Bank Lending, Bank Regulation and European Sovereign Debt Crisis

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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Abstract

This dissertation comprises three empirical studies that aim to achieve a better understanding of financial crises, especially the most recent European sovereign debt crisis, and to contribute to the literature in the field.

In the first empirical study, I review the lending behaviour of small and large banks in the Eurozone during the sovereign debt crisis. I find that relative to large banks, small banks in peripheral countries (1) barely substitute private loans with public debt and, as a result, are less likely to contribute to a credit crunch in the crisis and, (2) are less pro-cyclical in their lending behaviour. Such results support incentives embedded in new banking regulations that penalise bank size.

In the second empirical study, I investigate how model-based capital regulations can be misused by European banks for capital saving purposes. I find that relative to banks from core countries, banks from peripheral countries (1) could greatly reduce the risk-weight associated with their assets by applying more model-based capital rules, and (2) that the default frequency of their assets is not reflected in their capital requirement calculations. These results indicate that banks from peripheral countries are more likely to abuse model-based capital rules.

In the third empirical chapter, I examine how banks developed a home bias in their debt portfolios during the Eurozone crisis. I find that while state-owned banks have a greater home bias than private banks in their sovereign debt portfolios only when their domestic government faces considerable funding pressure, for private

banks the home bias is always more pronounced in their retail and corporate portfolios. This new test supports the view that state-owned banks are more likely to be influenced by moral suasion, which may divert important sources of funding from the private sector.

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Chapter 1 Introduction

It has been a decade since the beginning of the Great Recession, which is regarded as the worst global recession since World War II (International Monetary Fund (IMF) 2009[1]). The Great Recession is characterised by two consecutive crises, namely, the subprime crisis caused by the collapse of the US subprime mortgage market in 2007, and the subsequent European sovereign debt crisis that spread across Europe. Unlike the subprime crisis, the effect of the European crisis appears to be very long lasting; some European countries are still struggling to recover. Various factors may have contributed to the European crisis, though the so-called 'diabolic loop' or nexus between sovereigns and banks is certainly crucial. A distressed banking sector may exacerbate a solvency problem in the public sector because governments face higher potential bailout costs and lower taxation income due to reduced bank lending to the real economy (Acharya et al. 2015). In turn, increased sovereign credit risk weakens the banking sector as banks suffer losses in their government bond portfolios, and the implicit guarantee of future government support, if any, is less credible (Brunnermeier et al. 2016; Farhi and Tirole 2018). This dissertation aims to explore banking activity in the context of the European debt crisis, deepen our understanding of the interplay of sovereigns and banks, and offer insights on how to better control the corresponding risks.

[1] "World Economic Outlook — April 2009: Crisis and Recovery" (PDF). Box 1.1 (page 11-14). IMF. April 24, 2009. Retrieved September 17, 2013.

The first empirical chapter of this dissertation explores the question of whether small banks were more resilient than large banks during the European crisis. I study this topic by focusing on one of the most important activities of banks: lending to the real economy (i.e. the non-financial private sector). A number of studies have demonstrated that a bank's sovereign debt holdings have a negative impact on its lending to the private sector, what is referred to as the substitution effect (Gennaioli et al. 2014; Popov and Van Horen 2015; Acharya et al. 2015; De Marco 2017; Altavilla et al. 2017; Becker and Ivashina 2018). Reduced credit supply also significantly depressed real economic activity, such as investments and job creation (Acharya et al. 2015).

In comparing the impact of banks' sovereign exposure on lending to the private sector, I find that small banks do not substitute private loans with public debt, that is, they are not subject to the substitution effect while large banks are. Noteworthy is that the absence of this effect is not necessarily due to small banks' low exposure to sovereign debt. I show that small banks from peripheral European countries have a much greater share of sovereign exposure in their portfolios than do large banks. I also show that small banks are less pro-cyclical in terms of lending, that is, they exhibit more stable lending behaviour during both good and bad times. Furthermore, small banks that have adequate capital and customers with high creditworthiness are more likely to increase both their sovereign bond exposure and their loans to the private sector. Such results suggest that new regulations that aim to increase banks' capital ratios and lower leverage should not necessarily cause a contraction in lending as suggested by critics of the new rules. This is also in line with studies that support a banking sector with more small banks, for example, Vallascas and Keasey (2012), Cotugno et al. (2013), Deyoung et al. (2015), and Berger et al. (2017).

Banks from peripheral European countries were quite vulnerable during the crisis, and the second empirical chapter aims to find explanations for this. In particular, I focus on the model-based capital regulations used by large European banks. In order to increase the stability of the financial system and improve risk management in banks, model-based capital regulation, what is referred to the internal rating-based (IRB) approach, was introduced by the Basel II Accord. The IRB approach allows banks to design and calibrate their own risk models (subject to regulatory approval). Regulators believe that this approach can be more effective in capturing risk drivers and can motivate banks to improve internal risk management. However, it also provides banks with considerable incentive to apply strategic modelling to save capital for further investment – that is, regulatory capital arbitrage. A few studies have provided evidence of banks' strategic modelling for capital-saving purposes (Vallascas and Hagendorff 2013; Mariathasan and Merrouche 2014; Behn et al. 2016; Ferri and Pesic 2017). I conduct the analysis in the context of the European debt crisis. After carefully addressing the endogeneity issue, I provide strong evidence that banks in peripheral countries are more associated with regulatory capital arbitrage by means of strategic IRB modelling than are banks from core countries.

Apart from strategic modelling, I provide evidence of another form of regulatory arbitrage – cherry-picking, that is, strategically choosing not to use the IRB approach for certain exposures. As required by the Basel Committee, if a bank applies the IRB approach to one part of its assets, it must take steps to implement it across all significant portfolios and business lines; the so-called 'permanent partial use of IRB' is only permitted for insignificant portfolios (BCBS 2001). In the second empirical chapter, I show that many banks from peripheral countries barely apply the IRB approach to their public-sector exposure and as a result, they can achieve unrealistically low risk-weights. At the same time, the IRB approach is widely used for private sector exposure. Hence, banks from peripheral countries appear to be abusing the IRB approach by means of not only strategic modelling but also cherry-picking. I do not find indications of a breach of rules regarding the implementation of the IRB approach among core country banks. Such results provide insightful explanations for why some peripheral banks were very vulnerable and suggest that not only should use of the IRB approach be carefully granted and closely supervised, but also that (permanent) partial use of the IRB should be limited. In this manner, both strategic IRB modelling and cherry-picking can be brought under control.

As mentioned above, the sovereign–bank diabolic loop is one of the principal factors that has made the European sovereign debt crisis so widespread and long-lasting. A key ingredient of the loop is the banks' excessive holdings of domestic sovereign bonds, that is, the home bias in banks' sovereign portfolios. The third empirical chapter examines the cause of such home bias. In a manner similar to

Crosignani (2017), I demonstrate that banks in the crisis-affected countries shifted their sovereign bond portfolios to other crisis countries. However, such behaviour is much less remarkable than how they reallocate their sovereign portfolios toward domestic debt. I also find that such home bias in sovereign debt investment does not necessarily affect non-bank institutions or individuals. Moreover, I provide evidence that state-owned banks and private banks have different types of home bias. State-owned banks have a stronger home bias in the sovereign debt portfolio than do private banks. Private banks, on the other hand, have a stronger home bias towards private debt. By means of these empirical findings, I argue that the home bias in banks' sovereign debt portfolios can be best explained by the 'moral suasion' theory (Becker and Ivashina 2018). This theory states that financially distressed governments may (implicitly and/or explicitly) ask domestic large banks to absorb their new debt issuance in order to alleviate financing pressure. This result may also raise concerns for policymakers. As the government may influence the investment decisions of domestic banks through direct ownership, this may impede the integration of the European financial market. Indeed, one of the fundamental conditions for a fully integrated market is that all potential market participants are treated equally (ECB 2017).

Chapter 2 Literature Review

In this chapter, I discuss the literature on the main topics covered in this dissertation. All the analysis of this dissertation is conducted in the context of the European sovereign debt crisis, in Section 2.1, I look at the interplay between sovereigns and banks. In Section 2.2, I discuss bank capital regulation and its implications. Lastly, I explore the differences between large and small banks, especially during crises.

2.1 Risk Contagion between Sovereigns and Banks – The Diabolic Loop

The following quote is from a 2012 speech by IMF Director Christine Lagarde:

> We must also break the vicious cycle of banks hurting sovereigns and sovereigns hurting banks. This works both ways. Making banks stronger, including by restoring adequate capital levels, stops banks from hurting sovereigns through higher debt or contingent liabilities. And restoring confidence in sovereign debt helps banks, which are important holders of such debt and typically benefit from explicit or implicit guarantees from sovereigns[2].

[2] This entire speech by Christine Lagarde, Managing Director, IMF, is available at https://www.imf.org/en/News/Articles/2015/09/28/04/53/sp012312

Following the Greek sovereign debt default in 2011, the four largest Greek banks (Alpha Bank, Eurobank Ergasias, National Bank of Greece, and Piraeus Bank) suffered a total loss of more than 28 billion euros, which was equivalent to 13% of Greek gross domestic product (GDP). Such a loss is large enough to wipe out these four banks' combined equity capital. In 2010, following the bailout of the banking system in Ireland, the Irish government accumulated an unprecedented budget deficit, equal to 32% of GDP. Since the banking sector's losses had been nationalised, Ireland was forced to seek financial support from the IMF and the European Union. These are two typical examples of the so-called diabolic loop between sovereigns and banks[3]. In Greece, banks that were otherwise solvent became insolvent due to their holding defaulted domestic government debt. In contrast, the Irish government, which used to have one of the lowest debt-to-GDP ratios in Europe, suffered considerable funding problems in the sovereign bond market as investors became extremely concerned about the liability created by the bailout of the large and insolvent Irish banking system. For the other peripheral European countries, diabolic loops are less dramatic but still contribute to the ongoing tensions in sovereign and bank debt markets.

Cooper and Nikolov (2013) argue that if the failure of the banking system involves significant costs for the real economy, then a bailout is always provided ex post by the government. Hence, banks do not need to be 'self-insured' ex ante through having issued equity. However, if a sovereign is powerful enough to

[3] The term `diabolic loop' was coined by Markus Brunnermeier who used it in a presentation on the Euro Crisis at the July 2012 NBER Summer Institute Conference

commit the bailout ex ante, it would choose not to do so and would leave it to the banks to protect depositors through equity buffers. In other words, Cooper and Nikolov's (2013) arguments explain why a bailout can create such a significant burden for governments. Pagano (2014) shows that, compared to the US and the UK, continental European governments are more willing to give assistance to the financial sector. Acharya et al. (2014) suggest that a potential bailout of the banking sector increases sovereign credit risk. They support this argument by proposing a model in which the government can finance a bailout through two channels, increasing taxation and/or diluting existing government debtholders. The bailout is beneficial because it relieves a distortion in the provision of financial services, that is, it ensures that important banks keep running. However, the corresponding financing is costly because higher taxation decreases investment incentives in the non-financial sector. Therefore, when the planned bailout is large, dilution becomes a relatively attractive option, although it will worsen the sovereign's creditworthiness.

If a bailout is the dominant ingredient for the transmission of risk from bank to government, the opposite transmission, from government to bank, can be built by banks' holdings of sovereign debts, that is, the asset-holding channel. The theories proposed for banks' holdings of sovereign debt can be grouped into three broad categories: (1) moral suasion theory, (2) risk-shifting theory, and (3) discrimination theory. Moral suasion theory suggests that when sovereign risk increases and government financing becomes costlier, governments may persuade the local financial sector (especially large domestic banks) to absorb more government debt.

Many empirical studies support this theory, including De Marco and Macchiavelli (2016), Ongena et al. (2016), and Becker and Ivashina (2018). Risk-shifting theory suggests that banks, especially those with low capital ratios, prefer risky assets, for example, the sovereign bonds of a distressed government. Hence, shareholders may benefit substantially if the government recovers, while the potential losses would be absorbed primarily by the banks' debtholders (Acharya and Steffen 2015; Acharya et al. 2015; Horvath et al. 2015; Buch et al. 2016). The discrimination theory relies on selective sovereign defaulting on foreign creditors though not on domestic creditors. Consequently, domestic banks secure a higher return on domestic sovereign bonds than do foreign banks. This difference is greater in bad times when sovereign bond yields are high, which causes domestic banks to increase their holdings of domestic sovereign debt. Overall, with the rising credit risk of government bonds, losses in their sovereign portfolios weaken banks' balance sheets and increase their riskiness (Altavilla et al. 2017). Further, Bolton and Jeanne (2011) consider international spillovers through cross-country sovereign debt holdings and Lucas et al. (2014) present evidence for such cross-country spillovers. Apart from the asset-holding channel, there are a few more channels through which sovereign risk can be transmitted to banks, namely, the collateral channel, the rating channel, and the guarantee channel.

First, the collateral channel. Sovereign securities are used extensively by banks as collateral to secure wholesale funding from central banks, private repo markets, and the issuance of covered bonds, and to back over-the-counter derivative positions. Increases in sovereign risk reduce the availability or eligibility of sovereign collateral, and hence banks' funding capacity (Trichet 2010; Davies and Ng 2011; Allen and Moessner 2012).

Then, the rating channel. Owing to strong links between sovereigns and banks, sovereign downgrades often lead to downgrades for domestic banks. This may in turn affect banks' funding costs and possibly worsen their access to the money market and deposit market. When the sovereign does not have a triple-A rating or closer, which is the high end of the scale, the ratings of the banks from that country will tend to suffer, regardless of their financial strength. This is because the sovereign rating usually acts as a ceiling for the rating of the banks (Peter and Grandes 2005; Borensztein et al. 2013). It is noteworthy that this correlation between changes in sovereign ratings and changes in bank ratings is significantly higher for rating downgrades than for upgrades (Ferri et al. 2001).

Finally, the guarantee channel. Systemic banks have traditionally had an implicit government guarantee that has lowered the cost of debt funding. Following the collapse of Lehman Brothers, advanced economies also provide explicit guarantees to banks. However, government guarantees may lose value as a sovereign's fiscal position worsens. In turn, it is more difficult for the financial sector to extract benefits from such guarantees. Systemic banks tend to enjoy an implicit government guarantee due to the adverse effects such banks' bankruptcy would have on the economy. These additional guarantees can reduce funding costs for these banks (Grande et al. 2011; Correa et al. 2012). Due to sovereign risk tensions, the value of these guarantees may be reduced in peripheral European countries (Schich and Lindh 2012; Gray and Malone 2012).

This dissertation focuses primarily on the asset-holding channel. In Chapter 3, I discuss the impact of banks' holdings of sovereign bonds on their lending to the private sector, and compare this impact in large and small European banks. In Chapter 4, part of the analysis involves exploring the riskiness of banks' public-sector exposure. In Chapter 5, I examine the home bias in banks' sovereign debt portfolios.

2.2. The Role of Capital

Bank capital is the cornerstone of bank regulation and is considered a key determinant of a bank's ability to withstand economic shocks. In the area of bank capital regulation, there is a wide debate on whether 'more capital is better' or 'less capital is better'. For example, Admati et al. (2018) argue that banks should be financed with significantly more equity and that regulatory capital requirements should be set much higher than the levels proposed by the Basel Committee. On the other hand, DeAngelo and Stulz (2015) argue that high leverage is optimal for banks.

Capital is closely related to the fate of banks. According to most theories, capital enhances a bank's survival probability. First, one set of theories emphasises the role of capital as a buffer to absorb banks' earning shocks. This is because, holding fixed the bank's assets and liabilities, more capital automatically implies a higher likelihood of survival (Repullo, 2004). Second, a set of theories focuses on monitoring incentives and capital. For example, Allen et al. (2011) suggest that it is optimal for banks to use more capital rather than charging higher loan rates to improve monitoring. This generates higher borrower surplus which indirectly increases the odds of survival of banks. Meharn and Thakor (2011) also indicate that a greater amount of capital will induce more monitoring, enhance the value of relationship lending, and increase the value of the bank. Third, another set of theories focuses on the asset-substitution moral hazard issue. For example, as suggested by Acharya et al. (2016), lower leverage can induce the bank's shareholders to avoid assets with excessive risk, which reduces the risk-shifting incentive. In the model developed by Thakor (2012), more capital can reduce the attractiveness of innovative but risky products that increase the probability of financial crises. Freixas and Rochet (2008) also suggest that capital has a positive effect on the probability of survival. Similarly, in Calomiris and Kahn (1991), if bank insiders had more equity capital, a depositor-initiated run would be less likely, thereby promoting stability.

However, some theories suggest that, under certain circumstances, increasing bank capital could be counterproductive. For example, Koehn and Santomero (1980) examine the impact on bank portfolio risk of an increase in the required minimum capital ratio and find that the dispersion of risk taking across the banking industry will expand accordingly. Specifically, with a higher minimum capital requirement, relatively conservative banks can offset capital restrictions. Meanwhile, banks willing to take on higher levels of risk reshuffle the balance sheet towards risky assets to an even greater extent and hence increase the variance of the total risk for the entire industry. Besanko and Kanatas (1996) show that the equity value of an impaired bank might decrease when it is required to meet a capital standard. Regardless of the change in the bank's equity value, however, its stock price will definitely fall in response to forced recapitalisation. They also argue that more capital may hurt bank safety. This is because the benefits of reduced asset risk could be more than offset by the cost of the lower effort exerted by insiders due to the dilution of their ownership. Diamond and Rajan (2001) also indicate that more capital may reduce a bank's chance of survival. They find that capital reduces banks' incentives to collect loan repayments and hence they tend to prefer more illiquid loans in their portfolios. Such findings imply that if there is a liquidity shock, more highly leveraged banks are more likely to survive as they can cope with such shocks more effectively by selling their liquid loans.

Apart from survival, there are two concerns for banks managers: competitiveness and market share. A set of theories suggests that capital and bank competitiveness are positively related (Holmstrom and Tirole 1997; Allen and Gale 2004; Allen, Carletti, and Marquez 2011; Mehran and Thakor 2011), as banks can derive a competitive advantage from more capital. These theoretical predictions are supported by much empirical evidence. For example, Calomiris and Powell (2000) find that capital had a positive impact on deposit supply in the Argentinian banking market during the 1990s. Calomiris and Mason (2003) show the same trend for the US market during the Great Depression. Looking at a sample of New York banks during the Great Depression, Calomiris and Wilson (2004) find that banks with adequate capital are more competitive about risky loans because they are less exposed to the pressure of satisfying the preferences of low-risk depositors. However, the results of Kim, Kristiansen, and Vale (2005) imply that banks with higher capital ratios do not have a competitive advantage in terms of being able to charge higher interest rates to borrowers.

Capital not only matters for banks; it also has a significant impact on the real economy. On one hand, there is a vast literature that criticises the capital adequacy requirement as it reinforces macroeconomic fluctuations (Blum and Hellwig 1995) and creates considerable social welfare costs (Van den Heuvel 2008). Diamond and Rajan (2000) and Gorton and Winton (2000) show that capital adequacy requirements may have an important social cost because they reduce a bank’s ability to create liquidity. Similarly, Diamond and Rajan (2001) suggest that the costs of illiquidity are avoided if the relationship lender is a bank with a fragile capital structure and is subject to runs. Fragility commits banks to creating liquidity, enabling depositors to withdraw when needed, while buffering borrowers from depositors’ liquidity needs.

In contrast, many others argue that a greater amount of capital is important and beneficial. For example, Kashyap et al. (2008) argue that the main cause of credit crises is the fact that banks finance risky assets with short-term borrowing. In comparison, Beltratti and Stulz (2012) provide a comprehensive study of the influence of both bank- and country-level characteristics on bank performance during the crisis. They document a positive impact of bank capital on the performance of banks during the crisis. Similarly, Garel and Petit-Romec (2017) find that the book-equity ratio, market-equity ratio and regulatory tier 1 capital ratio all have a positive impact on bank stock performance during the crisis. Admati et al. (2013) argue that bank equity is not socially expensive, and that high leverage (even if at the levels allowed by regulators) can make banking inefficient. In addition, better capitalised banks suffer fewer distortions in lending decisions and perform better. Gambacorta and Shin (2016) show that an increase in a bank's equity ratio reduces the cost of debt financing and increases loan growth.

This dissertation also discusses the role of capital, and capital regulation and implication. In Chapter 3, I consider the impact of capital adequacy on bank lending. In Chapter 4, I explore model-based capital regulation. In Chapter 5, the analysis is more broadly related to the composition of ownership (or the role of state-owned capital) as I assess the differences between state-owned banks and private banks in terms of asset reallocation during the European crisis.

2.3 Small vs. Large Banks

The relationship between the size of banks and financial stability has been debated for decades. Some studies (Diamond 1984; Marcus 1984; Besanko and Thakor 1993; Demsetz et al. 1996; Allen and Gale 2000; Hughes et al. 2001; Marquez 2002; Morgan et al. 2004; Stern and Feldman 2004; Stiroh 2006; Feng and Serletis 2010; Martínez-Miera and Repullo 2010; Jiménez et al. 2013) support the idea that a greater number of large banks can improve financial stability because they take fewer risks to protect their franchise value. Furthermore, they are more efficient in controlling operational costs, can extract higher informational rents and prevent informational dispersion, and are better at risk-diversification. On the other hand, others (Stiglitz and Weiss 1981; Boyd and De Nicoló 2005; Wheelock 2012) argue that the levels of moral hazard, risk-taking, and operational inefficiencies are higher for large banks. Vallascas and Keasey (2012) show that restricting the size of banks can reduce the default risk of individual banks as well as their contribution to systemic risk. Canova and De Nicoló (2003) and Uhdea and Heimeshoff (2009) also provide some empirical evidence to support such ideas and suggest that countries with a larger share of large banks are more likely to be associated with financial instability and more vulnerable to financial crises.

In order to generate a clearer understanding of this debate, I can focus on a more specific question: ‘Does the geographical expansion of a bank’s activities reduce risk?’ According to textbook portfolio theory, geographical expansion will reduce a bank’s risk if the returns of the newly added assets are imperfectly correlated with those of the existing assets. In addition, Diamond (1984) and Boyd and Runkle (1993) argue that diversified banks are more cost-efficient, which improves stability. Furthermore, if diversification makes a bank too big or interconnected to fail, implicit or explicit government guarantees can lower the risk of investing in the bank (Gropp et al. 2011).

In contrast, other theories argue that expansion increases bank risk. Models based on agency theory (Jensen 1986; Berger and Ofek 1995; Servaes 1996; Denis et al. 1997) suggest that bankers might expand geographically to extract the private benefits of managing a larger ‘empire’ even if this lowers loan quality and increases bank fragility, the so-called ‘empire-building’ issue. In contrast, Goetz et al. (2016) argue that geographical expansion can significantly decrease risk and does not affect loan quality. Moreover, Brickley et al. (2003) and Berger et al. (2005) stress that distance reduces the ability of a bank’s headquarters to monitor its subsidiaries, which may have adverse effects on asset quality. Moreover, to the extent that diversification increases complexity, it may adversely affect loan monitoring and risk management (Winton 1999). Demsetz and Strahan (1997) and Chong (1991) find that geographically diversified bank holding companies (BHCs) hold less capital and choose riskier loans. Similarly, Acharya et al. (2006) find that as BHCs expand geographically, their loans become riskier. A comprehensive study by Meslier et al. (2016) incorporates the arguments from both sides. They investigate the US banking sector and find that, for small banks, only intrastate diversification enhances risk-adjusted returns and decreases the risk of default. Meanwhile, for very large banks, only interstate expansions are beneficial and only as regards default risk. More importantly, in all cases, the relationship is bell-shaped; that is, at some point the possible agency costs associated with banks’ geographical expansion outweigh the benefits.

Small businesses are generally considered more financially constrained than large businesses. This is due to the fact that hard (quantitative) information on small businesses, for example, financial ratios from audited financial statements or prices for publicly traded securities, is very limited. It is difficult for banks to make credit decisions regarding small business based on limited information (e.g. Petersen and Rajan 1994; Hubbard 1998). However, banks can alleviate the financial constraints of small business by means of relationship lending based on soft (qualitative) information, for example, knowledge of the character of the small-business owner (Sharpe 1990; Rajan 1992; Boot and Thakor 2000). Small banks tend to be better at using soft information as such information is easier to communicate within a small organisation with few layers of management (e.g., Berger and Udell 2002; Stein 2002; Berger et al. 2005; Liberti and Mian 2009; Canales and Nanda 2012; Kysucky and Norden 2016).

There is also a growing literature on the role of relationship lending during economic downturns and crises which argues that small banks' comparative advantages may be greater when financial market conditions are adverse. Many papers support this idea by exploring the individual firm–bank relationship. Typically, by using loan or loan application data from credit registries of a particular country, these papers attempt to identify the impact of firm–bank relationships on access to credit. For Spain, Jiménez et al. (2012) show that during an economic downturn measured by low GDP growth, banks are more likely to provide continued credit to long-term clients. For Germany, Puri et al. (2011) find that savings banks began to reject more loan applications during the subprime crisis, but did so to a lesser extent for existing clients. For Portugal, Iyer et al. (2014) show that banks that showed greater reliance on interbank funding before crisis decreased their credit supply more during the crisis. However, such a credit crunch is mostly irrelevant for firms with strong lending relationships. For Italy, Gobbi and Sette (2014) and Sette and Gobbi (2015) show that firms with more enduring lending relationships had easier access to credit, at a lower cost, following the collapse of Lehman Brothers. Taking a slightly different approach, Bolton et al.,(2016) find a similar trend: that Italian firms located closer to their bank's headquarters (implying relationship, not transaction-based, lending) were offered better lending terms following the collapse of Lehman Brothers.

Some papers attempt to explain the comparative advantage of small banks as relationship lenders by focusing on the characteristics of their balance sheets. Song and Thakor (2007) argue that the higher comparative advantage for small banks during downturns is due to the fact that during such periods wholesale funding used by large banks tends to dry up quickly. In contrast, core deposits used by small banks are more stable. In addition, Bolton et al. (2016) suggest that banks with more capital are able to perform their relationship banking role more effectively during a crisis. Aysun (2016) shows that larger banks' lending is considerably more sensitive to the strength of their borrowers and their own balance sheets compared to smaller banks.

According to the literature mentioned above, relationship lending alleviates credit constraints during crises. So, I may ask whether such a benefit comes at some expense, for example, greater constraints during a credit boom. Beck et al. (2018) find that relationship lending is not associated with credit constraints during a credit boom; however, they concur that it alleviates constraints during crises. Moreover, such a positive effect of relationship lending is more pronounced for small and opaque firms and in regions that experience greater economic downturns.

Similar evidence can be obtained from the perspective of borrowers. For example, based on a novel survey dataset of small business managers' perceptions of financial constraints, which was then matched with information on local banks, Berger et al. (2017) suggest that small banks have comparative advantages in alleviating these constraints. More importantly, for those small business customers that are credit rationed by large banks (i.e. firms experiencing liquidity shocks) during financial crises, small banks also appear to have comparative advantages in providing liquidity insurance to them.

Relationship lending may also have a critical impact on innovation. On this matter, Hombert and Matray (2017) studied how relationship lending determines the financing of innovation. By exploiting a negative shock to the bank–firm relationship, they show that it reduces the number of innovative firms, especially those that rely to a greater extent on relationship lending, for example, small and opaque firms.

Notably, it is not necessary that all small banks be 'relationship lenders' and willing to alleviate credit constraints on small firms. Based on a sample of US community banks, DeYoung et al. (2015) define a sub-sample of banks, – those had a high share of small business lending in their loan portfolios before financial crises

– as relationship lenders. They find that while most community banks reduced their small business lending during the crisis, the relationship lenders did not.

Overall, the literature mentioned above suggests that if more firms could be induced to seek a long-term relationship with banks, and if relationship-lending-focused banks could be made to hold more capital in expectation of a crisis, the negative effects of crises on corporate investment and economic activity could be reduced. However, aggressive competition through capital savings and lower-cost transaction-based banking erodes access to relationship-based banking. Overall, more competition caused by transaction-based banks contributes to amplifying the pro-cyclical effect of banking on the economy.

Given the benefits associated with small bank relationship lending, it is potentially concerning that the number of small banks has been decreasing over time. As indicated by Berger and Bouwman (2016, Table 8.1), from 1984 to 2014, in the US, the number of small banks – those with assets under $1 billion – decreased by more than 50% from 11,497 to 4,864. It is possible that something important is being lost in this process, for example, the ability to alleviate the financial constraints of small firms.

In Chapter 3, I directly compare the lending behaviour of large and small European banks during the European sovereign debt crisis. My results support the idea that more small banks can reduce pro-cyclical banking and improve financial stability. In chapters 4 and 5, I explore two crucial issues that are more associated with large banks, namely, regulatory capital arbitrage through applying sophisticated capital models and government moral suasion.

Chapter 3 Is Small Beautiful? The Resilience of Small Banks during the European Debt Crisis

3.1 Introduction

The European debt crisis erupted in the wake of the Great Recession in late 2009 and was characterised by an environment of accelerating government debt levels and increasing government bond yields. One of the main causes of the debt crisis is that several European governments were forced to rescue troubled banks (Acharya et al. 2014). This led to a substantial increase in national debt burdens (IMF 2009). As banks absorbed higher levels of government debt, the balance in bank lending between private and public borrowers and the consequences of such allocations for economic growth became the subject of much debate. Two major hypotheses were developed to explain the relationship between banks' sovereign debt holdings and loan growth. The moral-suasion channel documented by De Marco and Machiavelli (2016), Ongena et al. (2016) and Becker and Ivashina (2018) suggests that when sovereign risk increases and government financing becomes costlier, governments may persuade the local financial sector (especially large domestic banks) to absorb more government debt. If the financial sector cannot raise additional funds to purchase government debt, these purchases may be made at the expense of other investments, for example, retail and corporate loans. In contrast, as suggested by Acharya and Steffen (2015), Acharya et al. (2016), and Buch et al. (2016), the 'carry-trade' and risk-shifting hypotheses can also explain this crowding-out effect.

Additionally, given the capital treatment of sovereign debt, banks may realise higher yields and benefit from lower regulatory capital by shifting from bank loans to risky government debt (Acharya and Steffen 2015). Banks willing to take on higher levels of risk may even take this risk-shifting strategy as a bet on their own survival (Diamond and Raja 2011; Broner et al. 2014; Acharya and Steffen 2015; Crosignani 2015; Drechsler et al. 2016). A further link between sovereign debt exposure and bank loans may arise as a result of the marking to market of government debt, as discussed by Altavilla et al. (2017) and De Marco (2017). Specifically, when sovereign bonds depreciate as credit spreads rise, banks suffer book losses that may further affect their ability to lend.

This study contributes to the literature mainly in four ways. First, when studying the substitution of bank loans with sovereign debt, previous research mainly focuses on large banks. It is true that the overall market share of small banks may not be prominent[4]. Small banks are believed to play a critical role in the economy by financing small businesses, and their decentralized lending structure gives them an important advantage (Sapienza 2002; Berger et al. 2005; Mian 2008). Moreover, Cotugno et al. (2013) and Deyoung et al. (2015) suggest that pro-cyclical lending behaviour can be moderated if banks are strategically committed to relationship-based small business lending. In addition, Vallascas and Keasey (2012) show that restricting the size of banks can reduce both the default risk of individual banks and their contribution to systemic risk. Moreover, a recent study by Berger et al. (2017)

[4] In my sample, the aggregated loan provided by small banks is around 10% of the total, and aggregated sovereign debt exposure held by small banks is around 7%.

shows that small banks have a comparative advantage in alleviating the financial constraints of small business and that such an advantage tends to be greater during crisis periods. For these reasons, I broadened my sample to include small banks and to provide an extensive comparison of the determinants of banks' lending to small and large institutions. This is particularly relevant in the light of new bank regulations that penalise large banks (i.e. through capital add-ons applied to systemically important institutions as well as by ring-fencing) and may lead to a more distributed banking system with fewer large players and more small-to-medium ones[5]. So far, Albertazzi et al. (2014), with a sample of Italian banks, is the only paper I am aware of that compares large and small banks when looking at the interaction between sovereign risk and bank lending. They find that large banks are more affected by sovereign risk changes. My study differs from theirs in several respects: (1) while Albertazzi et al. (2014) focus solely on sovereign risk, I also take into account bank-specific exposure to sovereign debt from a rich database sourced from the European Banking Authority (EBA, for large banks) and Bureau van Dijk's (BvD's) Bankscope (for both large and small banks). This enables us to capture cross-sectional variations in sovereign exposure which I find to be highly significant in explaining bank lending patterns; (2) I extend the analysis beyond the Italian market to include a broad sample of Eurozone banks; (3) my sample period includes the peak of the sovereign debt crisis and the following recovery phase, which are characterised by a remarkable growth in small banks' exposure to

[5] Downsizing may also result in the forced segregation of trading from lending operations in banks. Provisions to ring-fence risky activities were included in the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act in the US, the UK's 2011 "Vickers Report" and the EU's "Liikanen Report" on Bank Structural Reform.

sovereign debt, especially in peripheral countries (see Figure 3.1). This growth takes place from 2011, which is right after the sample period (1991–2011) covered by Albertazzi et al. (2014). It is conceivable that their conclusions may partly be driven by the fact that small banks were much less exposed to sovereign debt securities in their observation period. Instead, I show that small banks' sovereign debt holdings may have a significant impact on their loan growth.

