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ESSAYS ON THE BANKING SECTOR: CAPITAL STRUCTURE, PRODUCTIVITY AND BANK RESTRUCTURING

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Summary

This dissertation thesis analyzes the determinants of the capital ratio of banks and also the dynamics of the leverage ratio, exploring the driving forces of the issuance of debt and capital instruments. My thesis contributes to shed light on how certain decisions of banks during the years prior the crisis generated latent risks in their liability side that were revealed with the outburst of the crisis, and on the implications of the restructuring for the banking system in terms of productivity, concentration and profitability. This dissertation can be divided in three well-differentiated chapters. The first two chapters focus on the years before the crisis, and the last chapter analyzes the changes in the banking sector after the crisis.

Chapter 1 explores how banks choose the composition of regulatory capital, and whether different structure of regulatory capital might entangle different risks of the bank. The target is to analyze whether banks fulfill their regulatory obligations using a combination of financial instruments that do not minimize the capacity to absorb losses, but that respond to other incentives such as the minimization of financing costs. Using data of Spanish banks during the period 1998-2007, we provide evidence that the increasing weight of hybrid capital can be read as a leveraging process within the regulatory capital, since there is an increment of the debt-like instruments with respect to the common capital that responds to the same determinants than the standard leverage ratio.

The second Chapter of this thesis analyzes the same problem from a dynamic perspective, focusing on the issuances of financial instruments and empirically testing a

set of hypotheses on the decisions to issue different types of financial instruments. This Chapter analyzes the financing choices of banks under capital regulation during the expansion period that preceded the crisis using data from Dealogic on the issuances of financial instruments of Spanish banks to test whether financing choices respond to predictions derived from the corporate finance theory and/or to capital regulation. We find that banks financed their exponential growth with debt instruments and covered the additional regulatory capital requirements from higher risk-weighted assets with the issuance of hybrid instruments. We also find that banks choose the financial instruments that minimize asymmetric information costs.

Finally, Chapter 3 of this thesis is focused on the consequences of the crisis on banks from the point of view of productivity and the effect on bank restructuring. This Chapter analyzes the effects of banking productivity on the evolution of interest rates and on the exit of banks from the Spanish banking sector during the years 2007-2015. Using a theoretical framework of competition with heterogeneity in operating costs, we propose a set of hypotheses which are tested using empirical models. The results show that the productivity of the banking industry had a moderate growth of 2% during the period analyzed, that improvements in the efficiency of the banks are transferred to a decrease in loans' interest rates and bank fees, and that a context of low interest rates does not necessarily imply a reduction in the intermediation margin because the banks can compensate the negative margins of the deposits with an increase in the differential of their loans with respect to the interbank interest rate. The study also shows that the most productive banks could have taken advantage of the restructuring process to expand their branch network in markets where they have a low presence through the absorption of less productive banks.

Resumen

Esta tesis analiza los determinantes del ratio de capital de los bancos así como la dinámica del ratio de endeudamiento, explorando los elementos que determinan la emisión de deuda y los instrumentos de capital. Mi tesis contribuye a arrojar luz sobre cómo ciertas decisiones de los bancos durante los años previos a la crisis generaron riesgos latentes en su pasivo que se revelaron con el estallido de la crisis, y sobre las implicaciones de la reestructuración para el sistema bancario en términos de productividad, concentración y rentabilidad. Esta tesis se puede dividir en tres capítulos bien diferenciados. Los dos primeros, se centran en los años previos a la crisis mientras que el último capítulo analiza los cambios en el sector bancario posteriores a la crisis.

El Capítulo 1 se centra en los determinantes de las estructuras de capital de los bancos considerando la existencia de la regulación de capital. El objetivo es analizar si los bancos cumplen con los requerimientos regulatorios mediante una combinación de instrumentos financieros que no minimizan la capacidad de absorber pérdidas, sino que responden a otros incentivos, como la minimización de los costes de financiación. Utilizando datos del sistema bancario español durante el período 1998-2007, aportamos evidencia de que el peso creciente del capital híbrido puede interpretarse como un proceso de apalancamiento dentro del capital regulatorio, ya que existe un incremento de los instrumentos de características típicas a los instrumentos de deuda en relación al capital que responde a los mismos determinantes que el ratio de apalancamiento estándar.

El segundo Capítulo de esta tesis analiza el mismo problema desde una perspectiva dinámica, centrándose en las emisiones de instrumentos financieros y contrastando empíricamente un conjunto de hipótesis sobre las decisiones de emitir diferentes tipos de

instrumentos financieros. Este Capítulo analiza las elecciones de financiación de los bancos sujetos a la regulación de capital durante el período de expansión que precedió a la crisis utilizando datos de Dealogic sobre las emisiones de instrumentos financieros de bancos españoles para evaluar si las opciones de financiación responden a las predicciones derivadas de las teorías clásicas de finanzas corporativas y/o a la existencia de regulación bancaria. Encontramos que los bancos financiaron su crecimiento exponencial con instrumentos de deuda cubriendo los requerimientos adicionales de capital regulatorio con la emisión de instrumentos híbridos. También concluimos que los bancos eligen los instrumentos financieros que minimizan los costes derivados de la existencia de información asimétrica.

Por último, el Capítulo 3 se centra en las consecuencias de la crisis desde el punto de vista de la productividad y el efecto sobre la reestructuración bancaria. Este Capítulo analiza los efectos de la productividad bancaria en la evolución de los tipos de interés y en la salida de los bancos del sector bancario español durante los años 2007-2015. Usando un marco teórico de competencia con heterogeneidad en los costes operativos, proponemos un conjunto de hipótesis que se contrastan mediante modelos empíricos. Los resultados muestran que la productividad de la industria bancaria tuvo un crecimiento moderado del 2% durante el período analizado, que las mejoras en la eficiencia de los bancos repercutieron en una disminución en las tasas de interés y comisiones bancarias, y que un contexto de bajas tasas de interés no implica necesariamente una reducción en el margen de intermediación ya que los bancos pueden compensar los márgenes negativos de los depósitos con un aumento en el diferencial de sus préstamos con respecto a la tasa de interés interbancaria. Nuestro análisis también muestra que los bancos más productivos podrían haber aprovechado el proceso de reestructuración para expandir su red de sucursales en mercados en los que tienen una baja presencia mediante la absorción de bancos menos productivos.

Resum

Aquesta tesi analitza els determinants de la ràtio de capital dels bancs així com la dinàmica de la ràtio d'endeutament, explorant els elements que determinen l'emissió de deute i els instruments de capital. La meva tesi contribueix a comprendre com certes decisions dels bancs durant els anys previs a la crisi van generar riscos latents en el seu passiu que es van revelar amb l'esclat de la crisi, i sobre les implicacions de la reestructuració per al sistema bancari en termes de productivitat, concentració i rendibilitat. Aquesta tesi es pot dividir en tres capítols ben diferenciats. Els dos primers, se centren en els anys previs a la crisi mentre que l'últim capítol analitza els canvis en el sector bancari posteriors a la crisi.

El Capítol 1 se centra en els determinants de les estructures de capital dels bancs considerant l'existència de la regulació de capital. L'objectiu és analitzar si els bancs compleixen amb els requeriments regulatoris mitjançant una combinació d'instruments financers que no minimitzen la capacitat d'absorbir pèrdues, sinó que responen a altres incentius, com la minimització dels costos de finançament. Utilitzant dades del sistema bancari espanyol durant el període 1998-2007, aportem evidència que el pes creixent del capital híbrid pot interpretar-se com un procés de palanquejament dins el capital regulatori, ja que hi ha un increment dels instruments de característiques típiques als instruments de deute en relació al capital que respon als mateixos determinants que la ràtio de palanquejament estàndard.

El segon capítol d'aquesta tesi analitza el mateix problema des d'una perspectiva dinàmica, centrant-se en les emissions d'instruments financers i contrastant empíricament un conjunt d'hipòtesis sobre les decisions d'emetre diferents tipus d'instruments financers.

Aquest capítol analitza les eleccions de finançament dels bancs subjectes a la regulació de capital durant el període d'expansió que va precedir a la crisi utilitzant dades de Dealogic sobre les emissions d'instruments financers de bancs espanyols per avaluar si les opcions de finançament responen a les prediccions derivades de les teories clàssiques de finances corporatives i / o l'existència de regulació bancària. Trobem que els bancs van finançar el seu creixement exponencial amb instruments de deute cobrint els requeriments addicionals de capital regulatori amb l'emissió d'instruments híbrids. També vam concloure que els bancs trien els instruments financers que minimitzen els costos derivats de l'existència d'informació asimètrica.

Finalment, el Capítol 3 es centra en les conseqüències de la crisi des del punt de vista de la productivitat i l'efecte sobre la reestructuració bancària. Aquest capítol analitza els efectes de la productivitat bancària en l'evolució dels tipus d'interès i en la sortida dels bancs del sector bancari espanyol durant els anys 2007-2015. Usant un marc teòric de competència amb heterogeneïtat en els costos operatius, proposem un conjunt d'hipòtesis que es contrasten mitjançant models empírics. Els resultats mostren que la productivitat de la indústria bancària va tenir un creixement moderat del 2% durant el període analitzat, que les millores en l'eficiència dels bancs van repercutir en una disminució en les taxes d'interès i comissions bancàries, i que un context de baixes taxes d'interès no implica necessàriament una reducció en el marge d'intermediació ja que els bancs poden compensar els marges negatius dels dipòsits amb un augment en el diferencial dels seus préstecs pel que fa a la taxa d'interès interbancària. La nostra anàlisi també mostra que els bancs més productius podrien haver aprofitat el procés de reestructuració per expandir la seva xarxa de sucursals a mercats en els que tenen una baixa presència mitjançant l'absorció de bancs menys productius.

Introduction

There is a growing literature that analyzes the causes and consequences of the 2008 crisis and it seems to be a consensus in pointing to financial innovation as responsible of the excessive credit growth and the reduction in credit standards applied by banks at the time of granting loans. Within this line of research, there are papers that point the increasing deterioration of bank capital as one of the main culprits of banks' risky decisions prior and during the current financial crisis. It is generally accepted that capital should deter banks to take bad risk practices and enhance good bank governance to minimize the exposition of shareholders to the risk of failure (Rochet, 1992; Morrison and White, 2005). Indeed, there is evidence that more capitalized banks have been able to cope better with severe losses derived from the current crisis (Demirguc-Kunt et al. 2013; Beltratti and Stulz, 2012; Berger and Bouwman, 2013). However, recent papers provide descriptive evidence of a deterioration of bank capital prior and during the crisis that could have dwindled the capacity of capital to act as a corporate governance mechanism, since the participation of owners in potential losses has become smaller (Acharya *et al.*, 2009, Mehran *et al*., 2012). According to Acharya *et al.* (2011) this dwindling weight of common capital could also explain the difficulties of banks to raise new funds, since creditors will only lend if common shareholders are bearing a significant part of the risk. The previous papers provide descriptive evidence of how the deterioration in quantity and quality of bank capital can be at the core of the excessive risk taken by banks and of the subsequent credit crunch that impedes them to lend. However, little is known about the reasons why banks decide to increase the proportion of hybrid capital within their regulatory capital.

This dissertation thesis analyzes the determinants of the capital ratio of banks and also the dynamics of the leverage ratio, exploring the driving forces of the issuance of debt and capital instruments. My thesis contributes to shed light on how certain decisions of banks during the years prior the crisis generated latent risks in their liability side that were revealed with the outburst of the crisis, and on the implications of the restructuring for the banking system in terms of productivity, concentration and profitability. This dissertation can be divided in three well-differentiated chapters. The first two chapters focus on the years before the crisis, and the last chapter analyzes the changes in the banking sector after the crisis.

Chapter 1 explores how banks financed their growth during the period prior the current financial crisis and the consequences on the quantity and quality of the bank capital. We adopt an approach that adapts the traditional leverage equation used in the corporate finance theory to explain leverage of non-financial firms including risks' determinants relevant to the banking industry.

It has been argued that bank leverage is determined by regulation because of their obligation to fulfil the capital regulation set at supra-national level (Mishkin, 2000). However, the empirical data shows that, far from being homogeneous, there is dispersion in the leverage ratio across banks. Using a sample of Spanish banks during the period 1998-2007 that uses data from Bankscope, we find that the variability of leverage ratios across banks can be explained by the theories of corporate finance accepted for non-financial firms. We also find that the same incentives govern the choice of banks when deciding the composition of debt-like capital and equity capital to fulfil their obligations set by capital regulation. That is, we provide evidence that the increasing weight of hybrid capital can be read as a leveraging process within the regulatory capital, since there is an increment of the debt-like instruments with respect to the common capital that responds to the same determinants than the standard leverage ratio. Therefore, the observed constant levels of risk-adjusted capital ratios were hiding a deterioration of the quality of capital, because banks increased the weight of debt-like capital that were eligible to fulfil their capital requirements in both Tier 1 and Tier 2. This *leverage in capital* presents an increasing trend during the period, even after controlling for these determinants of leverage. Furthermore, we find that banks, specially savings banks, that experienced higher growth rates during the pre-crisis period targeted a higher proportion of debt-like

instruments in their regulatory capital. This might explain why the capital of these banks could not absorb losses during the crisis.

The second Chapter of this thesis analyzes the same problem from a dynamic perspective, focusing on the issuances of financial instruments and empirically testing a set of hypotheses on the decisions to issue different types of financial instruments. To do so, we use data from Dealogic of 4,812 financial instruments issued by Spanish banks during the period 1988-2007. In this Chapter, we try to understand how capital regulation affects behavior of banks based on insights from the traditional theories of corporate finance (Bradley *et al*. 1984; Myers and Majluf 1984; Titman and Wessels 1988; Frank and Goyal 2008, 2009). In particular, we use the logic of the pecking order theory to examine whether the banks' choices of financial instruments are related to adverse selection costs. Likewise, we test whether the choice of financial instruments targets an optimal capital structure. For the sake of completion, our analysis addresses how the fulfillment of capital regulation affects the choice of financial instruments. To perform such tests, we will look at the expected choices of financial instruments if banks have liquidity needs or have growth opportunities as predicted by the different theories. Specifically, we test whether banks have a preference toward debt and debt-like instruments, as the pecking order predicts, or if banks want to maintain a target capital ratio and prefer to combine issuances of different instruments to reach or maintain an optimal capital structure, as predicted by the trade-off theory.

In this Chapter we find that the financial development and the access of banks to financial markets has increased the vulnerability of the banking sector, not only to shocks in the financial markets (Almazán *et al*. 2015) but to deterioration in the capital meant to absorb losses. More concretely, we find that banks with higher expansion in their balance sheets finance their liquidity needs with issuances of debt instruments. At the same time, we find that the issuances of debt are correlated with the issuances of hybrid instruments because hybrids were the instrument used by banks to comply with the higher regulatory capital requirements derived from the expansion of the (risk-weighted) assets. While finding little support for the trade-off theory, evidence points out that information asymmetries can explain the choice of debt/hybrid instruments by banks. That is, banks decide to issue the market instrument that more resembles debt in order to minimize the adverse selection discount. This decision can explain why banks finance growth with debt

and raise hybrid capital instead of common equity if they are close to the regulatory minimum or have low levels of provisions or earnings that compute as eligible capital.

Chapter 3 of this thesis is focused on the consequences of the crisis on banks from the point of view of productivity and the effect on bank restructuring. More concretely, this Chapter analyzes the effects of bank productivity on the evolution of interest rates offered by Spanish banks and the exit of banks from the Spanish banking sector during the period 2007-2015. We develop a theoretical framework based on Martin-Oliver, Ruano and Salas-Fumás (2018) based on spatial competition with heterogeneous operating costs in order to obtain some testable theoretical predictions about how productivity can be translated to bank prices. Moreover, we explore whether more productive banks have followed a strategy of expansion of their branch network through the acquisition of less productive banks with branches in regions where the acquirer had relatively low presence. This hypothesis would be compatible with previous studies that have analyzed whether different levels of efficiency affect the exit of manufacturing plants in declining industries (Ghemawat and Nalebuff, 1985, Fudenberg and Tirole, 1986, Reynolds, 1988, Whinston, 1988).

The results show that the productivity of the banking industry had a moderate growth of 2% during the period analyzed, that improvements in the efficiency of the banks are transferred to a decrease in loans' interest rates and bank fees, and that a context of low interest rates does not necessarily imply a reduction in the intermediation margin because the banks can compensate the negative margins of the deposits with an increase in the differential of their loans with respect to the interbank interest rate. The Chapter also shows that the most productive banks could have taken advantage of the restructuring process to expand their branch network in markets where they have a low presence through the absorption of less productive banks.

One of the main contributions of this thesis is that it provides policy arguments to justify a tougher definition of regulatory capital in Basel III since, as our results confirm, banks have incentives to comply with capital regulation through the financing alternative of lowest cost that is recognized as eligible capital. This incentive indicates that the problem of credit expansions or recessions in capital are not only due to procyclicality (Repullo and Suárez 2012; Repullo et al. 2010; Ayuso et al. 2004), but also because of

the composition of the capital. This finding also originates a line of research. First, our analysis stands out that banks with higher growth rates deserves special attention by regulators since the increase of debt-like instruments was more pronounced for this group. Thus, future research should focus in the relationship between size and the quality of capital in order to refine mechanisms that prevent larger banks reducing their capacity to absorb losses.

In addition to this, compliance with the new Basel Standards could be a challenge for small-medium banks less known by the markets since they face the risk of higher discounts when issuing common shares. But an opportunity exists to control the potential excessive growth in these types of banks with access to almost unlimited financing in the form of debt, but with serious difficulties (from the supply and/or demand side) in raising high-quality capital. Future research in this sense would be related to macro-prudential policies channeled to reduce the procyclicality of capital requirements in the sense that banks with more difficulties to rise capital are able to accumulate it during expansions and periods of growth (for example, through retained profits).

As per regard the consolidation process that have taken place in recent years, another line of research would analyze if the increase in the concentration of the banking sector can cause an increase in the market power of the surviving banks that eliminates the improvements in price for customers due to higher productivity and benefit. More investigation is needed to discern which effect dominates: the concentration of the sector that increases market power and reduces welfare or the increase of productivity due to the exit of productive banks that reduces interest rates and increase social welfare.

Chapter 1. Bank´s capital structure and quality of capital under capital regulation

1.1 Introduction

This Chapter explores how banks choose the composition of regulatory capital, and whether different structure of regulatory capital might entangle different risks of the bank. Banks are financial firms with an intermediation function based on raising funds (from wholesale markets and depositors) to finance loans and other investments. In order to guarantee the solvency and soundness of the banking system, regulators require banks to hold a minimum level of regulatory capital to absorb unexpected losses from the risky assets held by banks. Nonetheless, there have been different instruments with different characteristics that were eligible as regulatory capital. The target of this chapter is to analyze whether banks fulfill their regulatory obligations using a combination of financial instruments that do not minimize the capacity to absorb losses, but that respond to other incentives such as the minimization of financing costs.

There is a growing literature that analyzes the causes and consequences of the 2008 crisis and it seems to be a consensus in pointing to financial innovation as responsible of the excessive credit growth and the reduction in credit standards observed during the pre-

crisis period[1,2]. In this sense, the main bulk of papers has focused on the increase of latent risks in the asset side of the balance sheet that were manifested in the downturn period. However, this manifestation of risks could only become a solvency problem for banks if bank capital was not enough to absorb losses.

This Chapter focuses on the accumulation of risks in the liability side of banks' balance sheet and, more concretely, on the deterioration of regulatory capital. Until Basel III came into force[3], bank could fulfill their capital requirements using not only common equity, but also hybrid instruments with lower loss-absorbing capacity, such as preferred shares and subordinated debt. Preferred shares computed (up to a maximum) as capital of maximum category (Tier 1), whereas subordinated debt was eligible for Tier 2 capital. Therefore, banks could decide the composition of hybrid instruments and equity capital in both Tier 1 and Tier 2. This means that, even when fulfilling the capital regulation in terms of quantity of capital (Tier 1+ Tier 2 not lower than 8% of risk-weighted assets) and quality of capital (Tier 1 not lower than 4%), banks have a high level of discretion to choose the composition of hybrid capital versus equity capital. In this Chapter, we refer to the proportion of debt-like instruments (hybrid capital) with respect to regulatory capital as *leverage in capital* and our target is to analyze whether banks have incentives to increase the leverage in capital at the expense of decreasing the loss-absorbing capacity of regulatory capital.

