structural models. Particularly it revises the Merton's model and its extensions in a form of First Passage Models, Liquidation Process Models, State Dependent Models, etc. The review also presents some approaches to model default dependences between firms such as cyclical default correlation and contagion effects and suggests different possible extensions for existing structural models.

Konishi, M & Yasuda, Y (2004)

The paper empirically examines a few determinants of risk taking using Japanese commercial banks' data from 1990-1999. The following conclusions are made: 1) the capital adequacy requirement reduced Japanese commercial banks' risk taking incentives, 2) while the acceptance

of government official in banks' board does not have a significant influence. 3) Regarding the stable shareholders effect it finds non-linear relationship where the risk initially decreases with the proportion of shareholders and increase as the assets substitution effect dominates over the effect of managerial entrenchment on bank risk. 4) In the case of franchise value, its decline increases bank risk.

APPENDIX B Summary of revised papers for Chapter 4

Author(s) & year of publishing	Summary of findings
Allen, 2005	The work reviews and compares both traditional and modern approaches of credit risk measurement by placing emphasis on the credit risk exposure of middle market firms. It estimates credit risk models (both academic and proprietary models) using hypothetical portfolios of middle market credit obligations. The paper concludes that credit models exhibit directionally consistent outputs if used with similar inputs. The discrepancies in results are mainly associated with differences in module inputs, pre-processing or valuation errors. The existence of substantive differences across models is due to different approaches applied to valuation and correlation calculation methods. The study concludes that middle market firms are affected by inaccuracies and inconsistencies in credit risk measurement models as different models reveal different credit risk assessments.
Altunbas, Manganelli, & Marques-Ibanez, 2011	The paper revises European and US banks and analyses whether the variability across bank business models is related to their realized risk during the financial crisis. The results reveal that a higher level of capital decreases the bank risk though this is argued to be a non-linear relationship. Besides, ex-post bank risk is associated with ex-ante bank size and the degree of credit expansion in the years preceding crises. Moreover, it finds that banks with more deposit base funding are less risky than banks with a higher market funding. In general, the study encourages bank supervisors to distinguish the impact of different business models on bank risk to explain the divergence in risk realization during crises.
Auvray & Brossard, forthcoming	The study focuses on European banks and investigates, using Merton's KMV model, whether dispersed ownership leads to weaker monitoring by shareholders causing poor power of predictability of the distance-to-default indicator. This idea is supported by the theory that too much ownership dispersion may impair the information content of share prices due to weaker monitoring. The paper also tests the quality of the information gathered by banks' shareholders and checks how well they incorporate received information into banks' share prices. The results confirm that ownership dispersion of bank's shareholders clearly reduces

	the effectiveness of the distance-to-default as a predictor of bank distress and bank recovery. In contrast, when ownership is concentrated it raises the predictive power of the indicator.
Berger & Bouwman, 2012	The study examines the effect of capital on bank performance and whether it varies across financial crises and periods of financial stability. Here bank performance is measured in terms of survival and market share. The work argues that capital helps small banks to survive at all times and for medium and large banks only during banking crises. Capital helps small banks improve their market share at all times, while for medium and large banks it is helpful only during banking crises.
Bongini, Laeven, & Majnoni, 2001	The study investigates to what extent market signals of bank fragility are reliable. The data consists of South East Asian crisis countries through the years 1996-1998. By exploring three publicly available indicators of bank fragility (accounting data, stock market prices and credit ratings) it tries to identify which of them has more power in predicting actual bank distress. The study takes balance sheet indicators by using CAMEL ratios, market signals - by deposit insurance premiums applying Merton's model (1977) and credit ratings from Moody's ratings. The results suggest that none of the three indicators exhibits a significant amount of information with regard to identifying distressed banks from non-distressed ones. From these three indicators implicit deposit insurance premiums demonstrate a relatively higher power, followed by the balance sheet indicator.
Brossard, Ducrozet & Roche, 2006	The study analyses European banks, applying distance-to default and a variable detecting the adverse selection effect of rapid growth strategies. The latter indicator accounts for problems when banks are undertaking aggressive growth strategies and employ lower standards in the selection and monitoring of their new assets. The empirical findings confirm the robustness of DD as an early indicator of banks' failure, though a more restrictive definition of the "failure" is used. Support Ratings (Fitch/ICBA) are used to control for the "Too-Big-To-Fail" effect. The study concludes that DD remains significant when it is joined with CAMEL accounting indicators and after the introduction of the "Too-Big-Too-Fail" effect. The new indicator of adverse selection effect improves the predictive power of the model. With its introduction CAMEL and DD