Second, in addition to the substitution effect discussed in the literature (Gennaioli et al. 2014; Popov and Van Horen 2014; Abbassi et al. 2016; Altavilla et al. 2017; De Marco 2017; Becker and Ivashina 2018), I also find a complementarity effect where sovereign debt and bank loan growth are positively correlated[6]. I provide evidence that banks that have adequate funding and customers with high creditworthiness, and/or make substantial gains in the sovereign bond portfolio, are more likely to increase both their sovereign bond exposure and their loans to the private sector.

Third, Popov and Van Horen (2014), Acharya et al. (2016), Altavilla et al. (2017), De Marco (2017) and Becker and Ivashina (2018) measure bank lending using data on syndicated loans (to large firms) or loans to non-financial corporations. By combining loan data from BvD's Bankscope (bank-level) and the ECB Statistical Data Warehouse (country-level), I was able to measure bank lending as total loans to the non-financial private sector, which includes both non-financial corporations

[6] The results of Altavilla et al. (2017) also observe a similar phenomenon when, in the recovery phase of the sovereign debt crisis decreasing bond yields generate capital gains in banks' government bond portfolios which may help loan expansion.

and households. In this manner, I can comprehensively explore the relationship between banks' sovereign bond exposure and their total lending.

Fourth, I contribute to the literature that looks at the relation between regulatory capital and loan growth (Bridges et al. 2015; De Nicolo 2015; Deli and Hasan 2016; Gambacorta and Shin 2016). I observe that in peripheral countries small banks have substantially higher capital ratios than large banks, combined with lower leverage and lower default risk, as measured by loan loss provisions. I conjecture that this may explain why small banks tended to lend more than large banks during the sovereign debt crisis. In other words, a greater amount of capital may contribute to a bank's resilience to crises and ensure stable financing of the real economy, a conclusion that has been much debated by regulators and bankers (see, for example, Admati et al. 2011).

My work relates more broadly to the literature on the sovereign–bank 'doom loop', that is, the destabilising link generated by potential default risk spillovers between banks and sovereigns through banks' government bond holdings (Cooper and Nikolov 2013; Farhi and Tirole 2014; Acharya et al. 2014, and Brunnermeier et al. 2016). I observe a dramatic increase in sovereign debt holdings in the banking sector, especially in small banks from the peripheral countries, which may exacerbate doom-loop effects. This may have serious implications for financial stability in cases of future shocks to sovereign debt yields.

This chapter proceeds as outlined in what follows. In Section 3.2, I present the data and some stylised facts. In Section 3.3, I introduce the empirical model. In

Section 3.4, I discuss the results of the determinants of loan growth, paying particular attention to the impact of sovereign exposure and provide robustness tests. Section 3.5 concludes the chapter.

3.2 Data and Stylised Facts

This section describes the data and presents some stylised facts about the relationship between sovereign debt holdings and loan growth in Eurozone banks. My sample covers core countries (Austria, Belgium, Germany, France, and the Netherlands) and peripheral countries (Greece, Ireland, Italy, Portugal, and Spain) in the Eurozone and the analysis is conducted for the period 2007–2015.

Sovereign debt exposure data were collected from two data sources. First, I used a novel database of country-specific sovereign exposure for a sample of large European banks that participated in the stress tests and risk assessments conducted by the EBA during the period March 2010 to June 2015[7]. The number of banks varies among the different tests, but according to the EBA, each test covers at least 60% of total EU banking assets. These data constitute the 'large bank' sample in my analysis. A bank was included in the sample if it is from any of the ten countries mentioned above, participated at least twice in any of the EBA tests, and had an

[7] Stress Test 2010 (March 2010), Stress Test 2011 (December 2010), Capital Exercise 2011 (December 2011 and June 2012), Transparency Exercise 2013 (December 2012 and June 2013), Stress Test 2014 (December 2013) and Transparency Exercise 2015 (December 2014 and June 2015).

average asset size of 20 billion euro over the sample period. This leaves us with 94 banks. Then, I used end-of-year data for government bond exposure, which excludes loans and advances to governments[8,9]. In this way I could make the data more consistent with the other source for sovereign data, BvD Bankscope, which has only information on sovereign bond exposure.

In order to include more banks and extend the sample period, I used the BvD Bankscope database as a second source for data on banks' government bond exposure. However, the data from Bankscope is less detailed and, unlike the EBA database, only presents the total government debt of a bank with no counterparty breakdowns. I included all the banks from the 10 countries. I then split the sample into three sub-groups according to the size of the banks: large banks, as defined above; medium banks, with average assets between 2 billion and 20 billion euros; and small banks with average assets below 2 billion euros. For the large banks, disaggregated sovereign exposure by country of issue were sourced from the EBA. All other bank-level variables for large, medium, and small banks were sourced from BvD Bankscope. I also collected aggregated sovereign exposure for all banks from Bankscope. I used Bankscope aggregated sovereign data in most of the analyses where large and small banks are included. I employ EBA detailed

[8] Since semi-annual financial statements are not very populated for those banks in the Bankscope database, I have to use annual data. Therefore, I extract data at end of year 2010, 2011 ,2012, 2013, 2014 and apply linear extrapolation to the first observation – March 2010 – to match them with other end of year bank variables. Thus, I have 6 years of annual observations.

[9] Notably, the sovereign exposure in March 2010, i.e. the first test, does not distinguish between securities exposure and loan exposure. Thus, I approximate each banks securities exposure using country-level data from the ECB database.

sovereign data in robustness tests to distinguish between domestic and foreign government debt.

Apart from banks' sovereign debt exposure, there is another important variable - the annual growth rate of loans to the private, non-financial sector. The variable is obtained from 'Gross Loan' in the Bankscope database, which covers all loans provided to the non-financial sector but includes government loans (and excludes government bonds). Therefore, I needed to adjust this variable in order to obtain a measure of lending to the private sector. To do so, I used country-level data from the ECB to calculate the ratio, $(\text{loans to the nonfinancial private sector})/(\text{loans to the nonfinancial private sector} + \text{loans to governments})$ for each year-country in the sample[10]. The 'non-financial private sector' includes loans to households and corporates. Then, I adjusted the original variable (Gross Loan) with this ratio to obtain loan growth to the private sector. This adjustment has a marginal effect on my regression results as government loans are a small proportion of the loans to the non-financial private sector (about 10%) and their aggregated amount does not fluctuate much over the sample period.

Summary statistics of my data are reported in Table 3.1. I compare four bank groups: large core against small core banks and large peripheral against small peripheral banks. The sample period is divided into the 2007–2009 and the 2010–2015 sub-periods, which denote the subprime crisis and the European sovereign

[10] The assumption for such adjustment is that all the banks from the same country would have the same proportion of asset distributed between loans to the private sector and loans to the governments.

debt crisis, respectively. I can clearly observe that, relative to large banks, small banks exhibit more stable and less pro-cyclical lending behaviour (Panel A). This behaviour was characterised by weaker loan expansion relative to large banks during the subprime crisis with a statistically significant median difference of 4.6% and 2% in core and peripheral countries, respectively. During the sovereign crisis this trend is reversed, with small banks maintaining healthy loan growth as against sharp contractions in large banks, which even led to negative median growth in large peripheral banks (–2.1%). Again, the difference between the two groups of banks is statistically significant, with the median small bank exhibiting stronger growth of 3.3% (3.1%) than the median large bank in core (peripheral) countries. Figure 3.2 supports this conclusion. The first two years of the subprime crisis were characterised by strong expansion of lending in large European banks with a sharp contraction only in 2009, following Lehman's default. For large banks, negative loan growth is then seen in the years of the sovereign debt crisis, especially in peripheral countries. On the other hand, the median small core bank exhibited steady loan growth throughout the observation period. The median small peripheral bank showed more variability over time but this was much less pronounced than for large peripheral banks, as it was only in 2013 and 2014 that there was a small loan contraction.

A possible explanation for the ability of small banks to lend during the sovereign debt crisis is that they were expecting lower losses from their loan portfolios relative to large banks. This inference is supported by the lower amount of credit risk, as measured by loan loss provisions, in small banks during the crisis (Table 3.1, Panel

B). The median large core bank had 2.1% higher provisions than the median small core bank, while for peripheral banks there is a much more pronounced deviation of 6%. Both differences are highly statistically significant. The reason for the lower credit risk in small banks may follow from their relationship lending model (Albertazzi et al. 2014) and higher risk aversion (Deyoung et al. 2015). Smaller banks are also in a better position to support their customers in a crisis. This is the result of the soft information that small lenders can gather about their borrowers (Cotugno et al. 2013; Deyoung et al. 2015; Sette and Gobbi 2015).

The conclusion that sovereign debt holdings crowded out lending to the private sector during the sovereign debt crisis finds strong support in the literature (Altavilla et al. 2017; De Marco 2017; Becker and Ivashina 2018). However, the analysis on which it is based is mostly limited to large banks. The results in Table 3.1, panels A and D, suggest that the same conclusion might not hold for small peripheral banks. Government debt exposure relative to total assets were much higher for small peripheral banks than for their large peers, with a statistically significant median difference of 4.8% during the sovereign debt crisis. Yet, as reported above, small peripheral bank lending growth was much stronger (+3.1%) than that of large peripheral banks. Bank funding may provide some explanation for this pattern (see Table 3.1, panels E and F). For example, around 2011, small peripheral banks experienced a drop in retail deposits (Figure 3.3). This is probably due to sovereign risk and government bond yields reaching their highest level at that time. However, they were able to attract considerable wholesale funds that more than compensated for the contraction in deposits (Figure 3.4) and caused a large increase in overall short-term funding (+21.4%)[11]. Such patterns likely reflect the fact that the ECB carried out the two largest long-term refinancing operations in December 2011 and March 2012 (Figure 3.5). Their size was 489 billion and 529 billion euros and they extended to 523 and 800 banks, respectively, at a relatively inexpensive interest rate (1%) and a duration up to 3 years[12,13]. To prevent reputational damage, the ECB does not disclose the identities of the banks that borrowed. However, according to Van Rixtel and Gasperini (2013), around 60% of the Long-Term Refinancing Operation (LTRO) funds were borrowed by peripheral banks, particularly Italian and Spanish ones.

Finally, one of the main objectives of new banking regulations introduced with Basel III following the crisis was to require banks to be better capitalised (BCBS 2011). This was achieved through higher risk-adjusted capital ratios and a leverage cap. It is interesting to note that on both counts, smaller banks in crisis-hit peripheral countries did better than large banks. Specifically, small banks' leverage was lower, with a 7% and 6% median difference in the subprime and sovereign debt crisis periods, respectively, and their median tier 1 capital ratio was 4.9% higher (Table 3.1, panels C and H).

[11] Wholesale funding in Bankscope includes wholesale deposits and any other short-term funding with a maturity up to 1 year.

[12] "For some banks, the ECB funding comes with interest rates more than three percentage points lower than they could obtain on the open market". – The Guardian (https://www.theguardian.com/business/2011/dec/21/eurozone-banks-loans-ecb)

[13] The maturity of LTRO can be ranging from 3 months to 3 years, and those two largest LTRO with up to 3 years maturity has an early repayment option after 1 year. For more details: see https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html

3.3 Regression model

For the empirical analysis I employ the following regression:

$$\Delta \ln(loan)_{i,t} = \alpha_i + \sum \beta \cdot X_{i,t-1} + \sum \delta \cdot M_{i,t-1} +$$

$$\gamma \cdot Crunch_{i,t} * SOV_{i.t-1} + \varepsilon_{i,t} \qquad (3.1)$$

The dependent variable is the annual growth rate of loans to the private, non-financial sector. Also, I use four bank-level explanatory variables (denoted by X): log of total assets (SIZE), loan loss provision/total equity (LLP/TE), sovereign debt securities exposure/total asset (SOV), and the growth rate of funding sources that include retail deposits, and total short-term and wholesale funding (Δln(DEP&ST)) [14]. In addition, M is a vector of three country-level variables, GDP growth rate and CPI growth rate, as general control variables for macroeconomic conditions. GDP growth can be interpreted as a control for credit demand. I also added a more specific credit demand index (country-level) based on a quarterly bank lending survey conducted by the ECB since 2003. *i* and *t* indicate the bank and year of each observation respectively Average indices for core and peripheral countries are shown in Figure 3.6. Negative values indicate that demand decreased over the preceding quarter. The lowest levels are seen in 2008 in both core and peripheral

[14] I consider the level of the sovereign debt rather than its growth because it is consistent with the literature (Ongena et al 2016; Becker and Ivashina 2018). Also, due to the large number of banks in the sample and the relatively short observation period, it is better to not to use growth rate which would make the sample even 'shorter' but 'wider'.

countries. This is followed by a recovery and then further dips in 2011 and 2012. Further details on how I constructed the demand index can be found in Appendix A.1.

Based on the stylised facts presented in the previous section and results from the literature, I expect that a higher level of sovereign debt exposure will lead to a decrease in loan growth. However, a significant negative coefficient of SOV can be associated with two scenarios and can convey different meanings: (1) higher sovereign debt may cause loan growth to fall (substitution effect that leads to a credit crunch), or (2) lower sovereign debt may cause loan growth to rise (substitution that leads to credit expansion). To separate these two effects, I add two variables: a dummy variable, Crunch, which equals 1 if loan growth is negative and 0 otherwise, and Crunch interacted with (the lagged value of) SOV. The distribution of the proportion of banks with negative loan growth (i.e. the distribution of the Crunch dummy) is reported in Appendix A.2. I can clearly see that during the sovereign debt crisis, a much smaller proportion of small banks decreased lending relative to large banks in both core and peripheral countries.

I estimate equation (1) using panel fixed-effects at the bank level and year fixed effects. Standard errors are corrected for heteroscedasticity and clustered at the bank level. All explanatory variables are lagged by one year and bank-specific variables are winsorised at the 2nd and 98th percentiles in each of the four bank groups[15].

[15] Similar results can also be obtained when winsorizing at 1%, 3% and 5%.

3.4 Results

In this section, I discuss the results of my analysis of substitution and complementarity between private sector loans and government exposures. In the literature, the impact of sovereign debt holdings on loan growth is analysed by taking two distinct approaches. On one hand, researchers have focused on the 'balance sheet effects' of sovereign debt holdings where the *level* of sovereign exposure is deemed to have an impact on lending (Popov and Van Horen 2014; Becker and Ivashina 2018). Another strand of research has focused on the return generated by sovereign exposure, rather than their level, and its influence on lending, which I call 'profit and loss effects' (Altavilla et al. 2017; De Marco 2017). Below, I explore both sets of effects.

3.4.1 Balance sheet effects of sovereign debt on lending

In Table 3.2 I present the baseline regression. The literature on the balance sheet effects of sovereign debt consistently reports substitution in large banks (Popov and Van Horen 2014; Becker and Ivashina 2018). However, when considering the overall sovereign exposure of a bank (SOV_ALL), I find that its relationship to loan growth is not statistically significant (Panel A). The coefficients of SOV_ALL and its interaction with Crunch were not significant in either the subprime crisis period or during the sovereign debt crisis. Wald tests reported at the bottom of Panel A confirm the absence of substitution in credit contraction periods (SOV_ALL (1+Crunch)). This important difference compared to previous studies could be ascribed to the fact that I focus on lending to the entire non-financial sector. In contrast, Becker and Ivashina (2018) limited their analysis to loans to large firms that can issue commercial papers, and Popov and Van Horen (2014) investigated the syndicated loan market, which again involves large borrowers. As a consequence of a more comprehensive investigation of the credit market that includes small borrowers, as in my study, conclusions on lending contractions and expansions are bound to change. For instance, mortgages are typically longer-term contracts and, hence, represent a more stable asset base than corporate loans. I find that the results obtained for large banks also hold for medium-sized banks (Panel B). On the other hand, strongly significant complementarity effects were present in small peripheral banks in both sub-periods and during the credit crunch and credit expansion phases in those sub-periods (Panel C). Complementarity is also found in small core banks during lending expansions in the subprime crisis. At first sight, these results appear to contradict the trends reported in figures 3.1 and 3.2 that suggest a negative relationship between sovereign debt holdings and loan growth. In small peripheral banks in particular, I notice a sharp increase in sovereign exposure from 2011 and low or negative loan growth in the same period. However, my panel regressions are mostly driven by the cross-sectional relationships among the variables which, due to the large number of banks in the sample and the relatively short observation period, dominate the time series dimension. These results are interesting for two reasons: (1) it appears that lending growth in a large bank is not indiscriminately influenced by the bank's overall government exposure. Substitution may still be present, but limited to specific types of government debt (e.g. domestic vs. foreign, safe vs. risky). (2) Small banks do not appear to engage in aggressive portfolio selection strategies. Instead, it appears that they expand or contract their balance sheets by making same-direction adjustments across asset classes. I investigate these points in greater detail in later sections.

The control variables in my baseline regression are not always significant. However, when they are significant, their behaviour agrees with my expectations. Specifically, all else being equal, larger banks in each size group tend to have lower loan growth, which is in line with Altunbas et al. (2009) and Ehrmann et al. (2001). Higher credit risk, as measured by loan loss provisions, is associated with lower loan growth. However, this relationship is never significant for large banks, while it is more robust for small banks. Higher short-term funding growth allows bank to expand their loan base. However, the statistical significance of this relationship across specifications does not follow a recognisable pattern. Finally, an increase in domestic credit demand is positively associated with loan growth, particularly in small banks[16].

I further explore the strong complementarity effects seen in small peripheral banks by comparing the characteristics of small peripheral institutions with high sovereign debt exposure to those with low exposure. The purpose here is to identify factors that may determine sustained levels of loan growth in a crisis, over and above those inferred from Table 3.1, when contrasting this group of banks with

[16] I have tried different specifications of loan demand, e.g. by considering sector specific demands related to enterprises, mortgages and consumer credit, but without meaningful changes in my results.

larger banks. Hence, I split the sample of small peripheral banks into top and bottom sovereign exposure quartiles. The top quartile had a much higher proportion of average (median) sovereign debt over total assets during the sovereign debt crisis – 33.8% (33.7%). This is 27% (27.9%) higher than for the bottom quartile. Furthermore, I observe that there are large and statistically significant differences in loan growth between the two quartiles. The top quartile exhibits a mean (median) growth of 24.5% (19.4%), which is 16.9% (16.5%) higher than the bottom quartile. This suggests substantial differences within the small peripheral banks where the complementary effect is much more sustained in institutions with higher sovereign debt exposure. This points to a strong expansion of the balance sheet in those banks during the sovereign crisis. As shown in Table 3.3, rapidly expanding banks are characterised by their smaller size, lower credit risk, lower leverage, and higher tier 1 ratio. All these findings lend support to the provisions in new banking regulations that were designed to make banks more resilient and less prone to lending contractions in a crisis. Accordingly, the Basel 3 agreement introduced higher capital charges, additional capital charges for systemic banks that penalises size, and leverage restrictions (BCBS 2011). On the other hand, the greater reliance of small peripheral banks on short-term funding and their large sovereign debt exposure may pose financial stability concerns. Indeed, Basel 3 also introduced tighter liquidity requirements that aim to constrain banks' dependence on short-term funding unless it is compensated for by a commensurate level of short-term assets to absorb potential funding shocks (BCBS 2011). Regulators are also seeking to reduce the doom-loop risks associated with high sovereign debt exposures in banks (ESRB 2015)[17].

3.4.2. Profit and loss effects of sovereign debt on lending

I now consider the profit and loss effects of sovereign debt holdings on loan growth. I measure the profit and loss impacts of a bank's sovereign debt portfolio by employing a marked-to-market loss definition, as in DeMarco (2017), which is detailed in Appendix A.4. Portfolio loss summary statistics are shown in Appendix A5. The idea is that an increase in the yield of sovereign debt holdings will cause a loss to the bank. Even though the bonds may be held to maturity, the unrealised marked-to-market losses may still have an impact on bank lending (De Marco 2017). As in Altavilla et al. (2017), I assume two alternative debt maturities, 5 years and 10 years, and report results for each. My findings are shown in Table 3.4. As one would expect, profit and loss effects never lead to complementarity. Higher marked-to-market losses in the government bond portfolio cause banks to contract lending, while positive returns (i.e. negative losses) are associated with lending expansions. However, as shown in the Wald test in the table, these results for large banks are mostly not or only weakly statistically significant. Significance is found for peripheral countries when I use the 5-year maturity assumption, and is limited to the credit expansion phases of the sovereign debt crisis. On the other hand, in small peripheral banks, I consistently detect a negative (and weakly significant)

[17] See "Hopes for European 'safe' bonds lean on pre-crisis techniques", The Financial Times, August 15, 2017

relationship between bond portfolio losses and loan growth in the loan expansion phase of the crisis under both maturity assumptions. As I do not have a breakdown of sovereign exposure by country of issue for medium-sized and small banks, the results in panels C and D in Table 3.4 are estimated on the assumption that sovereign holdings wholly consist of domestic bonds. This appears to be an acceptable approximation considering the home bias observed in large banks, particularly in peripheral countries (Figure 3.7). I further explore profit and loss effects on sub-samples of the sovereign debt portfolios for large banks in Section 4.6.

3.4.3. Loan overhang effects

Deyoung et al. (2015) find that a bank's existing loan level can have a negative impact on future loan growth. This is because, due to regulatory capital requirements, larger loan books absorb equity capital. I aim to take this loan overhang effect into account and determine whether the loan-sovereign debt relationships reported in Table 3.2 still hold. However, the level of loans in the balance sheet is bound to be highly negatively correlated with the contemporaneous level of sovereign debt when both are measured as proportions of total assets (see Table 3.5). As the proportion of total assets (TA) captured by one asset class increases (e.g. from 30% to 40%), the proportion represented by the other asset classes will have to fall (from 70% to 60%). To avoid the interference of this mechanical relationship, I first orthogonalise loans/TA with respect to sovereign debt/TA. I also extend the orthogonalisation to all other explanatory variables to prevent indirect feedback effects on the sovereign exposure coefficients. The results are reported in Table 3.6. As loan/TA is orthogonalised, the coefficients of all other variables will not change relative to Table 3.2. However, their significance might. I see that changes in significance are very minor (e.g. SIZE loses some in model 1, and SOV_ALL(1+Crunch) becomes mildly significant in model 1). Thus, my previous conclusions are confirmed. Furthermore, loan overhang effects are present and strongly significant in most specifications, which is in line with the findings of Deyoung et al. (2015). Large peripheral banks appear to be the only ones for which such effects are either mildly significant (subprime crisis) or not significant (sovereign debt crisis). This may be due to the fact that loan growth or contraction in these banks may be driven primarily by external factors, that is, the macro-economic environment rather than balance sheet-specific factors.

3.4.4. The effect of funding on peripheral banks' balance sheets

In the previous sections, I showed that balance sheet-based complementarity was strongly significant in small peripheral banks. The implication is that higher (lower) sovereign exposure leads to higher (lower) loan growth in those banks. In this section, I investigate how the expansion and contraction of these asset classes can be explained through short-term funding adjustments. For comparison, I extend the analysis to all size groups of peripheral banks and report my findings in Table 3.7. I can see that short-term funding and its constituents, deposits and short-term debt, do not seem to influence lending and securities investment decisions (government bonds, SOV, or other securities, SEC) in large banks. However, for medium-sized banks, deposit growth was positively related to loan growth over the 2010–2015 period of the sovereign debt crisis (Panel B). This is probably driven by risk aversion as deposits tend to be a more stable source of funding than are short-term liabilities. This trend is also observed in small banks (Panel C). However, for small banks, deposit growth also appears to have fuelled sovereign debt growth, as indicated by the high statistical significance of the deposit coefficient in Model 4. Interestingly, in small banks, deposit growth is negatively related to the growth of interbank loans (Model 3). Indeed, if deposit growth were a general trend across all small banks, as one can infer from the mean and median growth levels reported in Table 3.1 Panel F, then small banks as a group would have less need to fund themselves by means of the interbank market.

3.4.5. Domestic vs. foreign sovereign debt holdings in large banks

As reported in an earlier analysis (Table 3.2), I do not observe balance sheet-driven substitution effects in large banks when total sovereign exposures are considered. I now test the robustness of this finding by studying the effects of sovereign–bank relationship on sub-portfolios of sovereign debt holdings. As shown in figures 7 and 8, the evolution of home vs. foreign debt and safe vs. risky debt in banks' balance sheets exhibits different patterns in each group of countries. For instance, it is evident that large banks from both core and peripheral countries developed a stronger home bias in their sovereign bond portfolio (Figure 3.7). Core banks showed fluctuating exposure to risky (the GIIPS) countries, while safer investments in German and French bonds steadily increased over time (Figure 3.8).

Hence, it is appropriate to test whether alternative types of government debt can have different impacts on bank lending. My analysis is limited to large banks and the 2010–2015 period because granular data on sovereign debt is only available for the large banks that participated in the EBA tests, which only started after the subprime crisis[18].

In Table 3.8, I explore the influence of home and foreign sovereign debt on loan growth separately. I find that the lack of statistical significance reported in Table 3.2 for total sovereign exposure conceals much richer and statistically significant patterns for different debt types. Such patterns may then offset one another when combined into one variable. Indeed, the original lack of substitution and complementarity of total exposure turns into strong substitution effects for domestic debt exposure during heightened crunch periods (i.e. when institutions contract lending for more than 5%) in peripheral countries. This is evidenced by the statistically significant coefficient of the Wald test for SOV_HOME*(1+Crunch) in model 4. On the other hand, strong complementarity effects are detected for foreign debt exposure in peripheral banks in both the crunch and lending expansion phases of the sovereign crisis. The behaviour of banks in core countries appears to be distinctly different. Complementarity for foreign debt is absent and is replaced by substitution in loan expansion periods. Domestic debt holdings do not appear to influence large core banks' lending decisions.

[18] As bond yields needed in later analysis are not consistently available for all EEA30 countries covered in the EBA sample, I only consider sovereign exposures to the 10 countries in my sample. Such restriction should not alter my findings, as the aggregated sovereign exposure held by my sample banks towards the included countries represents at least 85% of their total exposure to EEA30 countries.

As suggested by Ongena et al. (2016), De Marco and Machiavelli (2016), and Becker and Ivashina (2018) the substitution effect may be related to government pressure (the moral suasion channel) that is exerted to induce domestic banks to buy more government bonds. If the banks cannot raise external funds to meet these additional purchases, substitution of retail and corporate loans may follow. To test this channel, I extracted the ownership information for the large banks from Bankscope. Then, in my regressions, I include an extra interaction term, SOV_HOME*Public, where Public is a dummy that equals 1 if the bank is state-owned (see Appendix A.3 for a list of state-owned banks) [19]. The results in Table A1 support the contention that the moral suasion channel existed in peripheral countries during crunch periods, as confirmed by the statistical significance of HOME*(1+Crunch+Public).

Furthermore, previous research suggests that banks may prefer risky government debt to loans because the former, though paying a high yield, may not attract any regulatory capital charge (Acharya and Steffen 2015; Acharya et al. 2016; Buch et al. 2016). On the other hand, as banks face liquidity shocks particularly during crisis periods, they may prefer to hold liquid assets in the form of safe sovereign bonds at the expense of other assets (Krishnamurthy and Vissing-Jorgensen 2012). In both cases, banks may have the incentive to substitute safe or risky government debt with loans. I test both hypotheses by further breaking down foreign sovereign exposure

[19] In Bankscope, banks are defined as state-owned if the government holds more than 50% of the equity capital, I adopt the same definition.

into two parts: a safe portfolio, called DEFR, which includes German and French sovereign bond holdings, and a risky portfolio of GIIPS sovereign bond holdings[20]. As seen in Table 3.8, large banks' foreign debt exposure in core countries in phases of lending expansion (during the sovereign debt crisis) lead to substitution. In Table A2, column 1, I can see that such substitution is driven by flight-to-safety considerations as it is present only in the safe foreign debt portfolio. By contrast, in large peripheral banks, it appears that the complementarity detected in Table 3.8 is mostly the result of GIIPS exposure. This suggests that large peripheral banks may engage in aggressive risk-taking behaviour, with investments in high-yield debt leading to higher loan growth, that is, more strongly positive in credit expansions or less negative in credit contraction phases of the sovereign debt crisis. The latter effect is statistically significant only with severe lending contractions below –5%, as shown by the coefficient of SOV_GIIPS(1+Crunch) in model 4.

In Table A3 I report the profit and loss effects of sovereign debt holdings on loan growth when domestic and foreign debt are considered separately. I find that in core countries it is the losses in the foreign debt portfolio that cause a contraction in loan growth. This is evidenced by the statistically significant coefficient of LOSS(1+Crunch) in model 2 in the Wald test section. This applies to both panels A and B, where different bond maturity assumptions are employed. In Panel A (the 5-year maturity assumption) I also see that gains (i.e. negative losses) in the home

[20] As my focus is on foreign exposures, for banks headquartered in one of the safe or risky countries, the corresponding domestic debt exposure is not included when building the risky and safe portfolios. For instance, in Greek banks the risky foreign debt portfolio will only include exposures to the other GIIPS countries, namely Italy, Ireland, Portugal and Spain.

debt holdings of large peripheral banks cause an increase in loan growth, as revealed by the negative and statistically significant coefficient of LOSS in model 4.

As in De Marco (2017), GIIPS is used to test whether the negative relationship between portfolio losses and loan growth is indeed caused by supply shocks rather than by demand effects. Indeed, if a government is under distress, credit demand from individuals and corporations may fall. Hence, a lending contraction may be the result of demand-side effects rather than of supply-side effects. By considering the impact of portfolio holdings of GIIPS bonds in non-distressed (i.e. core) countries I could rule out demand effects in those countries due to their good economic conditions. The significant negative coefficient I find in credit contraction phases (reported in the Wald Tests for LOSS(1+Crunch) in model 3) reassures us that the profit-and-loss-effects for large banks are indeed the result of a credit supply shock.

3.5 Conclusion

Previous research has shown that the credit crunch observed in Europe during the sovereign debt crisis could be explained by, among other factors, banks reallocating assets to government debt and away from the private sector. This substitution effect is thought to have had pro-cyclical consequences that exacerbated the crisis. These findings are mostly based on evidence from large banks' lending practices. In this chapter I focused on small banks. Surprisingly, I observe that there is no evidence of substitution in their asset allocation strategy during the sovereign debt crisis. On the contrary, I find that sovereign exposure and bank loans are treated as complements rather than as substitutes by small banks on Europe's periphery. I find that an expansion in sovereign debt holdings did not cause a contraction in loan growth in those banks that had higher capital ratios and lower leverage. This has important implications. First, the evidence from small peripheral banks suggests that new regulations that aims to increase banks' capital ratios and to lower leverage should not necessarily cause a contraction in lending, as advocated by critics of the new rules. Second, provided there are no funding liquidity constraints, banks could be in a position to expand both their private lending and sovereign debt holdings in a crisis, thereby providing support to both the private and the public sectors, precisely when it is most acutely needed. However, a large expansion in sovereign debt holdings, as observed in small peripheral banks during the sovereign debt crisis, may reinforce the sovereign–bank doom loop in which government distress can easily cause instability in the banking system, and vice versa. Therefore, I conclude that a 'smaller is better' recipe for the banking system should be coupled with a framework to address the potentially critical interdependence between banks and sovereigns, which may prove politically challenging[21].

[21] See "Basel says sovereign debt bank capital change could take years", Reuters May 17, 2016. http://uk.reuters.com/article/us-finance-summit-basel-idUKKCN0Y80KO

List of Figures

Figure 3.1: Proportion of total government security exposure to total asset for the median bank.

A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has an average total asset higher than 20 billion Euro. Government security indicates a bank's exposure to all governments. A bank is qualified as a small bank if its average total asset is smaller than 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Data source: BvD Bankscope.