The basic framework to analyze the choice of the composition of regulatory capital of banks is grounded in the main theories of corporate finance. We test whether leverage in capital is driven by the same forces that explain the capital structure of non-financial firms. The justification is that the main theories of capital structure can also be applied to analyze the composition of regulatory capital, assuming that debt-like instruments acts as "debt" and equity capital acts as "capital". For instance, the application of the trade-off theory would suggest that it is not optimal to hold a 100% equity capital structure (no leverage in capital) because, given that interest from debt capital is tax-deductible, banks would have incentives to increase, at least marginally, the level of debt-like capital. On

[1] Greenlaw, Hatzius, Kashyap and Shin (2008) estimate the mortgage credit losses and highlight the role of leverage and mark-to-market in propagating the shock. Brunnermeier (2009) explains the economic mechanisms that caused losses in the mortgage market to amplify into the large dislocations and turmoil in the financial markets.

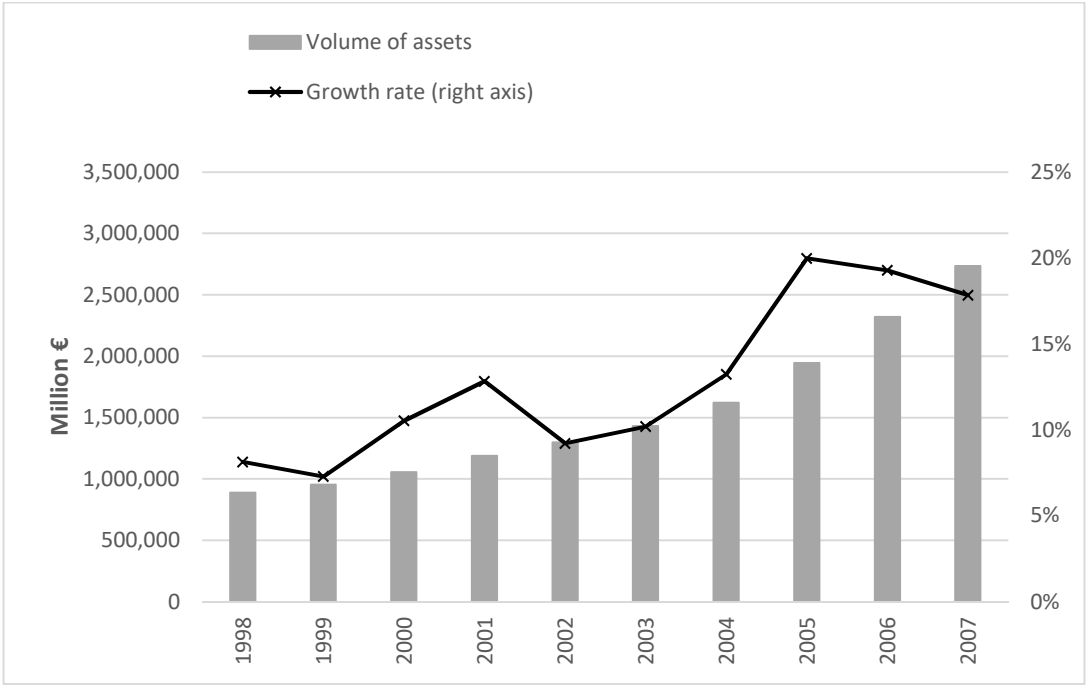
[2] The main focus of this literature is on analyzing how financial innovation has impacted on banks' performance and how it sustained the excessive growth in loans Almazán, Martín-Oliver and Saurina (2015), Loutskina (2011), Loutskina and Strahan (2009).

[3] Basel I regulation applied during the whole sample period.

the other hand, the pecking order theory would predict that banks prefer to issue debt-like instruments before equity capital because the former has lower informational costs. All in all, the application of both theories would predict a non-zero amount of debt-like capital in regulatory capital, that is, banks have incentives to deviate from the composition of capital that maximizes its loss-absorbing capacity (i.e., 100% equity capital).

The strategy followed in this paper is as follows. First, we test whether the predictions from the corporate finance theories of capital structure also apply to the banking firm. This is a natural step before testing the main hypotheses of leverage in capital. In a second step, we test whether the predictions from corporate finance also apply to the leverage in capital. We use a database of Spanish banks during the period 1998-2007 of relevant financial variables drawn from Bankscope. The reason why we focus on Spanish banks is because the deterioration of capital has been pointed as one of the factors that explains the large losses and the deep restructuring that the sector experienced after the outburst of the crisis (Martín-Oliver *et al*., 2018). Moreover, the growth rates of balance sheets were of two digits during the years prior to the crisis (Figure 1) that were financed mainly with securitization of assets (Almazán *et al*., 2015), which might have implied large changes in the structure of liabilities.

Figure 1 Volume of assets (m€) and asset growth rate of Spanish banks, 1998-2007



Our paper is related with the literature that analyzes the capital structure of non-financial firms and of banks. The limited number of studies on bank capital structure contrasts with the extensive literature[4] that analyzes the determinants of leverage for non-financial firms.[5] Summing up the findings of this literature, it is generally accepted that there is a limited list of factors that are correlated with cross-sectional differences in leverage (Frank and Goyal, 2008): leverage is positively related with size and tangibility of assets and it is negatively related with profits, growth and dividends. More recently, Lemmon, Roberts and Zender (2008) found that leverage ratios are mainly explained by time invariant, unobservable factors that are idiosyncratic for each firm. For the bank firm, it has been argued that the corporate finance theory cannot be applied to banks because they have the obligation to fulfill capital regulation and, thus, leverage ratios are exogenously determined. In this sense, there is a large literature that studies how to determine the levels of regulatory capital and the micro and macro effects derived from capital regulation (Repullo and Suárez, 2013; Repullo, Saurina and Trucharte, 2010; Ayuso, Pérez and Saurina, 2004). The strict interpretation of this statement would determine a given leverage ratio that would only respond to external regulation rather than to corporate finance incentives (Mishkin, 2000). However, this theory is not supported by data, given the dispersion observed in leverage ratios. Gropp and Heider (2010) found for a sample of large US and European banks that cross sectional determinants of non-financial firms' leverage also applied to banks' leverage, being the role of capital regulation and the role of deposit insurance of second-order importance.

This Chapter contributes to the previous literature in a variety of fields. First, our paper is the first to analyze how banks determine their composition of regulatory capital of banks. Mehran *et al*. (2012) and Acharya *et al*. (2011) provide descriptive evidence of the phenomenon, but there is no empirical analysis of the reasons that explain this deterioration, probably because it was thought that capital regulation determined the composition of regulatory capital. Second, we provide evidence that the leverage in capital of banks responds to the same predictions than leverage ratios of non-financial firms. This finding reveals that banks have incentives to deviate from the composition of 100% equity capital that maximizes the capacity to absorb losses, towards a composition that includes debt-like capital to benefit from lower costs of financing and reduce the

[4] See Harris and Raviv (1991) and Frank and Goyal (2008) for a survey.
[5] For instance, papers by Bradley *et al*. (1984), Long and Malitz (1985), Titman and Wessels (1988), Crutchley and Hansen (1989), Smith and Watts (1992) and Frank and Goyal (2009).

level of taxable income. In this sense, we find that *cajas* with high-growth rates in the pre-crisis period significantly increased the level of leverage in capital, which might partly explain the inability of their capital to absorb losses during the crisis. Third, corporate finance predictions also apply to the choice of the leverage ratio of banks. Despite all banks in the sample present regulatory capital ratios above the regulatory minimum, there is a large dispersion in the leverage ratios of banks that responds to the same variables as capital ratios in non-financial firms. Indeed, banks have increased their leverage ratios while maintaining strong regulatory capital ratios. Fourth, this chapter provides at least two policy implications related with Basel III. On the one hand, it justifies the increase in the requirements of equity capital within the regulatory capital to increase its loss-absorbing capacity. On the other hand, it justifies the inclusion of a simple, non-risk based measure of leverage in the Basel III framework to avoid that banks build up excessive leverage while apparently keeping high levels of regulatory capital ratios.

The rest of the Chapter is structured as follows. Section 2 analyzes the theoretical setup of the leverage equation applied to banks. Section 3 presents the database and some descriptive statistics of the variables. Section 4 presents the results of the estimations and, finally, Section 5 contains the conclusions of the Chapter.

1.2 Determinants of leverage

1.2.1 Some evidence on leverage in banks

We first provide some preliminary descriptive evidence that neither leverage nor leverage in capital are homogeneous across banks because of the existence of capital regulation (Mishkin, 2000). Figure 2A presents the distribution of the leverage ratio for Spanish banks for years 2000, 2003 and 2006 and Figure 2B presents the dispersion of the Basel ratio for Spanish banks during the same period. We confirm that there is a wide dispersion in the levels of both ratios and that, despite the fact that all banks present a Basel ratio no lower than 8% to fulfill with regulation, there are banks with high levels of leverage as we find banks with a ratio of equity capital with respect to assets at book value lower than 3%. Nonetheless, if we observe the evolution of the distributions of the capital ratios over

time, we can see that both the distribution of the book capital ratio and the Basel capital ratio have remained fairly stable over time, though the former is concentrated in values smaller than 10%. This constant distribution of ratios over the years suggests the existence of a constant heterogeneity across banks in optimal capital structures, that is, capital ratios are different across banks, but these differences are maintained over time.

Figure 2 Yearly distribution of capital ratios

Figure 2A: Equity / Assets

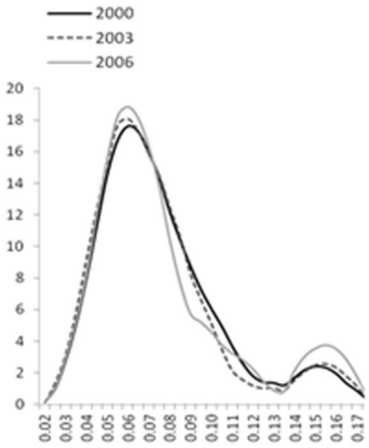


Figure 2B: Basel Coefficient

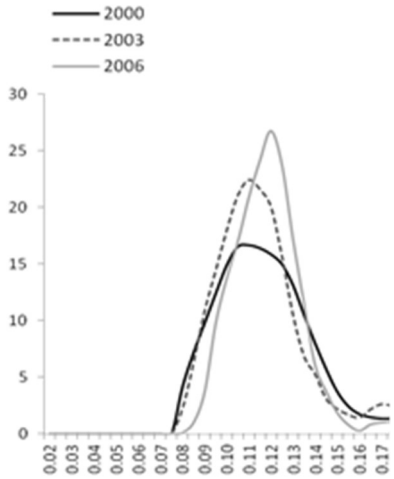
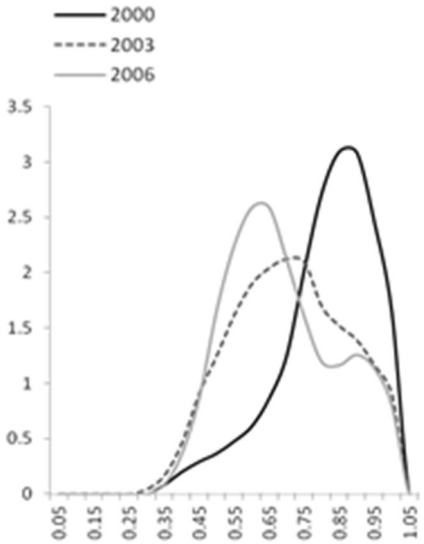


Figure 2C: Equity / (Equity+Pref.Shares+Subord.Debt)



As for leverage in capital, Figure 2C provides evidence of the increase in the weight of hybrid instruments, that is, a deterioration of Spanish banks' capital over time. The composition of capital has been evolving towards a structure in which debt-like instruments have become more important, which confirms that the deterioration of capital documented in Acharya *et al*. (2011) has also been a characteristic of Spanish banks prior the crisis.

1.2.2 Determinants of leverage in non-financial firms and banks

In this Chapter, we borrow the predictions from the corporate finance theory to explain the leverage in capital, and also extend some hypotheses for the banking firm. As a first step, we test whether the decisions of leverage in the bank firm are driven by the same forces that determine leverage in non-financial firms. Second, we analyse whether the determinants of capital structure can also explain the choice of the composition and quality of regulatory capital. The logic is that banks, besides capital regulation, might respond to the same incentives as non-financial firms. For instance, banks also benefit from holding debt or debt-like capital because these instruments generate interest payments that can be deducted from the tax bill. Also, banks' issuances might also be affected by asymmetric information and, if so, the pecking order theory predict that banks would issue, first debt, next hybrid securities and, ultimately, equity capital, to minimize the discount value applied by financial markets. All in all, banks might have the same incentives as non-financial firms at the time of deciding their capital structure of debt-equity and also at the time of determining the leverage in capital, even with the existence of capital regulation. Given that banks can fulfil their capital obligations with a combination of equity capital and debt-like capital in both Tier I and Tier II definitions, the particular choice made by each bank might respond to the same determinants than leverage.

There is an extensive literature that has aimed at determining which factors are correlated with leverage, including papers by Titman and Wessels (1988), Crutchley and Hansen (1989), Smith and Watts (1992) and Frank and Goyal (2009) and they have converged to a limited list of variables that are related to leverage. The main bulk of this literature estimates the leverage equation, which is based on explaining the leverage ratio

in terms of the observable finance variables in order to test an effect or prediction. They aim at finding the cross-sectional determinants that explain the dispersion in leverage ratios across non-financial firms. The consensus establishes that leverage is positively related with size and tangibility of assets and it is negatively related with profits, growth opportunity and dividends. The reasons for these relationships are explained by different corporate finance theories of leverage (see Harris and Raviv, 1991 and Frank and Goyal, 2008 for a survey).

1.2.3 Empirical model and variables

In our analysis, we adapt the list of determinants to the banking industry and also explore alternative explanations specific for the banking firm. The variables considered in the analysis are[6]:

Dividends. Dummy variable[7] that identifies a bank that has issued dividends. The expected sign is negative because firms that pay dividend are possibly not financially constrained and these firms face a lower cost of raising equity at short notice. In the banking firm, we could expect a positive sign if banks were holding capital buffers, so as to avoid costs of issuing equity at short notice (Gropp and Heider, 2010)

Growth Opportunities. It is defined as the ratio of market-to-book value of the capital of the bank[8] and it captures the effect of growth and expansion opportunities of the bank. The expected sign is negative because the existence of investment

[6] See the Appendix of Chapter 1 for an exact definition of the variables.
[7] We follow Frank and Goyal (2009) and use a dummy variable of dividend status to identify non-constrained firms. If we use the proportion of the dividend with respect to net profits, main results remained unchanged.
[8] As we have *cajas* and some small commercial banks that are not listed in the stock market, we construct the market value actualizing the forecast of future profits at a discount rate that depends on the risk of the bank (see definition of variables in the Appendix of Chapter 1). Our measure has a high correlation with the market value since, for the observations for which we have data (237 observations), the coefficient of correlation and Spearman's rho are 91.88% and 94.40%, both significant at 1%. We also obtain high correlation in the quartile regression at 50th percentile of the actual market value on our predicted value for the banks listed in the stock market, since the slope coefficient is 0.85 and intercept is 105.8, both significant at 1%. All the regressions in the Chapter have been estimated using the ratio of market-to-book value, *GrowthOpp*, replacing the market value by the predicted value for listed banks and the results do not change noticeably.

opportunities increases the financial costs of distress and, consequently, the firm reduces leverage.

Collateral. It is a measure of the tangibility of the assets available for the bank equal to the proportion of liquid assets that are easier to convert to cash and suffer a smaller loss of their value in case of distress. The trade-off theory then predicts that firms with more collateral will suffer smaller distress costs and will have more leverage. Nonetheless, in the banking firm we could obtain the opposite prediction, if the definition of collateral is closely related to liquidity. There are papers that have documented a relationship of complementarity/substitution between liquidity ratios and regulatory ratios that could affect this prediction[9].

Size: Leverage is expected to be positively related to size because they are more diversified and face lower risk of default. In the banking firm, this positive effect could be reinforced by the *too big to fail* paradox, that is, large banks are willing to take on more risks because they anticipate that the governments will not let them fail and, in this case, they could increase leverage because they could care less about financial risk. To account for this issue, we include the log of assets at the end of the period to capture this effect.

ROA: It is the proxy of banks' profits. Banks with higher profits would be less leveraged since they have more internal funds. However, if higher returns are linked to higher risk in the assets, we could obtain a positive relationship between ROA and leverage for the banking firm, because capital regulation sets higher capital requirements for riskier banks. This introduces the need of controlling for risk of the assets in the regression.

Risk: Despite risk not being included in the list of reliable factors related to leverage, we include it in the regression to control for the indirect relationship between returns and capital ratio through the bank capital regulation. Our measures of risk will be the non-performing loan ratio (NPL) as a measure of the risk within the loan portfolio of the bank and the standard deviation of the ROA to capture the risk in the returns of the bank.

[9] Macedo and Vicente (2017).

Taking into account all the previous factors, our basic regression will be:

$$L_{it} = \beta_0 + \beta_1 Div_{it-1} + \beta_2 GrowthOpp_{it-1} + \beta_3 Coll_{it-1} + \beta_4 ROA_{it-1} + \beta_5 ln\ Assets_{it-1} +$$

$$+ \beta_6 NPL_{it-1} + \beta_7 Sd(ROA_{it-1}) + \beta_8 \text{Id(Savings Bank)} + \text{Time Dummies} + u_{it} \quad (1)$$

where L is the measure of leverage and the expected signs of the coefficients are $\beta_1<0$, $\beta_2<0$, $\beta_3>0$, $\beta_4<0$, $\beta_5>0$, $\beta_6<0$ and $\beta_7<0$, according to the predicted effects and sub-index *i* and *t* respond to bank *i* and time *t*, respectively.

The dependent variable of leverage is defined as one minus the ratio of equity and reserves over total assets. To test the hypothesis of whether the deterioration of regulatory capital (*leverage in capital*) responds to a leveraging process that follows the same patterns as the choice of the whole bank capital structure, we use the weight of equity and reserves with respect to the total regulatory capital, $1 - \frac{Equity\ Capital}{Regulatory\ Capital}$, as the leverage variable.

All the regressions include time dummy variables as well as two dummy variables identifying whether the bank is a savings bank (as opposed to commercial bank) and whether the bank is listed in the stock market, to test whether these categories have any effect on leverage. All the variables are lagged one year, in line with the estimation of the standard leverage equation of previous papers, and standard errors are clustered at the bank-year level. Following previous papers, we estimate the leverage equation using OLS, but clustering the errors at two dimensions, bank and time.

1.3 Database and descriptive analysis

Our main source of data is Bankscope[10] that provides annual information on balance sheet, P&L account and regulatory capital. In the case of missing values, we have been completed the information from the annual reports of banks. We use consolidated data of commercial and savings banks (the so-called *cajas*)[11] operating in Spain during the period 1998-2007. Commercial banks differ from savings banks in their governance, ownership

[10] Global database published by Bureau van Dijk that provides information of spreadsheet data (balance sheet and income statement) of financial institutions around the globe.

[11] We exclude credit cooperatives because the data on NPL ratio and regulatory capital ratio was incomplete.

structure, and purpose. Commercial banks are for-profit organizations that belong to shareholders. Savings banks, on the other hand, are non-for-profit entities controlled by regional and local governments. The number of both types of financial institutions decrease the sample mainly because of the concentration of the sector through M&As; the number of commercial banks decreases from 40 in 1998 to 25 in 2007 and the number of *cajas* decreases from 52 in 1998 to 45 in 2007.

Our period of analysis covers the years of booming and expansion of the Spanish and global economy and expansion of banks' balance sheets. We exclude subsequent years of the financial crisis, when financial markets did not operate normally. Figure 1 shows that the total assets of Spanish banks increased during the whole period of study, especially in the second half where the slope of total assets became sharply steep with peaks of around 20% in 2005 and 2006. As stated in Almazán *et al*., 2015, the growth rate of Spanish balance sheets was mainly funded with the issuance of new instruments (securitization) in the financial markets.

Table 1 provides descriptive statistics of the main variables used in our empirical models. We observe that only 23.5% of the observations correspond to banks that paid dividends during the year, GrowthOpp is centered at 1.7 in a symmetric distribution (similar value of the average and the median); 36.7% of the assets are, on average, liquid assets and the profitability of assets is around 0.7%. Entities are heterogenous with respect to size: bank in percentile 75^{th} is more than 7 times bigger that the one in percentile 25^{th}. As mentioned before, the sample period is characterized by high assets' growth rate with an average of 13.8% and three quarters of the observations with a value over 7.2%. Our database is composed by 101 unique financial entities, 52 out of which are *cajas* that accumulates 57.8% of the observations in the sample. 13.7% of observations are from commercial banks listed in the stock markets, since *cajas* are not listed. Regarding variables related to risk measures, we observe that, on average, 1.5% of loans granted are non-performing.