	variables are still significant and they enable the prediction bank failure up to 24 months prior to the event.
Chan-Lau & Sy, 2006	The study proposes an alternative measure of risk to distance-to-default, namely distance-to-capital. Unlike DD, it incorporates "triggers" embedded in prompt corrective actions by regulators. Distance-to-capital uses the same theoretical framework as DD but its default barrier is consistent with the prevalent regulations. These two measures are compared in the case of Japanese banks. Analyses of differences between the two measures show that distance-to-capital (DC) becomes increasingly larger than DD as the capital adequacy threshold increases. Moreover, DC and DD are highly correlated though the value of DC is lower than DD in financially calm periods. The research concludes that DC is a useful measure for policy makers in monitoring the stability of banks but the existence of numerous capital thresholds limits its universal application.
Chan-Lau, Jobert, & Kong, 2004	The study investigates emerging market banks' vulnerabilities using Merton's option-based structural model (Merton, 1974) and deriving from it a normalized distance-to-default - a risk neutral indicator of bank vulnerability. The sample period covers July 1997 to July 2003 and comprises 38 banks from 14 different emerging countries. The findings show that the indicators can forewarn bank distress, defined as a rating downgrade to CCC or below, up to 9 months in advance in-sample. It is recommended to use these indicators in real time to forecast bank crises as part of a policy maker's toolkit. However, the distance to default indicator is considered to have an inherent weakness which stems from the fact that it is only a "risk neutral" measure making it difficult to apply it as a "real world" objective measure of financial distress.
Demirgüç-Kunt & Huizinga, 2009	The study examines how bank activity and short-term funding strategies affect risk and return trade-off. The sample period covers 1995-2007 and comprises international banks with stock exchange listings. Results indicate that a higher non-interest income or non-deposit funding level contributes to higher bank risk, though the impact of both variables on bank return is difficult to explain due to endogeneity concerns. The study concludes that overall, traditional banks – with heavy reliance on interest income and deposit funding - are safer.
Demirgüç-Kunt,	The paper investigates whether better capitalized banks have

Detragiache, & Merrouche, 2010	higher stock returns during financial crises for a large sample of international banks. The work discusses which concept of capital is more relevant in stock valuation during the crisis and what items are counted as capital for regulatory purposes. The results suggest that during the crisis banks with higher capitalization were better valued than undercapitalized banks though this trend is not observed before the crisis. Moreover, the strongest effect is observed for the leverage ratio rather than risk-adjusted capital ratio supporting the view that a stronger capital position is important during crises. In particular, this relates to "higher quality capital" – Tier 1 capital.
Distinguin, Rous, & Tarazi, 2005	The paper investigates how well stock market prices contribute to the improvement of predicting bank distress by applying a specifically designed logit econometric model for European banks. The findings suggest that market information can act as a substitute to accounting information and conveys additional information regarding the probability of bank downgrades. They argue that the accuracy of the predictive power depends on the extent to which bank liabilities are traded in the market. For those banks which rely heavily on insured and non-market priced deposits, larger subordinate debt issues do not contribute to improvements in prediction and the market seems to be unable to convey useful information. Regarding size and opacity effects, research shows that they may undermine the ability of stock prices to transmit useful information on future bank financial health.
Elizalde, 2005	The study reviews the structural approach of credit risk modelling for single firms and for default dependences between firms. It discusses both criticisms and extensions of the revised structural models. In particular, it revisesMerton's model and its extensions in the form of First Passage Models, Liquidation Process Models, State Dependent Models, etc. The review also presents some approaches to model default dependences between firms such as cyclical default correlation and contagion effects and suggests different possible extensions for existing structural models.
Gramlich, Miller, Oet, & Ong, 2010	The paper critically revises EWS for systematic banking risk literature in light of recent financial crises. It reviews existing concepts of EWS, discusses their suitability and recommends possible improvements to capture the increasing complexity and transmission of changes in