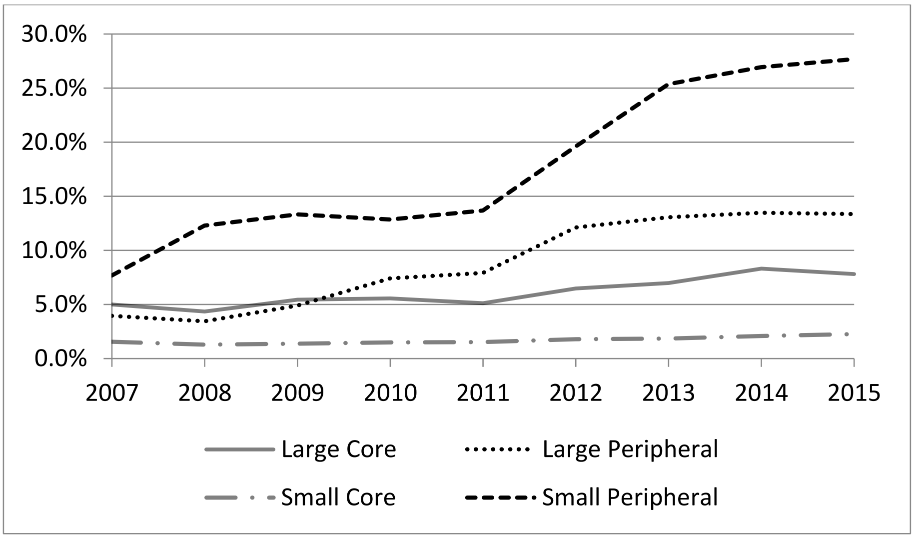


Figure 3.2: Growth rate of loans to the non-financial private sector, median value.

A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has an average total asset higher than 20 billion Euro. A bank is qualified as a small bank if its average total asset is smaller than 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Data source: BvD Bankscope.

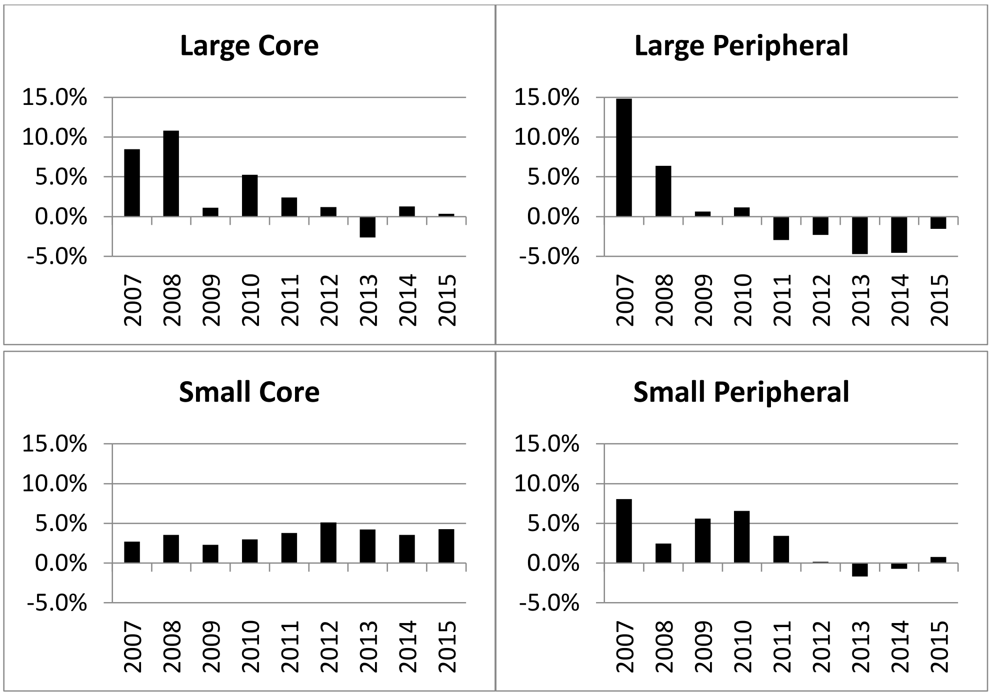


Figure 3.3: Growth rate of retail deposits, median value.

A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has an average total asset higher than 20 billion Euro. A bank is qualified as a small bank if its average total asset is smaller than 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Data source: BvD Bankscope.

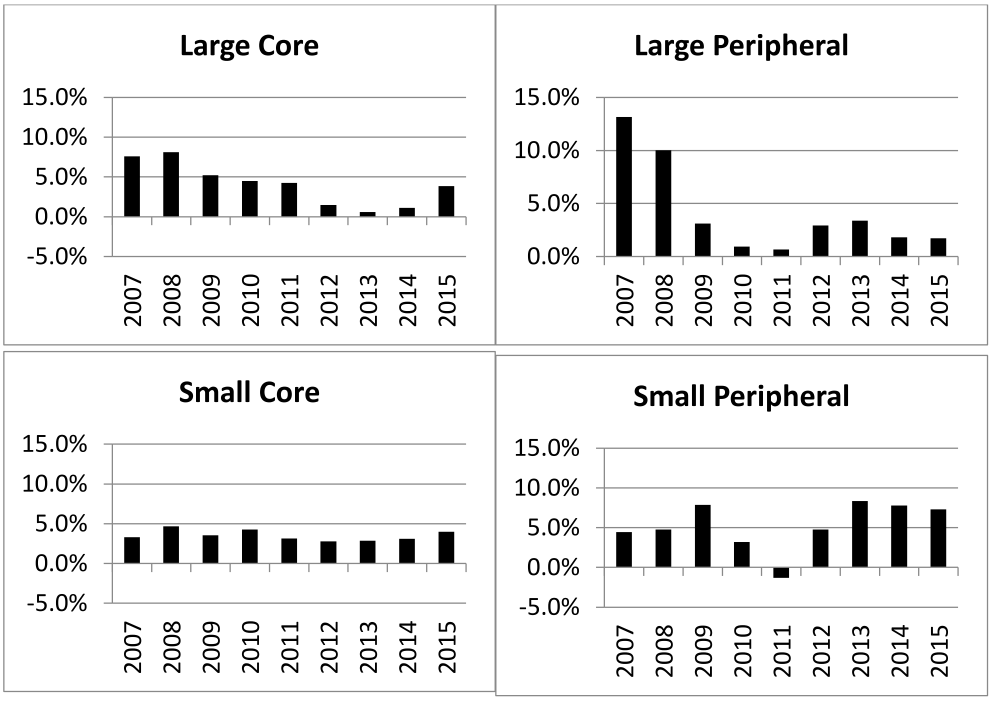


Figure 3.4: Growth rate of retail deposits and short-term funds, median value.

A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has an average total asset higher than 20 billion Euro. A bank is qualified as a small bank if its average total asset is smaller than 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Data source: BvD Bankscope.

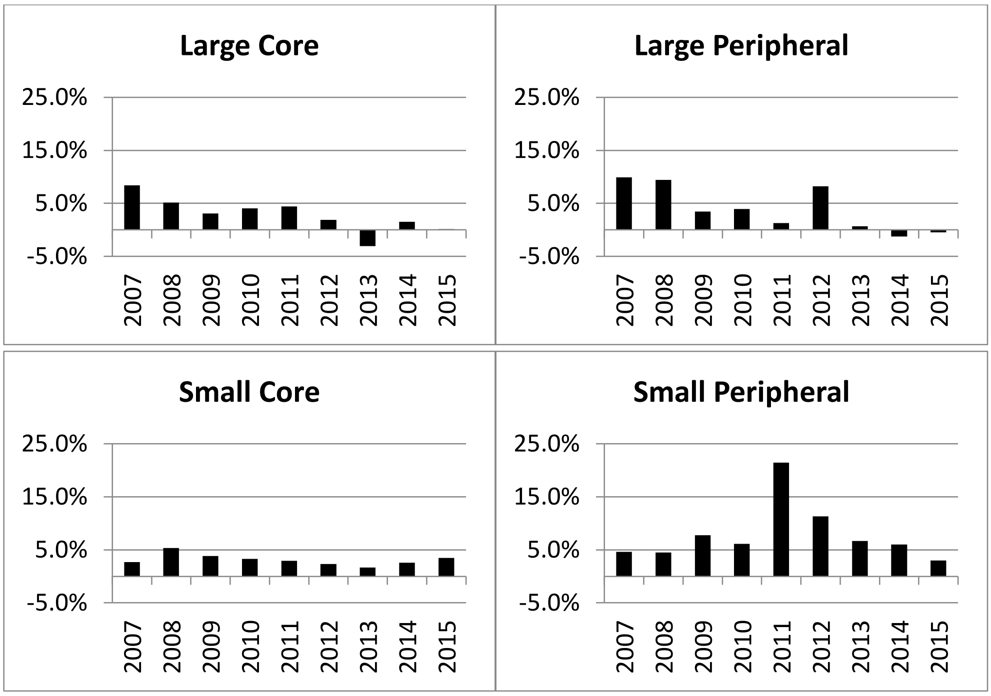


Figure 3.5: Characteristics of ECB's Long-Term Refinancing Operations (LTROs)

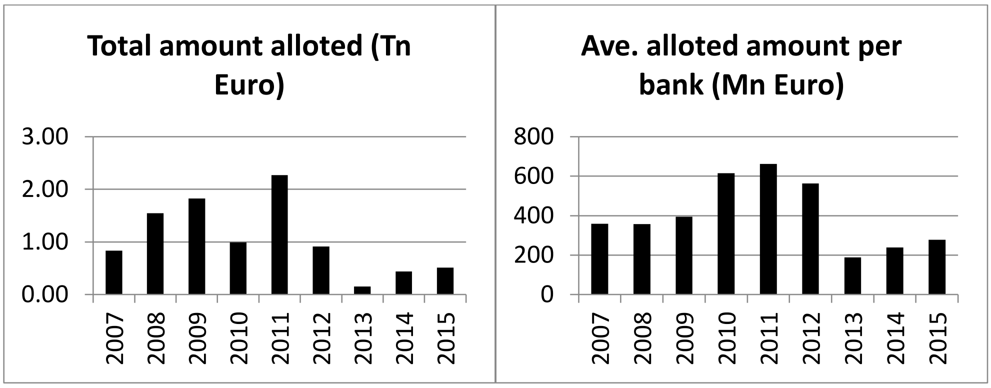


Figure 3.6: Bank loan demand index of core and peripheral countries.

The Figures are based on the data provided in the Bank Lending Survey by the ECB. The procedure followed to build the demand index is described in Appendix A.1. Core countries include Austria, Belgium, Germany, France and Netherlands. Peripheral countries include Greece, Ireland, Italy, Portugal and Spain. Data source: ECB data warehouse.

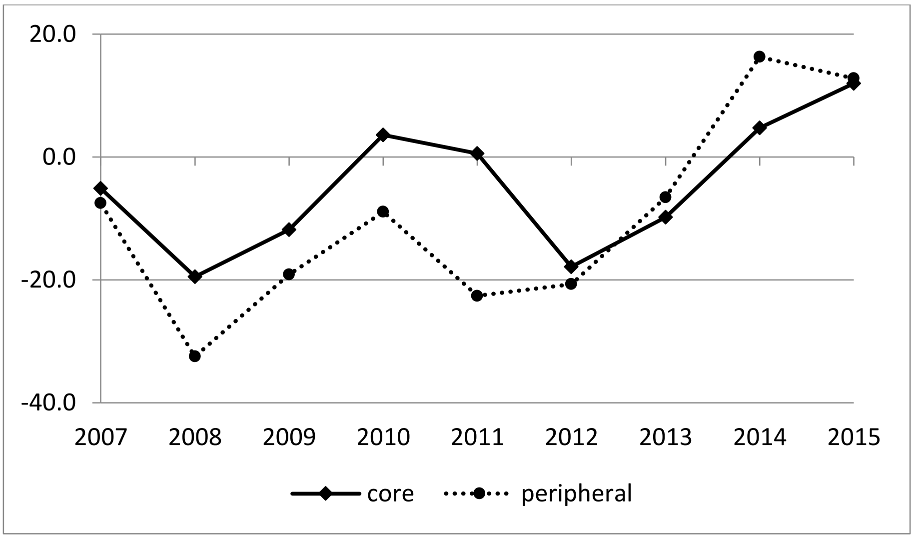
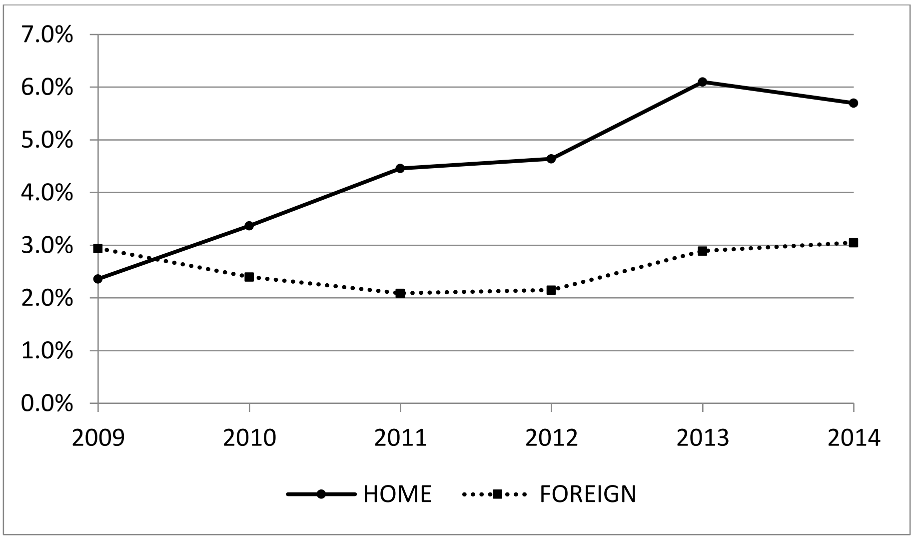


Figure 3.7: Average proportion of government security exposure to total asset – Home vs. Foreign.

Large banks are those that participated in the EBA stress tests and risk assessments. Core countries include Austria, Belgium, Germany, France and Netherlands. Peripheral countries include Greece, Ireland, Italy, Portugal and Spain. HOME is a bank's domestic sovereign bond exposure divided by total asset. FOREIGN is a bank's total sovereign exposure across all the above core and peripheral countries, divided by total assets. Data source: EBA.

A. Large banks in core countries.



B. Large banks in peripheral countries.

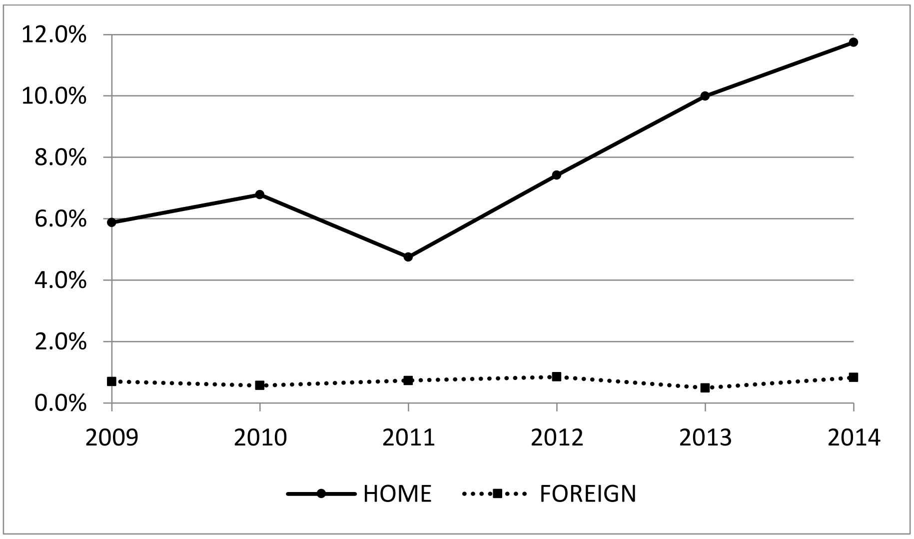
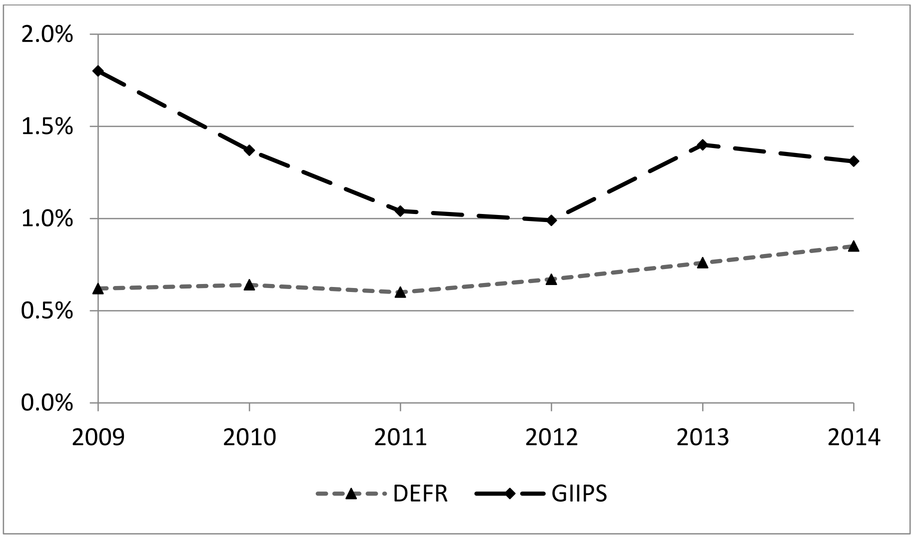


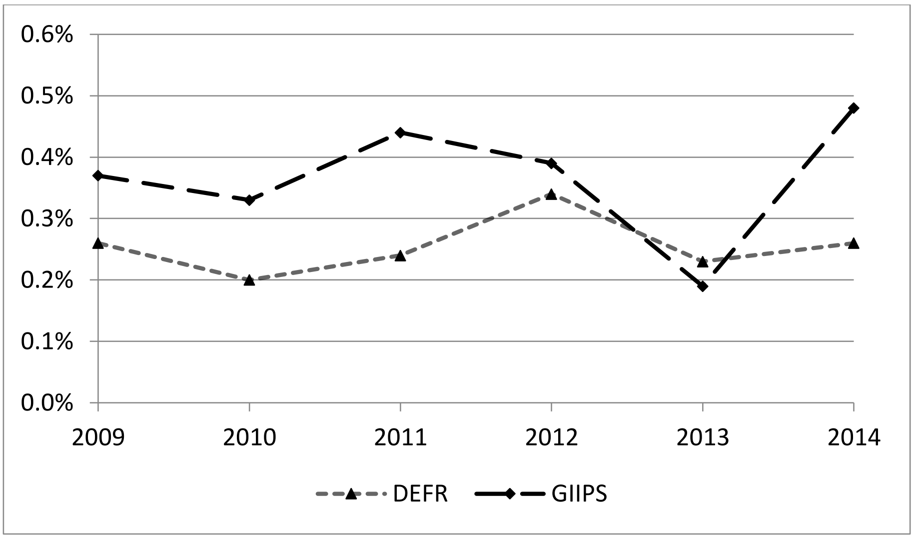
Figure 3.8: Average proportion of government security exposure to total asset – Foreign Safe vs. Foreign Risky.

Large banks are those that participated in the EBA stress tests and risk assessments. Core countries include Austria, Belgium, Germany, France and Netherlands. Peripheral countries include Greece, Ireland, Italy, Portugal and Spain. DEFR is a bank's exposure to German and French sovereign bonds when, for that bank, they are not a domestic exposure (e.g. for a German bank DEFR only includes exposures to French sovereign bonds) divided by the bank's total asset. GIIPS is a bank's total exposure to peripheral countries when they are not domestic exposures (e.g. for an Italian bank GIIPS only includes exposures to Greece, Ireland, Portugal and Spain) divided by the bank's total assets. Data source: EBA.

A. Large banks in core countries



B. Large banks in peripheral countries



List of Tables

Table 3.1: Summary Statistics

A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has an average total asset higher than 20 billion Euro. A bank is qualified as a small bank if its average total asset is smaller than 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Variables are winsorized at 2th and 98th percentile within each of the four bank groups. The significance level of t-test on mean and Wilcoxon test on median are indicated by ***, **, and * for 1%, 5% and 10%, respectively. Data source: BvD Bankscope.

Panel A:	Loan Growth: Δln(loan)					
	Large Core	Small Core	Diff	Large Peripheral	Small Peripheral	Diff
Period: 2007 – 2009						
Mean	7.8%	3.7%	4.0%***	8.3%	6.7%	1.6%
Median	7.4%	2.8%	4.6%***	7.3%	5.3%	2.0%**
N	117	5,075		111	1,762	
Period: 2010 – 2015						
Mean	0.3%	4.7%	-4.4%***	-0.7%	2.6%	-3.3%***
Median	0.7%	4.0%	-3.3%***	-2.1%	1.0%	-3.1%***
N	241	10,231		229	3,524	

Panel B:	Credit Risk: Loan Loss Provision / Total Equity					
Period: 2007 – 2009						
Mean	7.0%	6.1%	0.9%	11.0%	4.5%	6.6%***
Median	5.0%	5.5%	-0.4%***	6.9%	3.2%	3.7%***
N	117	5,075		111	1,762	
Period: 2010 – 2015						
Mean	4.5%	1.5%	3.0%***	20.7%	9.1%	11.6%***
Median	3.4%	1.3%	2.1%***	12.2%	6.2%	6.0%***
N	241	10,231		229	3,524	

Panel C:	Leverage: Total Asset / Total Equity					
Period: 2007 – 2009						
Mean	39	15	24***	18	10	8***
Median	32	15	17***	16	9	7***
N	117	5,075		111	1,762	
Period: 2010 – 2015						
Mean	29	12	17***	18	10	8***
Median	25	12	13***	16	10	6***
N	241	10,231		229	3,524	

Table 3.1 Continued

	Large Core	Small Core	Diff	Large Peripheral	Small Peripheral	Diff
Panel D:			Sovereign Debt Securities / Total Asset			
Period: 2007 – 2009						
Mean	4.9%	1.1%	3.7%***	4.9%	11.4%	-6.5%***
Median	3.6%	0.0%	3.6%***	3.9%	9.1%	-5.2%***
N	117	5,075		111	1,762	
Period: 2010 – 2015						
Mean	6.3%	1.8%	4.4%***	11.7%	16.8%	-5.1%***
Median	5.5%	0.8%	4.7%***	11.2%	15.9%	-4.8%***
N	241	10,231		229	3,524	
Panel E:			Deposit and Short Term Fund Growth: Δln(DEP&ST)			
Period: 2007 – 2009						
Mean	6.2%	4.9%	1.3%	9.3%	7.2%	2.1%*
Median	5.8%	4.0%	1.9%**	6.9%	6.1%	0.9%**
N	117	5,075		111	1,762	
Period: 2010 – 2015						
Mean	-0.9%	3.3%	-4.2%***	3.5%	10.1%	-6.6%***
Median	0.0%	2.7%	-2.7%***	1.2%	6.8%	-5.6%***
N	241	10,231		229	3,524	
Panel F:			Deposit Growth: Δln(DEP)			
Period: 2007 – 2009						
Mean	7.2%	4.8%	2.4%*	9.4%	7.2%	2.1%*
Median	6.7%	3.7%	2.9%***	7.6%	5.8%	1.7%**
N	117	50,02		111	1,750	
Period: 2010 – 2015						
Mean	1.4%	4.1%	-2.8%***	3.4%	5.8%	-2.4%***
Median	2.6%	3.3%	-0.7%***	2.1%	4.5%	-2.5%***
N	238	10,127		229	3,499	
Panel G:			SIZE: Million Euro			
Period: 2007 - 2009						
Mean	357,355	549	356,806***	149,632	467	149,165***
Median	158,400	387	158,013***	60,132	293	59,839***
N	117	5,075		111	1,762	
Period: 2010 - 2015						
Mean	350,196	610	349,586***	162,641	513	162,128***
Median	149,500	421	149,079***	69,859	334	69,526***
N	241	10,231		229	3,524	

Table 3.1 Continued

Panel H: Tier 1 ratio: tier1 capital / RWA

	Large Core	Small Core	Diff	Large Peripheral	Small Peripheral	Diff
Period: 2007 - 2009						
Mean	n/a	n/a	n/a	n/a	n/a	n/a
Median	n/a	n/a	n/a	n/a	n/a	n/a
N	n/a	n/a	n/a	n/a	n/a	n/a
Period: 2010 - 2015						
Mean	14.5%	13.9%	0.5%	10.9%	18.0%	-7.1%***
Median	13.0%	13.1%	-0.1%	11.0%	15.9%	-4.9%***
N	226	5,635		211	3,056	

Table 3.2: Determinants of loan growth: large banks vs. medium banks vs. small banks.

This table contains the results of fixed effects panel regressions of annual loan growth of banks on sovereign debt exposures and other control variables. Panel A, B and C show the results for large, medium and small banks respectively. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. The explanatory variables include, SOV_ALL: sovereign securities exposure / total asset; SIZE: log of total asset (in thousand Euros); LLP/TE: loan loss provision / total equity; Δln(DEP&ST): growth rate of total retail deposit and short-term funding; DEMD is a country-level variable that describes the changes of credit demand of domestic borrowers; Macro Controls include domestic GDP and CPI growth rates. SOV_ALL is interacted with a dummy variable *Crunch* which equals 1 if the dependent variable is negative and 0 otherwise. In addition, we include the result of Wald-tests that give the joint significance of linear combinations of the betas for SOV_ALL and SOV_ALL**Crunch*. All explanatory variables are lagged by 1 year and bank level variables are winsorized at the 2nd and 98th percentile within each of the six bank groups – large core, large peripheral, medium core, medium peripheral, small core and small peripheral. Standard errors are heteroscedasticity-robust and clustered at the bank level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively. Data source: Bankscope.

Panel A: Large Banks (EBA banks with total asset larger than 20 billion Euro)

	[1]	[2]	[3]	[4]
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2007 - 2009	2010 - 2015	2007 - 2009	2010 - 2015
SOV_ALL_{t-1}	0.1991	0.0119	0.3114	-0.0356
SOV_ALL_{t-1}*Crunch	0.5783	0.1571	0.0768	0.0368
Crunch	-0.1937***	-0.1007***	-0.0806**	-0.1412***
$SIZE_{t-1}$	-0.4364**	-0.0189	-0.5577***	-0.0786
LLP_{t-1}/TE_{t-1}	0.0196	0.1069	0.0103	-0.0251
$\Delta ln(DEP\&ST)_{t-1}$	0.1494**	-0.0182	0.0667	-0.0366
$DEMD_{t-1}$	-0.0022	0.0001	0.0006*	-0.0005
Macro Controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	105	237	104	218
Adj. R-Squared	0.71	0.42	0.68	0.45
Wald-tests				
SOV_ALL	0.1991	0.0119	0.3114	-0.0356
SOV_ALL (1+Crunch)	0.7774	0.169	0.3882	0.0012

Table 3.2 Continued

Panel B: Medium Banks (total asset between 2 to 20 billion Euro)

	[1]	[2]	[3]	[4]
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2007 - 2009	2010 - 2015	2007 - 2009	2010 - 2015
SOV_ALL_{t-1}	0.1466	-0.1200	0.5168	0.1696
SOV_ALL_{t-1}*Crunch	-0.1095	-0.0895	-0.5085	-0.0914
Crunch	-0.1260***	-0.1168***	-0.1553***	-0.1629***
$SIZE_{t-1}$	-0.3178***	-0.1382***	-0.1543***	-0.0605**
LLP_{t-1}/TE_{t-1}	-0.0466	-0.0222	-0.2058***	-0.0533
$\Delta ln(DEP\&ST)_{t-1}$	0.0086	0.0286	0.0509	-0.0064
$DEMD_{t-1}$	0.0002	-0.0003	0.0008	-0.0001
Macro Controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	1253	2643	541	766
Adj. R-Squared	0.40	0.33	0.50	0.40
Wald-tests				
SOV_ALL	0.1466	-0.1200	0.5168	0.1696
SOV_ALL (1+Crunch)	0.0371	-0.2095	0.0083	0.0782

Table 3.2 Continued

Panel C: Small Banks (total asset smaller than 2 billion Euro)

	[1]	[2]	[3]	[4]
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2007 - 2009	2010 - 2015	2007 - 2009	2010 - 2015
SOV_ALL_{t-1}	0.4879***	0.0281	0.1637***	0.1343***
SOV_ALL_{t-1}*Crunch	-0.4687**	-0.1003	0.0614	-0.0130
Crunch	-0.0912***	-0.1080***	-0.1136***	-0.0908***
$SIZE_{t-1}$	-0.1785***	-0.1246***	-0.3327***	-0.0929***
LLP_{t-1}/TE_{t-1}	-0.0301	-0.0253**	-0.2883***	-0.0486**
$\Delta ln(DEP\&ST)_{t-1}$	0.0063	0.0348**	0.0619**	0.0143
$DEMD_{t-1}$	0.0013**	0.0001	0.0003**	0.0002**
Macro Controls	YES	YES	YES	YES
Bank FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	4863	9734	1673	3312
Adj. R-Squared	0.31	0.31	0.51	0.42
Wald-tests				
SOV_ALL	0.4879***	0.0281	0.1637***	0.1343***
SOV_ALL (1+Crunch)	0.0192	-0.0722	0.2251***	0.1213***

Table 3.3: Complementarity effect in small peripheral banks

In this Table we look at the top and bottom quartiles of small peripheral banks ranked by their sovereign debt exposure during the period 2010 – 2015. Δln(loan1015) is the total loan growth in the period 2010 -2015; Δln(loan) is the annual loan growth; SIZE is the log of total asset (in thousand Euros); LLP/TE denotes loan loss provision / total equity; TA/TE equals total asset / total equity; SOV/TA is the ratio of sovereign securities exposure / total asset. Δln(DEP&ST) is the growth rate of total retail deposit and short-term funding; Δln(DEP) is the growth rate of retail deposit; Tier1 ratio is tier 1 capital / risk weighted asset. The significance level of t-tests on means and Wilcoxon test on medians are indicated by ***, **, and * for 1%, 5% and 10%, respectively.

	Mean			Median		
Item	High	Low	Diff	High	Low	Diff
SOV/TA	33.8%	6.8%	27.0%***	33.7%	5.8%	27.9%***
Δln(loan1015)	24.5%	7.6%	16.9%***	19.4%	2.7%	16.6%***
Δln(loan)	4.6%	1.6%	3.0%***	2.9%	0.8%	2.1%***
SIZE	434	1046	-612***	249	529	-281***
LLP/TE	7.7%	11.4%	-3.7%***	5.6%	6.4%	-0.8%***
TA/TE	9.9	11.0	-1.1***	9.2	10.3	-1.1***
Δln(DEP&ST)	12.0%	8.5%	3.5%***	8.4%	6.2%	2.2%***
Δln(DEP)	6.2%	4.8%	1.4%	4.9%	3.9%	1.0%
Tier1 ratio	22.5%	15.5%	7.0%***	20.8%	13.3%	7.5%***

Table 3.4: Effect of marked-to-market bond portfolio losses on loan growth

In this table we present panel regressions of loan growth on marked-to-market bond portfolio losses and bank specific and macro controls. Large banks are those that participated in the EBA serial tests at least twice and have average assets higher than 20 billion Euro. Medium banks have average total assets between 2 billion to 20 billion Euro. Small banks have average total assets below 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands LOSS_ALL is the marked to market loss on the total government bond portfolio of a bank. *Crunch* equals 1 if the dependent variable is negative and 0 otherwise. Panel A (B) shows the result for large banks under the assumption that all sovereign bonds have a 5-year (10-year) maturity, Panel C (D) shows the results for medium and small banks under the assumption that all sovereign bonds have a 5-year (10-year) maturity. Controls include: bank-level controls (the same bank level variables as in the baseline model in Table 2, except SOV and SOV*Crunch), demand control (a country-level variable which describes the changes in credit demand of domestic borrowers), macro controls (include domestic GDP and CPI growth rates), bank fixed effect, and year fixed effect. All the other regression settings regarding winsorization, error-clustering and coefficient significance levels are the same as in previous tables.