Table 1 Descriptive statistics of explanatory variables. Spanish banks, 1998-2007

	Mean	Median	Std. Dev.	P25th	P75th
Dividends	0.235	0	0.424	0	0
GrowthOpp	1.709	1.749	0.801	1.174	2.221
Collateral	0.367	0.326	0.233	0.204	0.483
ROA (100x)	0.763	0.829	1.126	0.590	1.088
Total assets (million €)	11,420	4,750	17,743	1,514	11,133
Ln assets	8.251	8.466	1.844	7.322	9.318
NPL ratio (100x)	1.481	1.000	1.458	0.600	1.800
Sd(ROA)	0.002	0.001	0.001	0.001	0.002
Savings bank	0.578	1	0.494	0	1
Listed in the stock markets	0.137	0	0.344	0	0
Assets growth rate	0.138	0.131	0.113	0.072	0.194
Upper assets' growth rate	0.101	0	0.301	0	0

Definition of variables in the Appendix of Chapter 1.

1.4 Results

1.4.1 Determinants of leverage in banks

Table 2 presents the results of the estimation using the leverage ratio defined as $1 - \frac{Capital+Reserve}{Assets}$. The first column reports the basic specification drawn from the corporate finance theory that does not include neither risk variables nor dummies of savings banks or listed firms. The second column includes all the explanatory variables. We observe that the coefficient of the first set of variables included are not affected when we control for risk variables, so we focus on the second column to analyze the results. As predicted, ROA is negatively related to leverage and the size increases the leverage of banks, both effects significant at 1% and 5%, respectively. More concretely, an increase of 1 percentage point in ROA implies a decrease of leverage by 1.6 basis points. Also, an increase of 1% in the level of total assets is associated with an increase in leverage by 1 basis points. Thus, total assets of Spanish banks increased at an average growth rate of 12.9% during the whole period of study (1998-2007) causing an increase in banks' leverage of 12.9 basis points.

Table 2 Estimation of bank's leverage ratio

	(1)	(2)
Dividends	-0.001	-0.001
	(0.006)	*(0.005)*
GrowthOpp	0.000	-0.004
	(0.005)	*(0.005)*
Collateral	-0.001	-0.009
	(0.019)	*(0.018)*
ROA (100x)	-0.013**	-0.016***
	(0.006)	*(0.004)*
Ln assets	0.017***	0.010**
	(0.004)	*(0.003)*
NPL ratio (100x)		-0.003
		(0.003)
Sd(ROA)		-14.107***
		(2.923)
Savings bank		0.023**
		(0.010)
Listed in the stock markets		0.016
		(0.014)
Intercept	0.794***	0.877***
	(0.026)	*(0.028)*
No. of observations	804	804
Adjusted R^2	0.299	0.464
Time dummies	Yes	Yes

The results are from OLS. The dependent variable of leverage is defined as one minus the ratio of capital and reserves over total assets. The explanatory variables refer to the value in year t-1. Definition of variables can be found in the Appendix of Chapter 1. The robust standard errors corrected for clustering at the bank and year level are in parenthesis.

$p < 0.01$ = ***, $p < 0.05$ = **, $p < 0.1$ = *.

In addition to this, the risk captured by the standard deviation of profits negatively affects the leverage ratio, possibly because of the capital regulation. Given that Basel obliges banks with higher risk-weighted assets to hold higher proportion of capital, Sd(ROA) could be acting as a proxy of the risk of the assets of the bank.

Next, we observe that savings banks tend to be more leveraged than commercial banks (p-value of 5%). This coefficient could be an indicator of higher financial risk of savings banks. Nonetheless, lower leverage can also be observed in banks with low-risk assets given that Basel regulation requires lower capital requirements.

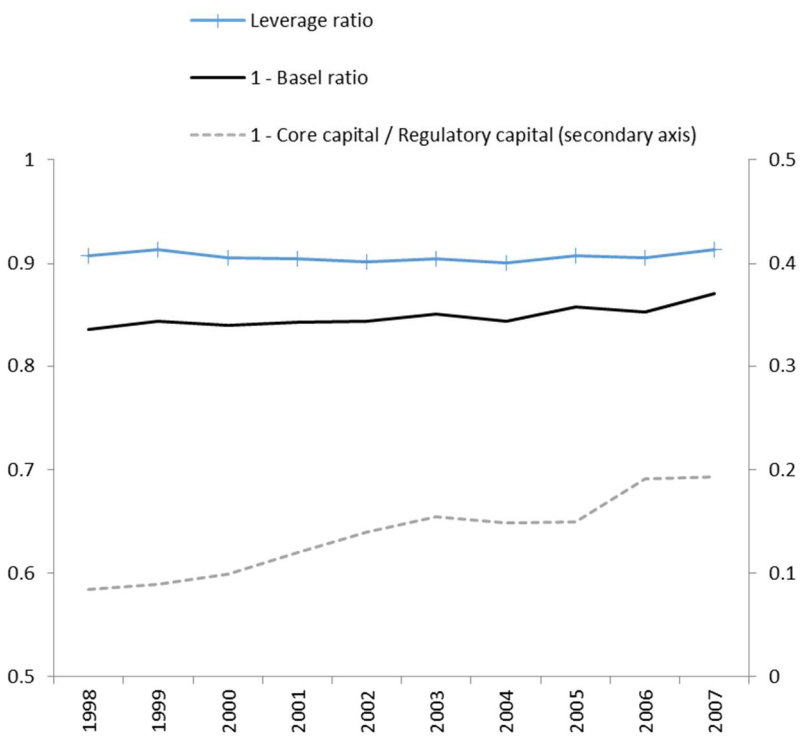
The rest of coefficients are not statistically significant. For the variables capturing the predictions of the corporate finance theory, neither the coefficient of dividends nor the coefficient of collateral are statistically significant for our sample.

Our results suggest that, far from being exclusively determined by capital regulation, the leverage ratios of banks are optimized following the patterns empirically observed in non-financial firms.

1.4.2 Determinants of *leverage in capital* of banks

Now we raise the question on how the quality of bank capital has been affected during a period in which banks have been continuously issuing hybrid instruments (subordinated debt, preferred shares, …) and new financing tools (securitization). Figure 3 shows evidence of deterioration in the quality of capital, since the ratio of one minus core capital to total regulatory capital has increased, from 8.4% in 1998 to 19.3% in 2007. Now we use this ratio as the dependent variable of the leverage equation to test whether the increasing proportion of hybrid capital is the result of a leveraging process within the regulatory capital that responds to the same determinants than the standard leverage ratio.

Figure 3 Leverage ratio, Basel ratio and Leverage in capital. Average across banks



The results are presented in Table 3. Column I presents the results without the risk and dummy variables that identify the type of banks, and Column II presents the model with all the variables. We find that the choice of the weight of debt-like instruments within the regulatory capital depends on the same determinants of the corporate finance as the standard leverage ratio, that is, it increases with the size of the bank, significant at 1%, and decreases with the profits and the risk of the bank, both of them significant at 5%. The positive relationship with size might also be explained in banking because of the too big to fail problem, that is, larger banks have incentives to take on more risks and, in this case, they hold regulatory capital of lower quality. The variable Collateral is negative and statistically significant at 5%. Though against the prediction of the corporate finance theory, this result might be specific of the banking industry because, by construction, the variable Collateral is closely related with liquidity ratio, and Macedo and Vicente (2017) provide evidence that capital ratios and liquidity ratios can be tools acting as complements at the time of determining the level of risk of the bank[12].

[12] Macedo and Vicente (2017) analyze the problem of a regulator that sets both capital and liquidity requirements to maximize social welfare in a framework in which a bank decides its level of solvency risk

Table 3 Estimation of bank's *leverage in capital* ratio

	(1)	(2)
Dividends	-0.016	-0.024
	(0.024)	*(0.029)*
GrowthOpp	0.005	-0.004
	(0.014)	*(0.013)*
Collateral	-0.079**	-0.087**
	(0.031)	*(0.029)*
ROA (100x)	-0.014	-0.017**
	(0.010)	*(0.007)*
Ln assets	0.036***	0.026***
	(0.006)	*(0.007)*
NPL ratio (100x)		0.001
		(0.003)
Sd(ROA)		-22.112**
		(8.693)
Savings bank		0.041
		(0.027)
Listed in the stock markets		0.049
		(0.041)
Intercept	-0.162***	-0.056
	(0.042)	*(0.058)*
No. of observations	804	804
Adjusted R^2	0.242	0.293
Time dummies	Yes	Yes

The results are from OLS. The dependent variable of regulatory capital ratio is defined as the weight of equity and reserves with respect to the total regulatory capital. The explanatory variables refer to the value in year t-1. Definition of variables can be found in the Appendix of Chapter 1.
The robust standard errors corrected for clustering at the bank and year level are in parenthesis.
$p < 0.01$ = ***, $p < 0.05$ = **, $p < 0.1$ = *.

Finally, the coefficients of the time dummy variables (not shown) present an increasing trend, what implies that the leveraging in capital is increasing over time, even after controlling for the variables included in the regression. These two findings, positive

facing a risk-return trade-off. They show that liquidity and capital requirements complement each other when the cost of capital or the return on loans is high and offset each other otherwise.

and significant coefficient of size and increasing trend of time dummies, can explain the positive trend observed in the evolution of the leverage in capital in Figure 3.

Our results support the initial hypothesis that banks consider hybrid instruments within regulatory capital as having debt properties and they have increased the proportion of hybrid instruments in the same way that they choose the optimal proportion of debt in their capital structure. Therefore, the constant evolution of the Basel ratio hide the deterioration of regulatory capital, since banks were substituting part of their core capital by hybrid capital to fulfill the capital regulation.

1.4.2.1 *Leverage in capital* and growth of banks

To further explore the result of whether banks with higher growth of assets are those that experienced a higher deterioration in capital, we present in Table 4 the estimation of the *leverage in capital* including dummies that identify banks with growth rates higher than the percentile 90th of the distribution of growth.

The third column of Table 4 shows that the interaction of the dummy of high growth (90th percentile) is positive and statistically significant, whereas the coefficient of ROA without interaction remains negative and statistically significant. This implies that the prediction of the negative effect of profits on leverage stated by the corporate finance theory (higher profits means higher core capital and lower *leverage in capital*) does not apply for banks that are experiencing high growth. Instead, more profitable banks that are experiencing large growth rates offset the negative effect found in Table 4, given that the sum of coefficients is not statistically different from zero (-0.026+0.028).

Moreover, we find that the savings banks that are increasing the *leverage in capital* are those with a growth higher than 90th percentile, whereas the coefficient of savings banks without interaction indicates that the rest of *cajas* have no different behavior than banks. Therefore, we find that *cajas* with higher growth in assets were experiencing a decrease in the quality of their regulatory capital higher than banks, what could explain the higher losses that they suffered after the outburst of the crisis[13].

[13] We have also calculated the value of the Upper asset's growth rate dummy variable for percentiles 75th and 95th. We obtain similar results (available upon request) when interacting with dummy built using percentile 95th but not with percentile 75th.

Table 4 Estimation of bank's *leverage in capital* ratio including the impact of assets' growth

	(1)	(2)	(3)
Dividends	-0.024	-0.024	-0.018
	(0.029)	*(0.029)*	*(0.029)*
GrowthOpp	-0.004	-0.004	0.004
	(0.013)	*(0.013)*	*(0.015)*
Collateral	-0.087**	-0.085**	-0.095**
	(0.029)	*(0.029)*	*(0.031)*
ROA (100x)	-0.017**	-0.016**	-0.026**
	(0.007)	*(0.007)*	*(0.010)*
Ln assets	0.026***	0.026***	0.025***
	(0.007)	*(0.007)*	*(0.007)*
NPL ratio (100x)	0.001	0.002	0.002
	(0.003)	*(0.003)*	*(0.004)*
Sd(ROA)	-22.112**	-22.817**	-20.612**
	(8.693)	*(8.64)*	*(8.636)*
Savings bank	0.041	0.044	0.038
	(0.027)	*(0.027)*	*(0.026)*
Listed in the stock markets	0.049	0.051	0.038
	(0.041)	*(0.041)*	*(0.043)*
Upper assets' growth rate		0.023*	0.137
		(0.012)	*(0.132)*
Upper assets' growth rate x Dividends			-0.067
			(0.046)
Upper assets' growth rate x GrowthOpp			-0.026
			(0.017)
Upper assets' growth rate x Collateral			0.002
			(0.042)
Upper assets' growth rate x ROA (100x)			0.028**
			(0.010)
Upper assets' growth rate x Ln assets			-0.010
			(0.013)
Upper assets' growth rate x NPL ratio (100x)			-0.010
			(0.008)

Table 4 Estimation of bank's *leverage in capital* ratio including the impact of assets' growth (*continued*)

	(1)	(2)	(3)
Upper assets' growth rate x Sd(ROA)			-10.116
			(19.207)
Upper assets' growth rate x Savings bank			0.105*
			(0.061)
Upper assets' growth rate x Listed in the stock markets			0.134*
			(0.071)
Intercept	-0.056	-0.059	-0.051
	(0.058)	*(0.058)*	*(0.057)*
No. of observations	804	804	804
Pseudo-R^2	0.293	0.294	0.304
Time dummies	Yes	Yes	Yes

The results are from OLS. The dependent variable of regulatory capital ratio is defined as the weight of equity and reserves with respect to the total regulatory capital. Upper assets' growth rate is a dummy variable that takes the value of 1 if the asset's growth rate is higher than or equal to the value of 90^{th} percentile of the bank-year asset's growth rate distribution. The explanatory variables refer to the value in year t-1. Definition of variables can be found in the Appendix of Chapter 1.
The robust standard errors corrected for clustering at the bank level are in parenthesis.
$p < 0.01$ = ***, $p < 0.05$ = **, $p < 0.1$ = *.

For robustness purposes, we have run all the models of the paper excluding year 2007, given that it could be considered a year of crisis (outburst of subprime crisis in august) and there were significant modifications in the tax legislation that could have affected the results. The results are relatively stable and the main conclusions remain unchanged.

1.5 Conclusions

This Chapter explores how banks financed their growth during the period prior the current financial crisis and the consequences on the quantity and quality of the bank capital. We adopt an approach that adapts the traditional leverage equation used in the corporate finance theory to explain leverage of non-financial firms including risks' determinants relevant to the banking industry.

It has been argued that bank leverage is determined by regulation because of their obligation to fulfil the capital regulation set at supra-national level (Mishkin, 2000). However, the empirical data shows that, far from being homogeneous, there is dispersion in the leverage ratio across banks. Using a sample of Spanish banks during the period 1998-2007 that uses data from Bankscope, we find that the variability of leverage ratios across banks can be explained by the theories of corporate finance accepted for non-financial firms. We also find that the same incentives govern the choice of banks when deciding the composition of debt-like capital and equity capital to fulfil their obligations set by capital regulation. That is, we provide evidence that the increasing weight of hybrid capital can be read as a leveraging process within the regulatory capital, since there is an increment of the debt-like instruments with respect to the common capital that responds to the same determinants than the standard leverage ratio. Therefore, the observed constant levels of risk-adjusted capital ratios were hiding a deterioration of the quality of capital, because banks increased the weight of debt-like capital that were eligible to fulfil their capital requirements in both Tier 1 and Tier 2. This *leverage in capital* presents an increasing trend during the period, even after controlling for these determinants of leverage. Furthermore, we find that banks, specially savings banks, that experienced higher growth rates during the pre-crisis period targeted a higher proportion of debt-like instruments in their regulatory capital. This might explain why the capital of these banks could not absorb losses during the crisis.

The findings of this Chapter can be used as arguments in favour of the stricter definition of regulatory capital set in the new Basel III. Given that we show that banks have incentives to decrease the quality of their regulatory capital, the new higher requirements in terms of equity capital will limit the potential deterioration of capital.

Besides, our findings also justify the introduction of a simple, non-risk adjusted measure of leverage as an additional requirement for banks. Banks can increase their leverage ratios while holding a relatively stable risk-adjusted capital ratio. Given that banks might have incentives to increase their leverage, in the same terms as non-financial firms, the new limit of leverage set by Basel III complements the risk-adjusted capital ratio and limits the potential financial risk of banks.

In addition to this, our analysis stands out that banks with higher growth rates deserves special attention by regulators, since the increase of debt-like instruments was more pronounced for this group. Again, this might justify the inclusion of "buckets" of additional core capital in the systematically important financial institutions (SIFIs) to prevent the excessive accumulation of risks. Future research should focus in the relationship between size and the quality of capital in order to define mechanisms that prevent larger banks reducing their capacity to absorb losses.

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Appendix of Chapter 1

Definition of variables

Dependent variables

Leverage ratio. One minus the ratio of the sum of book capital (capital and reserves) to assets, winsorized at 5%.

Regulatory capital ratio. One minus the Basel ratio, winsorized at 5%.

Leverage in capital ratio. One minus the ratio of common capital and reserves to Basel capital requirements, winsorized at 5%.

Explanatory variables

Dividends. Dummy variable that takes the value of 1 if the bank issued dividends during the year.

Growth Opportunity. It is the ratio of the market-to-book value of equity or Tobin's Q. Since there are savings banks and small banks that are not listed in the stock market, we estimate a proxy of the market value, *V*. The estimated market value of a bank *i* in year *t* is then calculated as follows,

$$\hat{V}_{it} = \hat{P}_{it}^{t} + \xi_{i,t}\hat{P}_{i,t+1}^{t} + \xi_{i,t}^{2}\hat{P}_{i,t+2}^{t} + \xi_{i,t}^{3}\overline{P}_{i}^{t}\frac{1+\overline{\rho}_{it}}{\overline{\xi}_{it}-\overline{\rho}_{it}}$$

where $\hat{P}_{i,t+s}^{t}$ are the predicted adjusted earnings of bank *i* at time *t+s*, given the information available at time *t* using an AR(2) model; $\xi_{i,t}$ is the discount factor of each bank, inversely related to the opportunity cost of capital of that bank at time *t*. The opportunity cost of capital of the bank is set equal to the risk-free interest rate plus a risk premium that takes into account the credit risk of loans plus the risk from debt leverage.

From *t+3* onwards, the level of profit of banks is calculated applying a constant expected growth rate to the average of the predictions for *t*, *t+1* and *t+2*, ... It is assumed that this rate of growth of profit is equal to the profit retention rate times the long-run Return On Equity (ROE). The proxy value of the long-term growth rate $\overline{\rho}_{it}$ is obtained assuming

that banks retain one half of their earnings, and further assuming that the long-term ROE is equal to the average of the ROE of the last three years (with equity valued at replacement cost). The long-term discount factor $\overline{\xi}_{it}$ has been approximated to the average of the opportunity cost of capital of the bank in the previous three-year period.

Collateral. Ratio of liquid assets and the assets of the banks, winsorized at 1%.

$$Collateral = \frac{Total\,Securities + Gov't\,Securities + Other\,Earning\,Assets + Cash\,and\,due\,from\,Banks + Fixed\,Assets}{Total\,Assets}$$

ROA (100x). Ratio of the after-tax profit and the assets of the bank, winsorized at 1% and expressed in percentage.

Ln Assets. Book value of the bank's assets at the end of the year, in logs and winsorized at 1%.

NPL ratio (100x). Ratio of the non-performing loans in the balance sheet to the total amount of loans, winsorized at 1% and expressed in percentage.

Sd(ROA). Standard deviation of the ROA computed with the data of ROA of the five previous years. We have data on ROA from 1994 onwards.

Savings bank. Dummy variable that takes the value of 1 if the bank is a savings bank and 0 if it is a commercial bank.

Listed in the stock markets. Dummy variable that takes the value of 1 if the bank is listed in the stock market and 0 otherwise.

Upper assets' growth rate. Dummy variable that takes the value of 1 if the asset's growth rate is higher than or equal to 90th percentile value of the bank-year asset's growth rate distribution.

The asset's growth rate of a bank *i* in year *t* is calculated as ln(assets' growth rate of bank *i* in *t*) minus ln(assets' growth rate of bank *i* in *t-1*). From the overall distribution of asset's growth rates for all financial entities in the sample and for all years from 1998 to 2007, we calculate the 90th percentile. The dummy variable takes the value of 1 for bank *i* and year *t* when the observed growth rate of assets is equal to or higher than 90th percentile, respectively.

Chapter 2. Determinants of bank's financing choices under capital regulation

2.1 Introduction

How does the development of financial markets affect the financing choices of banks that are subject to capital regulation? Prior to the crisis, financial innovation and the development of markets allowed banks to decouple the evolution of credit from their capacity to collect deposits. The development of financial instruments, such as securitization, also granted small and medium banks access to financial markets (Almazán *et al*., 2015). Furthermore, innovation has enabled banks to expand their balance sheets and increase their reliance on financial sources other than deposits. However, banks must comply with capital regulation imposed by the Basel Accords[14]. Thus, the banks' choice of the financial instruments to fund their activity has to be consistent with the fulfillment of the capital ratios set by regulation. Therefore, banks cannot base their growth only on debt securities but must issue instruments that are eligible as regulatory capital if internally generated funds cannot guarantee the bank's target level of regulatory capital.