	current financial markets. It proposes that recent developments evidenced in the financial system and its increasing fragility suggests the modification of basic concepts of existing EWS. EWS should be reassessed continually and adopted according to the objectives and availability of data of it users. It is also recommended to incorporate micro-prudential and macro-prudential perspectives as well as the structural consideration of the financial system itself. As a supervisory tool EWS needs to have an ex-ante approach to reduce the need of costly ex-post regulations.
Gropp, Vesala, & Vulpes, 2002	The study finds that negative distance-to-default and bond spreads are complete and unbiased indicators and have predictive power in revealing problem banks. Negative DD demonstrates poor predictive power closer to the default while demonstrating good predictive power up to 18 months prior to the event. In contrast, bond spread has better predictive power closer to the event, 3-6 months prior to the default, when the situation is quite desperate. The research suggests that the predictive power of bond spread deteriorates with the possible public bail out of a bank. Conversely, equity-based DD does not react to an expectation of public bail out. Generally, the research concludes that the two indicators complement each other and together reduce Type I errors.
Harada, Ito, & Takahashi, 2010	The paper investigates the predictive power of DD via eight failed Japanese banks. DD is calculated through a structural model of credit risk assessment based on Merton's (1974) option pricing theory. The banks are classified into two groups based on their asset size: 3 large banks and 5 smaller regional banks. The results reveal that DD becomes smaller in predicting bank failure in many cases. They found that DD is generally a reliable measure, but a lack of transparency in financial statements and disclosed information deteriorates its predictive power. The DD spreads, defined as DD of failed banks minus DD of sound banks, is also found to be a helpful indicator in predicting bank failures.

APPENDIX C Tables of regression results for Chapter 3

Table C-1EDF1 baseline model panel logit

	Panel logit 1 lag	Panel logit 2 lags	Panel logit 3 lags	Panel logit 4 lags	Panel logit 5 lags	Panel logit 6 lags	Panel logit 7 lags	Panel logit 8 lags
edf1year								
L1.	0.701*							
L2.		0.849*						
L3.			0.884*					
L4.				1.040*				
L5.					1.102*			
L6.						1.144*		
L7.							1.051*	
L8.								0.901*
_cons	-2.733***	-2.533***	-2.334***	-2.176***	-2.004***	-1.823***	-1.878***	-1.970***
N	525	556	587	620	653	686	683	680
Pseudo R^2								
Wald χ^2	3.201	3.155	3.194	3.204	3.149	3.155	2.776	3.237
Log likelihood								

Table C-2 EDF5 baseline model panel logit

	Panel logit	Panel logit	Panel logit	Panel logit	Panel logit	Panel logit	Panel logit	Panel logit
edf5years	1 lag	2 lags	3 lags	4 lags	5 lags	6 lags	7 lags	8 lags
L1.	0.462**							
L2.		0.548*						
L3.			0.572*					
L4.				0.645*				
L5.					0.672*			
L6.						0.690*		
L7.							0.644*	
L8.								0.549**
_cons	-2.834***	-2.623***	-2.399***	-2.208***	-2.030***	-1.858***	-1.937***	-2.037***
N	525	556	587	620	653	686	683	680
Pseudo R^2								
Wald χ^2	3.904	3.543	3.42	3.199	3.184	3.273	3.385	4.067
Log likelihood								

Table C-3 EDF 5 years with selected CAMEL variables, marginal effect

	6 lags		7 lags		8 lags	
edf5year	AME	ME (Mean)	AME	ME (Mean)	AME	ME (Mean)

L6.	0.84***	0.102***				
		(0979)				
L7.			0.097***	0.126**		
				(0.874)		
L8.					0.075***	0.090***
						(0.813)
imploanstogrossloans L4.	0.028***	0.035***	0.035***	0.032***	0.029***	0.034***
		(3.304)		(3.304)		(3.304)
costtoincome L4.	0.005***	0.006**	0.006**	0.005**	0.005***	0.006**
		(62.799)		(62.799)		(62.799)
roae L4.	-0.009**	-0.011**	-0.011***	-0.011***	-0.010***	-0.012***
		(8.082)		(8.082)		(8.082)
liqassettototdepbor L4.	-0.008***	-0.010***	-0.010***	-0.008***	-0.009***	-0.010***
		(23.737)		(23.737)		(23.737)