Panel A: Large Banks, 5-year bond maturity

	[1]	[2]
Sample country	Core	Peripheral
Sample period	2010-2015	2010-2015
LOSS_ALL	-0.2953	-1.7593
LOSS_ALL * CRUNCH	-2.0162**	1.5096*
CRUNCH	-0.0900***	-0.1265***
Controls	YES	YES
N	164	158
Adj. R-squared	0.48	0.59
Wald Test		
LOSS	-0.2953	-1.7593
LOSS (1+CRUNCH)	-2.3115	-0.2497

Table 3.4 Continued

Panel B: Large Banks, 10-year bond maturity

	[1]	[2]
Sample country	Core	Peripheral
Sample period	2010-2015	2010-2015
LOSS_ALL	-1.0857	-2.9798*
LOSS_ALL * CRUNCH	-1.9431	2.5957*
CRUNCH	-0.0864***	-0.1265***
Controls	YES	YES
N	164	158
Adj. R-squared	0.47	0.60
Wald Test		
LOSS	-1.0857	-2.9798*
LOSS (1+CRUNCH)	-3.0288	-0.3841

Panel C: Medium and Small Banks, 5-year bond maturity

	[1]	[2]	[3]	[4]
Sample country	Medium Core	Small Core	Medium Peripheral	Small Peripheral
Sample period	2010-2015	2010-2015	2010-2015	2010-2015
LOSS_ALL	-2.619	0.2965	0.9134	-0.3868*
LOSS_ALL * CRUNCH	3.7521	0.3040	1.4586	-0.0134
CRUNCH	-0.1344***	-0.1794***	-0.1259***	-0.1051***
Controls	YES	YES	YES	YES
N	2643	766	9734	3312
Adj. R-squared	0.33	0.44	0.29	0.37
Wald Test				
LOSS	-2.619	0.2965	0.9134	-0.3868*
LOSS (1+CRUNCH)	1.1331	0.6005	2.3720	-0.4002

Table 3.4 Continued

Panel D: Medium and Small Banks, 10-year bond maturity

	[1]	[2]	[3]	[4]
Sample country	Medium Core	Small Core	Medium Peripheral	Small Peripheral
Sample period	2010-2015	2010-2015	2010-2015	2010-2015
LOSS_ALL	-0.9668	0.0444	0.0478	-0.2730*
LOSS_ALL * CRUNCH	1.1025	0.1568	0.7884	-0.0008
CRUNCH	-0.1351***	-0.1792***	-0.1259***	-0.1049***
Controls	YES	YES	YES	YES
N	2643	766	9734	3312
Adj. R-squared	0.33	0.44	0.29	0.37
Wald Test				
LOSS	-0.9668	0.0444	0.0478	-0.2730*
LOSS (1+CRUNCH)	0.1357	0.2012	0.8362	-0.2738*

Table 3.5: Correlation between loans and sovereign exposures.

This table shows the pairwise correlation between loans to total assets and sovereign exposure to total assets. Large banks are those that participated in the EBA serial tests at least twice and have average assets higher than 20 billion Euro. Medium banks have average total assets between 2 billion to 20 billion Euro. Small banks have average total assets below 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. * indicate significance at the 1 percent levels.

Period	Large Core	Large Peripheral	Medium Core	Medium Peripheral	Small Core	Small Peripheral
2007 – 2009	-0.16	-0.35*	-0.31*	-0.38*	-0.27*	-0.55*
2010 – 2015	0.03	-0.40*	-0.36*	-0.43*	-0.27*	-0.44*

Table 3.6: Loan overhang effect

In this table we employ panel regressions of loan growth on LOAN/TA which denotes lagged loan levels to total assets (loan overhang effect), and other bank specific and macro controls. LOAN/TA is orthogonalized with respect all the other explanatory variables. Panel A, B and C show the results for large banks, medium banks and small banks. Large banks are those that participated in the EBA serial tests at least twice and have average assets higher than 20 billion Euro. Medium banks have average total assets between 2 billion to 20 billion Euro. Small banks have average total assets below 2 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Explanatory variables include, SIZE: log of total asset (in thousand Euros); LLP/TE: loan loss provision / total equity; SOV_ALL: sovereign securities exposure / total asset. Δln(DEP&ST): growth rate of total retail deposit and short-term funding; DEMD is a country-level variable that describes the changes in credit demand of domestic borrowers; Controls include domestic GDP and CPI growth rates; Bank fixed effect and Year fixed effects. *Crunch* equals 1 if the dependent variable is negative and 0 otherwise. In addition, we include the result of Wald-tests that give the joint significance of linear combinations of betas of SOV_ALL and SOV_ALL**Crunch*. All the other regression settings regarding winsorization, error-clustering and coefficient significance levels are the same as in Table 2.

Panel A: Large Banks (EBA banks with total asset larger than 20 billion Euro)

	[1]	[2]	[3]	[4]
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2007 - 2009	2010 - 2015	2007 - 2009	2010 - 2015
$LOAN/TA_{t-1}$	-1.4036***	-0.3221***	-0.6005*	-0.1987
SOV_ALL_{t-1}	0.1991	0.0119	0.3114	-0.0356
SOV_ALL_{t-1}*Crunch	0.5783	0.1571	0.0768	0.0368
Crunch	-0.1937***	-0.1007***	-0.0806**	-0.1412***
$SIZE_{t-1}$	-0.4364***	-0.0189	-0.5577***	-0.0786
LLP_{t-1}/TE_{t-1}	0.0196	0.1069	0.0103	-0.0251
$\Delta ln(DEP\&ST)_{t-1}$	0.1494**	-0.0182	0.0667	-0.0366
$DEMD_{t-1}$	-0.0022	0.0001	0.0006	-0.0005
Controls	YES	YES	YES	YES
N	105	237	104	218
Adj. R-Squared	0.78	0.45	0.70	0.45
Wald-tests				
SOV_ALL	0.1991	0.0119	0.3114	-0.0356
SOV_ALL (1+Crunch)	0.7774*	0.1690	0.3882	0.0012

Table 3.6 Continued

Panel B: Medium Banks (total asset between 2 to 20 billion Euro)

	[1]	[2]	[3]	[4]
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2007 - 2009	2010 - 2015	2007 - 2009	2010 - 2015
$LOAN/TA_{t-1}$	-1.0873***	-0.3849***	-0.5675***	-0.3037***
SOV_ALL_{t-1}	0.1466	-0.1200	0.5168	0.1696
SOV_ALL_{t-1}*Crunch	-0.1095	-0.0895	-0.5085	-0.0914
Crunch	-0.1260***	-0.1168***	-0.1553***	-0.1629***
$SIZE_{t-1}$	-0.3178***	-0.1382***	-0.1543***	-0.0605**
LLP_{t-1}/TE_{t-1}	-0.0466	-0.0222	-0.2058***	-0.0533
$\Delta\ln(DEP\&ST)_{t-1}$	0.0086	0.0286	0.0509	-0.0064
$DEMD_{t-1}$	0.0002	-0.0003	0.0008	-0.0001
Controls	YES	YES	YES	YES
N	1253	2643	541	766
Adj. R-Squared	0.49	0.37	0.53	0.41
Wald-tests				
SOV_ALL	0.1466	-0.1200	0.5168	0.1696
SOV_ALL (1+Crunch)	0.0371	-0.2095	0.0083	0.0782

Table 3.6 Continued

Panel C: Small Banks (total asset smaller than 2 billion Euro)

	[1]	[2]	[3]	[4]
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2007 - 2009	2010 - 2015	2007 - 2009	2010 - 2015
$LOAN/TA_{t-1}$	-0.6506***	-0.2558***	-0.5621***	-0.3595***
SOV_ALL_{t-1}	0.4879***	0.0281	0.1637***	0.1343***
SOV_ALL_{t-1}*Crunch	-0.4687**	-0.1003	0.0614	-0.0130
Crunch	-0.0912***	-0.1080***	-0.1136***	-0.0908***
$SIZE_{t-1}$	-0.1785***	-0.1246***	-0.3327***	-0.0929***
LLP_{t-1}/TE_{t-1}	-0.0301	-0.0253**	-0.2883***	-0.0486**
$\Delta ln(DEP\&ST)_{t-1}$	0.0063	0.0348**	0.0619**	0.0143
$DEMD_{t-1}$	0.0013**	0.0001	0.0003**	0.0002*
Controls	YES	YES	YES	YES
N	4863	9734	1673	3312
Adj. R-Squared	0.35	0.32	0.55	0.46
Wald-tests				
SOV_ALL	0.4879***	0.0281	0.1637***	0.1343***
SOV_ALL (1+Crunch)	0.0192	-0.0722	0.2251***	0.1213***

Table 3.7: Funding Effects on Peripheral Banks

In this Table we employ panel regressions to study the effects of funding on average loan growth Δln(loan), growth in interbank loans Δln(loan_bank), and the ratio of sovereign exposures (SOV) and non-sovereign securities (SEC) to total assets. Controls include: bank-level controls (the same bank level variables as in the baseline model in Table 2), demand control (a country-level variable which describes the changes in credit demand of domestic borrowers), macro controls (include domestic GDP and CPI growth rates), bank fixed effect, and year fixed effect. The settings of regressions are the same as in Table 2.

Panel A: Large Peripheral Banks (EBA banks with total asset larger than 20 billion Euro)

	[1]	[2]	[3]	[4]	[5]
Dependent Variable	Δln(loan)	Δln(loan)	Δln(loan_bank)	SOV	SEC
Sample Period	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015
$\Delta\ln(DEP\&ST)_{t-1}$	-0.0366				
$\Delta\ln(DEP)_{t-1}$		-0.0114	0.203	0.0178	-0.0222
$\Delta(ST)_{t-1}$		-0.0006	-0.0365	0.0119	0.0008
Controls	YES	YES	YES	YES	YES
N	218	218	218	218	218
Adj. R-squared	0.45	0.44	0.21	0.56	0.16

Panel B: Medium Peripheral Banks (total asset between 2 to 20 billion Euro)

	[1]	[2]	[3]	[4]	[5]
Dependent Variable	Δln(loan)	Δln(loan)	Δln(loan_bank)	SOV	SEC
Sample Period	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015
$\Delta\ln(DEP\&ST)_{t-1}$	-0.0052				
$\Delta\ln(DEP)_{t-1}$		0.0642**	0.0456	-0.0095	-0.0062
$\Delta(ST)_{t-1}$		-0.0026	0.0205	-0.0007	-0.0003
Controls	YES	YES	YES	YES	YES
N	766	751	748	751	751
Adj. R-squared	0.40	0.40	0.05	0.56	0.04

Panel C: Small Peripheral Banks (total asset smaller than 2 billion Euro)

	[1]	[2]	[3]	[4]	[5]
Dependent Variable	Δln(loan)	Δln(loan)	Δln(loan_bank)	SOV	SEC
Sample Period	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015
$\Delta\ln(DEP\&ST)_{t-1}$	0.0219**				
$\Delta\ln(DEP)_{t-1}$		0.0259*	-0.4969***	0.0317***	-0.0045
$\Delta(ST)_{t-1}$		0.0004	0.0054	-0.0002	0.0002
Controls	YES	YES	YES	YES	YES
N	3312	3288	3275	3288	3269
Adj. R-squared	0.42	0.42	0.10	0.56	0.05

Table 3.8: Impact of sovereign debt on loan growth, domestic vs foreign.

This table shows the impact of a specific sub-portfolio of sovereign exposures (domestic or foreign) on loan growth for large banks. A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and with an average total asset larger than 20 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. SOV_HOME (SOV_FOREIGN) is the domestic (foreign) sovereign exposure (to the other nine countries) divided by total asset. SOV_ is interacted with the dummy variable *Crunch* which equals 1 if the dependent variable is smaller than a certain level (0% and -5% respectively) and 0 otherwise. Controls include: bank-level controls (the same bank level variables as in the baseline model in Table 2), demand control (a country-level variable which describes the changes in credit demand of domestic borrowers), macro controls (include domestic GDP and CPI growth rates), bank fixed effect, and year fixed effect. All the other regression settings regarding winsorization, error-clustering and coefficient significance levels are the same as in previous tables. Data source: EBA.

Large Banks (EBA banks with total asset larger than 20 billion Euro)

	[1]	[2]	[3]	[4]
Threshold for Crunch	0%	-5%	0%	-5%
Sample Country	Core	Core	Peripheral	Peripheral
Sample Period	2010-2015	2010-2015	2010-2015	2010-2015
SOV_HOME_{t-1}	-0.3406	-0.1284	0.2263	0.1393
SOV_HOME_{t-1}*Crunch	0.0892	-0.1393	-0.4135	-0.5104**
$SOV\_Foreign_{t-1}$	-0.9954**	-0.5368	3.5310**	5.2857***
$SOV\_Foreign_{t-1}$*Crunch	0.6473	0.1548	-1.5695	-0.8259
Crunch	-0.1012***	-0.0991***	-0.0766***	-0.0610**
Controls	YES	YES	YES	YES
N	164	164	158	158
Adj. R-squared	0.51	0.53	0.60	0.51
Wald tests				
SOV_HOME	-0.3406	-0.1284	0.2263	0.1393
SOV_HOME (1+Crunch)	-0.2514	-0.2677	-0.1872	-0.3711**
SOV_FOREIGN	-0.9954**	-0.5368	3.5310**	5.2857***
SOV_FOREIGN (1+Crunch)	-0.3481	-0.3820	1.9615**	4.4598***

Appendix A

Table A1: Effect of public ownership on loan growth for large banks (EBA Sample, 2010 -2015)

In this Table we employ panel regressions of loan growth of large banks on their sovereign debt exposures, other bank level and macro variables, while controlling for the banks' public ownership. A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has average total assets larger than 20 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. SOV_HOME (SOV_FOREIGN) is the domestic (foreign) sovereign exposure divided by total asset. *Crunch* equals 1 if the dependent variable is negative and 0 otherwise. *Public* equals 1 if the owner of the bank is the domestic government (see Appendix C for a list of state owned banks). Controls and all regression settings regarding winsorization, error-clustering and coefficient significance levels are the same as in Table 2.

	[1]	[2]	[3]	[4]
Threshold for Crunch	0%	-5%	0%	-5%
Sample Banks	Large Core	Large Core	Large Peri.	Large Peri.
Sample Period	2010-2015	2010-2015	2010-2015	2010-2015
SOV_HOME_{t-1}	-0.2121	-0.0137	0.2366	0.1530
SOV_HOME_{t-1}*Crunch	0.0503	-0.1148	-0.4028	-0.4836*
SOV_HOME_{t-1}*Public	-0.1990	-0.376	-0.4561	-0.6879
$SOV\_FOREIGN_{t-1}$	-0.6012	-0.3876	3.8787***	5.4850***
$SOV\_FOREIGN_{t-1}$*Crunch	0.7655	0.2310	-1.2698	-0.6350
$SOV\_FOREIGN_{t-1}$*Public	-0.7966	-0.2186	-3.0198*	-1.8159*
Crunch	-0.1021***	-0.1013***	-0.0765***	-0.0615**
Controls	YES	YES	YES	YES
N	164	164	158	158
Adj. R-squared	0.51	0.53	0.60	0.51
Wald tests				
HOME	-0.2121	-0.0137	0.2366	0.1530
HOME*(1+Crunch)	-0.1618	-0.1285	-0.1662	-0.3306*
HOME*(1+Public)	-0.4111	-0.3897	-0.2195	-0.5349
HOME*(1+Crunch+Public)	-0.3608	-0.5045	-0.6223	-1.0185**
FOREIGN	-0.6012	-0.3876	3.8787***	5.4850***
FOREIGN*(1+Crunch)	0.1643	-0.1566	2.6089**	4.8500***
FOREIGN*(1+Public)	-1.3978	-0.6062	0.8589	3.6691***
FOREIGN*(1+Crunch+Public)	-0.6323	-0.3752	-0.4109	3.0341***

Table A2: Risk-shifting and flight-to-safety in large banks (EBA sample, 2010 - 2015)

In this Table we employ panel regressions of loan growth of large banks on domestic (HOME), foreign safe (DEFR) and foreign risky (GIIPS) sub-portfolios of their sovereign debt exposures and other bank level and macro controls. SOV_HOME is the domestic sovereign exposure divided by total assets. SOV_DEFR is the total sovereign exposure to Germany and France (except when any of the two countries is the home country) divided by total assets. SOV_GIIPS is the total sovereign exposure to Greece, Ireland, Italy, Portugal and Spain (except when any of the five countries is the home country) divided by total assets. A bank is qualified as a large bank if it has participated in the EBA serial tests at least twice and has average total assets larger than 20 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. *Crunch* equals 1 if the dependent variable is negative and 0 otherwise. Controls and all regression settings regarding winsorization, error-clustering and coefficient significance levels are the same as in Table 2.

	[1]	[2]	[3]	[4]
Threshold for Crunch	0%	-5%	0%	-5%
Sample Banks	Large Core	Large Core	Large Peri.	Large Peri.
Sample Period	2010-2015	2010-2015	2010-2015	2010-2015
SOV_HOME_{t-1}	-0.3357	-0.2198	0.1884	0.1213
SOV_HOME_{t-1}*Crunch	0.1701	0.0089	-0.3437	-0.5475*
SOV_DEFR_{t-1}	-2.7505***	-1.3151	0.3069	4.9911*
SOV_DEFR_{t-1}*Crunch	1.3313	2.0357	1.0411	-0.3650
SOV_GIIPS_{t-1}	0.1682	-1.0835	7.0103***	5.9674***
SOV_GIIPS_{t-1}*Crunch	0.6267	0.6910	-6.9233***	-1.5587
Crunch	-0.1080***	-0.1276***	-0.0761***	-0.0566**
Controls	YES	YES	YES	YES
N	164	164	158	158
Adj. R-squared	0.51	0.54	0.61	0.49
Wald tests				
SOV_HOME	-0.3357	-0.2198	0.1884	0.1213
SOV_HOME (1+Crunch)	-0.1656	-0.2109	-0.1553	-0.4262**
SOV_DEFR	-2.7505***	-1.3151	0.3069	4.9911*
SOV_DEFR (1+Crunch)	-1.4192	0.7206	1.3480	4.6261
SOV_GIIPS	0.1682	-1.0835	7.0103***	5.9674***
SOV_GIIPS (1+Crunch)	0.7949	-0.3925	0.0870	4.4087**

Table A3: Effect of marked-to-market bond portfolio losses on loan growth

In this table we present panel regressions of loan growth on marked-to-market bond portfolio losses and bank specific and macro controls. Large banks are those that participated in the EBA serial tests at least twice and have average assets higher than 20 billion Euro. Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands LOSS_HOME is the marked to market loss on the domestic government bond portfolio of a bank. LOSS_FOREIGN and LOSS_GIIPS denote losses on foreign (all) and foreign peripheral sovereign exposures respectively. *Crunch* equals 1 if the dependent variable is negative and 0 otherwise. Panel A (B) shows the result for large banks under the assumption that all sovereign bonds have a 10-year (5-year) maturity, Panel C (D) shows the results for medium and small banks under the assumption that all sovereign bonds have a 10-year (5-year) maturity. Controls include: bank-level controls (the same bank level variables as in the baseline model in Table 2, except SOV and SOV*Crunch), demand control (a country-level variable which describes the changes in credit demand of domestic borrowers), macro controls (include domestic GDP and CPI growth rates), bank fixed effect, and year fixed effect. All the other regression settings regarding winsorization, error-clustering and coefficient significance levels are the same as in previous tables.

Panel A: Large Bank, 5-year bond maturity

	[1]	[2]	[3]	[4]	[5]	[6]
Sample country	Core	Core	Core	Peripheral	Peripheral	Peripheral
Sample period	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015
LOSS_HOME	4.1945			-2.7412*		
LOSS_HOME *CRUNCH	-1.8383			2.4372*		
LOSS_FOREIGN		-7.3490*			-32.3808*	
LOSS_FOREIGN *CRUNCH		-2.8799			28.8994*	
LOSS_GIIPS			-3.9665			-3.1088*
LOSS_GIIPS *CRUNCH			-2.7387			2.7623**
CRUNCH	-0.0871***	-0.0848***	-0.0834***	-0.1276***	-0.1347***	-0.1254***
Controls	YES	YES	YES	YES	YES	YES
N	164	164	164	158	158	158
Adj. R-squared	0.47	0.49	0.49	0.59	0.58	0.60
Wald Test						
LOSS	4.1945	-7.3490*	-3.9665	-2.7412*	-32.3808*	-3.1088*
LOSS (1+CRUNCH)	2.3562	-10.2289**	-6.7052***	-0.3040	-3.4814	-0.3465

Table A3 Continued

Panel A: Large Bank, 5-year bond maturity

	[1]	[2]	[3]	[4]	[5]	[6]
Sample country	Core	Core	Core	Peripheral	Peripheral	Peripheral
Sample period	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015	2010-2015
LOSS_HOME	1.3281			-1.6653		
LOSS_HOME *CRUNCH	-2.5856			1.4653*		
LOSS_FOREIGN		-2.7459			-24.3192	
LOSS_FOREIGN *CRUNCH		-2.8639			20.5996	
LOSS_GIIPS			-2.6582			-1.7797*
LOSS_GIIPS *CRUNCH			-1.0644			1.6100**
CRUNCH	-0.0903***	-0.0862***	-0.0846***	-0.1271***	-0.1326***	-0.1238***
Controls	YES	YES	YES	YES	YES	YES
N	164	164	164	158	158	158
Adj. R-squared	0.47	0.48	0.48	0.59	0.58	0.60
Wald Test						
LOSS	1.3281	-2.7459	-2.6582	-1.6653	-24.3192	-1.7797*
LOSS (1+CRUNCH)	-1.2575	-5.6098**	-3.7226**	-0.2000	-3.7196	-0.1697

Appendix A.1: Bank Lending Survey and Demand/Supply Indexes

The ECB's Bank Lending Survey, which has been running since 2003, is compiled quarterly and gathers information from senior loan officers of a representative sample of 140 Euro area banks. I consider specific survey questions – Q6 and Q18 that ask banks to assess how loan demand has changed across different lending sectors. The demand index refers to the difference between the share of banks reporting a (weighted) increase in loan demand and the share of banks reporting a (weighted) decline. The index will then be positive (negative) if a larger proportion of banks have reported an increase (decline) in loan demand. The survey distinguishes between demand being "somewhat" or "considerably" changed giving different weights to the two responses (1 and 2 respectively). The ECB aggregates these responses in each country for each of the following lending sectors: enterprises, house purchases and consumer credit, which cover all loans to the non-public sector excluding monetary financial institutions. We combine the three sectors into one demand index by computing a weighted average demand where the weights are the sectors' outstanding loan amount.

Appendix A.2: Distribution of the "Crunch" dummy

year	Large Core	Large Peripheral	Small Core	Small Peripheral
2007	13%	0%	25%	12%
2008	8%	8%	21%	33%
2009	48%	49%	29%	17%
2010	15%	36%	24%	12%
2011	25%	63%	18%	21%
2012	43%	61%	13%	48%
2013	69%	77%	16%	62%
2014	42%	80%	19%	56%
2015	47%	60%	15%	44%
2007 - 2009	23%	19%	25%	21%
2010 - 2015	42%	63%	17%	40%

Appendix A.3: List of state-owned banks

Bank Name	Bankscope ID	Countr y
ABN AMRO Bank NV	11581	NL
BPI France Financement SA	12990	FR
Norddeutsche Landesbank Girozentrale NORD/LB	13584	DE
Portigon AG	14021	DE
Hypo Real Estate Holding AG	16697	DE
NRW.BANK	19856	DE
Allied Irish Banks plc	20103	IE
SNS Bank N.V.	22324	NL
Caixa Geral de Depositos	22529	PT
La Banque Postale	29070	FR
Dexia SA	45621	BE
Permanent TSB Plc	48505	IE
Landeskreditbank Baden-Wuerttemberg - Förderbank-L-Bank	48901	DE
Belfius Banque SA/NV-Belfius Bank SA/NV	48939	BE
SFIL	51740	FR

Appendix A.4: Definition of sovereign portfolio losses.

Similar to De Marco (2017), we construct a bank-specific (unrealised) loss variable for bank *i*'s sovereign bond portfolio at time *t*:

$$LOSS_{i,t} = \sum_{s=1}^{S} Duration_{s,m,t} \times \Delta yield_{s,m,t} \times \frac{Exposure_{i,s,m,t-1}}{Total\ Asset_{i,t-1}} \quad (2)$$

where *s* is the specific sovereign country that bank i is exposed to, *t* refers to end-of-year observations 2010 to 2015, and *m* is the original time to maturity of each exposure in years. We focus on exposures to the 10 countries in our sample. As in Altavilla et al (2017) we assume two alternative debt maturities: 5 years or 10 years.

One of the components of the loss measure is each exposure's modified duration ($Duration_{s,m,t}$). For its calculation we need the exposure's coupon value. As this is not available, we assume that all sovereign bonds are par value bonds (i.e. the coupon equals the yield) and pay coupons semi-annually. Then, $Duration_{s,m,t}$ is calculated as follows :

$$Duration_{s,m,t} = \frac{1}{yield_{s,m,t}} * \left(1 - \frac{1}{(1+yield_{s,m,t})^{2m}}\right) \quad (3)$$

Given the semi-annual coupon assumption, $yield_{s,m,t}$ is a semi-annual yield. Accordingly, maturity is multiplied by 2.

Appendix A.5: Distribution of marked-to-market sovereign portfolio losses (based on the 5-year maturity assumption). LOSS_ALL is the marked to market loss on the total government bond portfolio of a bank. LOSS_HOME and LOSS_FOREIGN denote losses on domestic and foreign sovereign exposures respectively.

		LOSS_ALL		LOSS_HOME		LOSS_FOREIGN	
year	percentile	Core	Peri.	Core	Peri.	Core	Peri.
2010	10% perc	0.01%	0.06%	-0.09%	0.06%	0.03%	-0.01%
	25% perc	0.02%	0.19%	-0.07%	0.16%	0.07%	0.00%
	50% perc	0.13%	0.32%	-0.02%	0.30%	0.15%	0.01%
	75% perc	0.16%	1.09%	-0.01%	0.90%	0.24%	0.06%
	90% perc	0.43%	7.44%	0.03%	7.44%	0.35%	0.26%
2011	10% perc	-0.24%	0.01%	-0.39%	0.01%	0.03%	-0.03%
	25% perc	-0.03%	0.07%	-0.20%	0.05%	0.10%	0.00%
	50% perc	0.09%	0.17%	-0.05%	0.09%	0.16%	0.01%
	75% perc	0.27%	2.51%	0.00%	1.96%	0.33%	0.09%
	90% perc	0.50%	9.28%	0.01%	9.28%	0.57%	0.49%
2012	10% perc	-1.27%	-3.29%	-0.40%	-2.06%	-0.89%	-1.23%
	25% perc	-0.62%	-1.59%	-0.28%	-1.54%	-0.45%	-0.18%
	50% perc	-0.41%	-0.78%	-0.12%	-0.61%	-0.27%	-0.08%
	75% perc	-0.24%	-0.24%	-0.06%	-0.10%	-0.11%	-0.02%
	90% perc	-0.15%	-0.06%	-0.04%	-0.05%	-0.07%	-0.01%
2013	10% perc	-0.02%	-1.67%	0.01%	-1.67%	-0.12%	-0.11%
	25% perc	0.02%	-0.94%	0.03%	-0.93%	-0.06%	-0.01%
	50% perc	0.07%	-0.35%	0.07%	-0.36%	0.00%	0.00%
	75% perc	0.12%	-0.22%	0.16%	-0.22%	0.01%	0.01%
	90% perc	0.19%	-0.08%	0.24%	-0.13%	0.04%	0.05%
2014	10% perc	-1.32%	-2.28%	-0.69%	-2.28%	-0.60%	-0.16%
	25% perc	-0.70%	-1.33%	-0.37%	-1.33%	-0.24%	-0.06%
	50% perc	-0.31%	-0.83%	-0.16%	-0.80%	-0.13%	-0.01%
	75% perc	-0.21%	-0.32%	-0.07%	-0.32%	-0.06%	0.00%
	90% perc	-0.12%	0.05%	-0.03%	0.07%	-0.03%	0.00%
2015	10% perc	-0.25%	-0.46%	-0.14%	-0.46%	-0.11%	-0.05%
	25% perc	-0.11%	-0.29%	-0.06%	-0.28%	-0.06%	-0.02%
	50% perc	-0.07%	-0.20%	-0.03%	-0.17%	-0.03%	0.00%
	75% perc	-0.04%	-0.10%	-0.01%	-0.08%	-0.02%	0.00%
	90% perc	-0.03%	-0.05%	-0.01%	-0.03%	0.00%	0.00%

Chapter 4 The IRB Model, Bank Regulatory Arbitrage, and the Eurozone Crisis

4.1 Introduction

In order to increase the stability of the financial system, policymakers have been improving the regulatory framework, with particular attention given to the design of bank's capital charge. In this regard, the most important innovation is model-based capital regulation, which was introduced around the new millennium. Regulations under Basel II allow banks to choose between two different approaches to assess the credit risk associated with their assets and to evaluate capital adequacy, namely the IRB approach and the standardised approach (SA). Specifically, the IRB approach enables banks to design and calibrate their own risk models, subject to approval from the supervisors. Thus, it ties the capital charge to the actual risk associated with specific assets. Regulators believe that capital requirements based on such an approach can be more sensitive to the drivers of risk, and that an appropriately structured framework can motivate banks to improve their internal risk management (BCBS 2001).

However, critics point out that complex and opaque rules can create high compliance costs and barriers to entry (BCBS 2004). More importantly, by applying internal models, banks have considerable autonomy in terms of risk assessment, which can provide extensive incentive for regulatory arbitrage. Mariathasan and Merrouche (2014) find that the risk-weight density of the bank becomes lower once regulatory approval for the adoption of the IRB approach is granted and suggest that part of the decline in reported riskiness with the IRB approach is due to strategic risk modelling. Ferri and Pesic (2017) provide evidence of regulatory arbitrage and show that such an effect is stronger in banks that adopt the Advanced IRB than in those that employ only the Foundation IRB. Analysing the German banking sector using loan-level data, Behn et al (2016) show that the IRB approach underpredicts actual default rates by 0.5%–1%. They also show that loans that originated with the IRB approach have higher default rates and higher interest rates than those originated with the SA. This suggests that banks were aware of the higher risk associated with these loans and priced them accordingly but reduced the capital charge by underestimating the corresponding risks using the IRB models.

This chapter contributes to the literature in two ways principally. First, I explore regulatory arbitrage using IRB models in the context of the Eurozone crisis. A few papers with a similar objective have found evidence of regulatory arbitrage (Vallascas and Hagendorff 2013; Beltratti and Paladino 2016; Ferri and Pesic 2017). However, due to a lack of available data, they were not able to clearly exploit the effect of the Eurozone crisis on regulatory arbitrage. In this chapter, the data from the EBA allows me to conduct an analysis at the country exposure level rather than merely at the bank level. I find that regulatory arbitrage by means of strategic risk modelling is primarily related to banks from Eurozone peripheral countries, especially those with less than adequate tier 1 capital. In contrast, banks from Eurozone core countries are more cautions when applying the IRB approach. This may explain why the peripheral banks were more vulnerable during the European sovereign debt crisis.

Second, I show that peripheral banks may game regulatory capital by avoiding the IRB approach for certain exposures, that is, so-called cherry-picking. The Basel Committee requires that, as indicated above, once a bank uses the IRB approach for some of its assets, it must take steps to implement the IRB approach across all significant portfolios and business lines (BCBS 2001). In this chapter, I show that some banks from peripheral countries barely apply the IRB approach to their exposure to the public sector, which, in terms of size and risk, can be quite material. Meanwhile, the IRB approach is widely used for their private sector exposure. Furthermore, I show that cherry-picking can be facilitated by the widely criticised zero-risk-weight for investment in sovereign debt, which supports the criticism regarding the 'IRB permanent partial use' mentioned by Hannoun (2011) [22, 23].

In addition, this chapter relates more broadly to the literature on the sovereign–bank doom loop, that is, the destabilising link generated by potential default risk spillovers between banks and sovereigns through banks' government bond holdings (Cooper and Nikolov 2013; Farhi and Tirole 2014; Acharya et al. 2014;

[22] The European CRDs have introduced a generalised zero risk weight which is not in line with the spirit of Basel II. Article 89(1)(d) of the CRD (amended by Directive 2009/111/EC or "CRD II"), and Annex VI Part 1 paragraph 4 assign a risk weight of 0% for "exposures to Member States' central government … denominated and funded in the domestic currency of that central government."

[23] Hannoun (2011) claims that "According to the European directive, a bank can apply the IRB approach to corporate, mortgage or retail exposures, while applying a one-size-fits all zero risk weight to the sovereign debt of EU member states. This is equivalent to a mutual and unqualified exemption of certain sovereign risks from capital charges, an exemption inconsistent with Basel II's risk-sensitive framework."

Brunnermeier et al. 2016). I observe near-zero risk-weights assigned using the standardised approach by some peripheral banks, especially Greek banks, to their public-sector exposure, which can provide a great incentive for banks to 'carry trade' (Acharya and Steffen, 2015). In addition, the zero risk-weights may have facilitated the unexpected trend observed by Liu and Varotto (2017): that small local banks in peripheral countries have increased sovereign bond holdings dramatically in recent years.

This chapter proceeds as indicated in what follows. In Section 4.2, I briefly introduce the development of the Basel accords. In Section 4.3, I discuss the related literature. In Section 4.4, I introduce the dataset and present some summary statistics. In Section 4.5, I explain the empirical model. In Section 4.6, I discuss the results regarding regulatory arbitrage by means of strategic IRB modelling. In section 4.7, I explore the cherry-picking issue resulting from the 'permanent partial' use of the IRB approach. Section 4.8 concludes the chapter.