[14] The Basel Accords (Basel I, Basel II and Basel III) are a set of recommendations for regulations in the banking industry that refer to the capital holdings of banks. The target is that riskier banks hold higher amount of capital in order to absorb the higher potential losses of their balance sheet. The Basel Accords recognize different types of regulatory capital in terms of quality, and banks are obliged to cover a part of their capital requirements with high-quality capital.

Given that not all the financial instruments that are eligible as regulatory capital have the same capacity to absorb losses, banks' choices on the type of issuances could affect not only the level but also the quality of their capital holdings.

Banks' financing choices and capital structure did not receive much attention in the banking literature until the crisis, possibly because the amount of capital was thought to be determined by capital regulation (Mishkin, 2000). The crisis revealed that issues such as leverage, liquidity and the quality of capital determined financial stability and their deficiencies spread the negative effects of the crisis. Since then, there has been a growing literature on banks' capital structure and liquidity (Acharya and Thakor, 2016; Almazán *et al*., 2015; Adrian and Shin, 2010a; Gropp and Heider, 2010), short-term whole sale financing (Adrian and Shin, 2010b; Kalemly-Ozcanetal, 2012), and the quality and quantity of bank capital (Demirguc-Kunt *et al*., 2013; Beltratti and Stulz, 2012; Berger and Bouwman, 2013). However, the literature has not studied the determinants of banks' financing choices in the context of the constraints and incentives introduced by capital regulation. This is the focus of our analysis.

This Chapter is related to the literature that analyzes the deterioration of bank capital during the years prior to crisis. The literature generally accepts that capital should deter banks from taking bad risks, and instead it should enhance good governance to minimize the exposure of shareholders to risk (Rochet, 1992; Morrison and White, 2005). Indeed, there is evidence that well capitalized banks could better cope with the severe losses incurred during the crisis (Demirguc-Kunt *et al*., 2013; Beltratti and Stulz, 2012; Berger and Bouwman, 2013). However, recent papers provide evidence of a deterioration in bank capital prior to and during the crisis that hurt capital's capacity to act as a corporate governance mechanism (Acharya *et al*., 2009; Mehran *et al*., 2011). Furthermore, this deterioration limited the capacity of banks to raise new funds during the crisis (Acharya *et al*., 2011). Our Chapter analyzes the determinants of this deterioration in capital.

For our data, we use Dealogic. Our data consist of 4812 financial instruments issued by Spanish banks during the period 1988–2007 and information from banks' annual reports for the period 1998-2007. We use these data to empirically test a set of hypotheses on the decisions to issue different types of financial instruments. We try to understand how capital regulation affects behavior of banks based on insights from the traditional theories of corporate finance (Bradley *et al*., 1984; Myers and Majluf, 1984; Titman and

Wessels, 1988; Frank and Goyal, 2008, 2009). In particular, we use the logic of the pecking order theory to examine whether the banks' choices of financial instruments are related to adverse selection costs. Also, we test whether the choice of financial instruments targets an optimal capital structure. To perform such tests, we look at the expected choices of financial instruments if banks have liquidity needs or have growth opportunities as predicted by the different theories. Specifically, we test whether banks have a preference toward debt, as the pecking order predicts, or if banks want to maintain a target capital ratio, as predicted by the trade-off theory. The pecking order theory argues that the issuance of financial instruments responds to informational problems and banks should prefer to issue the type of market instrument that minimizes the adverse selection discount. The trade-off theory states that there is an optimal capital structure for each individual bank and banks should issue those financial instruments that minimize the overall cost of their capital structure. If the pecking order holds, we expect a higher probability in issuing instruments with more information asymmetries (*i.e.*, capital) for those banks that the markets know, such as listed banks. If the trade-off theory holds, banks prefer to combine issuances of different instruments to reach or maintain an optimal capital structure. We also test how the fulfillment of capital regulation affects the choice of financial instruments. Under the pecking order, we hypothesize that banks prefer to issue debt-like capital instruments (from now on, hybrid instruments) rather than capital instruments (*i.e.*, common shares) because the former can also be computed as regulatory capital but suffer from lower costs of asymmetric information as compared to capital instruments. Under a trade-off, we could expect a combination of issuances of hybrid and capital instruments to maintain the relative weight of the different capital instruments.

We use the Spanish banking sector because Spain's financial markets sustained exponential growth in their balance sheet items of around 20% during the expansion period. Further, they have undergone a deep restructuring in part due to the financing decisions made in the pre-crisis period. In addition, the focus on one single country exploits how banks' characteristics affect the financing choices when they are affected by the same macroeconomic and regulatory conditions.

Five findings emerge from our analysis. First, we find that banks issue financial instruments to cover liquidity needs and growth opportunities during the sample period. The choices among the available instruments respond to a combination of capital regulation and the costs of asymmetric information. Indeed, banks' preferred choice to

finance growth is debt, in line with the pecking order. Second, to comply with capital regulation given the growth of assets, banks prefer to issue hybrid instruments rather than capital instruments, which is also in line with the existence of discount costs from asymmetric information. This finding is supported by the evidence that banks close to the regulatory minimum are more likely to issue hybrid instruments than common shares. We find that the probability of issuing debt increases after the issuance of hybrid instruments during the last 12 months, and the decision to issue hybrid instruments is also positively affected by the issuance of debt during the previous 12 months. Third, the preference for issuing debt and hybrid capital explains the constant distribution of Basel capital ratios while the weight of core capital over the total regulatory capital decreases. Fourth, the issuance of capital instruments is more likely in banks listed in the stock markets and banks operating internationally, possibly because they are well-known to the markets and suffer from a lower (if any) discount at issuance due to asymmetric information. Fifth, banks might raise capital instruments to improve their soundness if the level of loan loss provisions is low and/or the risk of their assets (loans) is high.

This Chapter contributes to a variety of fields. First, it explores the driving forces in the deterioration of bank capital during the pre-crisis period. Mehran *et al*. (2011) and Acharya *et al*. (2011) provide evidence of this phenomenon, but there has not been any empirical analysis that explains the determinants of such deterioration. Second, it is the first analysis to our knowledge that analyzes the determinants of banks' financing choices by accounting for the corporate finance theories and the role of capital regulation. There are a handful of studies that study issuances of financial instruments, but they focus only on a subset, such as long-term debt in European banks (Rixtel *et al*., 2016), subordinated debt in the United States (Covitz and Harrison, 2004), or bonds and securitization in European countries (Carbó-Valverde *et al*., 2017; Almazán *et al*., 2015). Third, it provides policy arguments to justify a tougher definition of regulatory capital in Basel III, since banks have incentives to comply with capital regulation through the financing alternative of lowest cost that is recognized as eligible capital. This incentive indicates that the problem of credit expansions or recessions in capital are not only due to procyclicality (Repullo and Suárez, 2012; Repullo *et al*., 2010; Ayuso *et al*., 2004), but also because of the composition of the capital.

The rest of the Chapter is structured as follows. Section 2 presents the database and some statistics on the variables. Section 3 analyzes the theoretical setup applied to banks

and what determines the issuances of debt, hybrid, and capital instruments. Section 4 presents the main results for the decision of issuing and for the amount issued, and Section 5 concludes.

2.2 Database and characteristics of the sample

The database comprises 4,812 issuances of financial instruments from Dealogic. We collect the issuances on a monthly basis from 1988 to 2007. We match these data with information from banks' annual reports during the period of 1998 to 2007. This period covers the boom and expansion years of the Spanish and global economies that were funded mainly with the issuance of financial instruments in the financial markets (Brunnermeier, 2009). We exclude subsequent years of the financial crisis when financial markets did not operate normally. Figure 1 shows that the total assets of Spanish banks increased at an average growth rate of 12.9% during the whole period of study. They increased 17.6% during the period of maximum growth from 2004 to 2007, with peaks of around 20% in 2005 and 2006.

We classify the issuances as debt instruments, capital instruments and hybrid instruments, attending to the capacity to absorb losses without risking the viability of the bank (Acharya *et al*. 2011). The first group, debt instruments, comprises the long-term instruments that share the characteristics of typical debt contracts whose value and proceeds do not absorb any kind of losses for the bank. More concretely, we include standard senior debt issuances; the so-called *cédulas hipotecarias*, which are covered bonds backed by a portfolio of high-quality mortgages; and securitization issuances, which gather MBS and ABS[15]. There are papers that study the determinants of issue securitization (Loutskina, 2011; Loutskina and Strahan, 2009). They provide evidence that it is the financial innovation that has enabled banks to decouple the evolution of credit from deposit collection. Securitization has decreased the problems of asymmetric information in the markets for small and medium banks that could issue securities backed

[15] Securitized bonds are backed by a pool of assets and will not absorb losses coming from other concepts (*i.e*., losses from loans not belonging to that pool of assets, losses from tradable securities, etc). As well, Almazán *et al*. (2015) show that Spanish banks deployed securitization not to transfer risks (they offered credit enhancements and kept the worst tranches) but to exclusively obtain liquidity as a complement instrument to debt. Indeed, Spanish banks accounted the liability counterpart of securitization as deposits because Spanish regulation did not let them remove securitized assets from their balance sheet.

by a common portfolio of loans from different banks participating in the issuance (Almazán *et al*., 2015). The second group, capital instruments, includes the claims held by the owners of the bank who have control over the bank's operations (*i.e*., common shares), that is, what it is defined as "pure equity capital" in Acharya *et al*. (2011). These instruments present the highest capacity to absorb losses, and it is the ultimate shareholder that assumes the loss of value. The last group, hybrid instruments, comprises the issuances of preferred shares and subordinated debt, which are considered hybrid capital since they present characteristics of both capital and debt. For instance, preferred shares are issued in perpetuity, and subordinated debt is not obligated to pay interest unless the bank has profits. As commented in the introduction, these instruments can absorb losses, but they present a lower capacity to absorb losses compared to core capital, although Basel I and Basel II Accords consider them as eligible capital. According to the applicable regulation during the sample period, preferred shares account for 50% of Tier I capital, which is the definition of maximum quality. The rest of the preferred shares and hybrid instruments (subordinated debt) count as Tier II capital. However, under Basel I, banks could issue preferred shares and decrease the weight of common equity with in the total regulatory capital that increases the quality of their capital. Table 5 shows the figures for the issuances of debt and capital instruments drawn from Dealogic. We split the period in two: 1998 to 2002, where the assets' growth rate remained fairly stable between 5 and 10%; and 2003 to 2007 where the slope of total assets became sharply steep. If we compare the two-time periods, then the total amount of debt and hybrid capital increased exponentially whereas common equity had relatively low growth. More concretely, total debt issuances increased from a yearly average of 57,040 million euros during 1998 to 2002 to 212,382 million euros during 2003 to 2007, that is, a growth rate of 272%. The growth in the volume of total hybrid capital issuances was lower but still almost doubled from a yearly average of 6,661 million euros during the first period to 11,654 million euros in the second period (growth rate of 74.94%). The yearly average of common capital issuances remained stable between 3,275 and 3,224 million euros.

Table 5 Descriptive statistics of the issuances of Spanish banks, 1998-2007

	Volume of issuance (in millions €)							
	Total	*Mean*	*Std. Dev.*	*P10 th*	*P25 th*	*P50 th*	*P75 th*	*P90 th*
Total sample								
1998-2002	334,892	1,053	2,090	54	135	301	1,000	2,478
2003-2007	1,136,303	1,211	3,256	75	150	326	1,000	2,913
Debt								
1998-2002	285,205	954	1,981	60	140	325	1,000	2,065
2003-2007	1,061,911	1,181	3,037	74	150	330	1,000	2,913
Hybrid instruments								
1998-2002	33,308	529	604	54	135	333	700	1,070
2003-2007	58,270	525	882	75	150	300	608	1,028
Capital instruments								
1998-2002	16,379	780	1,000	99	158	348	902	1,976
2003-2007	16,122	1,612	2,112	63	210	998	1,999	5,000

The rows under "Total sample" group the total volume issued regardless of the instrument. In the remaining groups, the statistics of the respective type of issuance are shown. Data on volume of issuances is expressed in millions of euros.

The data that capture the essential characteristics of individual banks are mainly drawn from the information that Bankscope has on balance sheets, income statement, and regulatory capital. We complete this information by using the annual reports of banks in cases of missing values. This information is merged with the Dealogic database on a yearly basis. Thus, we attribute the values of the financial variables at the end of the period to the issuances of the bank that take place during the months of the following year, since it is sensible to assume that the decisions during a given year will depend on the financial situation at the beginning of the year. Our database includes commercial and savings banks (the so-called *cajas*)[16] operating in Spain during the period from 1998 to 2007.

Table 6 presents the statistics on the bank variables obtained from Bankscope that we use as explanatory variables in our empirical models.

[16] We exclude credit cooperatives because of missing data for key variables in the empirical analysis.

Table 6 Descriptive statistics of explanatory variables. Spanish banks, 1998-2007

	Mean	Median	Std. Dev.	P25th	P75th
Capital regulation					
Low Capital	0.159	0	0.365	0	0
Loan Loss Reserve/Loans (x100)	2.063	1.932	1.010	1.559	2.474
NPL ratio (x100)	1.621	1.100	1.570	0.600	2.100
Issuer Capital Instruments in t-1 to t-3	0.009	0	0.095	0	0
Issuer Capital Instruments in t-4 to t-12	0.021	0	0.144	0	0
Issuer Hybrid Instruments in t-1 to t-3	0.042	0	0.202	0	0
Issuer Hybrid Instruments in t-4 to t-12	0.086	0	0.280	0	0
Issuer Debt in t-1 to t-3	0.239	0	0.427	0	0
Issuer Debt in t-4 to t-12	0.365	0	0.482	0	1
Liquidity needs and growth opportunities					
Loans / Deposits	0.804	0.824	0.321	0.673	0.952
ROA (x100)	0.769	0.828	1.096	0.584	1.088
Assets growth rate	0.135	0.129	0.113	0.070	0.191
Market access					
Total assets (million €)	11,379	4,732	17,636	1,573	11,023
Ln Assets	8.270	8.462	1.813	7.361	9.308
Issuer in Past	0.276	0	0.447	0	1
Maturity Past Issuance	0.175	0	0.380	0	0
Savings bank	0.582	1	0.493	0	1
Asymmetric information					
Listed in the stock markets	0.139	0	0.346	0	0
International bank	0.025	0	0.155	0	0
Macroeconomic variables					
GDP	0.036	0.036	0.006	0.030	0.040
Real Interbank 12m	0.008	0.004	0.011	-0.002	0.014

Definition of variables in Appendix of Chapter 2.

2.3 Determinants of issuing financial instruments

Apart from traditional deposits, banks can choose among different tools in the financial markets to finance their growth. The aim of this section is to explore which are the driving factors behind the decision on one instrument (if any) among the available list of possibilities. We draw insights from the theories that are related to the issuing of financial instruments and capital structure and apply them to the case of banks in order to derive some testable hypotheses about the types of issuances by banks. In particular, we hypothesize that the issuances of financial instruments could be affected (1) by a targeted leverage ratio that minimizes the cost of financing (trade-off theory), (2) by asymmetric

information and adverse selection (pecking order theory) and (3) by the statutory requirement to fulfill the capital regulation.

The predictions that can be extracted from the trade-off theory and the pecking order theory (Bradley *et al*. 1984; Myers and Majluf 1984; Titman and Wessels 1988; Frank and Goyal 2008, 2009) are common to non-financial firms. The pecking order theory argues that the issuance of financial instruments responds to informational problems. Thus, firms (banks) prefer to issue the type of market instrument that minimizes the adverse selection discount. In this sense, debt instruments mitigate adverse selection compared to capital instruments. To examine whether this theory explains the issuance of financing instruments, we analyze whether banks more affected by the costs of adverse selection are those that are more likely to raise market funds through debt instruments. They could also issue debt if they were committed with market discipline and want to translate a positive signal to the markets, given that they will have to get refinancing at maturity dates. The trade-off theory states that there is an optimal capital structure for each individual bank. This theory argues that banks issue those financial instruments that enable them to minimize the overall cost of their capital structure. If banks have access to new financial markets, then those that are financially constrained could decide to issue large amounts of money through new financial instruments, although they would still be issuing traditional capital instruments to maintain a target capital structure. To identify those banks that are financially constrained, we use two indicators: (a) the liquidity position of the bank and (b) the growth rate opportunities in the bank's loan portfolio.

However, banks have additional drivers in their financing choices compared to non-financial firms because they have to comply with the capital regulation from the Basel Accords. This is not an alternative theory, but a requirement from regulation that can be perfectly compatible with the stated corporate finance theories. To fulfill the capital requirement, banks are obliged to hold 8% of their risk-weighted assets in the form of capital[17]. The observed high growth rates in banks' balance sheets during the sample period should reflect an increase in risk-weighted assets and, thus, in higher capital requirements. Therefore, banks cannot base their growth only on the issuance of debt instruments but must increase their capital holdings at the same pace if they want to maintain their capital ratio above the regulatory minimum. Therefore, we expect banks to issue hybrid or capital instruments simultaneously to debt issuances if their internal funds

[17] The 8% corresponds to Basel I regulation that applied during the whole sample period.

are not enough to guarantee their target Basel ratio. Whether banks decide to issue hybrid instruments, capital instruments, or both could be determined by the corporate finance theories. On the one hand, we could expect that banks issue a combination of hybrid and capital instruments if they want to maintain a target capital structure. On the other hand, banks could issue hybrid instruments if they want to minimize the adverse selection discount, given that hybrid capital presents characteristics of debt and, thus, it is less affected by costs of adverse selection.

The rest of this section presents the dependent variables and proxies that are used in the empirical strategy to determine the drivers of banks' financing choices, and an explanation of the empirical methodology used in the analysis. Depending on the different predictions of each possible theory, we detail the expected effect of each explanatory variable on each financing decision.

2.3.1 Dependent variable

The dependent variable identifies the banks' decision to issue one of the three types of instruments (if any) during a given month during the period from 1998 to 2007. It takes the value of zero if the bank does not issue any financing instrument at month *t* and the value of 1, 2, or 3 if the bank issues debt, hybrid, or capital instruments, respectively[18]. An alternative dependent variable also considered is the total amount of each instrument at every point in time in order to explore whether the determinants that drive the decision to issue also can explain the volume of each instrument.

2.3.2 Explanatory variables

We distinguish four groups of explanatory variables related to the potential reasons to raise funds in the financial markets: (1) proxies related to capital regulation, (2) proxies related to liquidity needs, (3) variables related to asymmetric information, and (4) variables of market access.

[18] If a bank issues several types of instruments in the same month, the dependent variable takes the value of 3 if any of the issuances is a capital instrument and 2 (hybrid instrument) otherwise.

Further, we add macroeconomic variables as control variables in the estimation, namely GDP growth and the real interbank 12-month interest rate.

2.3.2.1 Capital regulation

We argue that banks have to actively manage their regulatory capital ratio by assessing how new issuances of instruments affect their capital requirements. During our sample period, banks had to comply with Basel I, and this regulation determined the definitions of eligible capital during our whole sample[19]. Tier I mainly comprised common shares, reserves, and preferred shares (up to a maximum), and Tier II comprised the rest of the hybrid instruments. During the sample period, banks had to keep a minimum of 4% of their risk-weighted assets in the form of Tier I and 8% in Tier I + Tier II.

Figure 2B shows that the distribution of the Basel ratio remains practically unchanged over time, in spite of the large growth of assets shown in Figure 1. This lack of change could indicate active management of the regulatory capital ratio, possibly resulting from the combination of issuances of debt and capital instruments to keep the capital ratio constant. Nonetheless, we observe in Figure 2C that the distribution of capital with respect to total regulatory capital shifts leftwards, which indicates that the weight of common capital decreases generally for all banks over time. This is consistent with Figure 3 that shows that the quality of the regulatory capital decreases over time because the weight of core capital to regulatory capital constantly diminishes.

To test whether any of these hypotheses hold, we define a group of variables whose effect on the issuance of instruments could be attributed only to capital regulation.

1. *Low Capital* is a dummy variable that takes the value of one if the bank has a Basel capital ratio below 10% and zero otherwise. Banks closer to the regulatory limit are less likely to finance their growth based only on debt issuances compared with banks with a capital buffer over the minimum because this financing would deteriorate their capital ratio even more. In this case, we expect that the coefficient of this variable will be negative for the issuances of debt and/or positive for the

[19] Basel II came into force in 2008. Despite that banks could have adapted to Basel II during the years before its implementation, we consider that this possibility does not affect the decision to issue different financing instruments given that the changes mainly affect the computation of risk-weighted assets and not the definitions of Tier I and Tier II.

issuances of instruments considered regulatory capital. If the pecking order holds, we should observe a positive and statistically significant sign only in hybrid issuances, whereas the statistical significance of both hybrid and capital instruments would support the trade-off theory.