Table C-4 Cost-to-income ratio, two-sample t-test with unequal variances

Cost/Income	Status	N	Mean	Difference	T
1-quarter lag	0	330	60.122	-14.882	-2.073**
	1	59	74.067		
2-quarter lag	0	328	60.122	-13.945	-2.219**
	1	59	74.067		
4-quarter lag	0	334	59.701	-12.368	-2.424**
	1	75	72.068		
6-quarter lag	0	287	59.078	-13.755	-2.626***
	1	74	72.833		
8-quarter lag	0	249	58.525	-15.250	-2.689***
	1	68	73.774		

Note: Status 0 is Not downgraded banks, Status 1is Downgraded banks; Difference is mean *(Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0;* legend: * p<.1; ** p<.05; *** p<.01.

Table C-5 Capital ratio, two-sample t-test with unequal variances

Equity/Assets	**Status**	**N**	**Mean**	**Difference**	**T**
1-quarter lag	0	321	7.202	-0.479	-0.502
	1	49	7.681		
2-quarter lag	0	320	7.239	-0.547	-0.601
	1	57	7.786		
4-quarter lag	0	327	7.366	-0.344	-0.420
	1	72	7.710		
6-quarter lag	0	282	7.449	-0.211	-0.243
	1	69	7.660		

8-quarter lag	0 1	244 63	7.493 7.716	-0.223	-0.233

Note: Status 0 is Not downgraded banks, Status 1is Downgraded bank*s; Difference is mean (Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0;* legend: * p<.1; ** p<.05; *** p<.01.

Table C-6 Liquidity ratio, two-sample t-test with unequal variances

Liquidity	Status	N	Mean	Difference	T
1-quarter lag	0 1	320 49	27.772 18.792	8.980	3.551***
2-quarter lag	0 1	319 57	27.879 18.791	9.088	3.665***
4-quarter lag	0 1	326 72	27.985 18.027	9.958	4.426***
6-quarter lag	0 1	281 69	27.427 19.803	7.625	2.978***
8-quarter lag	0 63	243	27.269 21.270	5.999	2.205**

Note: Status 0 is Not downgraded banks, Status 1is Downgraded banks; Difference is mean (Status=0) – mean (Status=1); t is t-statistics for testing the hypothesis that difference is not equal to 0; legend: * p<.1; ** p<.05; *** p<.01.