4.2 The Introduction of Model-Based Capital Regulation

In order to establish a closer link between capital charges and the risk associated with banks' assets, regulators have been promoting stronger risk management practices in recent decades. In 1988, the Basel I regulation accord introduced risk-based capital charges. More specifically, different types of bank assets are assigned to different groups with preassigned risk-weights (BCBS 1988). Capital requirements are defined in terms of risk-weighted assets (RWAs). A bank is considered 'sufficiently capitalised' if its regulatory capital is 8% (or more) of its RWAs. RWAs are calculated by multiplying certain risk-weights (one of the following: 0, 10, 20, 50, or 100%) with corresponding asset amounts. In 2007, the next version of this regulatory accord – Basel II – was introduced. This allows banks to choose between two broad methodologies for calculating capital charges for credit risk: The so-called SA, which is basically equivalent to the old Basel I framework, and the IRB approach. It is noteworthy that the IRB approach has two sub-versions: the Foundation IRB (F-IRB) and the Advanced IRB (A-IRB) approaches[24]. In terms of the IRB approach, loans receive individual risk-weights that fundamentally depend on the bank's internal risk assessment. RWAs are still calculated by multiplying these risk-weights with actual asset values, and capital requirements are still defined in terms of risk-weighted assets, as with Basel I (BCBS 2006).

While the Basel framework aims to harmonise international bank regulation, the implementation process of the new framework differed across countries. For example, in Germany, Basel II was implemented by revising the Solvabilitatsverordnung (2006). Basically, it provides the foundation for national bank regulation and specifies a set of prudential supervisory reviews, including on-site audits, to ensure compliance with the regulatory accord (Deutsche Bundesbank 2004). Banks have to validate their models at least annually and adjust them if the

[24] F-IRB only allows banks to estimate the probability of default (PD) of their assets, while A-IRB allows banks to estimate not only PD but also a bunch of other credit risk factors such as loss-given-default (LGD), exposure-at-default (EAD) and maturity (M).

estimates are inconsistent with realised default rates. Moreover, banks have to prove that a specific model has been used internally for at least three years; regulators may then approve its use for regulatory purposes. Obviously, the IRB approach involves considerable management effort and administrative expense. In addition, it requires a certain level of sophistication (BCBS 2004). Hence, it is only implemented by the largest banks.

The banks that choose model-based regulation do not apply the new approach to all assets at once but agree on a gradual implementation plan with the banking authorities (the so-called partial use of the IRB approach). The plan provides the order in which different asset portfolios should be shifted from the SA to the IRB approach. In order to calibrate a meaningful risk model, a sufficient amount of data on past loan performance is required. Hence, banks tend to begin with loan portfolios in active business units with adequate historical data. The SA still applies to the other portfolios until banks can prove that the corresponding model has been used internally for at least three years and they do not over-or-under predict defaults. However, banks may explore arbitrage opportunities during the transition period. In particular, they can attempt to adhere to the SA if they find that the risk-weights in terms of the SA are even smaller than those of the IRB approach. In order to prevent this, as indicated above, the Basel Committee requires that once a bank uses the IRB approach for one part of its assets, it must take steps to implement it across all significant portfolios and business lines (BCBS 2001). However, as mentioned above, local competent authorities possess considerable flexibility in authorising

'Permanent Partial Use of the IRB' (PPU), which leads to different practice regarding the PPU in different countries (EBA 2013b) [25].

The financial crisis that arise in around 2008 and the European sovereign debt crisis that followed it have highlighted a number of shortcomings related to the use of internally modelled approaches for regulatory capital. These shortcomings include the excessive complexity of the IRB approaches, a lack of comparability of banks' internally modelled IRB capital requirements, and a lack of robustness in modelling certain asset classes. The Basel Committee has been improving the framework. The Basel III framework was initiated in response to these shortcomings that were exposed during the crisis. For example, the latest revision of Basel III (BCBS, 2017) removes the option to use the A-IRB approach for certain asset classes; adopts 'input' floors (for metrics such as probabilities of default and loss-given-default) to ensure a minimum level of conservativism in model parameters for asset classes for which the IRB approaches remain available; and provides greater specification of parameter estimation practices to reduce RWA variability.

[25] EBA, 2013. Report on the comparability of supervisory rules and practices. December. The report claims that "a majority of Competent Authorities (CAs) have no explicit qualitative or quantitative definition of 'material counterparty.' The situations where the unduly burdensome condition is considered fulfilled diverge among CAs. Half of the CAs apply a quantitative definition of 'non-significant business unit'. Most of them refer to the definition of a global limit of the total RWA for credit risk. Very few CAs apply a qualitative definition, and one-third of the CAs have no explicit quantitative or qualitative definition. Half of the CAs apply a quantitative definition of 'immaterial exposures in terms of size'. Most of them refer to the definition of a global limit of the total RWA for credit risk".

4.3 Literature Review

Some regulatory reports and academic papers find that the risk-sensitivity of Basel II risk-weights is limited. For example, BCBS (2009) suggests that some banks may present themselves as very well capitalised based on the regulatory capital, but in reality only hold low levels of high-quality capital (e.g. tangible common equity). Furthermore, BCBS (2013) shows that one of the principal factors that determines the risk-weights is heterogeneity across the banks' modelling choices. According to the Financial Services Authority (2010), a sample of banks were asked to assess a common portfolio's risk based on their own internal models, and the banks responded with very different implied amounts of the capital requirement. Other than variations between banks, Samuels et al. (2012) demonstrate that considerable variations occur within banks (up to 20% on a year-to-year basis) for RWAs from the same credit-risk bucket. This chapter supports this literature by showing that the risk-weights may largely diverge from the real risk (approximated by the default frequency).

This chapter is closely related to the literature on strategic risk-modelling by means of risk-weight manipulation. For example, Mariathasan and Merrouche (2014) examined at the relationship between the approval of a bank's IRB model and risk-weights based on a sample of 115 banks from 21 OECD countries. Consistent with risk-weight manipulation, they show that a bank's overall risk-weight drops following regulatory approval of the adoption of the IRB approach. Moreover, they find that such reduction in risk-weight is more pronounced (1) in weakly capitalised banks; (2) in jurisdictions where the legal framework for supervision is weak; and (3) in countries where banking authorities oversee many IRB banks. Vallascas and Hagendorff (2013) tested whether movements in RWAs can be explained by market measures of portfolio risk and show that these two factors are irrelevant. Ferri and Pesic (2016) provide evidence of regulatory arbitrage and show that such an effect is stronger in banks that adopt the A-IRB than in those that only employ the F-IRB. Similar work has been undertaken by Cannata et al. (2012), Le Leslé and Avramova (2012), Bruno et al. (2014), and Beltratti and Paladino (2016). After carefully addressing the endogeneity issue, I analyse bank's strategic risk-weight modelling in the context of European sovereign debt crisis. I contribute to this literature by showing that banks from European peripheral countries are much more involved in strategic modelling than are banks from European core countries.

Glaeser and Shleifer (2001) argue that complex and sophisticated rules are often dominated by simpler regulation. Complex regulation imposes a significant enforcement cost on society and provides incentives to regulated entities to find ways around the regulation. Koijen and Yogo (2015; 2016) provide similar empirical evidence of the impact of complex regulation on the insurance sector. Similarly, the public economics literature has discussed the merits of a flat-tax schedule. For example, Gorodnichenko et al. (2009) show that a move towards a flat-tax regime in Russia reduces tax evasion and increases tax revenue. I relate my paper to this strand of literature by showing that the sophisticated IRB models may be subject to strategic modelling as well as cherry-picking, which may render them less efficient than the much simpler SA in terms of credit risk management. Although the SA has been criticised as being too simple, in the recently proposed Basel III reforms (BCBS 2017), the granularity and risk sensitivity of the SA are significantly improved. For example, the Basel II SA assigns a flat risk-weight to all residential mortgages. In the revised SA of BCBS (2017), mortgage risk-weights depend on the loan-to-value ratio of the mortgage.

In addition, this chapter relates more broadly to the literature on the sovereign–bank doom loop. I observe near-zero risk-weight assigned by some banks from peripheral countries to their public sector exposure in terms of the SA. Such an observation is very likely to be facilitated by the heavily criticised one-fits-all zero-risk-weight for investment in sovereign debt, which may have contributed greatly to the risk-taking behaviour of European banks during the crisis[26].

4.4 Data and Summary Statistics

This section describes the dataset and illustrates the various features of banks from the country groups. The sample covers 50 banks from 10 major Eurozone countries, either core countries or peripheral countries (see Appendix B.1 for the list of banks). The sample period runs from December 2012 to June 2016 and includes European stress tests and risk assessments published on the following dates:

[26] The European CRDs have introduced a generalised zero risk weight which is not in line with the spirit of Basel II. Article 89(1)(d) of the CRD (amended by Directive 2009/111/EC or "CRD II"), and Annex VI Part 1 paragraph 4 assign a risk weight of 0% for "exposures to Member States' central government … denominated and funded in the domestic currency of that central government"

December 2012, June 2013, December 2013, December 2014, June 2015, December 2015, and June 2016.

The main data source is the EBA, which discloses detailed credit portfolio compositions of banks that participated in the stress tests and risk assessments during the sample period[27]. The number of banks varies across the tests, but, as indicated, according to the EBA, each test covers at least 60% of total EU banking assets. In order to generate a consistent data sample, a bank is included if it is from any of the 10 countries mentioned above and participated at least twice in any of the EBA tests. Since I intend to capture strategic modelling through the IRB approach, I exclude banks that did not use the IRB approach during the period. Table 4.1 Panel A provides a summary description of the data from the EBA. The data include each bank's exposure at default (EAD) and risk-weighted assets (RWA), which are broken down to the country level. I also compute risk-weight (RW), which simply equals RWA/EAD. It is noticeable that RWA/EAD can better approximate the true credit risk of the bank than can RWA/TA, as both the reported RWA and EAD consider off-balance sheet items, for example, credit lines, which may be a considerable component of a bank's business, while total assets only capture on-balance sheet items. Since EAD and RWA can be divided further based on the default status of the exposure (i.e. defaulted and non-defaulted), I can derive the second main variable as the default frequency of a bank's exposure (DF%), which equals default EAD / (default EAD + non-default EAD). Furthermore, EAD

[27] Transparency Exercise 2013 (December 2012 and June 2013), Stress Test 2014 (December 2013), Transparency Exercise 2015 (December 2014 and June 2015) and Transparency Exercise 2016 (December 2015 and June 2016)

can be classified into two groups based on the regulatory approach the bank is following – the standardised approach (EAD_SA) or the internal rating-based (EAD_IRB) approach. Then, I can build the third main variable – the IRB approach coverage (IRB%), which is equal to EAD_IRB / (EAD_IRB + EAD_SA). The detailed structure of the data allows the analysis to be conducted at the country level for each bank rather than merely at the bank level. Appendix B.2 summarises the geographical breakdown of the data. In addition to the three main variables described above, there are other five banks exposure country-level variables, namely RETAIL%, CORP%, GOV%, BANKS%, and OTHER%, which indicate a bank's exposure to a country's retail (corporate, public, banking, other) sector divided by the bank's total exposure to all five sectors in the same country[28]. See Table 4.1 Panel B for a summary description of all variables used in this chapter.

Table 4.2 shows the summary statistics. Panel A compares banks from core countries and banks from peripheral countries. I can see that the RW and DF% of peripheral banks are significantly higher than those of core banks, while the IRB approach is more widely used by core banks. To some extent, such results are surprising as intuitively I may expect a lower RW given a higher IRB%. Thus, I intend to explore the relation between RW and IRB% and to compare such a relation in core banks and peripheral banks. In addition, peripheral banks focus more on retail clients than do core banks.

[28] OTHER% is not included in the regression to avoid potential collinearity issues.

4.5 Empirical Method

4.5.1 The roll-out effect vs. regulatory arbitrage

Many papers in the literature have provided evidence that banks carry out regulatory arbitrage using IRB models (Le Lesle and Avramova 2012; BCBS 2013; Vallascas and Hagendoff 2013; Mariathasan and Merrouche 2014). Furthermore, extensive use of the IRB approach may considerably reduce risk weights (EBA 2013a; Bruno et al. 2014; Montes et al. 2016; Ferri and Pesic 2017). However, as emphasised by Ferri and Pesic (2017), reduced risk-weight due to extensive use of the IRB approach may not necessarily indicate the existence of regulatory arbitrage. Instead, it could be the result of the roll-out effect (i.e. shifting EAD from the SA to the IRB approach), which is a fair use of the regulatory option. In other words, in the absence of incentives for arbitrage, the IRB approach can still lead to a lower risk-weight because it is supposed to be more efficient in capturing risk factors and more responsive to changes in risk factor. In contrast, reduced risk-weights due to unfair use of the IRB approach, for example, by intentionally underestimating the probability of default (Behn et al 2016), would indicate regulatory arbitrage.

4.5.2 Regression model

In order to identify banks' regulatory arbitrage due to strategic IRB modelling, I propose the following regression:

$$RW_{l,b,c,t} = \alpha + \beta_1 \cdot IRB\%_{l,b,c,t} + \beta_2 \cdot DF\%_{l,b,c,t} + \sum \delta \cdot P_{l,b,c,t} + \theta_{b,t} + \rho_{c,t} + \varepsilon_{l,b,c,t} \qquad (4.1)$$

Here (l) denotes the home country of the bank, (b) indicates the specific bank, (c) is the country of exposure and (t) identifies time. The dependent variable is the risk-weight, which equals RWA/EAD. IRB% fully controls for the roll-out effect and may partially reflect regulatory arbitrage. In other words, it is difficult to ascertain whether the reduced risk-weight is purely driven by the roll-out effect or by regulatory arbitrage through manipulation, or a combination of both mechanisms. Based on the literature that suggests that greater use of the IRB approach may lead to reduced risk-weights (Mariathasan and Merrouche 2014; Ferri and Pesic 2017), I expect to see a negative sign for β_1. In order to better distinguish regulatory arbitrage from the roll-out effect, DF%, the default frequency of exposure, is introduced to approximate the true risk of exposure. The estimations of β_1 and β_2 may indicate the existence of arbitrage. Specifically, β_2 should be positive and significant in the absence of arbitrage. In contrast, if β_1 is negative and statistically significant while β_2 is not positively significant, that is, risk-weights can be reduced by applying the IRB approach to a greater extent and asset risk does not reflect the realised true risk, which can indicate regulatory arbitrage. There are other four bank exposure country-level variables ($P_{l,b,c,t}$), namely RETAIL%, CORP%, GOV%, and BANKS%, which indicate a bank's exposure to a country's retail (corporate, public, banking) sector divided by the bank's total exposure to all sectors in the same country.

It is noticeable that there may be reverse causality of the two explanatory variables, IRB% and DF%. For example, banks may use the IRB approach to a greater extent simply because they know that it will lead to lower risk-weights. To deal with the endogeneity issue, I use IRB% $_{l,\ b,\ c\_other,\ t}$ (named Z_1), which is the average IRB approach coverage of a given bank (*b*) from a given country (*l*) at a given time (*t*) though concerning all countries other than country *c* (i.e. *c_other*) as the instrument for IRB% $_{l,\ b,\ c,\ t}$, since, for a particular bank, the use of the IRB approach for its exposure to one country can be related to that of the other countries because the IRB models of a bank are developed (and approved) sector by sector rather than country by country. Meanwhile, the risk-weight of the same exposure may not have any direct relation to the use of the IRB approach in the other countries, which makes the IRB% $_{l,\ b,\ c\_other,\ t}$ thoroughly exogenous to the dependent variable. Due to information asymmetry among a bank's geographical portfolios, I expect a negative sign for Z_1. In other words, a bank may apply more IRB approach to the assets of a country where they have more information advantage, while they are less confident to apply the IRB approach for the assets of an unfamiliar country where they have less knowledge. Similarly, I use $DF_{l,\ b,\ c\_other,\ t}$ (named Z_2) as the instrument for $DF_{l,\ b,\ c,\ t}$. I also expect a negative sign for Z_2 because of the diversification strategy among a bank's geographical portfolios. All bank level characteristics, such as banks size, capital ratio, profitability etc., are captured by the *Bank*Time* fixed effect and all country level characteristics such as GDP and CPI are captured by *Exposure-Country*Time* fixed effects. (1) is estimated using separate observations of core countries' banks and peripheral countries' banks. All variables are winsorised at 1% and 99%, and standard errors are clustered at the *Bank*Time* level[29].

4.6 Results

4.6.1 The baseline model

In this sub-section, I discuss the results of the analysis of banks' regulatory arbitrage by means of strategic IRB risk-weight modelling. Table 4.3 shows the baseline results and I can observe distinct difference between core banks and peripheral banks. For core banks, IVIRB% is not statistically significant, which means the risk-weights of core banks cannot be reduced by greater use of the IRB approach. Meanwhile, IVDF% is significantly positive, meaning the asset risk very much reflect the true risk. In contrast, the IVIRB% estimation for peripheral banks is significantly negative. Noteworthy is that the magnitude of the coefficient is very large compared to that of the core banks (–0.3217 vs. –0.0579) while the standard deviation of the two variables are quite close (0.2661 vs. 0.2313). In other words, the asset risk of peripheral banks could be considerably reduced by applying the IRB approach to a greater extent, and such effect is more pronounced than that of the core banks both statistically and economically. Meanwhile, the IVDF% of peripheral banks is not statistically significant but is, surprisingly, negative, while the corresponding coefficient of core banks is significant at the 5% level. Therefore,

[29] Such a clustering setting is mainly due to the fact that the observations are less likely to be clustered at bank level. For example, the observation of a bank's exposure to Greece in 2013 may not have much relation with the observation of this same bank's exposure to Germany in 2016.

the asset risk of peripheral countries may not be as sensitive to the true realised risk as that of core banks.

From these baseline results, it appears that core banks are highly unlikely to be involved in regulatory arbitrage as they cannot reduce asset risk with greater use of the IRB approach and the asset risk reflects the true realised risk. Peripheral banks may present some indications of regulatory arbitrage; specifically, peripheral banks' asset risk can be substantially reduced by greater use of the IRB approach, while it does not respond to the true realised risk even at a considerable confidence level[30]. However, I cannot yet draw a clear conclusion for these banks as one could argue for the statistical insignificance of IVDF% based on the possibility that there may be more friction (or a weaker correlation) between projected risk and the realised risk during crises due to technical rather than incentive issues.

The estimation of the instrument variables are noticeably very significant for IRB% (Z_1) in columns 1 and 4 and for DF% (Z_2) in columns 2 and 5, which indicates a strong correlation between the instrument variables and the endogenous explanatory variables. The negative signs are as expected, which reflects the diversification effect of banks, that is, invest in different asset classes with different risk levels across countries. To further test the validity of the instrument, the bottom of Table 4.3 shows the Stock and Yogo (2005) weak ID test critical values for the Cragg-Donald Wald F-statistics. In all the regressions, the F-statistics are much

[30] P-Value of IVDF% estimation is 0.892, i.e. very far from significant.

larger than their Stock and Yogo (2005) critical values based on 2SLS regression size. Therefore, I reject the null hypothesis that the instruments are weak.

4.6.2 Information Asymmetry

It is possible that the insignificant estimation of the default frequency variable for peripheral banks is driven by the fact that peripheral banks are more likely to use the IRB approach on domestic exposure because they have more data on their own clients. In other words, the insignificant estimation of IVDF% reflects model frictions due to lack of data rather than strategic modelling for arbitrage purposes.

To test this point, I include a dummy variable Foreign which equals to 1 if the exposed country is different from the bank's home country, and I also interact it with IVIRB% and IVDF% separately in the second stage regression. The results are shown in Table 4.4. In column [2], the risk weights of peripheral banks' foreign exposures reflect the corresponding default frequency but not for that of the domestic exposure. Meanwhile, the risk weights of peripheral banks' domestic exposures can be greatly reduced by applying more IRB approach but not for that of the foreignexposures. Such results totally go against the hypothesis that it is lack of information which leads to the insignificant link between the realised risk (DF%) and the projected risk (the dependent), and it seems that peripheral banks are more likely to carry out strategic modelling in their domestic market where they may have a larger information advantage.

4.6.3 Exposure to GIIPS

Regarding the result in the last section, it may be the case that peripheral banks are subject to regulatory arbitrage to a greater degree because they are more exposed to peripheral countries due to home bias. I may also identify regulatory arbitrage in core banks due to their exposure to peripheral countries. Summary statistics comparing exposure to peripheral countries (GIIPS) and other countries (NonGIIPS) are presented in Table 4.5. In Panel A, core banks' NonGIIPS exposure is less risky than their GIIPS exposure in terms of both RW and DF. However, in Panel B, peripheral banks' NonGIIPS exposure has a higher RW than does their GIIPS exposure. However, the default ratio of GIIPS exposure is much higher (four times) than that of NonGIIPS exposure. In addition, peripheral banks make greater use of the IRB approach in their GIIPS exposure than in NonGIIPS exposure – approximately twice as much. This may indicate that peripheral banks strategically manipulate the risk-weights of their GIIPS exposure by means of the IRB approach for capital saving purposes.

Next, I formally test this point using the baseline model with the dummy variable GIIPS which equals 1 if the exposed country is Greece, Ireland, Italy, Portugal, or Spain. GIIPS is also interacted with IVIRB and IVDF separately in the second stage of the 2SLS regression. According to the results in Table 4.6, column 1, core banks' GIIPS exposure may have a quite different pattern compared to their NonGIIPS exposure. Although none of the results are statistically significant, there is a switch of signs for IVIRB% and IVIRB%*(1+GIIPS), from negative to positive. This indicates that core banks may be even more cautious when applying the IRB approach to their GIIPS exposure as compared to their NonGIIPS exposures, and that they are highly unlikely to be involved in regulatory arbitrage because greater use of the IRB approach will not reduce risk-weights at all.

In contrast, for peripheral banks in column 2, their NonGIIPS exposure and GIIPS exposure present similar results. Specifically, IVIRB% is statistically significant for both NonGIIPS and GIIPS exposure, that is, greater use of the IRB approach will reduce the risk-weight, and IVDF% is still not significant. Noticeably, the IVIRB% for GIIPS exposure is more significant than the NonGIIPS. This indicates that if peripheral banks were involved in regulatory arbitrage, they are more likely to carry out such behaviours in their exposure to risky countries.

4.6.4 Regulatory arbitrage and macro shocks

When there is a macro shock to a particular country, banks may be required to hold excess capital for their exposure in that particular country. Regulatory arbitrage may arise if banks perceive the cost of raising extra capital as being too high. They may then deleverage themselves by strategically underestimating the riskiness of the corresponding exposure. Following Brutti and Saure (2016), a country is categorised as being 'in crisis' ($CRISIS_{c,t}$) if it is a Eurozone member and its average daily 10-year bond spreads (with respect to Germany) for the previous three months are above 400 basis points. I add CRISIS and the interaction IVIRB*CRISIS and IVDF*CRISIS to the baseline model. The results are reported in Table 4.7 column 1 for core banks and in column 2 for peripheral banks. For core countries' banks, regardless of the exposed country, the risk-weight is never significantly associated with the use of the IRB approach but always reflects the realised true risk. This confirms the previous results to the effect that core banks are very unlikely to be associated with regulatory arbitrage. For peripheral countries' banks, in their exposure to distressed countries, I find further evidence of regulatory arbitrage. Specifically, the risk-weight of peripheral banks' exposure to both normal countries and distressed countries can be significantly reduced (both statistically and economically) [31]. Most importantly, at the same time, the risk weight does not reflect true realised risk at all – although one may still argue that such an insignificant estimation of the default frequency variable is due to the fact that banks may be compensating for higher defaulted exposures by rebalancing their portfolio towards safer assets, which may also be required by the supervisors. However, core banks with exposure to those distressed countries may also be subject to the same need and/or requirement, though their default frequency variable in their exposure to the distressed country affects the risk-weight variable. Hence, I read the results for peripheral banks regarding their exposure to distressed countries as indications of regulatory arbitrage.

4.6.5 Regulatory arbitrage in low-capital banks

It is important to identify the impact of the level of capital on regulatory capital arbitrage. This is because a bank with limited capital may have more incentives to manipulate regulatory risk-weights. This may improve its tier 1 capital ratio in order

[31] Noticeably, there may not be any significant difference of the level of such reduction effect between normal countries and distressed countries because the interaction term is not statistically significant, i.e., the strong significance in the Wald-Test is mainly driven by the stand-alone variable.

to meet capital requirements, as well as being more attractive to investors. Accordingly, I include a dummy variable LOWT1, which represents observations with a tier 1 capital ratio below the sample mean. Furthermore, the corresponding interaction terms with IVIRB% and IVDF% are included so that the marginal effect of low capital on regulatory arbitrage can be captured. According to the results in Table 4.8, for core banks, the results differ between high-capital and low-capital banks. However, they do not indicate regulatory arbitrage. Specifically, for well-capitalised core banks, the risk-weight can be reduced by greater use of the IRB approach; however, it also reflects true realised risk. As for less capitalised core banks, the coefficient of IVIRB %*(1+LOWT1) is insignificant, meaning greater use of the IRB approach will not reduce risk-weights. This may imply that core banks become more cautious about using the IRB approach when they have less than adequate capital.

In contrast, I may find a different trend among peripheral banks by comparing the estimations of IVIRB% and IVIRB%*(1+LOWT1). Specifically, the negative impact of using the IRB approach on risk-weights is more significant (both statistically and economically) for less capitalised peripheral banks than for well-capitalised ones.

4.7 Capital Saving by Avoiding the IRB approach

As mentioned above, banks may also try to reduce risk-weights by avoiding using the IRB approach for certain exposures (cherry-picking). Such strategy can be facilitated by the 'IRB permanent partial use (PPU)' rules, by means of which an EU bank may apply the IRB approach to corporate, mortgage, or retail exposures, while adopting a one-size-fits-all zero-risk-weight for the sovereign debt of EU member states (Hannoun 2011). Also, local competent authorities possess considerable flexibility when authorising PPU, which leads to high variability in the application of the PPU in different countries (EBA 2013b).

I aggregated the data of all banks in my sample according to their country of origin. The proportion of the IRB exposures at the aggregated country level for different sectors is shown in Figure 4.1. Graph (A) shows the IRB coverage for exposure to all sectors, and clearly reveals variation in the use of the IRB approach across countries. Specifically, banks from southern Europe – Greece, Italy, and Spain – have the lowest level of IRB exposure. Graph (B) shows the proportion of IRB exposure for the private sector (retail and corporate) and the public sector (central and regional governments). Surprisingly, there are banks from many countries that barely use the IRB approach for government exposure, including southern European banks and Scandinavian banks. However, such partial use of the IRB may only indicate a cherry picking issue in the southern European banks. This is because, first, government exposure constitutes a less significant proportion in Scandinavian banks (Figure 4.2), which satisfies one of the main requirements of PPU, that it can be only applied in immaterial business segments; and because, second, only Finland is in the Eurozone[32]. In contrast, the proportion of public sector exposure is a significant component for the south European banks. This exposure may possess considerable a level of risk due to high home bias in those banks' portfolios and the high default risk of those sovereigns.

Due to a lack of available data, it is difficult to perform formal empirical tests for cherry-picking. Instead, some simple evidence is provided in Table 4.9 to further support the claim that the issue occurs. Specifically, the proportion of IRB exposure to the public sector (shown in Graph (B) in Figure 4.1), is now split into three groups: domestic government exposure, non-US foreign government exposure, and US government exposure. The results are reported in Panel A, Table 4.9. In particular, banks from Austria and Italy barely apply the IRB approach to their domestic government exposure. In contrast, the IRB approach is widely used to assess risk regarding exposure to the US government, which is not related to the zero-risk-weight in terms of the SA. Then, in Panel B, I observe very low risk-weights for some peripheral banks' domestic exposure, especially for Greek banks, which may considerably deviate from the true risk level because the yields of Greek sovereign bonds was considerably higher than all others[33]. In addition, I use simple OLS univariate regressions to complement the stylised facts mentioned above and

[32] The European Capital Requirements Directives only assigns zero-risk-weight to "exposures to Member States' central governments … denominated and funded in the domestic currency of that central government", which is not eligible for banks from Denmark, Norway and Sweden. On the other hand, Scandinavian governments have quite high credit in general, thus, the corresponding risk weight should always be very low if either IRB or SA is applied.

[33] The risk-weights for Italian banks' domestic government exposure is around 14%, which is considerably higher than those of the other peripheral banks' domestic government exposures. This is because the risk -weight became much higher in 2014 (from around 5% to 20%), probably due to policy changes introduced by local competent authorities.

determine the average impact of the IRB proportion on the risk-weight of the public and private sectors. The model is as follows:

$$RW_{l,b,c,s,t} = \alpha + \beta_1 \cdot IRB\%_{l,b,c,s,t} + Fixed\ Effects + \varepsilon \quad (4.2)$$

Here (l) denotes the home country of the bank, (b) indicates the specific bank, (c) is the country of exposure, (s) represents the sector of exposure, and (t) identifies time. The dependent variable is the overall risk-weight of exposures in terms of both the SA and the IRB approach. IRB% indicates the proportion of the IRB approach for a bank's exposure to a certain sector of a country (due to a lack of data availability, IRB% is not instrumented here). Results are reported in Panel C, Table 4.9, and show that the impact of IRB% on RW is opposite for public exposure and private exposure. Specifically, for private exposure, greater use of the IRB approach may reduce risk-weights, which is in line with the roll-out effect and/or regulatory arbitrage by means of strategic IRB modelling. In contrast, for public exposure, IRB% has a significantly positive coefficient, meaning that less use of the IRB approach for government exposure can save capital. This is in line with the evidence previously provided and supports cherry-picking being associated with PPU of IRB approach.

4.8 Conclusion

By exploiting the relationship between the use of the IRB approach and the risk-weights of bank assets, I provide evidence that banks may reduce their capital requirement by means of strategic manipulation of the IRB approach. This may be accomplished in the forms of regulatory arbitrage, and/or partial use of the IRB approach for certain business segments (cherry-picking). The former is a bank's voluntary behaviour while the latter may be the result of moral suasion from governments and of yield-seeking from banks. In particular, the governments of financially distressed countries require domestic banks to absorb their new debt issuance, and those banks have incentives to improve their regulatory capital ratio and to seek yield. Thus, this phenomenon may greatly contribute to the sovereign–bank doom loop that has caused serious financial stress in the recent years. Furthermore, I show that peripheral banks (especially less capitalised ones)are more likely to engage in regulatory arbitrage, while core banks are generally more cautious in applying the IRB approach. This may explain why the peripheral banks were more vulnerable during the European sovereign debt crisis.

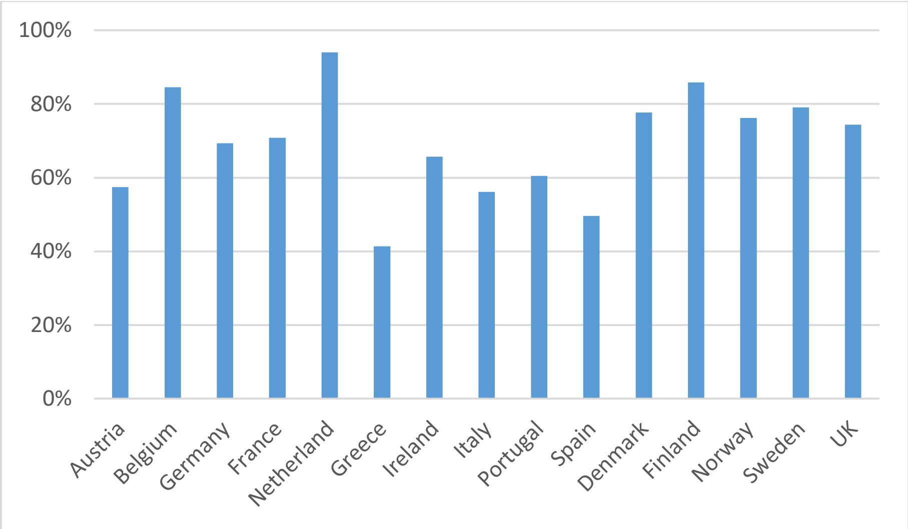
The main findings of this chapter have policy implications. First, they support the concerns raised in recent regulatory proposals (EBA, 2016). In particular, not only should the use of the IRB approach be carefully granted and closely supervised; in addition, its (permanent) partial use should be limited, so that both strategic IRB modelling and cherry-picking can be properly confined. More importantly, my findings are in line with the BCBS (2017) that aims to constrain the use of the IRB approach (e.g. input and output floors, an extra capital buffer on global systemically important banks, removing the advanced IRB for certain asset classes, etc.) and to promote the SA by improving its granularity.