2. *Loan Loss Reserve/Loans* (LLR) can be used up to a limit as regulatory capital. Thus, banks with higher LLR are less likely to issue hybrid or common capital, because the LLR acts as a substitute and softens the need for capital issuances.

3. *NPL ratio* is the total amount of capital requirements that depends on the size of the risk-weighted assets of the bank, which increases with the size of the bank and the risk of the assets. We consider the ratio of the non-performing loans as a proxy for the risk in the bank's assets. Thus, we expect that banks will be more (less) likely to issue hybrid and/or common capital (debt) issuances as the ratio increases.

4. *Issuance behavior* identifies the type of issuances made by the bank (if any) during the last 12 months. More concretely,

    a. *Issuer Capital Instruments in months t-x to t-y:* Dummy variable that takes the value of one if the bank has issued capital instruments during the months *t-x* to *t-y*.

    b. *Issuer Hybrid Instruments in months t-x to t-y:* Dummy variable that takes the value of one if the bank has issued hybrid instruments during the months *t-x* to *t-y*.

    c. *Issuer Debt in months t-x to t -y:* Dummy variable that takes the value of one if the bank has issued debt during the months *t-x* to *t-y*.

We expect the issuance of debt instruments to be positively correlated with the recent issuance of hybrid instruments, and vice-versa, if banks only use hybrid instruments to cover the increase in capital requirements originated by the growth of debt. If this is the case, we expect a lower correlation or nil correlation of the issuance of debt instruments and the issuance of capital instruments. If banks use both hybrid and capital instruments to compensate for debt growth, we should observe that the probability of issuing both types of instruments increases right after the issuance of debt, and vice-versa.

2.3.2.2 Liquidity needs and growth opportunities

Banks with higher liquidity constraints could be subject to tougher investment constraints, so they can be more likely to issue financial instruments to finance their growth. We use variables related to the dependence of the bank on traditional funds to finance its activity and to its capacity to generate internal funds as proxies for the bank's liquidity constraints. As for growth opportunities, we expect that banks with higher opportunities are more likely to issue financial instruments.

Besides the effect on the pure decision of issuing versus not issuing, we analyze which instruments banks choose to respond to liquidity needs. If the decision on the instrument follows the pecking order, banks would only issue debt instruments to minimize the cost of asymmetric information and, therefore, the liquidity and growth variables would only be significant for debt issuances. If the decision on the instruments follows the trade-off theory, we should observe significant coefficients in all financial instruments because the banks have to combine the issuances of all types of financial instruments to maintain the same proportion of each component. This result could be consistent with the fulfillment of capital regulation, if banks issue both hybrid and capital instruments to keep their regulatory capital levels constant. Nonetheless, if the issuances of eligible capital instruments are meant to fulfill capital regulation at the lowest possible cost, we could observe issuances of debt and hybrid instruments only, but not capital instruments.

Taking into account the previous predictions, we consider the following variables to analyze the determinants of the choice of funding for banks attending to liquidity needs and growth opportunities:

1. *Loans/Deposits* is the ratio of the total balance of loans to the total balance of deposits of the bank. A higher imbalance between loans and deposits indicates higher needs for financing resources beyond those provided by traditional banking. Thus, the higher this ratio, the higher the probability of issuing financial instruments.
2. *ROA* Return on assets is a measure of the bank's capacity to generate internal funds. Banks with higher profitability have lower liquidity needs because they can use their earnings to finance new operations. In this case, higher ROA means a lower probability of issuing fresh financial instruments.

3. To capture potential growth, the corporate finance literature has used the price-to book ratio. However, since a large part of the banks in our sample are not listed in the stock markets, we consider the growth rate of bank's assets during the previous year, *assets growth rate*, as a proxy of future growth opportunities.

2.3.2.3 Market access

The accessibility of banks to financial markets affects their decision to issue new financial instruments. On the one hand, a bank that has access to the market can issue fresh financial instruments without high transaction costs or big investments in recognition in that market. On the other hand, banks that issued instruments in the market that are about to reach maturity could find its easier to refinance them.

The following variables are included to estimate these effects:

1. *ln Assets*. Larger banks are more likely to have low transaction costs of accessing the markets, and thus they are more likely to issue financial instruments.
2. *Issuer in Past*. Dummy variable that takes the value of one if the bank has issued any type of instrument in the financial markets since 1988. We expect that banks that managed to issue in the past present lower transactional costs and, thus, the probability to issue new securities is higher.
3. *Maturity Past Issuance*. Dummy variable that takes the value of one if the bank issued a security since 1988 that is reaching maturity at month *t* of the database. We have constructed this variable by using detailed information of banks' issuances since 1988 according to the Dealogic database. We expect a higher probability of issuing securities in the current month to refinance the operation that is reaching maturity.
4. *Savings bank*. Almazán *et al*. (2015) find that the development of securitization, which we define as a debt instrument, reduces the adverse selection faced by *cajas*. Therefore, we expect a positive and statistically significant coefficient for this variable in the decision to issue debt instruments.

2.3.2.4 Asymmetric information

Banks more subject to informational problems will be more reluctant to issue instruments with high discounts due to asymmetric information costs. In our definition of groups, capital instruments would suffer higher discounts because of asymmetric information, followed by hybrid instruments and debt instruments. We use two variables to identify this effect:

1. *Listed in the stock markets*. Banks that are listed in the stock markets are less subject to asymmetric information and, thus, they are more likely to issue capital instruments, compared to the rest of banks.
2. *International bank*. Related with the previous argument, international banks are likely to have lower transaction costs when accessing markets to issue any type of security.

2.4 Empirical strategy and results

We perform two sets of tests. First, we estimate a multinomial logit to investigate the determinants of the banks' decision to issue (or not to issue) the different types of available financial instruments (*i.e.*, *extensive margin*). We examine both the sign and significance of the coefficient of each option (*i.e.*, issuing debt, capital, or hybrid instruments) with respect to the decision of not issuing and the cross-differences between the different options. We consider this first approach to account for the possibility that the decisions to issue different types of securities is affected by the different theories. Second, we estimate a Tobit model to explore the determinants of the amount issued by banks in each type of financial instrument (*i.e.*, *intensive margin*) and analyze whether they are different from the determinants that govern the decision to issue each type of instrument.

2.4.1 Decision to issue financial instruments

Table 7 presents the results from the multinomial logit of the decision to issue instruments that takes the decision of not to issue as the reference group. Columns (1), (2) and (3)

display the results for the option to issue debt, hybrid, or capital instruments, respectively. Table 8 presents the cross-tests of statistical differences between the coefficients for the same variable across columns (*i.e.*, in the first column of Table 8, the coefficient *Low Capital* is statistically different for debt and hybrid issuances with a p-value of 4.6%).

From Table 7, the coefficients for the variables *Loans/Deposits* and *Assets growth rate* show that banks with liquidity needs are more likely to issue debt to finance their growth, but they do not directly affect the issuance of hybrid or capital instruments. This means that the exponential growth in banks' balance sheets observed in Figure 1 is largely financed with issuances of debt, which would be consistent with the pecking order theory. As for *ROA*, high profits negatively affect the issuance of hybrid instruments but not debt or capital. While this is consistent with lower liquidity needs, this result could also be explained by a lower need to issue capital instruments to comply with the Basel ratio because the retained earnings compute as Tier I capital.

Focusing on the timing variables, the issuance of debt (Column 1) is preceded by issuances of debt (*Issuer Debt in t-4 to t-12* statistically significant) and hybrid instruments (both *Issuer Hybrid Instruments in t-4 to t-12* and *Issuer Hybrid Instruments in t-4 to t-12* statistically significant), but not issuances of capital. Similarly, issuances of hybrid instruments are preceded by other issuances of hybrid instruments and by issuances of debt. However, the probability of issuing capital is not correlated with the issuance of debt but increases with the issuances of hybrid instruments during the last three months. Table 8 shows that the coefficients that are statistically different from zero are also statistically different across types of issuances. Therefore, banks that finance their growth with issuances of debt also increase their issuances of hybrid instruments, which indicates that they are managing their regulatory capital holdings using hybrid instruments to comply with the higher requirements due to the increase in debt holdings. Further evidence for this finding is provided by the variable *Low Capital*, which is positive and statistically significant at 10% in hybrid instruments whereas it is not statistically significant for capital, which indicates that banks whose regulatory capital is close to the minimum are likely to issue hybrid instruments but not capital instruments. Given that the threshold of 8% is exogenous, the issuance of capital instruments might be a response to maintain or increase their Basel ratios by using only hybrid capital, which means they want to minimize the cost of regulatory compliance.

Table 7 Multinomial logit estimation of the decision to issue (or not to issue) among debt, hybrid instruments, or capital instruments

	(1)		(2)		(3)	
	Coeff	*Std. Error*	*Coeff*	*Std. Error*	*Coeff*	*Std. Error*
Capital regulation						
Low Capital	-0.116	*(0.129)*	0.605*	*(0.323)*	0.556	*(0.335)*
Loan Loss Reserve/Loans (x100)	0.068	*(0.087)*	-0.726***	*(0.207)*	-1.231**	*(0.434)*
NPL ratio (x100)	-0.270***	*(0.073)*	0.157	*(0.174)*	0.581**	*(0.265)*
Issuer Capital Instr. in t-1 to t-3	-0.076	*(0.148)*	-0.495	*(0.311)*	-1.444***	*(0.174)*
Issuer Capital Instr. in t-4 to t-12	-0.115	*(0.290)*	-0.198	*(0.341)*	-0.548	*(0.407)*
Issuer Hybrid Instr. in t-1 to t-3	0.298*	*(0.155)*	0.434**	*(0.204)*	0.851**	*(0.344)*
Issuer Hybrid Instr. in t-4 to t-12	0.213*	*(0.125)*	0.474	*(0.325)*	0.703	*(0.863)*
Issuer Debt in t-1 to t-3	-0.143	*(0.103)*	0.609**	*(0.303)*	1.675	*(1.370)*
Issuer Debt in t-4 to t-12	1.224***	*(0.152)*	1.407**	*(0.548)*	1.321	*(0.992)*
Liquidity needs and growth opportunities						
Loans / Deposits	0.888***	*(0.197)*	0.577	*(0.483)*	-1.224	*(1.608)*
ROA (x100)	-0.001	*(0.119)*	-0.310*	*(0.164)*	-0.869	*(0.662)*
Assets growth rate	1.316**	*(0.417)*	0.431	*(0.825)*	0.786	*(1.480)*
Market access						
Ln Assets	0.409***	*(0.067)*	0.588***	*(0.161)*	0.808	*(0.850)*
Issuer in Past	0.160	*(0.103)*	-0.188	*(0.195)*	-0.384	*(0.455)*
Maturity Past Issuance	0.289**	*(0.132)*	-0.014	*(0.316)*	0.025	*(0.536)*
Savings bank	1.103**	*(0.403)*	1.211	*(0.955)*	-0.255	*(3.453)*
Asymmetric information						
Listed in the stock markets	0.435	*(0.414)*	1.363	*(0.889)*	15.163***	*(3.595)*
International bank	2.605***	*(0.663)*	3.563***	*(0.914)*	3.078*	*(1.634)*
Macroeconomic variables						
GDP	-20.267**	*(9.234)*	-21.615	*(23.484)*	49.356	*(50.884)*
Real Interbank 12m	-16.156*	*(8.254)*	-9.995	*(17.648)*	4.026	*(16.039)*
Constant	-7.642***	*(0.742)*	-10.691***	*(1.379)*	-28.877***	*(5.192)*
No. of observations	10,282		10,282		10,282	
Pseudo-R2	0.3305		0.3305		0.3305	

The results are from multinomial logit. The dependent variable is a categorical variable that takes the value of one if the bank issues debt [Column (1)], two if it issues hybrid instruments [Column (2)], three if it issues capital instruments [Column (3)], and zero if it does not issue during that month; the latter is the reference group. The explanatory variables refer to the value in month t, except for the financial variables that are drawn from annual reports that refer to the previous' year end. Definition of variables can be found in Appendix of Chapter 2.
The robust standard errors corrected for clustering at the bank level are in parenthesis.
$p < 0.01$ = ***, $p < 0.05$ = **, $p < 0.1$ = *

Table 8 Cross-tests of equality of coefficients between equations

	(1) *vs.* (2)		(2) *vs.* (3)		(1) *vs.* (3)	
	chi2(1)	*Prob > chi2*	*chi2(1)*	*Prob > chi2*	*chi2(1)*	*Prob > chi2*
Capital regulation						
Low Capital	3.98 **	*(0.046)*	0.02	*(0.893)*	3.54 *	*(0.060)*
Loan Loss Reserve/Loans (x100)	14.42 ***	*(0.000)*	1.14	*(0.286)*	8.85 ***	*(0.003)*
NPL ratio (x100)	5.53 **	*(0.019)*	2.32	*(0.128)*	11.40 ***	*(0.001)*
Issuer Capital Instr. in t-1 to t-3	1.86	*(0.172)*	18.89 ***	*(0.000)*	79.40 ***	*(0.000)*
Issuer Capital Instr. in t-4 to t-12	0.12	*(0.727)*	1.20	*(0.274)*	1.33	*(0.249)*
Issuer Hybrid Instr. in t-1 to t-3	0.49	*(0.486)*	1.30	*(0.254)*	3.55 *	*(0.059)*
Issuer Hybrid Instr. in t-4 to t-12	0.51	*(0.474)*	0.06	*(0.802)*	0.33	*(0.567)*
Issuer Debt in t-1 to t-3	6.88 ***	*(0.009)*	0.63	*(0.428)*	1.82	*(0.177)*
Issuer Debt in t-4 to t-12	0.13	*(0.718)*	0.01	*(0.923)*	0.01	*(0.923)*
Liquidity needs and growth opportunities						
Loans / Deposits	0.40	*(0.525)*	0.97	*(0.324)*	1.64	*(0.201)*
ROA (x100)	2.45	*(0.117)*	0.75	*(0.386)*	1.70	*(0.192)*
Assets growth rate	1.31	*(0.252)*	0.09	*(0.765)*	0.13	*(0.721)*
Market access						
Ln Assets	2.00	*(0.158)*	0.07	*(0.799)*	0.22	*(0.638)*
Issuer in Past	4.28 **	*(0.039)*	0.19	*(0.661)*	1.55	*(0.213)*
Maturity Past Issuance	0.92	*(0.338)*	0.01	*(0.924)*	0.24	*(0.623)*
Savings bank	0.02	*(0.878)*	0.17	*(0.681)*	0.15	*(0.696)*
Asymmetric information						
Listed in the stock markets	2.00	*(0.157)*	12.89 ***	*(0.000)*	16.70 ***	*(0.000)*
International bank	3.87 **	*(0.049)*	0.09	*(0.770)*	0.11	*(0.744)*
Macroeconomic variables						
GDP	0.00	*(0.952)*	1.41	*(0.235)*	2.01	*(0.157)*
Real Interbank 12m	0.16	*(0.692)*	0.83	*(0.362)*	2.11	*(0.146)*

This table presents the results from the test for the equality of the coefficients for the variables across financial instruments based on the results presented in Table 7. Columns (1) and (2) compare the coefficients obtained for debt issuances presented in Column (1) of Table 7 with the coefficients obtained for hybrid issuances presented in Column (2) of Table 7 respectively. Columns (2) and (3) compare the coefficients obtained for hybrid issuances presented in Column (2) of Table 7 with the coefficients obtained for capital issuances presented in Column (3) of Table 7 respectively. Column (1) and (3) compare the coefficients obtained for debt issuances and presented in Column (1) of Table 7 with the coefficients obtained for capital issuances presented in Column (3) of Table 7, respectively.

The coefficients for *Loan Loss Reserves/Loans* show that loan loss reserves act as a substitute for capital issuances: banks with higher LLR are less likely to issue hybrid capital and core capital, whereas it does not affect the probability of issuing debt. Furthermore, the *NPL ratio* shows that banks with higher risk tend to issue less debt and more capital, but it does not affect the issuance of hybrid instruments. These results indicate that banks with higher risks are more likely to issue capital instruments to absorb losses, although this effect is mitigated if they have accumulated sufficient LLR to absorb such losses. Thus, we find partial evidence that banks can respond with high-quality capital issuances to compensate for the risk embedded in their loan portfolios. However, given the evidence presented in Figure 3, this is not enough to compensate for the deterioration in regulatory capital.

Related to the access to financial markets, we find a positive and significant coefficient on the variable *ln Assets* for debt and hybrid instruments. We also find that banks with a past issuance of an instrument that is now maturing at time *t*, *Maturity Past Issuances*, are more likely to issue debt to rollover. The fact of having previously issued in financial markets, *Issuer in the Past*, does not seem to positively affect the probability of issuing any type of financial instrument. Finally, we also find that, ceteris paribus, *cajas* are more likely to issue debt, which is consistent with Almazán *et al*. (2015). The effect of being a *caja* does not affect the probability of issuing either hybrid or capital instruments.

In line with the pecking order theory, banks that are *Listed in the stock markets* suffer lower costs from informational asymmetries and they are more likely to issue capital. Our other proxy of asymmetric information, *International bank*, has positive and statistically significant coefficients for the three types of instruments that shows that these banks with previous records of issuances can issue financial instruments at lower costs.

We perform a number of tests to assess the robustness of our results[20]. First, we add time dummy variables to all specifications to better capture potential cyclical effects, and the results remain unchanged. Second, we also substitute the measure of risk in the loan portfolio, *NPL ratio*, with the Z-score. The coefficient is not statistically significant in any specification, so it does not capture the risk better than the NPL. But, the rest of the coefficients do not change noticeably. Third, we re-estimate the model by substituting

[20] Results not shown though available upon request.

Asset Growth Rate with a Q-Tobin that we construct using an estimation of market value (based on a discount of forecasted future profits) for those banks that are not listed in the stock markets. The coefficient for this variable remains statistically significant for debt issuances (though at 10%), and the rest of results do not change.

2.4.2 Results on the amount issued

Table 9 displays the results for the models of the volume issued in each type of financial instrument (that is, *intensive margin*). We estimate these models with a Tobit specification[21] with standard errors robust to heteroscedasticity and clustered at the bank level. The dependent variable is the log of the amount issued at month *t*, taking the value of zero if the bank does not issue. Each regression has been estimated separately, but the results in Table 9 follow the same structure as the results in Table 7 and Table 8.

The explanatory variables are the same as in the multinomial logit that were explained in Sect.3.2. For columns (1), (2) and (3), the dependent variable is the log of the amount issued in the form of debt, hybrid, or capital instruments, respectively. For Column (4), the dependent variable is the log of the total amount of funds issued under any form of financial instrument. The explanatory variables in Column (1) of Table 9 show that the proxies for liquidity needs and growth opportunities, market access, asymmetric information, and capital regulation maintain their sign and statistical significance. However, the coefficient for *Issuer Capital Instruments in t-1 to t-3* is now positive and statistically significant with a similar magnitude as the coefficients of the two variables for *Issuer Hybrid Instruments*. This result indicates that even when the decision to issue capital and debt are not mutually dependent (Table 7 and Table 8), once the bank has decided to issue capital instruments in the near past, this decision provides a capital buffer that enables the bank to issue an amount of debt even higher than in the case of not having issued. Furthermore, *Issuer in Past* becomes statistically significant, in line with the predictions. Overall, we can claim that the determinants of the issuance of debt present similarly qualitative effects in the *extensive* and the *intensive margins*.

[21] Results for capital instruments have been estimated using OLS because of the lack of convergence using the Tobit model.

The conclusions about the effect of the explanatory variables are also comparable to the issuances of hybrid and capital instruments but not all of the coefficients are equal across specifications. Focusing on the differences, the amount issued now does not depend on the issuances of hybrid capital in the near past, whereas the coefficient of *Listed Stock Market* becomes statistically significant with the expected positive sign. For the issuances of capital, the amount issued does not depend on having issued hybrid capital during the last three months or on the risk variables and *Loan Loss Reserves*.

As a robustness exercise, Column (4) of Table 9 presents the results for the total amount issued under any kind of financial instrument. The results are similar to those of debt issuances, possibly because they represent the main volume of issuances during the sample period (from Table 5, 85.16% in 1998–2002 and 93.45% in 2003–2007).