APPENDIX D

List of Spanish Banks

1. Banco Santander SA
2. Banco Bilbao Vizcaya Argentaria SA
3. Caja de Ahorros y Pensiones de Barcelona-LA CAIXA
4. Caja de Ahorros y Monte de Piedad de Madrid-Caja Madrid
5. Banco Popular Espanol SA
6. Caja de Ahorros de Valencia Castellon y Alicante BANCAJA
7. Banco Espanol de Crédito SA, BANESTO
8. Banco de Sabadell SA
9. Caja de Ahorros del Mediterraneo CAM
10. Caja de Ahorros de Cataluña-Caixa d'Estalvis de Catalunya
11. Bankinter SA
12. Liberbank SA
13. Caja de Ahorros de Galicia - Caixa Galicia
14. Caja de Ahorros y Monte de Piedad de Zaragoza, Aragon y Rioja-Ibercaja
15. Bilbao Bizkaia Kutxa, BBK
16. Unicaja - Montes de Piedad y Caja de Ahorros de Ronda, Cadiz Almeria, Malaga Y Antequera
17. Caixa de Aforros de Vigo, Ourense e Pontevedra-Caixanova
18. CAJAMAR Caja Rural, Sociedad Cooperativa de Crédito
19. Banco Pastor SA
20. Barclays Bank S.A.
21. Monte de Piedad y Caja de Ahorros San Fernando de Guadalajara, Huelva, Jerez y Sevilla-Cajasol
22. Caja San Fernando de Sevilla y Jerez - Caja San Fernando
23. Caja de Ahorros de Castilla La Mancha
24. Caja Espana de Inversiones - Caja Espana
25. Caja de Ahorros del Penedés-Caixa d'Estalvis del Penedes
26. Caja de Ahorros de Murcia – Cajamurcia
27. Banco de Valencia SA
28. Caja Laboral Popular Coop. de Crédito - Lan Kide Aurrezkia-Euskadiko Kutxa
29. Caja de Ahorros de Salamanca y Soria - Caja Duero
30. Banco Grupo Cajatres SA-Caja 3
31. Caja de Ahorros y Monte de Piedad de Gipuzkoa y San Sebastian-Kutxa
32. Caja de Ahorros y Monte de Piedad de Navarra - Caja Navarra
33. Caja de Ahorros y Monte de piedad de Córdoba - Caja Sur
34. Dexia Sabadell, SA
35. Deutsche Bank SAE
36. Confederación Española de Cajas de Ahorros – CECA
37. Banco Cooperativo Espanol
38. Caja de Ahorros de Asturias – Cajastur
39. Caja de Ahorros y Monte de Piedad de las Baleares - Sa Nostra
40. Caja General de Ahorros de Canarias - Caja Canarias
41. Caja General de Ahorros de Granada - La General
42. Banco de Andalucia SA
43. Caixa d'Estalvis de Sabadell - Caixa Sabadell
44. Banca March SA
45. Caixa d'Estalvis de Terrassa-Caixa Terrassa
46. Caja de Ahorros Municipal de Burgos-Caja de Burgos
47. Caja de Ahorros de la Inmaculada de Aragon-Caja Inmaculada
48. Banco de Crédito Local de España
49. Caixa d'Estalvis de Tarragona-Caixa Tarragona
50. Caja de Ahorros de Santander y Cantabria - Caja Cantabria
51. Caja Insular de Ahorros de Canarias-La Caja de Canarias
52. Caixa d'Estalvis Laietana-Caixa Laietana
53. Caja Rural del Mediterraneo S. Coop de Credito
54. Caja de Ahorros de Vitoria y Alava-Caja Vital
55. Caixa d'Estalvis de Girona-Caixa Girona
56. Banco Guipuzcoano SA
57. Caja de Ahorros y Monte de Piedad de Extremadura-Caja d Extremadura
58. Caja Rural de Navarra Sociedad Cooperativa de Crédito
59. Caja de Ahorros y Monte de Piedad de Avila-Caja de Avila
60. Banco Caixa Geral SA
61. Caixa d'Estalvis de Manresa-Caixa Manresa
62. Caja de Ahorros y Monte de Piedad de Segovia-Caja Segovia
63. Caja de Ahorros y Monte de Piedad del Circulo Católico de Obreros de Burgos-Caja de Ahorros del Circulo Catolico
64. Banco de Castilla SA
65. Caja Rural de Granada
66. Caja Rural del Sur, S. Coop de Credito.
67. Banco Gallego, SA
68. Open Bank SA
69. Banco de Galicia SA
70. Monte de Piedad y Caja General de Ahorros de Badajoz-Caj Badajoz
71. Banco de Vasconia SA
72. Banesto Banco de Emisiones
73. Caja Rural De Castilla-La Mancha
74. Caja de Ahorros de la Rioja-Cajarioja
75. Ipar Kutxa Rural, S.C.C.
76. Caja Rural Aragonesa y de los Prrineos S Coop de Credito
77. Caja Rural de Asturias
78. Caixa d'Estalvis Comarcal de Manlleu-Caixa Manlleu
79. Banco de Crédito Balear SA

30. Targobank SA
31. Caixa de Credit dels Enginyers S. Coop de Credit-Caja de Crédito de Los Ingenieros Sociedad Coopérativa de Crédito
32. Caja Rural de Jaen, Barcelona y Madrid, Sociedad Cooperativa de Credito
33. Bancofar
34. Bankoa SA
35. Caja de Ahorros Provincial de Guadalajara-Caja de Guadalajara
36. Caja Rural de Ciudad Real
37. Caja Rural de Zamora
38. CajaSiete, Caja Rural
39. Caja Rural de Canarias Sociedad Cooperativa de Crédito
90. Caja Rural de Extremadura Sociedad Cooperativa de Credit
91. Caja Campo, Caja Rural S.C.C.