List of Figures

Figure 4.1. Use of IRB approach

Each figure is based on the aggregated data of all banks from the same country. Finland and Norway only include one bank observation each (OP-Pohjola Group and DNB Bank Group respectively).

A. Total Portfolio, IRB%.



B. Private Sector vs. Public Sector, IRB%.

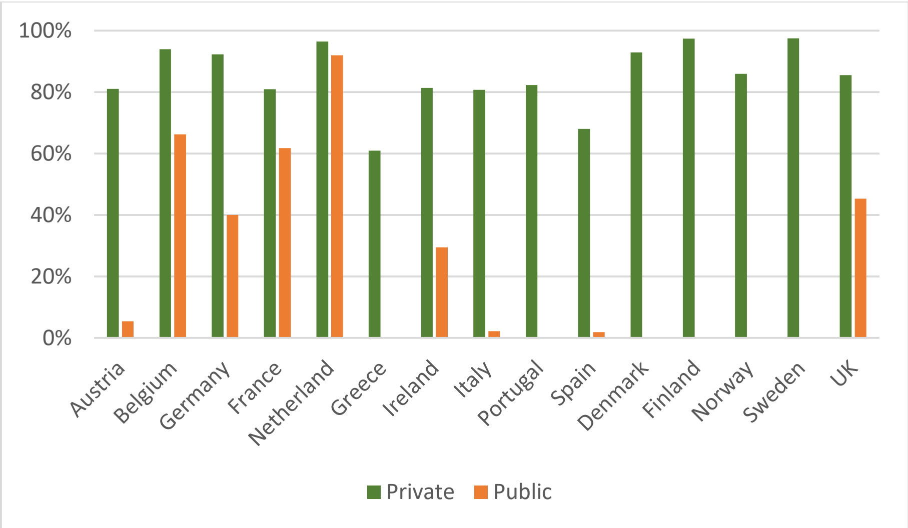


Figure 4.2. Proportion of public exposure

Each figure is based on the aggregated data of all banks from the same country. Finland and Norway only include one bank observation each (OP-Pohjola Group and DNB Bank Group respectively).

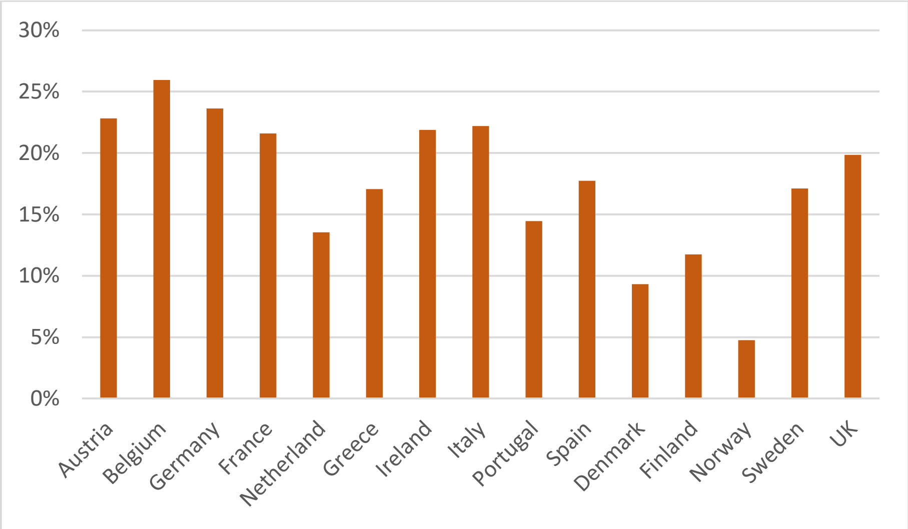


Table 4.1. Variables and Definitions.

Panel A. Description of credit risk items from EBA disclosure.

EBA Item	Explanation[34]
RWA_SA_D	Risk weighted assets under the standardized approach for defaulted exposures
RWA_SA_ND	Risk weighted assets under the standardized approach for non-defaulted exposures
RWA_IRB_D	Risk weighted assets under the IRB approach for defaulted exposures
RWA_IRB_ND	Risk weighted assets under the IRB approach for non-defaulted exposures
EAD_SA_D	Exposure-at-default under the standardized approach for defaulted exposures
EAD_SA_ND	Exposure-at-default under the standardized approach for non-defaulted exposures
EAD_IRB_D	Exposure-at-default under the IRB approach for defaulted exposures
EAD_IRB_ND	Exposure-at-default under the IRB approach for non-defaulted exposures

[34] Some tests report figures for Default and "Default&Non-Default" instead.

Table 4.1 Continued

Panel B. Definition of Variables	
Name	Definition
	Bank's Country-Portfolio Level Variables
RW	$(RWA_{IRB,D\&ND} + RWA_{SA,D\&ND}) / (EAD_{IRB,D\&ND} + EAD_{SA,D\&ND})$
IRB%	$EAD_{IRB,D\&ND} / (EAD_{IRB,D\&ND} + EAD_{SA,D\&ND})$
DF	$(EAD_{IRB,D} + EAD_{SA,D}) / (EAD_{IRB,D\&ND} + EAD_{SA,D\&ND})$
RETAIL%	A bank's exposure to a country's retail sector divided by this bank's total exposure to the same country
CORP%	A bank's exposure to a country's corporate sector divided by this bank's total exposure to the same country
GOV%	A bank's exposure to a country's public sector divided by this bank's total exposure to the same country
BANK%	A bank's exposure to a country's banking sector divided by this bank's total exposure to the same country
OTHER%	A bank's exposure to a country's other sectors divided by this bank's total exposure to the same country
	Dummy Variables
LOWT1	Dummy Variable for banks with tier1 capital ratio lower than sample mean
GIIPS	Dummy Variable for exposure to a "peripheral country"
CRISIS	Dummy Variable for exposure to a country in crisis[35]

[35] Note: A country is defined "in crisis" - only if it is a Euro country and its bond spread (with respect to Germany) is above 400 basis points calculated as the average of daily bond spreads over the 3-month period preceding the observation date

Table 4.2. Summary Statistics

The sample covers 50 banks from 10 Eurozone countries for the period covering the following time points, December 2012, June 2013, December 2013, December 2014, June 2015, December 2015 and June 2016. Core Bank are banks from Austria, Belgium, Germany, France and Netherland. Peripheral Bank are banks from Greece, Italy, Ireland, Portugal and Spain. RW: risk weight of a bank's exposure to a country. IRB%: % of IRB methodology upon a bank's exposure to a country. DF%: default frequency of a bank's exposure to a country. RETAIL% (CORP%, GOV%, BANK%, OTHER%): A bank's exposure to a country's retail (corporate, public, banking, other) sector divided by this bank's total exposure to the same country. The significance level of t-test on mean and Wilcoxon test on median are indicated by ***, **, and * for 1%, 5% and 10%, respectively. Variables are winsorized at 1th and 99th percentile. Data source: EBA.

	Mean			Median		
	Core Bank	Peripheral Bank	Diff.	Core Bank	Peripheral Bank	Diff.
RW	33.2%	46.8%	-13.6%***	30.0%	43.1%	-13.1%***
IRB%	73.7%	40.8%	32.9%***	82.0%	42.0%	40.0%***
DF%	2.5%	4.4%	-1.8%***	1.2%	2.1%	-0.9%***
RETAIL%	11.7%	22.4%	-10.7%***	1.00%	22.0%	-21.0%***
CORP%	38.7%	31.3%	7.37%***	36.0%	30.0%	6.00%***
GOV%	22.6%	20.4%	2.18%**	17.0%	18.0%	-1.00%
BANK%	21.3%	17.2%	4.14%***	14.0%	6.0%	8.0%***
OTHER%	5.65%	8.67%	-3.02%**	3.97%	7.21%	-3.24%*

Table 4.3. Baseline Results – Regulatory Arbitrage Core Banks VS. Peripheral Banks.

The purpose of this table is to provide evidence of regulatory arbitrage via IRB approach while controlling the Roll-Out effect. The table summarizes the results of the equation (4.1) estimated over the period from end 2012 to mid-2016 on a near biannual basis (with one gap in mid-2014). Core Banks are banks from Austria, Belgium, Germany, France and Netherland. Peripheral Banks are banks from Greece, Italy, Ireland, Portugal and Spain. The dependent variable for the first stage regression is IRB% (DF%), which indicates the % of IRB methodology upon a bank's exposure to a country (default frequency upon a bank's exposure to a country). *Z*1 (Z2) is the instrument variable for IRB% (DF%), which indicates the % of IRB methodology upon the same bank's exposure to all other countries (default frequency upon the same bank's exposure to all other countries). The dependent variable for the second stage regression is RW, risk weight of exposure to a country. IVIRB% (IVDF%) is the instrumented IRB% (DF%) from the first stage regression. RETAIL% (CORP%, GOV%, BANK%, OTHER%): A bank's exposure to a country's retail (corporate, public, banking, other) sector divided by this bank's total exposure to the same country. Fixed effect controls are included at *Bank*Time* and Exposure-Country*Time (Time indicates the time of data observations). All variables are winsorized at 1st and 99th percentile. Standard errors are heteroscedasticity-robust and clustered at the Bank *x* Time level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively. All country-portfolio level data are from EBA. The Stock and Yogo (2005) weak ID test critical values are for the Cragg-Donald Wald F-statistics. A higher Cragg-Donald Wald F-statistic than the corresponding critical value indicates a rejection of the null hypothesis that the instrument(s) are weak.

	Core Banks			Peripheral Banks		
	First Stage		Second Stage	First Stage		Second Stage
Dep. Variable	IRB%	DF	RW	IRB%	DF	RW
	[1]	[2]	[3]	[4]	[5]	[6]
IVIRB%			-0.0579			-0.3217**
IVDF			0.6376**			-0.0841
z1	-1.6159***	0.0436***		-1.5308***	0.0237	
z2	-0.8784	-1.7014***		-0.5509	-0.9782***	
RETAIL%	0.4873***	0.0208*	-0.1019	1.3073***	-0.0391	-0.2435
CORP%	0.6208***	0.0223**	0.1339**	1.2802***	-0.0537**	0.3240
GOV%	0.3492***	-0.0374***	-0.2906***	0.8350**	-0.0934***	-0.7771***
BANK%	0.6068***	-0.0256***	-0.1292**	1.0492***	-0.0994***	-0.4520*
Bank x Time FE	YES	YES	YES	YES	YES	YES
ExpoCountry x Time FE	YES	YES	YES	YES	YES	YES
N	1624	1624	1624	467	467	467
Adj. R-Squared	0.65	0.53	0.61	0.70	0.86	0.78
Cragg-Donald (CD) Wald F-statistic	105.77			31.20		
Stock and Yogo (2005) Weak ID test Critical Value	7.03			7.03		

Table 4.4. Regulatory Arbitrage or Pure Information Asymmetry

The purpose of this table is to test whether it is information asymmetry and lack of data that makes the insignificant relationship between the realised risk (IVDF%) and the projected risk (the dependent) for peripheral banks rather than due to regulatory arbitrage. Core Banks are banks from Austria, Belgium, Germany, France and Netherland. Peripheral Banks are banks from Greece, Italy, Ireland, Portugal and Spain. The dependent variable for the first stage regression is IRB% (DF%), which indicates the % of IRB methodology upon a bank's exposure to a country (default frequency upon a bank's exposure to a country). Z1 (Z2) is the instrument variable for IRB% (DF%), which indicates the % of IRB methodology upon the same bank's exposure to all other countries (default frequency upon the same bank's exposure exposure to all other countries). The dependent variable for the second stage regression is RW, risk weight of exposure to a country. IVIRB% (IVDF) is the instrumented IRB% (DF%) from the first stage regression. Foreign is a dummy variable, which equals to 1 if the exposed country is different from the bank's home country. Fixed effect controls are included at *Bank*Time* and *Exposure-country*Time* (Time indicates the time of data observations). Controls include: RETAIL% (CORP%, GOV%, BANK%, OTHER%): A bank's exposure to a country's retail (corporate, public, banking, other) sector divided by this bank's total exposure to the same country. For simplicity only the results of the second stage regressions are shown. All variables are winsorized at 1st and 99th percentile. Standard errors are heteroscedasticity-robust and clustered at the Bank *x* Time level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively. All country-portfolio level data are from EBA and all bank level variables are from Bloomberg

Sample Banks	Core Banks [1]	Peripheral Banks [2]
IVIRB%	0.0999*	-0.3084**
IVIRB%*Foreign	-0.1883***	0.1821
IVDF%	0.1341	0.4356
IVDF%*Foreign	1.4263	2.8051***
Controls	YES	YES
Bank *x* Time FE	YES	YES
Exposure-Country *x* Time FE	YES	YES
N	1624	467
Adj. R-Squared	0.49	0.36
Wald Test		
IVIRB%*(1+Foreign)	-0.0884*	-0.1263
IVDF%*(1+Foreign)	1.5604**	3.2407*

Table 4.5. Exposure to GIIPS and NonGIIPS Countries.

Core Bank are banks from Austria, Belgium, Germany, France and Netherland. Peripheral Bank are banks from Greece, Italy, Ireland, Portugal and Spain. GIIPS indicates a bank's exposures to Greece, Italy, Ireland, Portugal and Spain. NonGIIPS indicates a bank's exposure to countries other than GIIPS. RW: risk weight of exposure to a country. IRB%: % of IRB methodology upon a bank's exposure to a country. DF%: default frequency of a bank's exposure to a country. Panel A compares the NonGIIPS and GIIPS exposure of Core Banks, Panel B compares the same things but held by peripheral banks, and Panel C compares the GIIPS exposure held by Core Banks and Peripheral Banks. The significance level of t-test on mean and Wilcoxon test on median are indicated by ***, **, and * for 1%, 5% and 10%, respectively. Variables are winsorized at 1th and 99th percentile. Data source: EBA.

Panel A: Core Banks' Exposure - NonGIIPS VS. GIIPS

	Mean			Median		
	NonGIIPS	GIIPS	Diff.	NonGIIPS	GIIPS	Diff.
RW	31.8%	41.8%	-10.0%***	29.0%	38.2%	-9.3%***
IRB%	74.4%	69.6%	4.8%**	84.0%	75.0%	9.0%***
DF%	2.3%	4.1%	-1.8%***	1.1%	2.5%	-1.4%***

Panel B: Peripheral Banks' Exposure - NonGIIPS VS. GIIPS

	Mean			Median		
	NonGIIPS	GIIPS	Diff.	NonGIIPS	GIIPS	Diff.
RW	49.5%	38.7%	10.8%***	49.3%	40.0%	9.3%***
IRB%	35.5%	56.6%	-21.1%***	26.0%	61.0%	-35.0%***
DF%	2.5%	9.8%	-7.2%***	1.6%	9.4%	-7.8%***

Panel C: Exposure to GIIPS – Core Banks VS. Peripheral Banks

	Mean			Median		
	Core	Peripheral	Diff.	Core	Peripheral	Diff.
RW	41.8%	38.7%	3.1%*	38.2%	40.0%	-1.8%
IRB%	69.6%	56.6%	13.0%***	75.0%	61.0%	14.0%***
DF%	4.1%	9.8%	-5.7%***	2.5%	9.4%	-7.0%***

Table 4.6. Regulatory Arbitrage Regarding GIIPS Exposure: Core Banks VS. Peripheral Banks.

The purpose of this table is to test whether regulatory arbitrage is stronger regarding exposures to peripheral countries. Core Banks are banks from Austria, Belgium, Germany, France and Netherland. Peripheral Banks are banks from Greece, Italy, Ireland, Portugal and Spain. The dependent variable for the first stage regression is IRB% (DF%), which indicates the % of IRB methodology upon a bank's exposure to a country (default frequency upon a bank's exposure to a country). Z1 (Z2) is the instrument variable for IRB% (DF%), which indicates the % of IRB methodology upon the same bank's exposure to all other countries (default frequency upon the same bank's exposure exposure to all other countries). The dependent variable for the second stage regression is RW, risk weight of exposure to a country. IVIRB% (IVDF) is the instrumented IRB% (DF%) from the first stage regression. GIIPS is a dummy variable, which equals to 1 if the exposure is in one of the following countries: Greece, Italy, Ireland, Portugal and Spain. Fixed effect controls are included at *Bank*Time* and *Exposure-country*Time* (Time indicates the time of data observations). Controls include: RETAIL% (CORP%, GOV%, BANK%, OTHER%): A bank's exposure to a country's retail (corporate, public, banking, other) sector divided by this bank's total exposure to the same country. For simplicity only the results of the second stage regressions are shown. All variables are winsorized at 1st and 99th percentile. Standard errors are heteroscedasticity-robust and clustered at the Bank *x* Time level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively. All country-portfolio level data are from EBA and all bank level variables are from Bloomberg

Sample Banks	Core Banks [1]	Peripheral Banks [2]
IVIRB%	-0.0613	-0.3944*
IVIRB%*GIIPS	0.2244**	0.1395
IVDF%	0.6068*	2.1971
IVDF%*GIIPS	-0.2374	-1.9545
Controls	YES	YES
Bank *x* Time FE	YES	YES
Exposure-Country *x* Time FE	YES	YES
N	1624	467
Adj. R-Squared	0.62	0.78
Wald Test		
IVIRB%	-0.0613	-0.3944*
IVIRB%*(1+GIIPS)	0.1631	-0.2549**
IVDF%	0.6068*	2.1971
IVDF%*(1+GIIPS)	0.3694	0.2426

Table 4.7. Regulatory Arbitrage under Macro Shocks.

The purpose of this table is to identify regulatory arbitrage in the context of macro shocks. CRISIS is a dummy variable, which equals to 1 if the exposed country is "in crisis" - only if a Euro country's bond spread (with respect to Germany) is above 400 basis points calculated as the average of daily bond spreads over the 3-month period preceding the observation date. The sample period is still the same as baseline - from end 2012 to mid-2016 on a near biannual basis (with one gap in mid-2014). The dependent variable and control variables are also the same as the baseline. All the other regression settings regarding, winsorization, error-clustering and coefficient significance are the same as previous table. For simplicity only the results of the second stage regressions are shown. All country-portfolio level data are from EBA and sovereign bond yields are from ECB.

Sample Banks	Core Banks [1]	Peripheral Banks [2]
IVIRB%	-0.0581	-0.3007**
IVIRB%*CRISIS	-0.0448	-0.1456
IVDF%	0.6376**	-0.1011
IVDF%*CRISIS	-0.2846	0.1700
Controls	YES	YES
Bank *x* Time FE	YES	YES
Exposure-Country *x* Time FE	YES	YES
N	1624	467
Adj. R-Squared	0.62	0.78
Wald Test		
IVIRB%	-0.0581	-0.3007**
IVIRB%*(1+CRISIS)	-0.1029	-0.4463***
IVDF%	0.6376**	-0.1011
IVDF%*(1+CRISIS)	0.3530*	0.0689

Table 4.8. Regulatory Arbitrage Low Capital Banks.

The purpose of this table is to identify regulatory arbitrage among banks with low tier1 capital. LOWT1 is a dummy variable equal to 1 if the tier 1 capital ratio is below the sample mean. The sample period is still the same as baseline - from end 2012 to mid-2016 on a near biannual basis (with one gap in mid-2014). The dependent variable and control variables are also the same as the baseline. All the other regression settings regarding, winsorization, error-clustering and coefficient significance are the same as previous table. For simplicity only part of the results are shown. All country-portfolio level data are from EBA and all bank level variable are from Bloomberg.

Sample Banks	Core Banks [1]	Peripheral Banks [2]
IVIRB%	-0.1152**	-0.2145
IVIRB%*LOWT1	0.1747***	-0.1189
IVDF%	0.7229**	1.3959
IVDF%*LOWT1	-0.1776	-1.3668
Controls	YES	YES
Bank *x* Time FE	YES	YES
Exposure-Country *x* Time FE	YES	YES
N	1624	467
Adj. R-Squared	0.62	0.78
Wald Test		
IVIRB%	-0.1152**	-0.2145
IVIRB%*(1+LOWT1)	0.0595	-0.3334**
IVDF%	0.7229**	1.3959
IVDF%*(1+LOWT1)	0.5453	0.0291

Table 4.9. Evidence of Cherry-Picking.

This table provide evidence that some banks may strategically limit the use of IRB on certain exposures for capital saving purpose. Panel A shows the proportion of IRB exposure based on aggregated data of banks from the same country. Panel B shows the risk-weights for public exposures under SA, based on aggregated data of banks from the same country. Panel C shows the result of simple OLS univariate regression of risk weights of exposure to the public (private) sector on the proportion of IRB of exposure to that sector. All variables are winsorized at 1st and 99th percentile. Standard errors are heteroscedasticity-robust and clustered at the Bank *x* Time level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Panel A: Proportion of IRB exposure

Country of Exposure Sector of Exposure Bank's Home Country	Domestic Public [1]	Non-US Foreign Public [2]	US Public [3]
Austria	3.4%	6.7%	99%
Belgium	77%	60%	83%
Germany	32%	56%	94%
France	48%	79%	84%
Netherland	92%	92%	92%
Greece	0.0%	0.0%	/
Ireland	24%	48%	41%
Italy	0.1%	5.9%	39%
Portugal	0.0%	0.0%	/
Spain	2.3%	1.6%	4.8%
Denmark	0.0%	0.0%	0.0%
Finland	0.0%	0.0%	/
Norway	0.0%	0.0%	0.0%
Sweden	0.0%	0.0%	0.0%
UK	9.1%	67%	78%

Table 4.9 Continued

Panel B: Risk-Weights under SA

Country of Exposure Sector of Exposure Bank's Home Country	Domestic Public [1]	Non-US Foreign Public [2]	US Public [3]
Austria	2.0%	2.9%	20.0%
Belgium	1.7%	8.2%	29.6%
Germany	1.0%	2.5%	17.6%
France	9.4%	17.3%	12.0%
Netherland	31.1%	15.1%	0.0%
Greece	0.3%	16.6%	/
Ireland	0.4%	1.1%	11.4%
Italy	13.9%	4.7%	2.1%
Portugal	1.9%	22.9%	/
Spain	5.0%	10.3%	10.0%
Denmark	0.0%	0.4%	0.0%
Finland	0.1%	0.0%	/
Norway	0.0%	0.0%	0.0%
Sweden	0.3%	0.4%	0.0%
UK	1.1%	4.9%	12.3%

Panel C: Univariate Regression

Dep.Variable Sector of Exposure	RW Public [1]	RW Private [2]
IRB%	0.0792***	-0.4172***
Bank *x* Time FE	YES	YES
Exposure-Country *x* Time FE	YES	YES
N	2737	2737
Adj. R-Squared	0.50	0.64

Appendix B.1

List of Sample Banks

Country	Bankscope ID	Bank Name
AT	46146	Erste Group Bank AG
AT	44096	Raiffeisen Zentralbank Oesterreich AG - RZB
AT	43719	Bank für Arbeit und Wirtschaft und Österreichische Postsparkasse Aktiengesellschaft-BAWAG P.S.K. AG
BE	45621	Dexia SA
BE	46905	KBC Bank NV
BE	48939	Belfius Banque SA/NV-Belfius Bank SA/NV
DE	13216	Deutsche Bank AG
DE	13190	Commerzbank AG
DE	47734	Landesbank Baden-Wuerttemberg
DE	17881	DZ Bank AG-Deutsche Zentral-Genossenschaftsbank
DE	13109	Bayerische Landesbank
DE	13584	Norddeutsche Landesbank Girozentrale NORD/LB
DE	14021	Portigon AG
DE	19978	HSH Nordbank AG
DE	14104	Landesbank Berlin AG
DE	13229	DekaBank Deutsche Girozentrale AG
DE	14019	WGZ-Bank AG Westdeutsche Genossenschafts-Zentralbank
DE	13222	Aareal Bank AG
DE	13213	Deutsche Apotheker- und Aerztebank eG
DE	13568	Münchener Hypothekenbank eG
ES	47560	Banco Santander SA
ES	22628	Banco Bilbao Vizcaya Argentaria SA
ES	11965	BFA Tenedora de Acciones SAU
ES	11963	Caixabank, S.A.
ES	22724	Banco Popular Espanol SA
ES	23370	Banco de Sabadell SA
ES	22713	Bankinter SA
FR	10931	BNP Paribas
FR	11948	Crédit Agricole S.A.
FR	27918	BPCE SA
FR	11150	Société Générale SA
FR	27005	Fédération du Crédit Mutuel
FR	12953	RCI Banque
FR	51740	SFIL
GR	49514	Eurobank Ergasias SA
GR	43085	National Bank of Greece SA
IE	20103	Allied Irish Banks plc

IE	20112	Bank of Ireland-Governor and Company of the Bank of Ireland
IE	48505	Permanent TSB Plc
IT	46616	Intesa Sanpaolo
IT	47295	UniCredit SpA
IT	21413	Banca Monte dei Paschi di Siena SpA-Gruppo Monte dei Paschi di Siena
IT	21937	Banco Popolare - Società Cooperativa-Banco Popolare
IT	16185	Unione di Banche Italiane Scpa-UBI Banca
IT	45740	Credito Emiliano SpA-CREDEM
NL	22417	ING Bank NV
NL	22317	Cooperatieve Rabobank U.A.
NL	11581	ABN AMRO Bank NV
NL	22324	SNS Bank N.V.
PT	22541	Banco Comercial Português, SA-Millennium bcp

Appendix B.2

Geographical Breakdown of Banks’ Exposure

	Origin Country of Banks														
Country of Exposure	AT	BE	DE	DK	ES	FI	FR	GB	GR	IE	IT	NL	NO	PT	SE
ALL	189	157	746	81	145	33	336	252	32	73	172	232	70	48	224
Angola														5	
Australia		2						4				14			
Austria	19		54								7	2			
Belgium	2	15	6	1			18	2			2	16			
Bermuda			2												
Brazil					7			7				7			
Bulgaria	2								6						
Canada		1	4			2		7					2		
Cayman Islands			7	2				4							
Channel Islands								2							
Chile					14										
China			3					10			4	1			
Colombia					3										
Cook Islands			7												
CROATIA	12										10				
Cyprus									3						
Czech Republic	14	7					7				7				
Denmark				15									7		21
Estonia															14
Finland				7		6						2	5		28
France	9	17	76	3	9	5	38	25		11	19	25	4	5	1
Germany	17	14	79	8	6	5	37	18		3	12	24	7		12
Greece									6					2	
GUERNSEY				2											
Hong Kong								7				8			
Hungary	14	7	3								3				
India			2					1							
Int. organisations							3	3							
Ireland	4	7	7	7				14		19		3		3	
Isle of Man										1					
Italy	5	10	44		6		33	7			30	3			
Japan		5					16	2							
Korea							4								
Latvia													3		14
Lithuania													7		14
Luxembourg		6	60	5	1	4	30	12	4	2	3	3	2	5	4

Macedonia									1						
Marshall Islands			13												
Mexico					14			2							
Mozambique														7	
Netherlands	5	4	71				16	19		4	6	28			4
New Zealand												7			
Norway		2	1	9		1						2	7		28
Other					2		2								
Other Countries	2	6	14				1	4		2					
Peru					7										
Poland	14		12								7	10	5	7	5
Portugal		5	2		8									7	
Romania	14		2				1		6						
Russian	7		2				7				7				5
Saudi Arabia								6							
Serbia									2		1				
Singapore			2					7				7			
Slovakia	14	5									7				
Slovenia	3														
South Africa								7							
Spain	5	10	57		25		25	8		4	6	7		2	
Sweden			12	7		5							7		28
Switzerland	1		50	5			22	16				15			
Turkey			2		7		7		3		7	4			
Ukraine	5														
United Kingdom	14	17	77	8	13	5	36	28	1	15	16	21	7	5	23
United States	7	17	75	2	18		33	28		12	18	19	7		23
Venezuela					5										
VIRGIN ISLANDS								2				4			

Chapter 5 'Home Sweet Home': Asset Re-allocation During the European Debt Crisis

5.1 Introduction

The doom-loop between European peripheral sovereigns and banks has been widely discussed (Cooper and Nikolov 2013; Acharya et al. 2014; Brunnermeier et al. 2016; Farhi and Tirole 2018). A distressed banking sector may increase the solvency problem of the public sector because governments will face higher potential bailout costs and lower taxation income due to reduced bank lending to the real economy. In turn, increased sovereign credit risk weakens the banking sector, as banks will suffer losses in their government bond portfolios and future government support, if any, would be less credible (Acharya et al 2014; Brunnermeier et al. 2016). Figure 5.1 clearly shows that Eurozone banks have greatly increased their home bias for sovereign debt, especially in distressed countries. Specifically, as the sovereign default risk rises, banks from peripheral countries begin to increase holdings of domestic government bonds, and then this trend begins to reverse as sovereign bond spreads decrease. In comparison, the trend is much less significant for core country banks. The aim of this chapter is to discover why the home bias in banks' sovereign portfolios is highly associated with sovereign risk.

On this matter, a few major hypotheses have been developed. First, there is the secondary market theory that is based on the assumption that governments would be less willing to default on their debt if it were held mostly by domestic agents rather than foreign ones. This is because the harm to the domestic economy may overwhelm the benefit (Broner et al. 2014; Gennaioli et al. 2014). Therefore, if local agents have such an expectation, in active secondary markets, sovereign bonds should naturally flow back to domestic owners during periods of high sovereign risk, since they are more highly valued by domestic agents than foreign ones. Brutti and Saure (2016) provide empirical evidence to support this secondary market hypothesis. Regarding this argument, Figure 5.2 shows the progression of home bias for different types of creditors in peripheral and core countries. In peripheral countries, resident banks accumulated a large share of domestic sovereign debt however, non-bank residents barely increased their portion. Such trends go against the secondary market theory, which predicts the same trend for resident banks and non-bank residents.

A recent paper by Saka (2017) explains the repatriation of sovereign debt by means of informational friction theory (Brennan and Cao 1997; Van Nieuwerburgh and Veldkamp 2009; Dziuda and Mondria 2012). He argues that it is important to have soft information on the repayment intentions of the government during crisis periods. Uninformed foreign banks may naturally sell their exposure to domestic banks at very low prices. However, this theory may not explain well the trend for peripheral countries in Figure 5.3 Panel B. Basically, domestic non-bank investors should have a similar information advantage to that of domestic banks (when compared to foreign investors) in peripheral countries, and they held a similar amount of domestic government bonds at the beginning of the period reviewed. However, I observe a much stronger increase in domestic sovereign bond holdings only among domestic banks. In other words, I observe that the sovereign bonds of peripheral countries have been relocated only from foreign investors to domestic banks, not to both domestic banks and domestic non-bank investors.

Another strand of the literature focuses on the risk-shifting behaviour of banks with inadequate capital (Acharya and Steffen 2015; Horvath et al. 2015; Acharya et al. 2016; Buch et al. 2016). Specifically, these papers suggest that banks with low capital ratios prefer high-risk assets, for example, the sovereign bonds of distressed governments, so that the shareholders may benefit considerably if the government recovers, while potential losses would be absorbed mainly by the bank's debtholders. However, this argument does not necessarily explain why undercapitalised banks would risk-shift by increasing only their holdings of stressed domestic government bonds instead of the bonds of all stressed governments. In a manner similar to Crosignani (2017), I show that (potentially weak) banks in crisis countries shift their sovereign bond portfolios to other countries in crisis. However, such behaviour is much less remarkable compared to how they shift their sovereign portfolios to the domestic government that is also in crisis.

Then there is the moral suasion channel. Becker and Ivashina (2018) show that the crowding out of corporate lending and increased domestic government bond holdings by European banks during the crisis were the result of moral suasion, which is carried out through direct government ownership and by higher number of government-affiliated board members. De Marco and Macchiavelli (2016) follow a similar path and show that upon receiving liquidity injections, only politically related European banks increased their exposure to domestic sovereign debt. Ongena et al. (2016) demonstrate that, compared to foreign ones, domestic banks were more inclined to increase their exposure when governments had to rollover large chunks of outstanding public debt. This chapter provides strong evidence to support the existence of moral suasion and argues that this channel had a dominant effect on the repatriation of sovereign debt during the European sovereign debt crisis.

This chapter contributes to the literature in two ways primarily. First, in contrast to the recent literature focusing only on sovereign debt (Acharya and Steffen 2015; De Marco and Macchiavelli 2016; Ongena et al. 2016; Becker and Ivashina 2018), I show that banks' private sector exposure was at least equally affected by an increase in home bias. Furthermore, by comparing the difference between the repatriation of sovereign debt and private debt, I show that the sovereign debt of a crisis country flows back to domestic state-owned banks more than to domestic private banks; while private forms of debt (retail and corporate) flow back to domestic private banks more than state-owned banks. Based on these new tests, I argue that the repatriation of sovereign debt is best explained by the moral suasion theory.

This chapter proceeds as follows. Section 5.2 discusses the related literature. Section 5.3 presents the data and some stylised facts. The empirical methodology and results are discussed in Section 5.4. Section 5.5 concludes the chapter.