Table 9 Tobit estimation of the amount issued by banks in debt, hybrid and capital instruments

	(1)		(2)		(3)		(4)	
	Coeff	*Std. Error*	*Coeff*	*Std. Error*	*Coeff*	*Std. Error*	*Coeff*	*Std. Error*
Capital regulation								
Low Capital	-1.073	*(1.377)*	9.376**	*(4.770)*	0.041	*(0.034)*	-0.631	*(1.280)*
Loan Loss Reserve/Loans (x100)	0.975	*(0.983)*	-7.281**	*(2.501)*	-0.002	*(0.010)*	0.595	*(0.963)*
NPL ratio (x100)	-3.241***	*(0.867)*	1.990	*(2.023)*	0.004	*(0.004)*	-3.013***	*(0.857)*
Issuer Capital Instr. in t-1 to t-3	2.978**	*(1.146)*	-2.545	*(5.108)*	-0.770***	*(0.161)*	1.985	*(1.271)*
Issuer Capital Instr. in t-4 to t-12	0.198	*(2.640)*	3.203	*(4.410)*	0.424	*(0.564)*	1.425	*(2.234)*
Issuer Hybrid Instr. in t-1 to t-3	3.308**	*(1.523)*	3.598	*(3.392)*	0.198	*(0.123)*	3.351**	*(1.476)*
Issuer Hybrid Instr. in t-4 to t-12	2.967**	*(1.466)*	5.172	*(4.908)*	0.046	*(0.056)*	3.284**	*(1.349)*
Issuer Debt in t-1 to t-3	-1.293	*(1.303)*	10.077**	*(4.071)*	0.030	*(0.020)*	-0.493	*(1.284)*
Issuer Debt in t-4 to t-12	14.014***	*(1.804)*	14.977**	*(6.156)*	0.019	*(0.015)*	14.188***	*(1.819)*
Liquidity needs and growth opportunities								
Loans / Deposits	10.937***	*(2.675)*	3.298	*(6.058)*	-0.043	*(0.036)*	10.226***	*(2.568)*
ROA (x100)	-0.636	*(1.276)*	-4.146**	*(1.954)*	-0.001	*(0.002)*	-0.711	*(1.190)*
Assets growth rate	13.439**	*(4.950)*	5.706	*(11.223)*	0.107	*(0.116)*	14.472**	*(4.729)*
Market access								
Ln Assets	4.973***	*(0.875)*	6.668**	*(2.334)*	-0.005	*(0.004)*	4.951***	*(0.878)*
Issuer in Past	2.185**	*(1.114)*	-1.563	*(2.639)*	0.030	*(0.025)*	2.304**	*(1.119)*
Maturity Past Issuance	4.380**	*(1.672)*	-1.748	*(3.967)*	0.001	*(0.023)*	4.111**	*(1.636)*
Savings bank	11.995**	*(4.027)*	12.541	*(9.514)*	-0.015**	*(0.008)*	11.567**	*(4.113)*
Asymmetric information								
Listed in the stock markets	4.150	*(4.350)*	16.726*	*(9.110)*	0.041	*(0.025)*	4.868	*(4.285)*
International bank	20.132***	*(4.155)*	24.595***	*(6.539)*	1.920***	*(0.131)*	17.419***	*(3.593)*

Table 9 Tobit estimation of the amount issued by banks in debt, hybrid and capital instruments (*continued*)

	(1)		(2)		(3)		(4)	
	Coeff	*Std. Error*	*Coeff*	*Std. Error*	*Coeff*	*Std. Error*	*Coeff*	*Std. Error*
Macroeconomic variables								
GDP	-260.675**	*(103.163)*	-104.600	*(314.369)*	2.100	*(2.623)*	-234.225**	*(101.820)*
Real Interbank 12m	-148.714	*(94.353)*	33.096	*(224.910)*	2.706	*(1.690)*	-134.429	*(95.754)*
Constant	-90.561***	*(11.652)*	-149.300***	*(33.213)*	-0.060	*(0.099)*	-89.220***	*(11.229)*
No. of observations	10,282		10,282		10,282		10,282	
Pseudo-R2	0.155		0.211		0.101		0.156	

Column (1) represents the dependent variable as the amount of debt issued by a bank in that month (in logs). (2) represents the dependent variable as the amount of hybrid instruments issued by a bank in that month (in logs). (3) represents the dependent variable as the amount of capital instrument issued by a bank in that month (in logs). (4) represents the dependent variable as the total amount issued, regardless of the financial instrument, by a bank in that month (in logs). The explanatory variables refer to the value in month *t*, except financial variables that are drawn from annual reports that refer to the previous' year end. The definitions of variables are in Appendix of Chapter 2.

The robust standard errors corrected for clustering at the bank level are in parenthesis.

$p < 0.01$ = ***, $p < 0.05$ = **, $p < 0.1$ = *

2.5 Conclusions

The transition of Spanish banks to a business model more dependent on market financing has enabled them to decouple the evolution of the loan activity from the capacity to collect deposits. The high demand of international markets for financial products issued by Spanish banks fuelled the high demand for loans with the consequent growth of banks' balance sheets during the years prior to the crisis. In this study we find that the financial development and the access of banks to financial markets has increased the vulnerability of the banking sector, not only to shocks in the financial markets (Almazán *et al*. 2015) but to deterioration in the capital meant to absorb losses. More concretely, we find that banks with higher expansion in their balance sheets finance their liquidity needs with issuances of debt instruments. At the same time, we find that the issuances of debt are correlated with the issuances of hybrid instruments because hybrids were the instrument used by banks to comply with the higher regulatory capital requirements derived from the expansion of the (risk-weighted) assets.

We find that information asymmetries can explain the choice of debt/hybrid instruments by banks. That is, banks decide to issue the market instrument that more resembles debt in order to minimize the adverse selection discount. This decision can explain why banks finance growth with debt and raise hybrid capital instead of common equity if they are close to the regulatory minimum or have low levels of provisions or earnings that compute as eligible capital. We do not find evidence in favour of the trade-off theory in the sense of banks issue both capital of debts, though it cannot be rejected. Indeed, we observe that banks could be increasing the level of capital through internal mechanisms (accumulated earnings and loan loss provisions). That is, we can reconcile the results obtained in Chapter 1 (capital structure) and Chapter 2 (flows of financing) if we consider that banks follow the pecking order to raise fresh funds (first, retained earnings and, next, issuances less affected by asymmetric information) but they target at a composition of regulatory capital and leverage that combines debt, debt-like capital and equity capital.

Additional evidence in support of the asymmetric information theory is that only banks better known by investors can issue common equity without suffering a discount due to informational asymmetries.

Our findings support the stricter requirements in Basel III in terms of core capital requirements. During our sample period, banks could comply with Basel I by basically issuing hybrid instruments because they were included in the definition of Tier I. Because of the lower relative cost of debt-like instruments compared to capital instruments, banks preferred to issue hybrid capital to offset the increase in risk-weighted assets during the expansion period, which deteriorated the quality of regulatory capital. The new Basel standards prevent this regulatory capital arbitrage so compliance can only be achieved with high-quality capital. This compliance could be a challenge for small-medium banks less known by the markets because they face the risk of higher discounts when issuing common shares. But an opportunity exists to control the potential excessive growth in these types of banks with access to almost unlimited financing in the form of debt, but with serious difficulties (from the supply and/or demand side) in raising high-quality capital. Future research in this sense would be related to macro-prudential policies channeled to reduce the procyclicality of capital requirements in the sense that banks with more difficulties to rise capital are able to accumulate it during expansions and periods of growth (for example, through retained profits).

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Appendix of Chapter 2

Definition of variables

Capital regulation

Low Capital. Dummy variable that takes the value of one if the bank has a Basel capital ratio below 10% and zero otherwise.

Loan Loss Reserve/Loans (100×). It is the ratio of the loan loss provision to the total balance of loans. Since this variable is not available for all banks, we capitalize the volume of impairment provisions of the last three years and substitute this amount in the numerator. It provides a reasonable adjustment for the cases of banks with actual data on LLR. The variable is winsorized at 1% and expressed in percent.

NPL ratio (100×). Ratio of the non-performing loans in the balance sheet to the total amount of loans, winsorized at 1% and expressed in percent.

Issuer Capital Instruments in months t-x to t-y. Dummy variable that takes the value of one if the bank has issued capital instruments during the months t-x to t-y.

Issuer Hybrid Instruments in months t-x to t-y. Dummy variable that takes the value of one if the bank has issued hybrid instruments during the months t-x to t-y.

Issuer Debt in months t-x to t-y. Dummy variable that takes the value of one if the bank has issued debt during the months t-x to t-y.

Liquidity needs and growth opportunities

Loans/Deposits. Ratio of the total balance of loans to the total balance of deposits of the bank, winsorized at 1%.

ROA (100×). Ratio of the after-tax profit and the assets of the bank, winsorized at 1% and expressed in percent.

Assets growth rate. Annual growth rate of bank's assets, winsorized at 5%.

Market access

Ln Assets. Book value of the bank's assets at the end of the year, in logs and winsorized at 1%.

Issuer in Past. Dummy variable that takes the value of one if the bank has ever issued any instrument in the financial markets and zero otherwise. We use monthly information since 1988.

Maturity Past Issuance. Dummy variable that takes the value of one if there is a past issuance of the bank that is maturing in the current month, the previous month, or the next month and zero otherwise. We use monthly information of debt and capital issuances since 1988 to construct this variable.

Savings bank. Dummy variable that takes the value of one if the bank is a savings bank and zero if it is a commercial bank.

Asymmetric information

Listed in the stock markets. Dummy variable that takes the value of one if the bank is listed in the stock market and zero otherwise.

International bank. Dummy variable that takes the value of one if the bank has access to international markets and zero otherwise.

Macroeconomic variables

GDP. GDP growth.

Real Interbank 12m. Real interbank 12-month interest rate.

Chapter 3. Productivity, interest rates and banking restructuring process

3.1 Introduction

The Spanish banking sector has undergone a profound restructuring process since the beginning of the crisis. The concentration of the sector in a small number of large banks, the disappearance of the savings banks and the closing of branches represent a profound structural change that will have consequences in the future on the banking business in Spain. This Chapter tries to address the consequences of the changes that have taken place focusing on the analysis of the evolution of the productivity of Spanish banking entities during the period 2007-2015 and explore how this evolution affects competition in interest rates and possible strategies of non-organic growth of the most productive banks through mergers or acquisitions.

The empirical analysis is based on the conceptual framework of Martín-Oliver *et al*. (2018), which incorporates heterogeneity in operating costs to the circular bank competition model (Freixas and Rochet, 2008; Salop, 1979) and we analyze the effect of productivity on the levels of interest rates and branch expansion in a context of low interest rates. We apply this framework to data of Spanish banks during the period 2007-2015 because the Spanish banking sector underwent through a deep restructuring process, with bank liquidations and M&A; and because interbank interest rates were close to zero during the whole period. This constitutes a good framework to test our hypotheses about productivity, prices and branch closures. Specifically, we will contrast the hypothesis of

whether the most productive banks will apply lower (higher) interest rates on loans (deposits). The model also predicts that the most productive banks gain market share at the expense of the least productive. We will apply this hypothesis to the context of banking restructuring to analyze whether the most productive banks have followed a strategy of increasing their network of bank branches through the absorption or acquisition of less productive banks that have branches in markets (provinces) in which the acquiring entity has a low relative presence. The hypotheses proposed are compatible with previous studies that have analyzed how different levels of efficiency affect the output of manufacturing plants in declining industries (Ghemawat and Nalebuff, 1985; Fudenberg and Tirole, 1986; Reynolds, 1988, Whinston, 1988).

Among other results, the Chapter finds evidence that the most productive banks transfer productivity improvements to reductions in interest rates on loans and commissions, although we did not find an effect on deposit rates. Regarding the effect on the restructuring, we provide evidence that the consolidation of the banking sector has involved the exit of less productive banks and has reduced the heterogeneity among the surviving banks (the more productive ones). Given that the productivity of the banking industry during the sample period shows an average yearly growth of 2%, we conclude that the reduction in the level of loan interest rates due to improvements in efficiency has been 3.6 points. This modest improvement in productivity is due to the fact that the positive effect on productivity of the exit of less productive banks has been offset by the negative effect of the reduction in the demand for banking services during the most severe years of crisis. The effect on welfare is therefore ambiguous because, although the most productive banks that have survived may have prices closer to the reference interest rates, the effect could be offset by increases in market power as a result of the concentration of the sector.

The contributions of our work are as follows. First, the results show that in a context of low interest rates, banks are not necessarily engaged in a reduction in the intermediation margin. Although it is true that the low level of the Euribor implies a negative margin in the deposit activity, the banks compensate by increasing the differential of loans' interest rate with respect to the interbank rate, and increasing the volume of commissions charged to customers for payment services associated with deposits. This result confirms the descriptive evidence in Martínez-Pagés (2017), which also suggests that the low intermediation margins are due not only to the levels of interest

rates, but also to a lower activity of the banks and greater default rates of the loan portfolio due to the crisis. Nonetheless, we also find that banks have a lower bound of 0% for deposit interest rates, that is, banks are not willing translate to prices further reductions of the reference interest rates, once the deposit rates that they offer are already close to zero. Second, the incorporation of the commissions broadens the theoretical and empirical framework proposed by Martín-Oliver *et al*. (2018) to work outside the assumption of perfect separability of the interbank market, since the deposit market is partially subsidized by the collection of commissions. Finally, our database uses data of the Spanish banking sector during the restructuring period, which allow us to analyze the impact of the concentration in the sector on bank competition and productivity and provide some policy implications. In this sense, we find that the restructuring process could have benefited more productive banks because they could have adopted an expansion strategy based on the acquisition of less productive banks, faster than if it had been carried out through organic growth with the opening of its own branches.

The work is related to the literature that studies the differences in the benefits of banks as a result of differences in productivity (Caiazza *et al*., 2016; Almanidis, 2013; Fiordelisi and Molyneux, 2010; Weill, 2004; Berger and Mester, 2003; Grifell-Tatje and Lovell, 1999), although our analysis applies the methodology from Levinsohn and Petrin (2003) to obtain estimates of productivity, rather than relying on stochastic frontier models (SFA) or data envelopment analysis (DEA). Our analysis is also related to Caiazza *et al*. (2016) because it studies the effect of relative productivity among banks on the probability of being merged or acquired.

The rest of the work is structured as follows. Section 2 presents the conceptual framework of the work, as well as the hypotheses to be tested and equations of the empirical model. Section 3 details the database used in the analysis, main variables and their descriptive statistics. In Section 4, the main results of the empirical models are analyzed and Section 5 presents the main conclusions of the study.

3.2 Conceptual framework

The theoretical framework of the work replicates the spatial competence model of Martín-Oliver *et al*. (2018) that incorporates heterogeneity in productivity between banking

institutions in the theoretical framework of Salop (1979). Next, we present a brief description of the theoretical framework from which the main hypotheses to be tested will be extracted in the empirical part.

3.2.1 Price competition

We assume a market in which there are branches with different levels of productivity and marginal cost that are distributed symmetrically along a circumference of length L=1. Branches compete on prices to attract consumers that are distributed evenly around the circumference, and they have to face transport costs to access the branch (product differentiation). Banks grant loans and take deposits from customers, and there is an interbank market in which banks can lend and borrow at a given interest rate.

The Nash equilibrium of this model provides different testable hypotheses. In the first place, Martín-Oliver *et al.* (2018) find that the equilibrium interest rate in the loan market (deposits) increases (decreases) with a weighted average of the marginal operating costs of the bank and its competitors. Differences in operating costs between banks respond to differences in productivity, that is, differences in productivity are inversely related to costs. Martín-Oliver *et al*. (2018) assume that there is a common factor that determines the evolution of the productivity of all banks and decompose the marginal operating cost of each bank into the common component plus the relative difference in productivity between a bank and its competitors. From this conceptual framework, we extract the first hypothesis that we will contrast:

The interest rates on loans (deposits) will be lower (higher) when the productivity of the industry increases and they will be lower (higher) in those banks that show higher productivity.

It also easily follows that interest rates on loans and deposits depend positively on the interest rate of the interbank market, since it acts as a separation between the two markets. On the other hand, the greater the number of banks, the more competition there will be and the lower (higher) interest rates on loans (deposits) will be.

In this Chapter, we propose to extend the analysis of loan and deposit interest rates of Martín-Oliver *et al*. (2018) to also include bank services subject to commissions as an output of banks. During the last years of low reference interest rates, banks have increased

the volume of commissions in net terms. This could be a consequence of the decision to charge for the provision of financial services, especially those associated with payment services, which in the past were understood to be covered by the margin between the deposit types and the interbank rate. If this is the case, we will expect the commissions to increase when the margin between deposit rates and the interbank rate is low or even negative. Given that commissions are a price set by banks for a given output, they should be established by the same theoretical equations and determinants as loan interest rates. Thus, commissions will also depend on the productivity of the banks and the number of branches in the same terms as the interest rates of the loans. Therefore, *net commissions will be lower in those banks that show greater productivity, when the number of competitors is high and when the margin between interbank rates and loan rates is lower*.

To contrast the previous hypotheses, we will use the following empirical model:

$$r_{ijt}^{L} = \beta_0^L + \beta_1^L r_t^{IB} + \beta_2^L A_t^{IND} + \beta_3^L RA_{ijt} + \beta_4^L N_{jt} + CV'\beta_5^L + \varepsilon_{ijt}^L \quad (2A)$$

$$r_{ijt}^{D} = \beta_0^D + \beta_1^D r_t^{IB} + \beta_2^D A_t^{IND} + \beta_3^D RA_{ijt} + \beta_4^D N_{jt} + CV'\beta_5^D + \varepsilon_{ijt}^D \quad (2B)$$

$$Commission_{ijt} = \beta_0^C + \beta_1^C r_t^{IB} + \beta_2^C A_t^{IND} + \beta_3^C RA_{ijt} + \beta_4^C N_{jt} + \beta_5^C Margin_{ijt} + CV'\beta_6^C + \varepsilon_{ijt}^C \quad (2C)$$

where the subscripts *i*, *j* and *t* refer to entity, market and year, respectively. The dependent variables r_{ijt}^{L}, r_{ijt}^{D} and $Commission_{ijt}$ refer to the interest rates of loans, deposits and net commissions applied by entity *i* in market *j* at time *t*. The variable r_t^{IB} is the interbank interest rate, A_t^{IND} refers to the evolution of the productivity of the industry, RA_{ijt} is a measure of the relative productivity between the bank *i* and its competitors, N_{jt} is the number of banks that operate in the market *j* and moment *t*, $Margin_{ijt}$ is a measure of the margin of the deposit activity, and CV is a vector of control variables.

3.2.2 Productivity and restructuration of the banking system

During the period of study, there was a collapse in the demand for banking services that justifies the drop in the number of branches and the closing of a large number of banking entities. In this section we will propose two models to analyze the closing of banks according to their productivity. On the one hand, we examine if the banks that stop operating during the sample period are the least productive. On the other, we study

whether the mergers and takeovers of banks respond to a strategy of takeover by more productive banks of less productive banks.

3.2.2.1 Exit of banking entities

Disappearance of banks (absorbed, merged, rescued, adjudicated) can be explained by several factors that have negatively affected their benefits and economic viability. First, the fall in demand for banking products as a result of the economic-financial crisis. Second, the reduction of the banks' margins attributed to the environment of low reference interest rates, a situation that has demanded an increase in efficiency and cost savings in the banking system. Third, the development of digital banking that has replaced a part of the demand that was satisfied through traditional branches. The combination of these factors has caused the reduction of margins and profits of the banks that has led to the reduction of the productive capacity of the sector, as well as the number of banks that operate.

The aim of this section, however, focuses on explaining the reasons why some banks survive the fall in profits and margins while others cease to operate because they are liquidated, rescued or absorbed by other banks. In this Chapter, we propose a probability model to analyze which are the determinants that explain the exit of banks and, specifically, we will include a measure of productivity to test the hypothesis of whether the banks that have left the market are the least productive. In particular, we will estimate:

$$\Pr(Entity\ i\ exits\ in\ t) = f(RA_{ijt}, Profitability_i, Risk_i, Size_i) \quad (3)$$

where the variable RA_{ijt} is a measure of the relative productivity of the entity compared to its competitors. Previous articles that analyze the output of industrial plants in declining markets predict that the closing sequence will be inversely related to the cost efficiency of these plants (Ghemawat and Nalebuff, 1985; Fudenberg and Tirole, 1986; Reynolds, 1988). If we move this prediction to the exit of banks in the context of falling demand, we expect that less productive banks have a greater probability of leaving. The model also includes variables of profitability and risk, which we expect to be negative and positively correlated, respectively, with the probability of exit. The size of the entity is included as a control variable.