List of European banks

1 Wüstenrot & Württembergische
2 Van Lanschot NV
3 Unione di Banche Italiane Scpa-UBI Banca
4 Union Financière de France Banque
5 UniCredit SpA
6 Sydbank A/S
7 Swedbank AB
8 Svenska Handelsbanken
9 Svendborg Sparekassen A/S
10 Sparekassen Faaborg A/S
11 Spar Nord Bank
12 Société Générale
13 SNS Reaal NV
14 Skandinaviska Enskilda Banken AB
15 Paris Orléans SA
16 Nordfyns Bank
17 Nordea Bank AB (publ)
18 Natixis
19 MLP Ag
20 Mittel SpA
21 Mediobanca SpA
22 Max Bank A/S
23 Locindus
24 Landesbank Berlin Holding AG-LBB Holding AG
25 Laan & Spar Bank A/S
26 KBC Groep NV/ KBC Groupe SA-KBC Group
27 Jyske Bank A/S (Group)
28 Intesa Sanpaolo
29 ING Groep NV
30 HSBC Trinkaus & Burkhardt AG
31 HQ AB
32 Groupe Bruxelles Lambert
33 Exor Spa
34 DiBa Bank A/S
35 Dexia
36 Deutsche Postbank AG
37 Deutsche Bank AG
38 Delta Lloyd NV-Delta Lloyd Group
39 Danske Bank A/S
40 DAB Bank AG
41 Credito Valtellinese Soc Coop
42 Credito Emiliano SpA-CREDEM
43 Credito Bergamasco
44 Credito Artigiano
45 Crédit Industriel et Commercial - CIC
46 Crédit Foncier et Communal d'Alsace et de Lorraine (Banque)-CFCAL Banque
47 Crédit Agricole S.A.
48 Commerzbank AG
49 Comdirect Bank AG
50 Cofitem - Cofimur
51 Caisse Régionale de Crédit Agricole Mutuel Toulouse 31-Crédit Agricole Mutuel Toulouse 31 CCI
52 Caisse régionale de credit agricole mutuel Sud Rhône -Alpes-Credit Agricole Sud Rhône Alpes
53 Caisse régionale de Crédit Agricole mutuel du Morbihan-Crédit Agricole du Morbihan
54 Caisse régionale de crédit agricole mutuel de Paris et d'Ile-de-France-Crédit Agricole d'Ile-de-France
55 Caisse régionale de crédit agricole mutuel de Normandie-Seine

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56	Caisse régionale de credit agricole mutuel d'Alpes-Provence-Credit Agricole Alpes Provence
57	Caisse Régionale de Crédit Agricole Mutuel Brie Picardie-Crédit Agricole Brie Picardie
58	Boursorama
59	BNP Paribas
60	BinckBank NV
61	Bankinter SA
62	BANIF SGPS SA
63	Banco Santander SA
64	Banco Popular Espanol SA
65	Banco Popolare
66	Banco Pastor SA
67	Banco Espirito Santo SA
68	Banco Espanol de Crédito SA, BANESTO
69	Banco di Sardegna SpA
70	Banco Desio - Banco di Desio e della Brianza SpA
71	Banco de Valencia SA
72	Banco de Sabadell SA
73	Banco Comercial Português, SA-Millennium bcp
74	Banco BPI SA
75	Banco Bilbao Vizcaya Argentaria SA
76	Banca Profilo SpA
77	Banca Popolare di Spoleto SpA
78	Banca Popolare di Sondrio Societa Cooperativa per Azioni
79	Banca Popolare di Milano SCaRL
80	Banca popolare dell'Etruria e del Lazio Soc. coop.
81	Banca popolare dell'Emilia Romagna
82	Banca Monte dei Paschi di Siena SpA-Gruppo Monte dei Paschi di Siena
83	Banca Intermobiliare di Investimenti e Gestioni
84	Banca Ifis SpA
85	Banca Generali SpA-Generbanca
86	Banca Finnat Euramerica SpA
87	Banca Carige SpA
88	Baader Bank AG
89	Azimut Holding SpA
90	Avanza Bank Holding AB
91	Alm. Brand A/S
92	Aareal Bank AG

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