5.2 Literature Review

5.2.1. Recent home bias in the Eurozone

There is growing interest among academics and policymakers in the causes of the increasing fragmentation (i.e. home bias) in Eurozone sovereign debt markets. As documented by Becker and Ivashina (2018), there is a positive relationship between government ownership in the banking sector (at the country-level) and banks' exposure of domestic government bonds. Moreover, they extend such findings by showing that banks from distressed countries will hold more government bonds if they have more government-affiliated board members. Following a similar path, De Marco and Macchiavelli (2016) show that upon receiving equity injections (bailouts), only politically related European banks increased their holdings of domestic sovereign bonds. With unique bank-level data from ECB, Ongena et al. (2016) show that when a government have to rollover a considerable amount of outstanding debt, compared to foreign ones, domestic banks are more likely to increase the corresponding exposure. Other recent papers, including Horvath et al. (2015) and Altavilla et al. (2017), support these observations and conclude that the moral suasion channel existed during the European sovereign debt crisis. However, none of these studies considers banks' exposure of the private sector. I contribute to this literature and show that state-owned banks and private banks exhibit very different patterns for managing sovereign debt portfolios and private debt portfolios. In other words, moral suasion may have differential impacts on a bank's exposure to sovereign debt and to private debt.

Another stream of the literature on the home bias in sovereign debt investment is based on the secondary market theory developed by Broner et al., (2014). According to this theory, governments would be less willing to default on their debt when most of the debt is held domestically. Governments would rather choose not to default as the harm caused to the domestic economy may outrun the benefit. Therefore, if local agents have such an expectation, in active secondary markets, sovereign bonds should naturally flow back to domestic investors during periods of high sovereign risk, since these have a higher value for domestic agents than for foreign agents. Based on a massive dataset covering 20,000 banks from 191 countries, Gennaioli et al. (2014) reveal empirical patterns consistent with secondary market theory. However, they are unable to distinguish between the domestic and foreign bonds held by each bank. In addition, Brutti and Saure (2016) support this theory by presenting corresponding evidence in the context of the Eurozone crisis. Specifically, they show that reallocation (from foreign to domestic) is more intense for sovereign debt than for private debt. Moreover, the debt of the crisis governments that does not flow back to domestic investors is relocated to banks in large and influential countries in the Eurozone. This implies that debt reallocation was principally driven by investors that could potentially discourage the troubled governments from declaring bankruptcy. Using a dataset covering the entire European sovereign debt crisis and the recovery period that followed, I complement and challenge these findings. First, I show that reallocation of sovereign debt did indeed occur during the crisis. However, the trend holds only for domestic banks as opposed to other domestic agents. Such a result goes against the secondary market theory of Broner et al. (2014), which predicts the same trend for all domestic investors. Furthermore, I show that, compared to sovereign debt, private sector debt held by banks experienced a higher (if not equal) increase in home bias during the crisis. This trend is not entirely in line with the findings of Brutti and Saure (2016), and a possible explanation is that they focus only on the first part of the European sovereign debt crisis (2007–2011), and have limited coverage of European countries (they also include some non-European countries, such as Brazil and Mexico).

Another strand of related literature focuses on the risk-shifting behaviour of banks with inadequate capital. According to this argument, banks with low capital ratios may tend to increase holdings of high-risk assets, such as sovereign bonds of distressed governments. Thus, shareholders could benefit substantially if the government were to recover while potential losses would be absorbed mainly by the bank's debtholders (Acharya and Steffen 2015; Horvath et al., 2015). However, this argument does not necessarily explain why undercapitalised banks would risk-shift by increasing only stressed domestic government bonds instead of the bonds of all stressed governments. In a manner similar to that of Crosignani (2017), I show that (potentially weak) banks of crisis countries shift their sovereign bond portfolios to other countries during crisis; however, such behaviour is much less remarkable than how they shift their sovereign portfolios to the domestic government that is also in crisis. Similarly, banks may engage in carry trades – that is, buy risky sovereign debt and finance those purchases with short-term wholesale funds (Acharya and Steffen 2015). This would naturally lead to greater home bias for banks from countries with risky and high-yielding sovereign debt. I deal with such variations by controlling for country-time fixed effects that absorb country-level risk indicators, for example, sovereign bond yields.

5.2.2 Home bias in other markets

Other than home bias in sovereign debt investment, there are also many studies that explore home bias in portfolios of other asset types. Most of these papers focus on equity investment (French and Poterba 1991), while others examine home (regional) biases in bond portfolios (Lane 2005). The explanations for home bias in investment can be generally placed in three groups: exchange rate risk, transaction costs, and information asymmetry (Coeurdacier and Rey 2013). The European market has experienced increased financial integration and the exchange rate has been comparably stable over the years. Thus, it is more likely that information asymmetry may contribute to home bias in the European market. Some theoretical work regarding the information asymmetry channel has been developed. For example, Brennan and Cao (1997) model the sensitivity of equity investment decisions to asset-related news based on differences between the informational endowments of domestic and foreign agents. They illustrate that, when domestic investors have an informational advantage over foreign investors regarding the domestic market, investors tend to buy foreign assets when the return is high and to sell when the return is low. In other words, home bias would be positively associated with negative news as foreign investors would flee from the local market. Similarly, Van Nieuwerburgh and Veldkamp (2009) show that, for the existence of (initially small) informational differences, investors with rational expectations reinforce informational asymmetries by learning more about risks in which they have an advantage as they desire their information to be very different from that of others. From the perspective of performance evaluation, home bias may be attributed to the fact that investors are better at evaluating the performance of fund managers when the fund invests primarily in local assets rather than in foreign ones (Dziuda and Mondria 2012).

Following the intuition that information asymmetry may cause home bias in the investment of different asset types, many papers have empirically tested the effects informational distance on portfolio compositions. Coval and Moskowitz (1999; 2001) examined the US stock market and find that geographical proximity is critical for investors' portfolio composition as well as for returns. Grinblatt and Keloharju (2001) show that investors can be biased towards firms that are located close to the investor, that communicate in the investor's native language, and that have CEOs of the same cultural background. It is possible that the private debt market may subject to more information asymmetry than the sovereign debt market. I show that home bias in banks' private debt portfolios is not driven by any channels, whether they be moral suasion, risk-shifting, secondary market theory, or exchange rate risk. Hence, I conjecture that it may be driven by information asymmetries, and I would explore this channel in further research.

5.2.3 State-owned banks

This chapter relates broadly to the literature on the performance and behaviour of state-owned banks and the role of political connections at the corporate level (Barth et al. 2001; Faccio 2006; Faccio et al. 2006). Sapienza (2004) shows that Italian state-owned banks provided cheaper loans to firms from areas where the affiliated political party is more powerful. La Porta et al. (2003) find evidence in Mexico that loans provided to 'related parties', either family members or bank-controlled firms, have lower interest rates and require lower collateral but have higher default rates than unrelated ones. Illueca et al. (2013) and Cunat and Garicano (2010) show that political influence in Spanish savings banks is related to greater risk-taking behaviour and worse performance. Finally, Englmaier and Stowasser (2016) show that German savings banks negatively adjust lending pro-cyclically in response to local electoral cycles.

5.3 Data and Stylised Facts

The core of my data comes from various stress tests, and transparency and recapitalisation exercises conducted by the EBA over a period of seven years for a set of major European banks, covering 30 members of the European Economic Area (EEA). Table 5.1 shows the names of EBA tests and the corresponding information dates. Thirteen data time-points begin in the first quarter of 2010 and finish in the middle of 2017, which covers the start, rise, and fall of the European debt crisis. Sovereign bond exposure at bank-level is reported for all 13 time-points, while private sector exposure (corporate, retail, etc.) can only be found in nine out of the 13 time-points. In most disclosures, each bank's debt portfolio is fully broken down to the exposed-country-level for up to 200 countries. However, I only include exposure to the 30 EEA countries so that I can focus on debt reallocation across Europe. Noticeably, the country-breakdown of each bank's private sector exposure is reported based on a minimum of i) 95% of total exposure, and ii) the top 10 countries in terms of exposure. However, EBA always discloses the full country-breakdown for sovereign debt exposure. In other words, such treatment will result in the number of observations for private sector exposure being significantly less than that of the sovereign sector.

The major banks that participated in the EBA serial tests mostly remained the same. Only smaller banks are added or deducted between one test to another. According to the EBA, all exposure is consolidated to the parent bank-level and each test covers at least 65% of the total banking assets in Europe. Compared to other studies using proprietary datasets from the ECB (Ongena et al. 2016; Altavilla et al. 2017), the EBA data covers banks from more countries (including non-Eurozone countries) and has better exposure-country granularity.

In taking a global portfolio approach, the key variable of my analysis is the portion of a sovereign's total debt held by a specific bank. Thus, I name this variable $SovPortion_{b,c,t}$, which equals a specific bank's (*b*) nominal exposure to a specific country (*c*) at a specific time (*t*) divided by the total nominal exposure of all banks to that country at that time:

$$SovPortion_{b,c,t} = \frac{Exposure_{b,c,t}}{\sum_b Exposure_{b,c,t}}$$

To make ensure that this measure is valid, the valuation method used for bank-level sovereign exposure must be the same at a given time point for all banks. This is exactly the case for my sample as the EBA has homogenised the disclosures of banks for all the tests. More importantly, I define *SovPortion* as the share of a sovereign's debt held by a specific bank rather than as the share of a sovereign's debt in a specific bank's sovereign portfolio. Therefore, *SovPortion* will not be affected by price changes of sovereign bonds as these are automatically reflected in all banks' nominal exposures to that specific sovereign.

In a manner similar to the mainstream literature on home bias (Ahearne, Griever, and Warnock 2004; Coeurdacier and Rey 2013), I also use an alternative measure that considers the optimal portion of sovereign debt that should be held by a specific bank according to the standard capital asset pricing model (CAPM). According to CAPM, the optimal proportion that a bank holds should depend on the size of the bank's sovereign portfolio and the size of the global sovereign portfolio. This alternative measure, $SovBias_{b,c,t}$, is equivalent to the difference between $SovPortion_{b,c,t}$ and the proportion suggested by the CAPM ($SovCAPM_{b,c,t}$). As in the literature, this difference is standardized by ($1 - SovCAPM_{b,c,t}$), so that the maximum bias (for *SovPortion* = 1) is 1. That is:

$$SovBias_{b,c,t} = \frac{SovPortion_{b,c,t} - SovCAPM_{b,t}}{1 - SovCAPM_{b,t}}$$

where

$$SovCAPM_{b,t} = \frac{\sum_{c} Nominal\ Exposure\ _{b,c,t}}{\sum_{b,c} Nominal\ Exposure\ _{b,c,t}}$$

If $SovBias_{b,c,t}$ equals 1, this means all of a sovereign's debt is held by a specific bank, that is, perfect bias occurs. If $SovBias_{b,c,t}$ equals 0, this means the bank holds exactly the share suggested by CAPM model, that is, there is no bias at all. For the later sections of this study, I build the corresponding variable for private sector exposure (retail, corporate), $PrivatePortion_{b,c,t}$, in exactly the same way as above, while $DebtPortion_{d,b,c,t}$ is the variable that combines $SovPortion_{b,c,t}$ and $PrivatePortion_{b,c,t}$ where d denotes the type of debt.

In order to capture stressed scenarios during the sample period, I build the dummy variable $Crisis_{c,t}$. First, I obtained the monthly average of daily yields of 10-year bonds of almost all 30 EEA countries from ECB database[36]. Following Brutti and Saure (2016), a country is regarded as being 'in crisis' if it is a Eurozone member and its average daily bond spreads (compared to Germany), for the previous three months' average, is above 400 basis points. The summary of sovereign spreads for each time-point in the sample is presented in Table C.1.

In order to distinguish different types of creditors, I also need the amount of the sovereign bond held by non-bank agents. Unfortunately, the EBA dataset only includes the sovereign bond holdings of banks. Hence, I resort to a country-level dataset compiled from different national sources by Merler and Pisani-Ferry (2012)

36 The data for Estonia, Iceland, Liechtenstein and Norway are not available, but it will not have any material impact on the analysis. Not only because the size of sovereign debt of those countries are quite small, but also the way I define "crisis" – only consider whether a country is "in crisis" if it is a member of Eurozone countries.

which shows the share of a sovereign's total debt held by its resident banks and non-bank residents[37]. Observations are disclosed quarterly and cover 11 European countries[38]. I choose the same period covered by the EBA dataset, 2010Q1 to 2017Q2. For the panel regression, I create a dependent variable $DomesticPortion_{c,k,t}$, which indicates the share of a country's (c) sovereign debt held by a certain domestic creditor (k: resident banks or non-bank residents) at a given time-point (t).

Finally, in order to capture the effect of government pressure, I distinguish state-owned banks from private banks by using ownership data from Orbis Bank Focus. I create a dummy variable $Public_b$, which equals 1 if the global ultimate owner (i.e. that holds more that 50% of the equity capital of the bank) is the domestic government. See Table C.2 for a list of state-owned banks.

The summary statistics are shown in Table 5.2. Noticeably, for *SovPortion*, more than half of the observations are zero. However, these are meaningful zeros indicating that the bank does not have exposure to that sovereign at that time point. If the average levels of the overall and domestic samples are compared, I can see a clear home bias for sovereign debt and private debt.

37 "Non-bank residents" exclude central banks and public agencies, so I can assume that these are private non-bank parties and/or institutions.
38 Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and United Kingdom.

5.4 Methodology and Results

5.4.1 Sovereign home bias during the crisis

First, I aim to capture home bias in sovereign debt portfolios of European banks during the crisis. Hence, I apply a simple difference-in-difference method that assumes that a bank's home bias should evidence a common trend in the absence of a crisis. The model is as follows:

$$SovPortion_{l,b,c,t} = \beta_0 Domestic_{l,c} + \beta_1\left(Crisis_{c,t} * Domestic_{l,c}\right) + \theta_{b,t} + \gamma_{c,t} + \varepsilon_{l,b,c,t} \qquad (5.1)$$

Here (l) indicates the home country of the bank, (b) denotes the bank, (c) identifies the country of exposure, and (t) is time. Controls include a large set of fixed effects at the level of *Bank*Time* and *ExposureCountry*Time*. Variables are winsorised at 1% and 99% level, and standard errors are clustered at *Bank*Time* level. Thus, this model controls for the overall effects of the crisis both at the home country (banks never change home country) and exposure country levels, and the *Crisis* dummy (which is country-time specific) only needs to enter the regression as an interaction term. In addition, $Domestic_{l,c}$ is a dummy variable that equals 1 if the bank's home country is the same as the exposure country (i.e. $l = c$). Based on this setup, β_0 should reflect the general level of home bias in European banks' sovereign debt portfolios, and β_1 should reflect the marginal effect of the crisis on this home bias. Regarding the alternative dependent variable, $SovBias_{l,b,c,t}$, the same model is estimated.

Results are shown in Table 5.3. In tranquil times (columns 1 and 3), banks have some home bias in the sovereign debt portfolio, which is economically significant at a level of approximately 13%; in comparison, the average sovereign holding in my sample is around 0.01 (i.e. an average bank only holds 1% of the sovereign debt issued by a specific country). This result surely indicates that a bank holds much more of the sovereign debt of its home country. In stressed scenarios (columns 2 and 4), I can clearly see a significant rise in home bias. In addition, such effect is of great economic significance as the portion of a sovereign's debt held by an average domestic bank almost doubles when the country is in crisis. Therefore, I can confirm that home bias in sovereign debt portfolios greatly increased during the crisis. This is compatible with the findings of Giannetti and Laeven (2012) to the effect that international banks demonstrate a stronger home bias for syndicated loan issuance. However, with this observation, it is not yet possible to tell which channel has the principal impact on home bias.

5.4.2 Sovereign vs. private debt home bias

Most of the literature on European banks' home bias during the crisis focuses only on the sovereign debt portfolio (De Marco and Macchiavelli 2016; Ongena et al. 2016; Becker and Ivashina 2018). However, this trend may merely be an observation of a more general trend, that is, of home bias in all investments. Thus, I intend to compare the effect of crisis on home bias for the different types of assets of European banks, and I employ a more generalised model as follows:

$$DebtPortion_{d,l,b,c,t} = \beta_0(Domestic_{l,c} * Retail_d) + \beta_1(Domestic_{l,c} * Sovereign_d) + \beta_2(Domestic_{l,c} * Crisis_{c,t}) + \beta_3(Domestic_{l,c} * Crisis_{c,t} * Sovereign_d) + \theta_{b,t} + \gamma_{c,t} + \delta_d + \varepsilon_{l,b,c,t}$$

(5.2)

Here $Sovereign_d$ and $Retail_d$ are dummy variables denoting the corresponding asset types. All other variables are built as previously explained[39]. The coefficients β_0 and β_1 indicate home bias in these two different asset types in general. β_2 shows the overall effect of the crisis on home bias for both asset types and β_3 should indicate whether there is a stronger home bias for sovereign debt.

The results are shown in Table 5.4. In columns 1 and 4, the results confirm that both sovereign debt private debt are subject to significant home bias. Then, columns 2 and 5 show that the crisis has a positive impact on home bias for both asset types. Columns 3 and 6 consider the additional impact of the crisis on sovereign debt, which is insignificant. Moreover, such an additional effect is negative (–0.04) even if it were significant; that is, during the crisis, private debt may have displayed stronger home bias than sovereign debt. Thus, the next step is to find the mechanisms behind the repatriation of both asset types during the crisis, and discover whether they share common channels.

39 *Domestic* is excluded because its perfect collinearity with *Domestic * Retail* and *Domestic * Sovereign.* Also, for conciseness, the two-way interaction of *Sovereign*Crisis* is excluded, and its inclusion does not change the results anyways.

5.4.3 The effect of moral suasion

As suggested by De Marco and Macchiavelli (2016), Ongena et al. (2016), and Becker and Ivashina (2018), banks with a greater 'domestic government-relation' held more domestic governments bond during the crisis[40]. Furthermore, it is possible that domestic governments may implicitly ask domestic banks, especially those within their jurisdiction, to increase lending to domestic firms to stimulate the domestic economy. First, I compare the levels of home bias of state-owned banks and private banks in Table 5.5. Overall, private banks have stronger home bias in their private sector exposure; however, there is no significant difference between state-owned banks and private banks in terms of home bias in the sovereign debt portfolio. If I look at GIIPS banks[41] only, that is, focus on cases in which sovereigns face greater funding pressure[42], compared to private banks, state-owned banks have much stronger home bias in sovereign debt portfolios though they have less in private debt portfolios. These observations are in line with the moral suasion view of home bias (De Marco and Macchiavelli 2016; Ongena et al. 2016; Becker and Ivashina 2018), which would predict that, in general, state-owned banks in crisis countries would suffer more home bias in sovereign debt portfolios than their private counterparts; While in private debt portfolios, where domestic government

40 Measured by either direct government ownership of the bank and/or political links on the board of directors.

41 Banks from Greece, Ireland, Italy, Portugal and Spain.

42 Because the GIIPS sovereigns are often "in crisis" (i.e. high sovereign bond yield) during the sample period

pressure is much less influential, state-owned banks will not show higher home bias than private banks[43].

To test this, I employ the following model:

$$SovPortion_{l,b,c,t} = \beta_0 Domestic_{l,c} + \beta_1 (Domestic_{l,c} * Crisis_{c,t}) + \beta_2 (Domestic_{l,c} * Crisis_{c,t} * Public_b) + \theta_{b,t} + \gamma_{c,t} + \varepsilon_{l,b,c,t}$$

(5.3)

Here $Public_b$ is a dummy variable that indicates state-owned banks. A bank is defined as a state-owned bank if the global ultimate owner of the bank is the domestic government (see Table C.2 for a list of state-owned banks); otherwise it is a private bank. The ownership information of banks is sourced from Orbis Banks Focus, and is only available to the end of 2017. Thus, I assume that the controlling shareholder remains unchanged throughout the whole period. All other variables are built as previously explained. β_0 shows home bias in general for both types of banks, β_1 shows the additional effect of the crisis on home bias for both types of banks, and β_2 shows the additional effect of crisis on home bias for state-owned banks.

The results are shown in Table 5.6. In columns 1 and 2 (3 and 4), the dependent variable is *SovPortion* (*PrivatePortion*). According to the results in 1, overall, state-

43 Unless one assumes that domestic government also ask domestic banks to absorb debt of domestic firms/residents.

owned banks and private banks appear to have a similar level of home bias in sovereign debt portfolios. In other words, the domestic distribution of a country's sovereign debt is not biased to either state-owned banks or private banks. Then, I consider the scenarios in which sovereigns face significant funding pressures, approximated by the dummy variable "*Crisis*", the story might be different. In column 2, the result of a Wald Test on ($\beta1 + \beta2$) is very significant, both statistically and economically. However, it is very likely to be driven by the fact that $\beta1$ is highly significant while β_2 is not significant. In other words, under such a crisis scenario, state-owned banks do not have a stronger home bias in the sovereign debt portfolio than private banks. However, if I relax the definition of crisis: bond spread > 200bps in Panel C[44]. Then, in column 1, β_2 is quite significant, so is ($\beta1 + \beta2$) in the joint test. Therefore, the results suggest that under a less-intense-crisis scenario, state-owned banks have higher home bias in sovereign debt portfolios during stressed scenarios than do private banks, while during extremely stressed periods, the domestic distribution of a country's sovereign debt is indifferent between state-owned banks and private banks.

In contrast, if I look at home bias in private sector portfolios (in columns 3 and 4), it appears that state-owned banks always have a lower, if not the same, level of home bias as private banks in both crisis and tranquil periods. Thus, such results confirm the trend observed in Table 5.5: that state-owned banks have stronger home bias in sovereign debt portfolios than do private banks mainly when their domestic

44 So that there are more observations of public banks of countries in crisis.

sovereign faces funding pressure (such a difference may disappear as the funding pressure grows); and that private banks always have stronger home bias than state-owned banks in private sector portfolios. This suggests that the moral suasion channel may explain the repatriation of sovereign debt, but not private debt, during the crisis.

5.4.4 The effect of risk-shifting

As suggested by Crosignani (2017), banks from countries in crisis are particularly weakly capitalised: they tilt their government bond portfolios toward domestic securities, and link their fate to that of the sovereign. Thus, the risks are shifted to other stakeholders of the bank, while the shareholders can benefit from large profit if the sovereign recovers. However, if this theory works, one would also expect those banks to hold more sovereign bonds of other crisis countries. I employ the following model to capture the risk-shifting channel:

$$SovPortion_{l,b,c,t} = \beta_0 Domestic_{l,c} + \beta_1 (StressedBank_{l,t} * Crisis_{c,t}) + \beta_2 (Domestic_{l,c} * StressedBank_{l,t} * Crisis_{c,t}) + \theta_{b,t} + \gamma_{c,t} + \varepsilon_{l,b,c,t} \quad (5.4)$$

Here $StressedBank_{l,t}$ is a dummy variable representing observations where the home country of the bank is 'in crisis'[45]. All other variables are built as previously

[45] Noticeably, the *StressedBank* dummy is a country level variable rather than banks level. Therefore, the focus of such setting is to test the impact of a domestic shock of a country, e.g. domestic government funding pressure, rather than that of an individual bank's character.

explained. Due to the fixed effects at *Bank*Time* and *ExposureCountry*Time* levels, *Crisis* and *StressedBank* dummies only enter the regression as interaction terms. The two-way interactions, *Domestic*Crisis* and *Domestic*StressedBank*, are dropped from the estimation since they are perfectly collinear with *Domestic*StressedBank*Crisis* (they essentially indicate the same thing). If the risk-shifting channel can explain increasing home bias for banks in crisis countries, I should expect a similar trend of crisis countries' banks shifting their portfolios towards all countries in crisis – both domestic and foreign – which should be reflected in β_1. On the other hand, β_2 captures the marginal effect of the crisis on home bias that risk-shifting theory could not explain.

The results for sovereign debt portfolios are presented in Table 5.7 Panel A. Columns 1 and 3 confirm the existence of the risk-shifting channel, since banks in crisis countries would reallocate their sovereign investment to all other crisis countries. However, in 2 and 4, when the triple interaction is added, the coefficient of *Crisis*StressedBank* is still quite statistically significant, but its magnitude is much smaller than that of *Crisis*StressedBank *Domestic*. Therefore, general risk-shifting theory cannot well explain why banks from distressed countries have a strong preference for their own government bonds. According to the results in Panel B, general risk-shifting appears to be totally irrelevant to the reallocation of banks' private debt portfolios.

5.4.5 Secondary market theory

As discussed above, the secondary market theory is based on the assumption that a government will be less willing to default if its debt is mostly held domestically; thus, it suggests that government bonds are more valuable to domestic investors. Accordingly, sovereign debt will naturally flow back to domestic investors during crisis. However, this theory is not only limited to the asset management of banks. In other words, if the secondary market channel is prominent, I should expect that both banks and other types of financial institutions would increase home bias in their sovereign debt portfolio during the crisis. I use the Bruegel dataset at country-level to differentiate the effect of the crisis on the home bias of banks and other non-bank agents in the same country, and I employ the following model:

$$DomesticPortion_{c,k,t} = \beta_1(ResidentBanks_k * Crisis_{c,t}) + \omega_{k,t} + \gamma_{c,t} + \varepsilon_{c,k,t} \quad (5.5)$$

Here (c) is the country, (k) is the creditor type and (t) refers to a specific quarter. *ResidentBanks* is a dummy variable that is 1 if the creditor of the sovereign debt is its resident bank, and 0 if it is other private non-bank residents. All other variables are built as previously explained. Fixed effects are included at *Creditor*Time* and *Country*Time* levels, and that is why *ResidentBank* and *Crisis* enter the regression only in interaction form. β_1 indicates whether or not domestic banks behave differently compared to other domestic agents.

According to the results in Table 5.8, resident banks are more likely to increase home bias in their sovereign debt portfolios, while other non-bank agents appear to move in the opposite direction. Thus, such findings go against the secondary market theory which predicts that sovereign debt should flow back to all domestic investors indiscriminately. One may argue that governments care more about the well-being of domestic banking sector than other domestic sectors. In other words, governments are much less likely to default if most of the debt were held by domestic banks rather than other domestic investors. However, if secondary market theory is applicable, one would still expect a similar trend for domestic non-bank agents as compared to domestic banks. This is not observable in my analysis.

5.4.6 Exchange rate risk

One possible motivation for home bias in portfolio management may be hedging of exchange rate risk. As suggested by Stockman and Dellas (1989), investors are more willing to invest at home than abroad because they prefer to keep asset returns aligned with local currency denominated expenditure. To test the possible impact of this theory, I exclude non-Eurozone country banks from my sample (e.g. HSBC from the UK) [46]. Thus all banks in the sub-sample use the euro as the main currency. Table 5.9 updates all the major results for this sub-sample, and there is no

46 Only keep banks that are from the baseline sample and headquartered in Eurozone countries including: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Greece, Slovenia, Cyprus, Malta. The banks (very few) from Estonia, Latvia, and Lithuania are excluded because these countries joined the Eurozone during the sample period.

significant change from previous findings. Hence, exchange rate risk is not a primary determinant for rising home bias among European banks.

5.4.7 Redenomination risk

Apart from exchange rate risk, there is another potential issue faced by Eurozone banks: the risk that some countries may leave the monetary union. With such a concern, banks may sell government bonds to hedge against such countries. However, it is not easy to list the exact countries that plan to leave the union. As suggested by Lane (2012), Greece is the country that suffered the most during the Eurozone crisis, so it is easy to argue that Greece is more likely to leave the union than any other member country. I follow a strategy similar to that of Brutti and Saurre (2016) and drop all the bank exposure to Greece from my sample. Table 5.10 updates all the major results for this sub-sample – and there is no significant changes. That is, the results are not driven by redenomination risk.

5.5 Conclusion

According to the Eurosystem's mission statement, it has a keen interest in the integration of the financial system in Europe, particularly in the euro area[47]. However, the repatriation of both sovereign debt and private forms of debt during the crisis contributed to the fragmentation of the European financial market. By

47 For more details https://www.ecb.europa.eu/ecb/orga/escb/eurosystem-mission/html/index.en.html

using detailed datasets compiled from various tests conducted by the EBA, I find some empirical evidence that may explain the fragmentation of the European financial market. First, the home bias of banks' portfolios increased and sovereign debt (of financially distressed countries) was reallocated from foreign investors to domestic banks, but not to other domestic agents. Second, the home bias of banks' portfolios for private forms of debt (corporate and retail) also experienced a significant increase, which was at least equally as large as that for sovereign debt portfolios. Third, state-owned banks and private banks have different focuses regarding home bias. State-owned banks have stronger home bias in sovereign debt portfolios than do private banks, while private banks have stronger home bias in private debt portfolios. I have discussed these findings in light of different theories, and I argue that the repatriation of sovereign debt can be best explained by the moral suasion theory, while further investigation is required regarding the repatriation of private forms of debt.

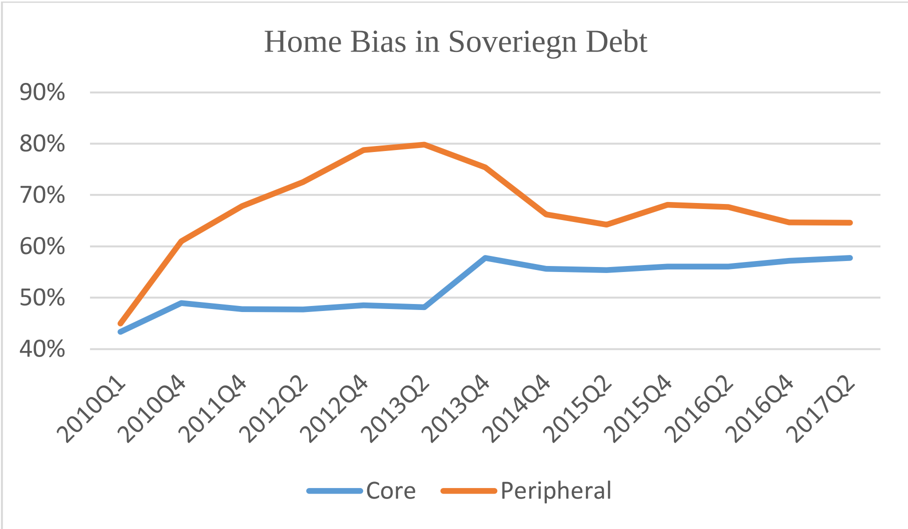
My results have certain policy implications. Governments may influence the investment decisions of domestic banks through direct ownership, which may essentially impede the integration of European financial market. This is because one of the fundamental conditions for a fully integrated market is that all potential market participants should be treated equally when they are active in the market (ECB 2017)[48]. Moreover, many papers argue that banks' excessive holdings of sovereign debt is a key ingredient in forming the sovereign–bank diabolic loop

48 Financial Integration in Europe. https://www.ecb.europa.eu/pub/pdf/other/ecb.financialintegrationineurope201705.en.pdf

(Cooper and Nikolov 2013; Acharya et al. 2014; Brunnermeier et al. 2016; Farhi and Tirole 2018). This chapter has identified a crucial factor, moral suasion, that significantly contributes to banks' excessive holdings of sovereign debt. This implies that minimising the chances of moral suasion may be particularly important in solving the deadly loop between sovereigns and banks.

Figure 5.1. Home bias in domestic banks and government bond spreads.

Home Bias is defined as the portion of the total sovereign debt of a country held by its domestic banks, and it is calculated as the simple average for countries of a country group (Core vs. Peripheral). Bond Spread for a country's 10-year government bond (with respect to Germany) is averaged over three-month daily values before each observation date. Then, it is calculated as the simple average for all countries of a country group (Core vs. Peripheral). Peripheral countries are Greece, Ireland, Italy, Portugal and Spain. Core countries are Austria, Belgium, Germany, France and Netherlands. Data of banks' sovereign bond exposure is from EBA.