3.2.2.2 Branch expansion through mergers and acquisitions

In this section we analyze whether the most productive banks have followed an expansion strategy during the crisis in order to grow at the expense of the most affected banks. Mergers and acquisitions can be a mechanism through which the most productive banks increase the size of their branch network in provinces where they have relatively little presence. Therefore, the period of crisis and restructuring of the banking system could have been an opportunity for institutions with a relative better position to acquire distressed banks and increase the number of branches in markets with a relatively lower presence. To analyze if this approach is met, we will contrast two hypotheses. The first is based on contrasting whether the acquiring banks are more productive than the banks acquired. The second hypothesis contrasts whether the acquiring banks target banks with significant presence in markets where they have a relatively low number of branches. These two hypotheses are complementary: we test whether high-productive banks absorb low-productive banks and whether they target at banks whose branch network is complementary to their branch network.

To test these hypotheses, we will use a probabilistic model to analyze the determinants of a bank (acquirer) absorbing another (acquired) bank:

$$\Pr(y_{ikt} = 1) = f(RA_{ikt}, Target_{ikt}, VC) \qquad (4)$$

where y_{ikt} is a binary variable that takes value 1 if entity *i* absorbs entity *k* at time *t*, and 0 otherwise. To estimate this model, we need to create a database that contains all the possible binary combinations between banks, including the *i*-*k* and *k*-*i* combinations, although y_{ikt} only takes value 1 if entity *i* absorbs entity *k*, but not viceversa. The variable RA_{ikt} is a measure of the relative productivity of bank *i* with respect to bank *k* in year *t*, and the variable $Target_{ikt}$ is a dummy that takes value 1 if the target bank *k* is present in provinces where the market share of bank *i* is below its target market share, and zero otherwise.

3.3 Database and variables

The database contains information on banks and savings banks that operated in Spain between 2007 and 2015. It contains balance and profit and loss account data extracted from Bankscope and completed with the annual reports published by the CECA and the AEB. The data on the number of branches have been obtained from the annual reports of the Banking Guide published by Maestre Edibán. The data of the macroeconomic variables have been obtained from the National Institute of Statistics and the Bank of Spain. The identification of M&A, auctioned banks and new entities has been constructed using the information published by the Bank of Spain about the restructuring process of the Spanish banking system. Table 10 presents a descriptive analysis of the restructuring process of the Spanish banking system build from the information published in the Bank of Spain's Report on Banking Supervision (*Memoria de Supervisión*) between 2007 and 2014[22]. From this table, we can observe that the reduction in the number of banking groups is mainly explained by the disappearance and consolidation of the old savings banks, and that the number of bank branches has been reduced in 2014 by one third from the maximum reached in 2008.

Next, we describe the most relevant variables used in the empirical analysis and its construction. Also, their descriptive statistics are presented.

Table 10 Restructuring process of the Spanish banking system. Descriptive analysis

Year	Nr. Deposit Institutions	Nr. Banking Groups	Nr. Mergers & Acquisitions (a)	Number of branches					Nr. of branches per 10.000 inhabitants (b)	Nr. Employees per Branch
				(1)+(2)	Banks (1)	Savings Banks (2)	Credit Cooperatives	Foreign Institutions		
2006	276	87	2	37,292	13,835	23,457	4,771	1,297	11.8	4.6
2007	282	89	7	38,850	14,213	24,637	4,953	1,362	12.0	4.5
2008	285	88	4	39,193	14,158	25,035	5,097	1,457	12.0	4.4
2009	283	88	8	37,718	13,466	24,252	5,043	1,413	11.6	4.4
2010	278	62	12 (23)	36,593	13,843	22,750	5,019	1,408	11.2	4.4
2011	247	59	6 (10)	33,714			4,890	1,311	10.4	4.5
2012	232	55	11 (16)	32,033			4,732	1,222	10.0	4.5
2013	227	50	8 (11)	27,848			4,511	1,223	8.9	4.7
2014	223	51	8 (8)	25,790			4,416	1,670	8.3	4.7

Spanish banks between 2006 and 2014, build from the information published in the Bank of Spain's Report on Banking Supervision (*Memoria de Supervisión*) being 2014 the last year for which this report publishes this data. (a) In parenthesis, number of banks affected by mergers and acquisitions. (2) Number of branches per 10.000 inhabitants older than 16 years.

[22] 2014 is the last year for which the Bank of Spain's Supervisory Report publishes this data.

3.3.1 Interest rates on loans, deposits and net commissions

Interest rates of loans and deposits have been calculated with balance sheet items and profit and loss accounts published by each entity. The interest rate for loans is equal to the ratio of the item "Interest Income" and the item "Loans to Customers". The interest rate for deposits has been calculated with the ratio of "Interest Expenses" and "Deposits from Customers". The interest rates presented in this Chapter should be comparable with the interest rates of the stock of loans presented in the Statistical Bulletin of the Bank of Spain and analyzed in Martínez-Pagés (2017). Even though this approach is not perfect because the magnitude of our rates does not coincide[23], our data constitute a reasonable approximation to the regulator series since the trend shown by the average of our rates is similar and their relative evolution with respect to the 12-month Euribor that serves as a reference to the banking business.

Figure 4A shows the average of the loan and deposit interest rates and the one-year Euribor. We observe that the Euribor has decreased during the sample period from 4.8% in 2008 to levels close to 0% in 2015. We see that, despite the years analyzed cover only partially the period of Quantitative Easing from the ECB (starting from March 2015), reference rates have remained below 2% since 2009 in a downward trend and, therefore, our sample period allows us to analyze the effects of an environment of low interest rates on banking industry. The trend of asset and liability rates has followed the evolution of the 1-year Euribor. The margins and relative differences between interest rates are observed more clearly in Figure 4B.

We observe that the margin of the deposit activity (difference between interbank and type of deposits) has remained at negative levels since 2008, which indicates that the activity of deposits has contributed negatively to the margin of the banks. This is due to the limited or null margin of maneuver that banks have to obtain returns on deposits in a context of low rates close to zero, added to the competition between banks to obtain stable financing within a context of financial market closures and lack of liquidity. However, on

[23] The reason is that, as mentioned, our rates are constructed as ratios of aggregate data of items in the banks' annual accounts, which constitute an imperfect approximation to an average data of interest rates of the stock of loans and deposits. For example, when computing interest income, we include flows that do not come from the entity's credit portfolio (for example, interests on debt securities), as well as the fact that interest expenses includes charges for liabilities other than deposits (for example, payment of debt).

Figure 4 Average interest rates and interest margins

Figure 4A: Interest rates

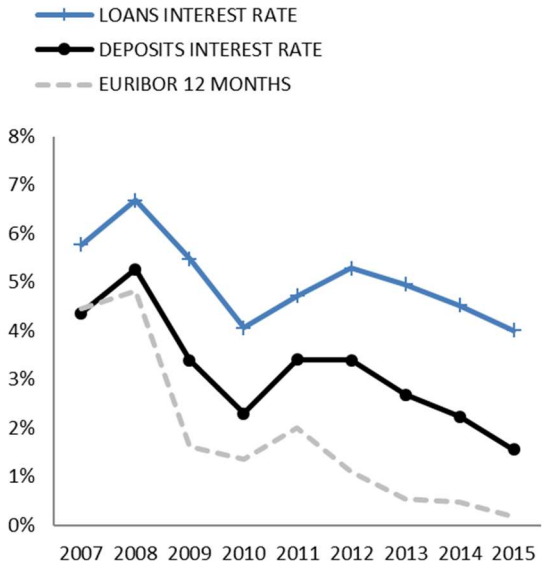
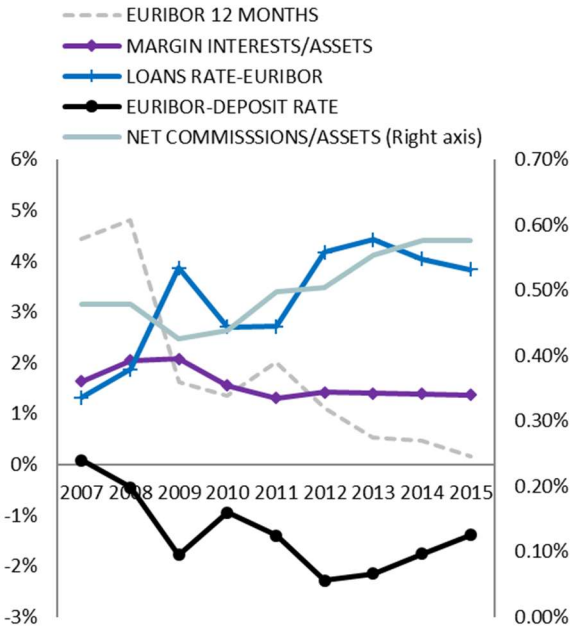


Figure 4B: Margins and spreads of interest rates



the side of loans, we note that the average margin over the interbank show an increasing trend reaching levels above 4 percentage points since 2012. This increase could be offsetting the decline in margin of liabilities, in line with results exposed in Martínez-Pagés (2017), which would explain the relative stability of margin of interests with respect to assets in Figure 4B. In addition, we observed an increase in the net commission income of the banks, which could come from the collection of payment services associated with liability products and which, therefore, would also cushion the negative margin in the liability side.

In summary, the environment of low interest rates has caused deposits institutions to operate with negative margins in the liability business, since reference rates are close to zero and the banks remunerate their clients above the reference interest rate. Despite this fact, the banks have begun a path of increasing margins on the asset side, which are not limited by the low interest rate environment, and of increasing the income from commissions for payment services to compensate for negative margins in the market of

deposits. Therefore, a low interest environment should not necessarily lead to a fall in interest margins. In fact, as Martínez-Pagés (2017) points out, the decline in margins is not only due to the fall in interest rates, but also to the decline in activity (volume) and increase of default rates that lessens income.

3.3.2 Measurement of the productivity of banking entities

The proposed models include a measure of productivity of banking entities. In the analysis we will use productivity variables in absolute and relative terms.

The estimation of productivity A_{it} for bank i in year t is estimated as in Martín-Oliver *et al*. (2013) using the proposed methodology in Olley and Pakes (1996) and developed in Levinsohn and Petrin (2003), but with a different time period and definition of inputs. This methodology is based on the estimation of the parameters of the production function of companies correcting an endogenous bias in the estimation of the elasticity of output with respect to labor and capital due to the existence of productivity shocks. More precisely, due to the fact that the amount of input (labor) used by the bank can be determined, in turn, by the level of the productivity shock. From the estimation of the parameters of the production function, the productivity estimates for each bank and period can be recovered[24].

In this Chapter we use as a measure of the output of the bank the sum of loans and deposits of the entity, as a proxy of the level of banking services provided by the entity. The labor input is approximated by the labor costs and the stock of capital is assumed equal to the volume of fixed material assets reported in the entity's balance sheet. To correct the bias caused by productivity shocks, it is necessary to define an intermediate input τ which in our case will be the total volume of debt[25]. The results of the estimation of the production function show that the elasticity of the output with respect to the labor

[24] Following Martin-Oliver *et al.* (2018), we have tried to obtain a net measure of productivity, regressing the gross productivity on variables capturing differences in business models available in Bankscope (weight of loans, weight of interbank, weight of total securities, regulatory capital and total assets) and on time dummies. Given that the coefficients of the variables were not statistically significant during this sample period, we assume that the residuals of this regression (measure of net productivity) were not different to our direct measure of productivity obtained from equation (5).

[25] This intermediate input fulfills the necessary assumption that the entity could increase the amount of debt to meet possible productivity shocks, for any level of capital.

factor is 0.578 and with respect to the capital factor of 0.357, and the null hypothesis of the existence of constant returns to scale cannot be rejected.

3.3.2.1 Productivity in the banking industry

With the estimation of the banking production function, the productivity estimate for bank *i* in year *t* can be recovered as:

$$\ln PRODUCTIVITY_{it} = \ln(D_{it} + L_{it}) - 0.578 \ln N_{it} - 0.357 \ln K_{it}. \quad (5)$$

Next, using the estimated productivity for each bank, we can construct an indicator of the total productivity of the industry. Olley and Pakes (1996) break down the evolution of total industry productivity into two components. On the one hand, the evolution of the simple average of productivity between banks and, on the other hand, a component that captures the differences in productivity associated with the size of the banks.

Figure 5A shows the evolution of the productivity of the industry (black line) and its decomposition in the two mentioned factors. We observe that during the sample period, the productivity of the industry has remained stable. In 2010 there was a rebound in the productivity of the industry, which could be explained by the exit of banks with low productivity (Table 10 shows in 2010 12 mergers with 23 banks involved). During the two following years there was a fall in the productivity of the industry, during the most severe years of the restructuring process, possibly due to the fall in demand for banking products and credit reduction in those years. In the years 2013-2014, productivity grew marginally and in 2015, coinciding with the start of the Quantitative Easing, productivity experienced a 5% growth. Figure 5B shows annual growth rates and cumulative growth rate of industry productivity. Comparing the levels of 2015 and 2007, we observe that productivity has grown by only 2%, with the average annual growth around 0.37%.

As for the decomposition into factors, in Figure 5A we observe that the size effect among banks explains about 10% of the productivity of the industry. That is, the largest banks are the most productive and, therefore, the simple average of productivity is lower than the weighted average that reflects the productivity of the industry. However, as the years progress, the efficiency component by size decreases its importance and, by the end of 2015, it is reduced to 2.83% of the productivity of the industry. This may be due to the fact that the restructuring of the banking sector has led to the exit of lower productivity

Figure 5 Productivity of the banking sector

Figure 5A: Productivity of the industry

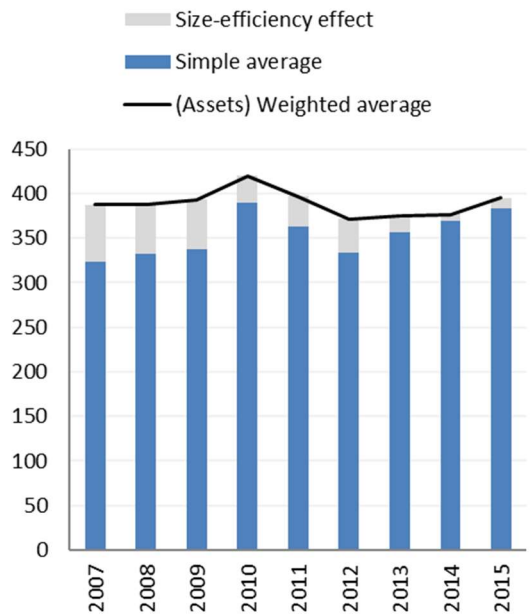


Figure 5B: Productivity growth

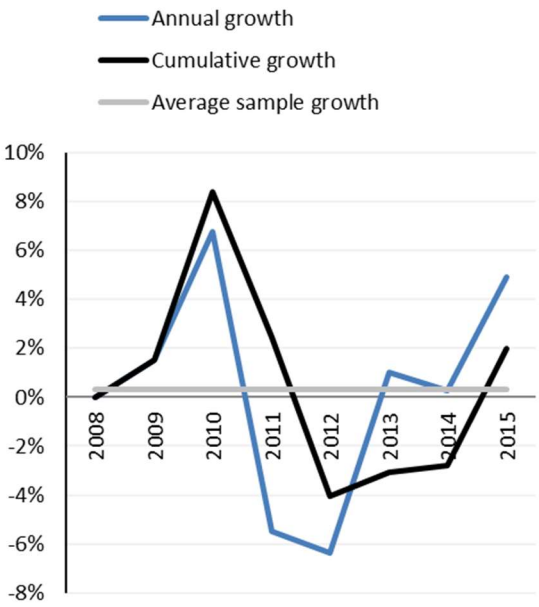
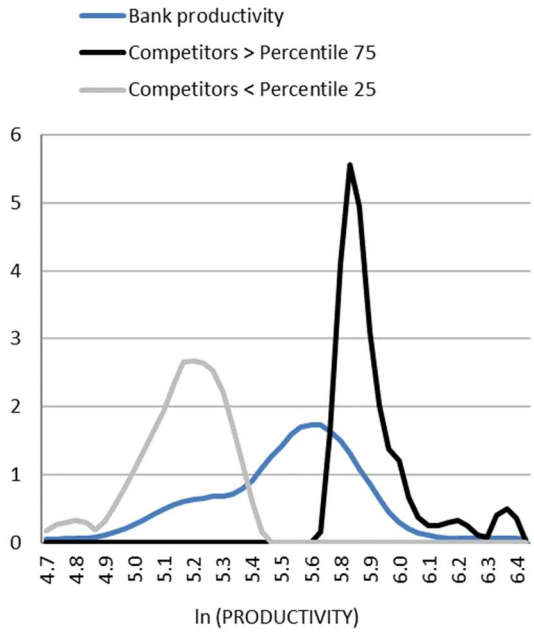


Figure 5C: Distribution of productivity



banks, a hypothesis that will be contrasted in the empirical models. If the hypothesis were true, this would imply, on the one hand, that the most productive banks survive and,

secondly, that mergers and acquisitions generate large and more productive institutions, reducing the heterogeneity in the size-efficiency. Therefore, the simple average and the weighted average (industry) would tend to converge.

3.3.2.2 Productivity measures

The proposed empirical models include different measures of productivity. In absolute terms, the variable $PRODUCTIVITY_{it}$ captures the level of absolute productivity of entity i in year t, obtained from equation (5), and the variable *PRODUCTIV.INDUSTRY* is a time variable that reflects the evolution of productivity of the industry shown in Figure 5A.

Relative productivity measures concerning an entity with respect to its competitors, who have called RA_{ikt}, are also used. We will use two variables to define banks that have high productivity and low productivity, in relation to the rest. The variable $Id(LOW\ PROD_{it})$ will take value 1 if bank i in year t has a productivity lower than the 25th percentile of the productivity distribution of banks that compete in the relevant market of bank i in year t. We define as the relevant market of bank i all those provinces where it has at least five branches. Similarly, the variable $Id(HIGH\ PROD_{it})$ will take value 1 if bank i in year t has a productivity higher than the 75th percentile of the productivity distribution of the banks that compete in the relevant market of bank i in year t. Figure 5C shows the distribution of the productivity of the banks during the sample period, as well as the distribution of the productivity of the banks that have a high (higher than the 75th percentile) and low (lower than the 25th percentile) productivity. We observe that productivity presents greater dispersion and wider tail in the left part of the distribution, while banks with higher productivity have a more concentrated distribution.

In the model of branch expansion through mergers and acquisitions, an alternative measure of relative productivity is used, $Id(PROD_{it}>PROD_{kt})$, which is a binary variable that identifies the cases in which the productivity of the acquiring entity is higher than the productivity of the acquired entity. The model also includes in some specifications the variable $Id(LOW\ PROD\ COMP_{ikt})$, which takes value 1 if the competitor k of entity i has a productivity in year t lower than the 25th percentile of the productivity distribution of the rest of competitors.

3.3.3 Other explanatory variables

In this section we define the rest of the variables used in the empirical models. The variable $MARKET\ SIZE_{it}$ (N in equations 2A, 2B and 2C) shows the size of the markets in which entity i operates in year t, approximated by the total number of branches operating in the provinces in which the bank i has at least 5 branches.

The rest of the variables included in the models capture the heterogeneity among financial entities. Thus, ln($TOTAL\ ASSETS_{it}$) is the logarithm of the volume of assets of the entity; $MARGIN_{it}$ is the difference between the average rate of loans and the average rate of deposits offered by the entity; ROA_{it} is the return of the entity in relation to the volume of assets; $CAPITAL\ RATIO_{it}$ is the weight of own funds over asset; $PROVISIONS/LOANS_{it}$ is equal to the weight of insolvency provision each year on the total loan portfolio; and Z_{it} is the z-score of the entity. The Z-score is a standard measure of risk (Goetz *et al*., 2016; Laeven and Levine, 2009) calculated as the sum of the ROA_{it} and the $CAPITAL\ RATIO_{it}$ of the entity divided by the standard deviation of the ROA_{it} of the entity.

Table 11 shows the descriptive statistics of the variables that capture the heterogeneity of the banking entities. There is a growing evolution of the average size of assets with a decrease in dispersion, which is consistent with the process of concentration of the sector in a small number of large banks. The trend in net interest income is decreasing for the middle of banks, as discussed in Figure 4. Z-score is a measure inversely related with the level of risk so we find an increase in the level of risk assumed by the banks during the period of crisis that softens in the last year 2015, which is also consistent with the evolution of the risk proxy of the loan portfolio $PROVISION/LOANS_{it}$. The average ROA_{it} of the banks has experienced a decline to negative levels during the most severe years of the crisis (where the greatest dispersion is recorded), although it has returned to the positive side since 2015. The $CAPITAL\ RATIO_{it}$ has followed the same evolution, reaching its minimum during the worst years of the crisis, and increasing to 7.75% in 2015, possibly due to the efforts of the banks to improve their levels and quality of capital to comply with Basel III.