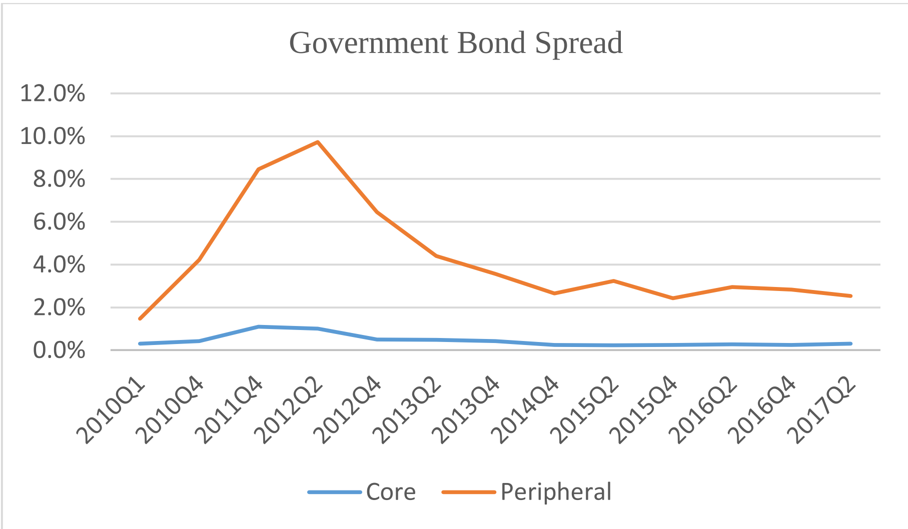
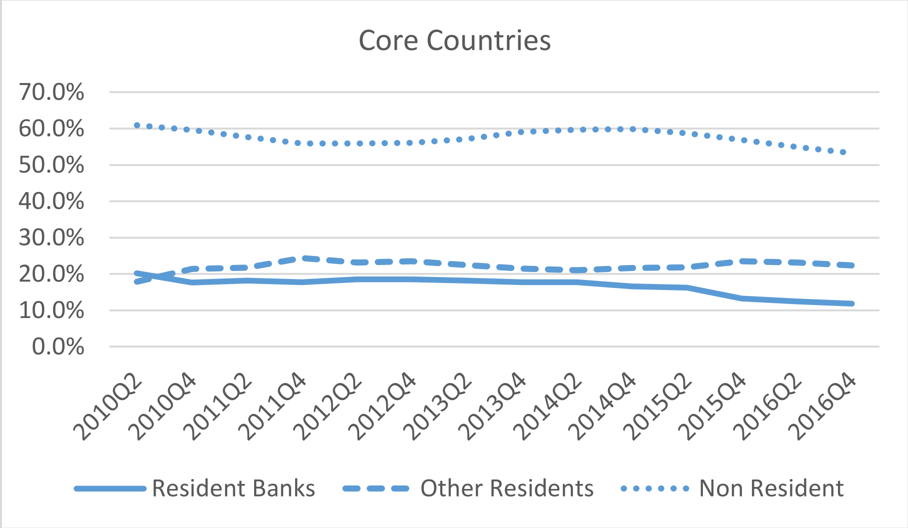


Figure 5.2. Domestic Debt Ownership: Bank Resident, Non-Bank Resident and Non-Resident

Home Bias is defined as the portion of the total sovereign debt of a country held by a particular domestic creditor group (bank resident or non-bank resident) or foreign creditor (Non-Resident), and it is calculated as the simple average for countries of a country group (Core vs. Peripheral). Data for domestic sovereign holding by Resident Banks and Other Resident comes from the dataset compiled by Merler and Pisani-Ferry (2012). Core countries include Belgium, France, Germany and Netherlands. Peripheral countries include Greece, Ireland, Italy, Portugal and Spain.



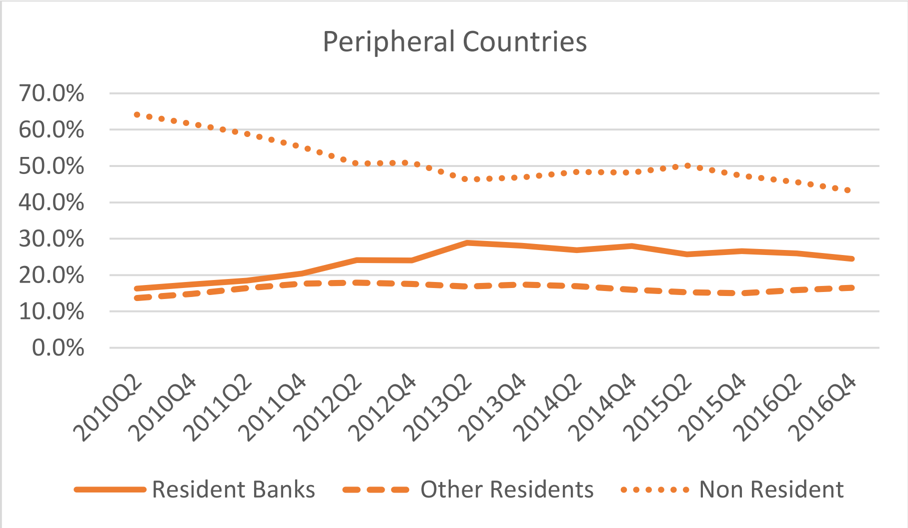


Table 5.1. Data disclosure details from European Banking Authority (EBA)

Disclosure Name	Information Date	No. of Banks	Type of Debt
2010 EU-wide stress testing exercise	2010-Q1	91	Sovereign
2011 EU-wide stress testing exercise	2010-Q4	90	Sovereign&Private
EU Capital exercise 2012	2011-Q4&2012-Q2	62	Sovereign
2013 EU-wide transparency exercise	2012-Q4&2013-Q2	64	Sovereign&Private
2014 EU-wide stress testing exercise	2013-Q4	123	Sovereign&Private
2015 EU-wide transparency exercise	2014-Q4&2015-Q2	105	Sovereign&Private
2016 EU-wide transparency exercise	2015-Q4&2016-Q2	131	Sovereign&Private
2017 EU-wide transparency exercise	2016-Q4&2017-Q2	132	Sovereign&Private

Table 5.2. Summary Statistics

SovPortion (PrivatePortion) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample. SovBias (PrivateBias) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample, adjusted by a CAPM model. Domestic in parentheses refers to the same variable but held by a specific domestic bank. Domestic Portion is the portion of the total sovereign debt of a country held by all domestic banks (Resident Banks) or by all domestic non-bank residents (Other Residents). Bond Spreads are the spreads between each country's 10-year government bond and German 10-year bond, averaged over three-month daily values before each observation date. Panel A shows the summary statistics for all variables used in the regressions. The significance level of t-test on mean are indicated by ***, **, and * for 1%, 5% and 10%, respectively.

Panel A: Summary Statistics

Variables	Mean	Median	Std.	Min	Max	N	Source
SovPortion	0.012	0.000	0.051	0	1	31470	EBA
SovBias	0	-0.004	0.052	-0.088	1	31470	EBA
PrivatePortion	0.045	0.001	0.109	0	1	5764	EBA
PrivateBias	0.030	-0.003	0.109	-0.073	1	5764	EBA
SovPortion (Domestic)	0.131	0.094	0.132	0	0.841	1056	EBA
SovBias (Domestic)	0.121	0.076	0.132	-0.027	0.840	1056	EBA
PrivatePortion (Domestic)	0.177	0.151	0.148	0	1	608	EBA
PrivateBias (Domestic)	0.163	0.129	0.145	-0.002	1	608	EBA
Domestic Portion							
Resident Banks	0.179	0.186	0.099	0.008	0.451	302	Bruegel
Other Resident	0.195	0.206	0.129	0.002	0.583	302	Bruegel
Bond Spreads (basis point)	203	116	260	-25	2398	338	ECB

Table 5.3. Home Bias in European Banks' Sovereign Exposure during Crises.

This table contains the results of panel regressions of equation (5.1) with dependent variables SovPortion (in [1] and [2]) and SovBias (in [3] and [4]). The sample period fully covers the Eurozone Crisis and the recovery phase from early 2010 to mid-2017 on a semi-annual basis. SovPortion is the ratio of a specific bank's exposure of the sovereign debt of a specific country divided by the same exposure of the same country held by all banks in the sample. SovBias is the ratio of a specific bank's exposure of the sovereign debt of a specific country divided by the same exposure of the same country held by all banks in the sample, adjusted by a CAPM model. Domestic is a dummy variable, which equals to 1 if the exposed country is also the home country of the bank. Crisis is a dummy variable, which equals to 1 if the exposed country is from Eurozone and its 10-year government bond spread (vs. German) is above 400 basis points, averaged over three-month daily values before each observation date. Fixed effects are included at Exposure-Country*Time and Bank*Time levels. In addition, I include the result of Wald-tests that give the joint significance of linear combinations of the betas for Domestic and Domestic*Crisis. Data of banks' sovereign bond exposure is from EBA and country exposures include all 30 members of the European Economic Area (EEA). Bond yields for Crisis dummy are from ECB Database. Standard errors are heteroscedasticity-robust and clustered at the bank level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Dependent Variable:	SovPortion		SovBias	
	[1]	[2]	[3]	[4]
Domestic	0.1313***	0.1199***	0.1331***	0.1218***
Domestic*Crisis		0.1106***		0.1104***
Fixed Effects				
*Exposure-Country*Time*	YES	YES	YES	YES
*Bank*Time*	YES	YES	YES	YES
Clustering	Bank	Bank	Bank	Bank
N	31470	31470	31470	31470
Adj. R-Squared	0.24	0.26	0.23	0.24
Wald-tests				
Domestic*(1+Crisis)		0.2305***		0.2322***

Table 5.4. Home Bias in European Banks' Exposure during Crisis – Sovereign vs. Private Exposure.

This table contains the results of panel regressions of equation (5.2) with dependent variables DebtPortion (Column [1]-[3]) and DebtBias (Column [4]-[6]). The sample period fully covers the Eurozone Crisis and the recovery phase from early 2010 to mid-2017 on a semi-annual basis. DebtPortion is the ratio of a specific bank's exposure of a specific type of debt of a specific country divided by the same exposure of the same country held by all banks in the sample. DebtBias is the ratio of a specific bank's exposure of a specific type of debt of a specific country divided by the same exposure of the same country held by all banks in the sample, adjusted by a CAPM model. Domestic is a dummy variable, which equals to 1 if the exposed country is also the home country of the bank. Crisis is a dummy variable, which equals to 1 if the exposed country is from Eurozone and its 10-year government bond spread (vs. German) is above 400 basis points, averaged over three-month daily values before each observation date. Sovereign and Private are dummy variables indicating the respective debt types held by banks. Data of banks' sovereign bond exposure is from EBA and country exposures include all 30 members of the European Economic Area (EEA). Bond yields for Crisis dummy are from ECB Database. Standard errors are heteroscedasticity-robust and clustered at the bank level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Dependent Variable	DebtPortion			DebtBias		
	[1]	[2]	[3]	[4]	[5]	[6]
Domestic*Sovereign	0.1358***	0.1243***	0.1251***	0.1376***	0.1261***	0.1270***
Domestic*Private	0.1519***	0.1463***	0.1448***	0.1544***	0.1488***	0.1473***
Domestic*Crisis		0.1128***	0.1442***		0.1127***	0.1445***
Domestic*Crisis*Sovereign			-0.0401			-0.0407
Fixed Effects						
Sector	YES	YES	YES	YES	YES	YES
*ExpoCountry*Time*	YES	YES	YES	YES	YES	YES
*Bank*Time*	YES	YES	YES	YES	YES	YES
Clustering	Bank	Bank	Bank	Bank	Bank	Bank
N	37234	37234	37234	37234	37234	37234
Adj. R-Squared	0.30	0.31	0.31	0.28	0.29	0.29

Table 5.5. Summary Statistics State Owned Banks vs. Private Banks.

SovPortion (PrivatePortion) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample. SovBias (PrivateBias) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample, adjusted by a CAPM model. Domestic in parentheses refers to the same variable but held by a specific domestic bank. The last column shows the results of t-test on the difference between state-owned banks and private banks. A bank is qualified as state-owned bank if its "global ultimate owner" is the domestic government (according to Orbis Bank Focus), otherwise the bank is a private bank. GIIPS banks include banks from Greece, Ireland, Italy, Portugal and Spain. The significance level of t-test on mean are indicated by ***, **, and * for 1%, 5% and 10%, respectively.

All Banks	State-Owned Bank	Private Bank	Diff.
SovPortion (Domestic)	0.131	0.132	-0.001
SovBias (Domestic)	0.119	0.121	-0.002
PrivatePortion (Domestic)	0.106	0.195	-0.088***
PrivateBias (Domestic)	0.098	0.180	-0.082***
GIIPS Banks	State-Owned Bank	Private Bank	Diff.
SovPortion (Domestic)	0.208	0.106	0.103***
SovBias (Domestic)	0.203	0.097	0.107***
PrivatePortion (Domestic)	0.174	0.216	-0.042***
PrivateBias (Domestic)	0.169	0.205	-0.036***

Table 5.6. Home Bias in European Banks' Sovereign Exposure during Crisis – State Owned Banks.

This table contains the results of panel regressions of equation (5.3) with dependent variables SovPortion, SovBias, PrivatePortion and PrivateBias in [1] – [4] respectively. The sample period fully covers the Eurozone Crisis and the recovery phase from early 2010 to mid-2017 on a semi-annual basis. SovPortion (PrivatePortion) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample. SovBias (PrivateBias) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample, adjusted by a CAPM model. Domestic is a dummy variable, which equals to 1 if the exposed country is also the home country of the bank. Crisis is a dummy variable, which equals to 1 if the exposed country is from Eurozone and its 10-year government bond spread (vs. German) is above 400 basis points, averaged over three-month daily values before each observation date. Public equals 1 if the global ultimate owner of the bank is the domestic government (see Appendix for a list of state owned banks). In addition, I include the result of Wald-tests that give the joint significance of linear combinations of the betas for Domestic and Domestic*Public, and Domestic*Crisis and Domestic*Crisis*Public. Data of banks' sovereign bond exposure is from EBA and country exposures include all 30 members of the European Economic Area (EEA). Bond yields for Crisis dummy are from ECB Database. Standard errors are heteroscedasticity-robust and clustered at the bank level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively

Dependent Variable:	SovPortion	SovPortion	PrivatePortion	PrivatePortion
	[1]	[2]	[3]	[4]
Domestic	0.1308***	0.1199***	0.1682***	0.1531***
Domestic*Public	0.0030		-0.0603**	
Domestic*Crisis		0.1048***		0.0956**
Domestic*Crisis*Public		0.0371		-0.0744
Fixed Effects				
*ExpoCountry*Time*	YES	YES	YES	YES
*Bank*Time*	YES	YES	YES	YES
Clustering	Bank	Bank	Bank	Bank
N	31470	31470	5764	5764
Adj. R-Squared	0.24	0.26	0.72	0.72
Wald-tests				
Domestic	0.1308***		0.1682***	
Domestic*(1+Public)	0.1338***		0.1079***	
Domestic*Crisis		0.1048***		0.0956**
Domestic*Crisis*(1+Public)		0.1419***		0.0212

Table 5.6 Continued

Panel B: Crisis if Bond Spread > 300bps		
Dependent Variable:	SovPortion	PrivatePortion
	[1]	[2]
Domestic	0.1158***	0.1520***
Domestic*Crisis	0.1010***	0.0741**
Domestic*Crisis*Public	0.0437	-0.0388
Fixed Effects		
*ExpoCountry*Time*	YES	YES
*Bank*Time*	YES	YES
Clustering	Bank	Bank
N	31470	5764
Adj. R-Squared	0.26	0.72
Wald-tests		
Domestic*Crisis*(1+Public)	0.1447***	0.0353

Table 5.6 Continued

Panel C: Crisis if Bond Spread > 200bps		
Dependent Variable:	SovPortion	PrivatePortion
	[1]	[2]
Domestic	0.1154***	0.1562***
Domestic*Crisis	0.0678***	-0.0069
Domestic*Crisis*Public	0.0573**	0.0326
Fixed Effects		
*ExpoCountry*Time*	YES	YES
*Bank*Time*	YES	YES
Clustering	Bank	Bank
N	31470	5764
Adj. R-Squared	0.26	0.72
Wald-tests		
Domestic*Crisis*(1+Public)	0.1251***	0.0257

Table 5.7. Home Bias in European Banks' Sovereign Exposure during Crisis – Banks from Stressed Countries.

This table contains the results of panel regressions of equation (5.4) with dependent variables SovPortion (in [1] and [2]) and SovBias (in [3] and [4]) in Panel A and PrivatePortion (in [1] and [2]) and PrivateBias (in [3] and [4]) in Panel B. The sample period fully covers the Eurozone Crisis and the recovery phase from early 2010 to mid-2017 on a semi-annual basis. SovPortion (PrivatePortion) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample. SovBias (PrivateBias) is the ratio of a specific bank's exposure of the sovereign (private) debt of a specific country divided by the same exposure of the same country held by all banks in the sample, adjusted by a CAPM model. Domestic is a dummy variable, which equals to 1 if the exposed country is also the home country of the bank. Crisis is a dummy variable, which equals to 1 if the sovereign exposure is towards a country from Eurozone and its 10-year government bond spread (vs. German) is above 400 basis points, averaged over three-month daily values before each observation date. StressBank is a dummy variable, which equals to 1 if the home country of the bank is "in crisis" (400bps < Spread). In addition, I include the result of Wald-tests that give the joint significance of linear combinations of the betas for Crisis*StressBank and Domestic*Crisis*StressBank. Data of banks' sovereign bond exposure is from EBA and country exposures include all 30 members of the European Economic Area (EEA). Bond yields for Crisis dummy are from ECB Database. Standard errors are heteroscedasticity-robust and clustered at the bank level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Panel A: Sovereign debt portfolio

Dependent Variable:	SovPortion		SovBias	
	[1]	[2]	[3]	[4]
Domestic	0.1286***	0.1199***	0.1303***	0.1217***
Crisis*StressBank	0.0314***	0.0081***	0.0314***	0.0081***
Domestic*Crisis* StressBank		0.1045***		0.1043***
Fixed Effects				
*ExpoCountry*Time*	YES	YES	YES	YES
*Bank*Time*	YES	YES	YES	YES
Clustering	Bank	Bank	Bank	Bank
N	31470	31470	31470	31470
Adj. R-Squared	0.25	0.26	0.23	0.24
Wald-tests				
Crisis* StressBank *(1+Domestic)		0.1126***		0.1124***

Table 5.7 Continued

Panel B: Private debt portfolio

Dependent Variable:	PrivatePortion		PrivateBias	
	[1]	[2]	[3]	[4]
Domestic	0.1553***	0.1532***	0.1589***	0.1568***
Crisis*StressedBank	0.0170	-0.0187*	0.0161	-0.0186*
Domestic*Crisis* StressedBank		0.0991*		0.0962*
Fixed Effects				
*ExpoCountry*Time*	YES	YES	YES	YES
*Bank*Time*	YES	YES	YES	YES
Clustering	Bank	Bank	Bank	Bank
N	5764	5764	5764	5764
Adj. R-Squared	0.72	0.72	0.71	0.71
Wald-tests				
Crisis* StressBank *(1+Domestic)		0.0804		0.0776

Table 5.8. Home Bias in European Banks' Sovereign Exposure during Crisis – Resident Banks vs. Non-Bank Residents.

This table contains the results of panel regressions of equation (5.5) with dependent variable Domestic Portion, which is the portion of the total sovereign debt of a country held by all domestic banks (Resident Banks) or by all domestic non-bank residents (Other Residents). The sample period fully covers the Eurozone Crisis and the recovery phase from early 2010 to end-2016 on a quarterly basis. ResidentBank is a Dummy variable, which equals to 1 if the creditor is the resident bank of the country. Crisis is a dummy variable, which equals to 1 if the exposed country is from Eurozone and its 10-year government bond spread (vs. German) is above 400 basis points, averaged over three-month daily values before each observation date. Data for domestic sovereign holding by Resident Banks and Other Resident comes from the dataset compiled by Merler and Pisani-Ferry (2012). The sample country include Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and United Kindom. Bond yields for Crisis dummy are from ECB Database. Standard errors are heteroscedasticity-robust and clustered at the bank level. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Dependent Variable: Domestic Portion			
	[1]	[2]	[3]
ResidentBank*Crisis	0.1246*	0.1391**	0.1391**
Crisis	-0.0739*	-0.0812*	
Fixed Effects			
Country	YES	YES	
Time	YES		
Creditor	YES		
*Time*Country*			YES
*Time*Creditor*		YES	YES
Clustering	Country	Country	Country
N	604	604	604
Adj. R-Squared	0.39	0.37	0.37

Table 5.9. Main results with Eurozone Banks only.

This table summarizes the results of previous regressions but using a sub-sample – including only Eurozone banks. All definitions of variables and regression settings remain the same, please see previous tables for details. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Dependent Variable	SovPortion	DebtPortion	SovPortion		PrivatePortion		DomesticPortion
Table	3	4	6A	7A	6B	7B	8
Domestic	0.1049***		0.1049***	0.1048***	0.1363***	0.1364***	
Domestic*Crisis	0.1242***	0.1585***	0.1184***		0.1121*		
Domestic*Sovereign		0.1097***					
Domestic*Retail		0.1343***					
Domestic*Crisis*Sovereign		-0.0414					
Domestic*Crisis*Public			0.0377		-0.0738		
Crisis*StressedBank				0.0060**		-0.0145	
Domestic*Crisis*StressedBank				0.1198***		0.1123*	
ResidentBank*Crisis							0.1211*
Fixed Effects							
*ExpoCountry*Time*	YES	YES	YES	YES	YES	YES	
*Bank*Time*	YES	YES	YES	YES	YES	YES	
Sector		YES					
*Time*Country*							YES
*Time*Creditor*							YES
Clustering	Bank	Bank	Bank	Bank	Bank	Bank	Country
N	25893	30587	25893	25893	4694	4694	548
Adj. R-Squared	0.28	0.33	0.28	0.28	0.75	0.75	0.78

Table 5.10. Main results without Greek Exposures.

This table summarizes the results of previous regressions but using a sub-sample – excluding all sample banks' exposure to Greece. All definitions of variables and regression settings remain the same, please see previous tables for details. ***, **, and * indicate significance at the 1, 5 and 10 percent levels, respectively.

Dependent Variable	SovPortion	DebtPortion	SovPortion		PrivatePortion		DomesticPortion
Table	3	4	6A	7A	6B	7B	8
Domestic	0.1203***		0.1203***	0.1203***	0.1536***	0.1536***	
Domestic*Crisis	0.1133***	0.1582*	0.1049**		0.1608*		
Domestic*Sovereign		0.1253***					
Domestic*Retail		0.1458***					
Domestic*Crisis*Sovereign		-0.0500					
Domestic*Crisis*Public			0.0368		-0.1392		
Crisis*StressedBank				0.0079**		0.0030	
Domestic*Crisis*StressedBank				0.1077***		0.1093*	
ResidentBank*Crisis							0.1016
Fixed Effects							
*ExpoCountry*Time*	YES	YES	YES	YES	YES	YES	
*Bank*Time*	YES	YES	YES	YES	YES	YES	
Sector		YES					
*Time*Country*							YES
*Time*Creditor*							YES
Clustering	Bank	Bank	Bank	Bank	Bank	Bank	Country
N	30276	35808	30276	30276	5532	5532	548
Adj. R-Squared	0.25	0.30	0.25	0.25	0.70	0.70	0.81

Appendix C

Table C.1 Summary of sovereign bond spreads.

This table summarize the 10-year government bond spread (vs. Germany) of Eurozone countries for the 13 time-point covered by the EBA dataset. Each figure of bond spread is the average daily bond spreads for the previous three months and it is presented in basis point.

	2010Q1	2010Q4	2011Q4	2012Q2	2012Q4	2013Q2
Austria	47	49	119	112	51	47
Belgium	53	96	253	191	91	84
Cyprus	142	200	507	558	563	566
Germany	0	0	0	0	0	0
Spain	76	211	373	475	419	316
Finland	20	28	59	49	31	32
France	31	42	125	135	74	62
Greece (GR)	306	844	1710	2398	1479	890
Ireland	152	510	650	561	331	242
Italy	85	160	468	437	341	287
Lithuania	364	255	342	377	277	234
Luxembourg	51	40	38	57	15	21
Latvia	946	600	383	369	199	180
Malta	126	155	241	282	257	200
Netherlands	22	25	50	64	29	44
Portugal	117	390	1030	997	654	463
Slovenia	75	122	424	397	413	455
Slovakia	89	125	282	338	272	132

Table C.1 Continued

	2013Q4	2014Q4	2015Q2	2015Q4	2016Q2	2016Q4	2017Q2
Austria	40	26	20	31	28	27	29
Belgium	73	35	34	33	43	34	45
Cyprus	425	530	413	331	382	332	276
Germany	0	0	0	0	0	0	0
Spain	240	129	128	118	145	117	127
Finland	26	23	18	30	33	20	21
France	58	41	35	36	39	44	51
Greece (GR)	686	723	1097	728	812	739	584
Ireland	181	84	72	59	74	58	54
Italy	241	153	130	109	139	161	190
Lithuania	215	141	50	104	93	16	4
Luxembourg	34	6	-11	-25	20	10	26
Latvia	196	116	36	58	45	40	61
Malta	146	138	99	79	91	60	108
Netherlands	39	21	21	20	26	18	26
Portugal	437	235	191	196	308	338	307
Slovenia	414	173	110	116	130	68	68
Slovakia	125	63	52	20	44	57	71

Table C.2 List of State-Owned Banks

Bank Name	Bankscope ID	Country
ABN AMRO Bank NV	11581	NL
BPIFrance Financement SA	12990	FR
Bayerische Landesbank	13109	DE
Norddeutsche Landesbank Girozentrale NORD/LB	13584	DE
Portigon AG	14021	DE
Hypo Real Estate Holding AG	16697	DE
NRW.BANK	19856	DE
Allied Irish Banks plc	20103	IE
Banca Monte dei Paschi di Siena SpA-Gruppo Monte dei Paschi di Siena	21413	IT
Banque et Caisse d'Epargne de l'Etat Luxembourg	22057	LU
SNS Bank N.V.	22324	NL
Caixa Geral de Depositos	22529	PT
Royal Bank of Scotland Group Plc (The)	24762	GB
KfW Ipex-Bank Gmbh	27782	DE
La Banque Postale	29070	FR
Bank Ochrony Srodowiska SA - BOS SA-Bank Ochrony Srodowiska Capital Group	42453	PL
Co-operative Central Bank Limited	43424	CY
Dexia SA	45621	BE
Permanent TSB Plc	48505	IE
Landeskreditbank Baden-Wuerttemberg - Förderbank-L-Bank	48901	DE

Chapter 6 Conclusions and Further Research

6.1 Concluding Remarks

This dissertation contributes to the literature in the areas of financial stability and bank regulation, with particular attention to the impact of the European sovereign debt crisis. Specifically, I examined three related topics: (1) small banks' resilience during the European debt crisis, which may provide a hint of how to reshape financial institutions to increase financial stability; (2) banks' regulatory capital arbitrage behaviour during the crisis, which may explain why some banks were more vulnerable during the crisis; (3) and home bias in banks' asset reallocation, which is closely related to the fragmentation of the European financial market. Although financial crises have repeated themselves throughout history and have been widely studied, the recent European sovereign debt crisis has many new features that stem from financial innovations, market developments, and the evolution of financial regulation. Research studies, including this dissertation, that incorporate new features of the recent crises, provide more informative insight to policymakers and contribute to financial stability.

In Chapter 3, I explored the question of whether small banks were more resilient during the European sovereign debt crisis than large banks. The relationship between the size of banks and financial stability has also aroused decades of debate; I extended the study to the context of the European debt crisis. I studied this topic by focusing on one of the most important activities of banks, that is, lending to the real economy (the non-financial private sector), and explored how this was affected by another crucial activity of European banks during the European sovereign debt crisis: their holdings of sovereign debt. In comparing the impact of banks' sovereign exposure to lending to the private sector for large and small banks, I find that small banks do not substitute private loans with public debt, that is, they are not subject to the substitution effect, while large banks are. Noticeably, the absence of the substitution effect is not necessarily due to small banks' low exposure to sovereign debt. I show that small banks from peripheral European countries have a much higher share of sovereign exposure in their portfolios compared to large banks. I show that small banks are less pro-cyclical in terms of lending, that is, they exhibit more stable lending behaviour during both good and bad times. Furthermore, small banks that have adequate capital and customers with high creditworthiness are more likely to increase both sovereign bond exposure and loans to the private sector. Such results suggest that new regulations that aims to increase banks' capital ratios and to lower leverage should not necessarily cause a contraction in lending as is argued by critics of the new rules.

In Chapter 4, I explored model-based capital regulation among European banks and attempted to find evidence of regulatory misconduct. Unlike previous studies, I explored related issues at the exposure-country level of each bank rather than merely at the bank level. Therefore, I am able not only to distinguish banks from core and peripheral European countries, but also to identify specific features of these banks' exposure to financially distressed countries. I find that regulatory arbitrage by means of strategic risk modelling primarily concerns banks from Eurozone peripheral countries, especially those with less than adequate tier 1 capital.

In contrast, banks from Eurozone core countries are more cautious when applying the IRB approach. This may explain why the peripheral banks were more vulnerable during the European sovereign debt crisis. Apart from strategic risk modelling, I also show that peripheral banks may game regulatory capital by strategically choosing not to use the IRB approach for certain exposures, that is, so-called cherry-picking. In particular, I show that peripheral banks make significantly less use of the model-based approach for exposure to the public sector because they may obtain a very low value for the risk calibration factor by adhering to the standardised approach. I read this behaviour as a combined result of moral suasion by governments and yield-seeking from banks. In particular, governments of financially distressed countries require domestic banks to absorb their new debt issuance, and these banks have the incentive to improve their regulatory capital ratio as well as seeking yield. Thus, this phenomenon may greatly contribute to the sovereign–bank diabolic loop that has caused serious financial stress in recent years. The principal findings of this chapter may have crucial policy implications. First, they support the concerns raised in recent regulatory proposals (EBA, 2016). In particular, the use of the IRB approach should be carefully granted and closely supervised. In addition, the (permanent) partial use of the IRB approach should be limited so that both strategic IRB modelling and cherry-picking can be properly confined. More importantly, this is in line with BCBS (2017), which aims to constrain the use of the IRB approach (e.g. input and output floors, an extra capital buffer on global systemically important banks, removing advanced IRB for certain asset classes, etc.) and to promote the standardised approach by improving its granularity.

In Chapter 5, I examined the causes of strong home bias in the sovereign debt portfolios of European banks during the Eurozone crisis. I find that for the sovereign debt of a particular country, the share of foreign creditors, non-bank domestic creditors, and domestic banks, decreased, was unchanged, and increased, respectively. Moreover, unlike previous studies that have focused only on sovereign debt portfolios, I also reviewed banks' holdings of private sector debt. Interestingly, I find stronger home bias in bank's private sector exposure than in their sovereign debt exposure. More importantly, I show that state-owned banks have stronger home bias in sovereign debt portfolios than do private banks, while private banks have stronger home bias in private debt portfolios. With these empirical findings, I argue that home bias in banks' sovereign debt portfolios can be best explained by moral suasion theory; that is, financial distressed governments may (implicitly and/or explicitly) request domestic large banks over which they have the most jurisdiction, to absorb their new debt issuance to alleviate financing pressure. Such results also have important policy implications. Governments may influence the investment decisions of domestic banks through direct ownership, which may essentially impede the integration of European financial market. This is because one of the fundamental conditions for a fully integrated market is that all potential market participants should be treated equally when they are active in the market

(ECB 2017)[49]. Moreover, many papers argue that banks' excessive holdings of sovereign debt is a key ingredient in forming the sovereign–bank diabolic loop (Cooper and Nikolov 2013; Acharya et al. 2014; Brunnermeier et al. 2016; Farhi and Tirole 2018). This chapter identifies a crucial factor, moral suasion, that significantly contributes to banks' excessive holdings of sovereign debt. This implies that minimising the chances for moral suasion can be particularly important in solving the deadly loop between sovereigns and banks.

6.2 Suggestions for Future Research

There are various ways to further develop the findings presented in this dissertation. I briefly mention some potentially interesting directions that could expand the study and provide additional contributions to the literature.

In Chapter 3, I investigated the impact of banks' sovereign debt exposure on banks' aggregated lending to the non-financial private sector and compared the difference of such impact for large and small banks. An obvious extension may be breaking down bank lending into specific sectors, for example, large corporate lending versus small and medium enterprises. Thereby, one could further explore the potential comparative advantages or disadvantages for small banks for different lending activities in the context of European sovereign debt crisis. In Chapter 4, I attempted to identify regulatory capital arbitrage behaviour in European banks and

[49] Financial Integration in Europe.
https://www.ecb.europa.eu/pub/pdf/other/ecb.financialintegrationineurope201705.en.pdf

find that it more concerns banks from peripheral countries. As Basel III will be implemented soon, it would be interesting to test, using similar methods, whether regulatory capital arbitrage is better controlled under the new regulations. In addition, it may be interesting to explore regulatory arbitrage behaviour in emerging markets, including China and India, and to investigate whether they share common features with the developed economies or have distinct characteristics. In Chapter 5, I argued that the banks' home bias in their sovereign debt portfolios is mainly driven by moral suasion. However, I have not found a very clear explanation for banks' home bias in their private sector exposure. This unexplained part of information friction theory may warrant further discussion as banks may have better knowledge of their local market.

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