Two more entity variables are used in the empirical model of equation (4). One is $TARGET_{ikt}$, which is a dummy variable that takes the value 1 if bank k has branches in at least one market considered "target" of entity i, being an "target" market where the share

of entity *i* is lower than the average of the shares of entity *i* in the rest of the markets. The other variable is the sum of the market shares (in terms of number of branches) of the entity *k* in markets that are considered as target markets for the entity *i*, $SUM\ SHARES_{ikt}$.

Table 11 Descriptive statistics of explanatory variables capturing the heterogeneity of the banking entities. Spanish banks, 2005-2015

	Nr.	ln ASSETS		MARGIN (x100)		Z-SCORE (%)		PROVISIONS/LOANS (%)		ROA (%)		CAPITAL RATIO (%)	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
2005	63	16.528	1.331	1.678	0.522	72.4	47.4	28.335	34.065	0.950	0.538	6.500	3.726
2006	63	16.590	1.359	1.626	0.532	72.3	47.4	24.412	29.093	0.977	0.577	6.440	3.654
2007	63	16.640	1.386	1.637	0.494	62.0	41.8	28.335	34.065	0.951	0.562	6.182	3.619
2008	63	16.676	1.518	2.047	3.479	49.4	37.0	41.588	40.897	0.680	0.796	6.127	4.047
2009	64	16.714	1.483	2.075	2.763	33.9	29.6	47.965	43.704	0.420	0.888	6.312	4.159
2010	54	16.932	1.473	1.551	1.862	34.7	31.5	35.497	41.455	0.258	1.198	5.799	4.848
2011	30	17.780	1.182	1.304	0.536	37.3	27.9	43.369	42.955	-0.079	1.372	6.608	4.165
2012	25	18.001	1.149	1.422	0.592	16.1	21.1	56.603	45.383	-2.958	3.262	5.414	4.744
2013	23	17.993	1.144	1.397	0.583	21.5	27.0	55.108	43.929	-0.091	0.828	6.265	4.275
2014	21	18.043	1.178	1.390	0.598	18.8	21.1	53.366	43.194	0.435	0.556	7.297	4.320
2015	21	18.073	1.239	1.426	0.612	43.4	30.1	49.937	40.077	0.476	0.607	7.755	4.221

Definition of variables can be found in the Appendix of Chapter 3.

3.4 Results of empirical model

3.4.1 Interest rates and net fees

The results of the estimation of the model of the determinants of interest rates and net fees are presented in Table 12.

In general, we observe that the predictions of the theoretical model are adjusted for interest rates on loans and net commissions, although we do not find significant evidence for the case of deposits. We observe that the evolution of the productivity of the industry has a negative impact on the interest rates of the loans, as we had predicted, although it does not seem that the effect of improvements in productivity affects the rates of deposits.

Table 12 Interest rates and commissions

	LOANS INTEREST RATE$_{it}$		DEPOSITS INTEREST RATE$_{it}$		NET COMMISSIONS$_{it}$	
	[I]	[II]	[III]	[IV]	[V]	[VI]
Id(HIGH PROD$_{it}$)	-0.000		0.001		-0.001***	
	(0.001)		(0.001)		(0.000)	
Id(LOW PRODit)	0.005***		0.002		0.000	
	(0.001)		(0.002)		(0.000)	
ln(PRODUCTIVITY$_{it}$)		-0.007***		-0.003		-0.001***
		(0.003)		(0.003)		(0.000)
ln(PRODUCTIV.INDUSTRY$_t$)	-0.018**	-0.011	-0.013	-0.011	-0.002	-0.001
	(0.008)	(0.008)	(0.009)	(0.009)	(0.002)	(0.002)
ln(TOTAL ASSETS$_{it}$)	0.001**	0.001**	0.004***	0.004***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MARGIN$_{it}$					-0.046***	-0.046***
					(0.013)	(0.013)
Z$_{it}$	-0.000**	-0.000**				
	(0.000)	(0.000)				
PROVISIONS/LOANS$_{it}$	0.000	0.000				
	(0.000)	(0.000)				
INFLATION$_t$	0.104	0.103	0.105	0.100	-0.123	-0.103
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
EURIBOR$_t$	0.646***	0.646***	0.703***	0.703***	0.011	0.012
	(0.059)	(0.058)	(0.068)	(0.068)	(0.014)	(0.014)
GDP GROWTH$_t$	-0.213***	-0.213***	-0.188***	-0.189***	0.002	0.002
	(0.026)	(0.026)	(0.036)	(0.036)	(0.007)	(0.007)
ln(MARKET SIZE$_{it}$)	-0.013*	-0.013*	0.005	0.005	-0.003*	-0.003*
	(0.008)	(0.008)	(0.007)	(0.007)	(0.002)	(0.002)
N	490	490	490	490	490	490
R^2	0.391	0.387	0.457	0.455	0.100	0.096
Adjusted R^2	0.379	0.375	0.448	0.447	0.083	0.081

The results are from OLS using data of Spanish banks between 2007 and 2015. The dependent variables are interest rates for loans [Column (I) and (II)], interest rates for deposits [Column (III) and (IV)] and net commissions [Column (V) and (VI)] built from balance sheet items and profit and loss accounts published by each entity. Definition of variables can be found in the Appendix of Chapter 3. The robust standard errors that are corrected for clustering at the bank level are in parenthesis

$p < 0.01$=***, $p < 0.05$=**, $p < 0.1$=*

The differences in productivity between banks also translate into differences in the interest rates of the banks in the sense predicted by the theoretical model. On average, the interest rate on loans is 50 basis points higher in banks with low productivity, while banks with high productivity charge lower fees (lower by an average amount equal to 0.1% of the entity's assets). If we substitute the relative productivity variables for the absolute

productivity one, ln($PRODUCTIVITY_{it}$), the result of lower commissions and loan interest rates for higher levels of productivity of the banks is confirmed.

The coefficient of the variable ln($MARKET\ SIZE_{it}$) is negative and significant at 10% in net loans and commissions, but not significant in deposit rates. The negative coefficient is consistent with the prediction that the number of branches in the market was a proxy for the intensity of competition, that is, the more competition the model predicts lower interest rates on loans and lower commissions.

Regarding the variables that capture the heterogeneity among deposit entities, the negative sign of the Z_{it} coefficient indicates that the banks compensate a higher risk profile (low values of Z) with a higher loan interest rate. The positive sign of the variable $PROVISIONS/LOANS_{it}$ goes in the same direction, although not significant. Larger banks ($TOTAL\ ASSETS_{it}$) pay more to their depositors, but also apply higher loans rates. Finally, banks with a lower intermediation margin, $MARGIN_{it}$, apply higher commissions, which is consistent with the prediction that banks substitute the margin obtained in the deposit activity for an increase in fees for the provision of payment services.

A possible reason that explains the non-significance of coefficients in the case of deposits is that banks are forced to remunerate above the reference rate and, therefore, obtain negative margins of this activity. As a result, banks may not follow the profit-maximizing behavior predicted by the model, since it would be an activity subsidized by others.

Regarding the macroeconomic variables, we observe that the interest rates depend positively on the $EURIBOR_t$, an expected result if the reference rate marks the evolution of the prices set by the banks. In terms of $GDP\ GROWTH_t$ and $INFLATION_t$, it seems that in years of higher growth, interest rates have been lower and that inflation does not affect rates and commissions once the effect of the Euribor has been considered.

3.4.2 Probability of exiting the banking market

During the sample period, the economic and financial crisis altered the competition between banking entities and caused the restructuring of the sector that resulted in the exit of banks. In this process, we have predicted that less efficient banks are more likely not to survive and to be liquidated / merged / acquired / restructured. To test this hypothesis,

we estimate a Logit with a dependent variable y_{it} that equals 1 if entity *i* exits market in year *t* and zero otherwise (*i.e.* for years after t the entity is not in the sample). The results are presented in Table 13.

In Column 1 we observe that the least productive banks have a higher probability of not surviving than the rest of the banks. If we include control variables (Column 2), the result of productivity remains (although statistical significance drops from 5% to 10%). In addition, it appears that the banks that are more likely to exit are the *cajas*, the banks with low profitability, higher risk (lower Z) and smaller size. All of them are results consistent with the theoretical predictions and in alignment with the profile of entity facing major problems during the crisis.

Table 13 Probability of exit of an entity

Dependent variable: Pr(Entity *i* exiting market in *t*)	[I]	[II]
Id(HIGH PROD$_{it}$)	0.207	0.112
	(0.412)	(0.460)
Id(LOW PROD$_{it}$)	0.735**	0.719*
	(0.364)	(0.394)
Id(SAVINGS BANK$_i$)		0.961*
		(0.509)
ROA$_{it}$		-68.905**
		(30.377)
CAPITAL RATIO$_{it}$		-2.890
		(8.003)
PROVISIONS/LOANS$_{it}$		-0.676
		(0.446)
Z$_{it}$		-0.035***
		(0.007)
ln(TOTAL ASSETS$_{it}$)		-0.314**
		(0.135)
N	490	490
Pseudo R^2	0.014	0.236

The results are from logit using data of Spanish banks between 2007 and 2015. The dependent variable is a categorical variable that takes the value of one if the bank exits market and zero otherwise. Definition of variables can be found in the Appendix of Chapter 3. The robust standard errors that are corrected for clustering at the bank level are in parenthesis.

$p < 0.01$=***, $p < 0.05$=**, $p < 0.1$=*

3.4.3 Branch expansion through mergers and takeovers

Table 14 shows the results of estimating equation (4) with a Logit model to analyze whether the most productive banks and those that have better withstood the crisis have taken advantage of the situation to expand their market share in 'target' provinces through the acquisition of less productive banks.

The positive and significant coefficient of the $TARGET_{ikt}$ variable implies that the probability of a bank acquiring another bank increases if the acquired entity has branches operating in at least one of the markets where entity *i* wants to grow. That is, the results confirm that the purchase of the network of branches of a competing entity is a strategy that has been used by banks that want to enter or expand their network in a certain market.

Table 14 Probability of one entity absorbing another entity

Dependent variable: Pr(Entity *i* absorbing entity *k at t*)			
	[I]	[II]	[III]
$TARGET_{ikt}$	2.544***	2.537***	2.501***
	(0.514)	(0.514)	(0.525)
$SUM\ SHARES_{ikt}$	0.287*	0.285*	0.327*
	(0.166)	(0.168)	(0.176)
$Id(PROD_{it}>PROD_{kt})$	2.049***	2.156***	1.999***
	(0.137)	(0.146)	(0.153)
$Id(LOW\ PROD\ COMP_{ikt})$		-0.308	
		(0.193)	
$Id(SIP_i)$			0.188
			(0.168)
N	95,024	95,024	95,024
Pseudo R^2	0.097	0.098	0.098

The results are from logit using data of Spanish banks between 2007 and 2015. The dependent variable is a categorical variable that takes the value of one if the bank *i* acquires bank *k* and zero otherwise. Definition of variables can be found in the Appendix of Chapter 3. The robust standard errors that are corrected for clustering at the bank level are in parenthesis.

$p < 0.01$=***, $p < 0.05$=**, $p < 0.1$=*

This result is reinforced by the positive of the variable $SUM\ SHARES_{ikt}$ (although significant at 10%), that is, the higher the market share of the acquired entity in the target market, the greater the likelihood that the entity *i* absorbed it. The positive sign of Id($PROD_{it}>PROD_{kt}$) indicates that this strategy is more likely if the acquired banks have a lower productivity than the acquiring banks. The coefficient Id($LOW\ PROD\ COMP_{ikt}$) is not statistically significant in Column 2, while the sign and significance of Id($PROD_{it}>PROD_{kt}$) remains unchanged. This indicates that what matters is not so much that the acquired has low productivity, but productivity being lower than that of the entity to acquirer. Column (4) includes the dummy Id(SIP)$_i$ that controls for mergers that come from previous partial mergers among savings banks[26], where we have identified the acquiring entity as the largest. The coefficient is not statistically significant and the rest of the results do not vary.

3.5 Conclusions

This Chapter analyzes how the evolution of productivity during the financial crisis has affected the level of competition in prices of banks in Spain, and whether it affected the process of restructuring of the banking system. Using data from Spanish banks that operated during the period 2007-2015, the work shows first that the productivity of the industry practically did not vary from the beginning to the end of the period, although the first years grew at an average annual rate of 2.7 %, due to the fact that in 2011 and 2012 it experienced drops of 5.49% and 6.34% that erased the previous accumulated growth. The results show that the stagnation in productivity could be explained by the combination of two factors. On the one hand, the restructuring caused the exit of less productive banks. This increases the average productivity of the survivors and decreases their heterogeneity. On the other hand, the contraction period causes a fall in demand for banking products that is not instantly compensated by a reduction in productive capacity, which may explain the negative effect on total productivity.

[26] The so-called *SIP* (*Sistemas de Protección Institucional*) or *cold mergers*. This is the name that was given to the partial merge among groups of savings banks to share their financial assets and management, but each savings bank maintained its brand and autonomy. They lasted for a short period of time since regulation obliged savings banks to transform their activity into commercial banks.

The differences in productivity among banks can explain differences observed in the interest rates offered by institutions in the loan market. We observe that the less productive banks offer loans with rates that are, on average, 50 basis points lower than the rest of the banks. Likewise, increases of 1% in the productivity of the industry are translated into a reduction of 0.7 basis points in the rates of loans. In the deposit market, we do not observe that the rates respond to the theoretical predictions, neither in productivity nor in the rest of the variables. The reason may be that the theoretical framework cannot be applied in the case of deposits in a context of reference rates close to zero, since it reaches the point where it is not possible to further reduce deposit rates to maintain a positive margin in that activity. Nonetheless, the Chapter presents evidence that reference rates close to zero do not necessarily imply that the banks have reduced the total intermediation margin. On the one hand, we find that as the deposit margin becomes more negative, the types of loans increase the differential with respect to the Euribor, so that the banks could be offsetting the negative result in the activity of deposits with an increase in the interest rate differential on the loans side. On the other hand, the banks that have narrowed their deposit margin are those that have increased commissions to customers, charging explicitly for payment services associated with deposits that were previously implicitly included in the deposit margin. Our results also suggest that banks, in periods of low or negative reference rates, have a lower limit of 0% in the interest rate set to depositors. They are not willing to translate the decrease in the reference interest rate below zero, explaining why interest rates of deposits are not related with the Euribor during our sample period.

The work also shows that the restructuring process has been an opportunity for expansion for the most productive banks, at the expense of the least productive ones. We find that merge and acquisition processes were more likely when the acquiring entity was relatively more productive than the acquired one and when it had a high density of branches in markets where the purchaser had little presence, in relation to its target share. In short, the consolidation processes that have taken place in recent years have led to the exit of less productive banks. The banks that have survived have acquired a large part of the network of branches of the absorbed banks, so that customers of these branches could benefit from lower interest rates on loans and commissions. However, it should be analyzed in the future if the increase in the concentration of the banking sector can cause

an increase in the market power of the surviving banks that eliminates the improvements in price for customers due to higher productivity.

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Appendix of Chapter 3

Definition of variables

Dependent variables

Loans interest rate $_{it}$. Interest rate for loans of entity *i* at year *t*, calculated as the ratio of the item "Interests' Income" and the item " Loans to Customers" obtained from balance sheet items and profit and loss accounts published by each entity, winsorized at 5%.

Deposits interest rate$_{it}$. Interest rate for deposits of entity *i* at year *t*, calculated as the ratio of "Interests Expenses" and "Deposits from Customers" obtained from balance sheet items and profit and loss accounts published by each entity, winsorized at 5%.

Net commissions$_{it}$. Net commissions of entity *i* at year *t*, calculated as the ratio of "net fees and commissions" and "total assets" obtained from balance sheet items and profit and loss accounts published by each entity, winsorized at 1%.

Pr(Entity i exiting market in t). Dummy variable that takes the value of one if entity *i* leaves the market in *t* (*i.e.*, entity *i* is not present in the sample from t+1 onwards) and zero otherwise.

Pr(Entity i absorbing entity k at t). Dummy variable that takes the value of one if entity *i* absorbs entity *k* at time *t*, and 0 otherwise.

Explanatory variables

Id(HIGH PROD$_{it}$*)*. Dummy variable that takes the value of one if bank *i* in year *t* has a productivity higher than the 75th percentile of the productivity distribution of the banks that compete in the relevant market of bank *i* in year *t*, where the relevant market is defined as all those provinces where bank *i* has at least five branches.

Id(LOW PROD $_{it}$*)*. Dummy variable that takes the value of one if bank *i* in year *t* has a productivity lower than the 25th percentile of the productivity distribution of banks that compete in the relevant market of bank *i* in year *t*, where the relevant market is defined as all those provinces where bank *i* has at least five branches.

lnPRODUCTIVITY$_{it}$. Logarithm of absolute value of the productivity estimate for bank *i* in year *t*, which is recovered from the estimation of the banking production function as:

$$\ln PRODUCTIVITY_{it} = \ln(D_{it} + L_{it}) - 0.578 \ln N_{it} - 0.357 \ln K_{it} \quad (5)$$

where (D_{it} + L_{it}) is the sum of loans and deposits of entity i in year t, measuring the level of banking services provided by the entity; N_{it} is the labour input approximated by the labor costs; and K_{it} is the stock of capital calculated as the volume of fixed material assets reported in the entity's balance. The estimation of productivity for bank *i* in year *t* is estimated as in Martín-Oliver *et al.* (2013) using the proposed methodology in Olley and Pakes (1996) and developed in Levinsohn and Petrin (2003), but with a different time period and definition of inputs. This methodology is based on the estimation of the parameters of the production function of companies correcting an endogenous bias in the estimation of the elasticity of output with respect to labor and capital due to the existence of productivity shocks. To correct the bias caused by productivity shocks, it is necessary to define an intermediate input τ which in our case is the total volume of debt.

ln(PRODUCTIV.INDUSTRY$_t$). Logarithm of absolute value of productivity of the industry in year *t*, calculated as the average of estimated productivity for all banks as explained above.

ln(TOTAL ASSETS$_{it}$). Book value of the bank *i*'s assets at the end of the year *t*, in logs.

MARGIN$_{it.}$ Difference between the average rate of loans (*Loans interest rate*) and the average rate of deposits (*Deposits interest rate*) offered by the entity *i* at year *t*.

Z$_{it}$. Z-score of the entity *i* in year *t*, winsorized at 1%. The Z-score is a standard measure of risk (Goetz *et al*., 2016; Laeven and Levine, 2009) calculated as the sum of the *ROA* and the *CAPITAL RATIO* of the entity divided by the standard deviation of the *ROA* of the entity.

PROVISIONS/LOANS$_{it}$. Ratio of the insolvency provision of entity *i* in year *t* to the total loan portfolio.

INFLATION$_t$. Inflation rate in year *t*.

EURIBOR$_t$. Average 12-month Euribor in year *t*.

GDP GROWTH$_t$. GDP growth rate in year *t*.

ln(MARKET SIZE$_{it}$). Size of the markets in which entity *i* operates in year *t*, approximated by the total number of branches operating in the provinces in which the bank *i* has at least 5 branches, in logs.

Id(SAVINGS BANK$_i$). Dummy variable that takes the value of one if the bank *i* is a savings bank and zero otherwise.

ROA$_{it}$. Ratio of after-tax profit and the assets of bank *i* in year *t*.

CAPITAL RATIO$_{it}$. Ratio of own funds over assets of entity *i* in year *t*, winsorized at 1%.

TARGET$_{ikt}$. Dummy that takes value of one if bank *k* has branches in year *t* in at least one market considered "target" of entity *i*, being a "target" market where the share of entity *i* is lower than the average of the shares of entity *i* in the rest of the markets in year *t*, and zero otherwise.

SUM SHARES$_{ikt}$. Sum of the market shares (in terms of number of branches) of the entity *k* in year *t* in markets that are considered as target markets for the entity *i*, being a "target" market where the share of entity *i* is lower than the average of the shares of entity *i* in the rest of the markets in year *t*.

Id(PROD$_{it}$>PROD$_{kt}$). Dummy variable that takes the value of one if the productivity of the acquiring entity *i* in year *t* is higher than the productivity of the acquired entity *j* in year *t*, and zero otherwise.

Id(LOW PROD COMP$_{ikt}$). Dummy variable that takes the value of one if the productivity of the competitor *k* of entity *i* in year *t* is lower than the 25th percentile of the productivity distribution of the industry.

Id(SIP$_i$). Dummy variable that takes the value of one if entity *i* is involved in a SIPs and zero otherwise. The so-called *SIPs* (*Sistemas de Protección Institucional*) or cold mergers refer to a partial merge among groups of savings banks to share their financial assets and management, while maintaining its brand and autonomy. They lasted for a short period of time since regulation obliged savings banks to transform their activity into commercial banks.