FACULTEIT ECONOMIE
EN BEDRIJFSKUNDE

Sovereign Yields & Bank Stock Return Volatility

The Impact of Changes in Sovereign Yields on Domestic Bank Stock Return Volatility in the Euro Area

Aantal woorden/ word count: 18.654

Stephen Amant
Stamnummer/ Student number: 01205352

Promotor/ Supervisor: Prof. dr. Rudi Vander Vennet
Co-promotor/ Co-supervisor: Thomas Present

Masterproef voorgedragen tot het bekomen van de graad van:
Master's Dissertation submitted to obtain the degree of:

Master of Science in Business Engineering

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Stephen Amant

Signature:

Preface

This thesis marks the conclusion of my education at Ghent University in order to obtain the degree of Master of Science in Business Engineering: Finance. As a result of the continuous efforts and devotion of my professors and the academic staff of Ghent University, I am proud to conclude my academic career at this wonderful institution.

I am first and foremost grateful to Prof. dr. Rudi Vander Vennet and Thomas Present. They have guided me through this thesis and were always available for questions, feedback and advice. This thesis would not have been possible without their extensive guidance and help. On a personal note, I would like to thank my parents, who gave me every opportunity, and my roommates, who were always available for advice and accompanied me during my career at Ghent University.

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LIST OF ABBREVIATIONS

EBA	European Banking Authority
ECB	European Central Bank
ESRB	European Systemic Risk Board
EU	European Union
FE	Fixed Effects
FSD	Forward Standard Deviation
GDP	Gross Domestic Products
GIIPS	Greece, Ireland, Italy, Portugal and Spain
HB	Home Bias
HHI	Herfindahl-Hirschman Index
IIPS	Ireland, Italy, Portugal and Spain
LM	Lagrange Multiplier
LR	Likelihood Ratio
LSDV	Least Squared Dummy Variable
MRI	Market Return Index
OLS	Ordinary Least Squared
PSD	Past Standard Deviation
QE	Quantitative Easing
RE	Random Effects
REM	Random Effects Model
RI	Return Index
RWA	Risk Weighted Assets
SY	Sovereign Yield
ZY	Zero Yield

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1 INTRODUCTION

The sovereign crisis in the euro area received a great deal of attention from European policy makers and the European Central Bank (ECB). For the better part of a decade, the crisis caused widespread instability and uncertainty in European financial markets and sovereign finances. Mainly the division between the core countries and the periphery countries was and still is a focal point in the sovereign crisis discussion. Exemplified by the increasingly diverging interest rates on government bonds, the GIIPS countries (Greece, Italy, Ireland, Portugal and Spain) came under scrutiny due to their fiscal and budgetary policies, in contract to the more stable core countries (Austria, Belgium, France, Germany and the Netherlands). Although the entire European market was heavily influenced by the financial and sovereign crisis, this segmentation between both groups persisted throughout the crisis. Today, except for Greece, the most apparent differences between both groups eroded to comparatively normal levels.

Not only the sovereign yields increased significantly during the crisis, the financial markets – with special attention to financial institutions – were also severely impacted by the macro-economic conditions. As the majority of European banks were already under duress due to the financial crisis that started in 2008, the increased vulnerability of the European sovereigns was cause for an extra burden on bank balances. It was due to this combination of factors that it was straightforward that a significant part of European banks was in financial troubles at one point in time. The financial markets were crippled and government action arose.

It was in these circumstances that several financial institutions received government aid to avoid bankruptcy. Not only the domestic banks itself profited from the government involvement, further contagion in both the country and the euro area was hampered to a certain degree. The phenomenon of bank bailouts was especially present in the GIIPS countries. In addition to these bailouts, a great number of banks received a so-called implicit subsidy from their government as to restore confidence in those banks and the banking sector in general. Implicit subsidies[1] allude to the benefits obtained by domestic banks due to the expectation in the market that the government will act as a lender of last resort – guaranteeing any exposure to the particular bank. This guarantee poses several problems in terms of moral hazard and competition between banks, as discussed in detail by Noss & Sowerbutts (2012).

Another problem with implicit subsidies is the fact that many banks were – as a return – implicitly obliged to record substantial amounts of domestic sovereign debt on their balance sheets. This is referred

1 Kloeck, A. (2014). Implicit subsidies in the EU banking sector. An Intermediary Report which is Part of the Forthcoming Study: “Banking Structural Reforms: A Green Perspective”, Study commissioned by the Greens/EFA group in the European parliament.

to in literature as the moral suasion hypothesis. Empirical evidence supports the premise that banks that have received government funds will hold significant more sovereign bonds in comparison to banks that did not receive government aid. In the climate of the sovereign crisis, the moral suasion premise indicates that a bank will absorb more of their own governments debt when its respective risk profile changes in order to cope with decreased demand and to reduce sovereign bond yields as a result.[2]

Increased domestic sovereign exposures in times of economic downfall, in combination with in general proportionally elevated exposures to the own sovereign state due to the home bias hypothesis, creates a potentially dangerous environment in which banks incorporate sovereign debt driven by their government instead of their own needs and value- and risk assessments. In general, the home bias hypothesis[3] indicates that banks commonly invest more in domestic sovereign debt and investment instruments than those of other countries. In our specific case, the home bias hypothesis indicates that in the periphery, banks increase their domestic exposures when sovereign yields increase in contrast to the other euro area countries. Not only do banks increase their domestic sovereign exposures when country-specific risks increase, they will also increase their home bias in the event of a systemic risk increase. Since both systemic risk and country-specific risk rose during the crisis, the combination home bias-moral suasion enhanced the segmentation in the euro area bond market.

These findings are cause for concern in the European Union given the high degree of interconnectedness between member states on the one hand and between country and domestic banks on the other hand. The relation of sovereign yields, sovereign exposures and bank risk is therefore an interesting notion, given the interrelation of the aforementioned concepts.

In this paper, we investigate what the relation is between sovereign yields, sovereign exposures and bank stock return volatility. Considering the feedback effects between the government and the banks, we expect that an increase in the sovereign yields will result in an increased volatility in the nation's domestic bank stock returns due to the increased risk profile of the government bonds. We predict that this effect will be more pronounced in countries and banks were there is already cause for speculation.

[2] Ongena, S., Popov, A., & Van Horen, N. (2016). The invisible hand of the government: “Moral suasion” during the European sovereign debt crisis (ECB Working Paper No. 1937). Frankfurt: European Central Bank. Doi: 10.2866/876475

[3] Battistini, N., Pagano, M., & Simonelli, S. (2013). Systemic risk and home bias in the euro area (No. 494). Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

There are several reasons why we can expect an elevated volatility in bank stock returns contingent upon an increase in sovereign bonds yields:

(i) An increase in sovereign bond yields leads to a mark-to-market loss on the previous sovereign bonds. Due to the high exposures of banks, this results in a deterioration of the bank balance.

(ii) Reason for an increase in sovereign bond yields is often the raised doubt and speculation regarding the creditworthiness of the government.[4] This ensures that there are fewer resources available to support banks in need. We expect this to be a factor especially in the GIIPS countries.

(iii) When the aggregate risk factor of countries increased during the crisis, countries with large banking sectors tend to have an increase in sovereign yields.[5] Although this effect works the other way around, it can influence both the government yields as it can affect the volatility of stock returns of banks.

During this paper we will examine the channels through which this relationship has its impact, the extent of this impact and we will make policy recommendations to maintain these feedback effects between bank and sovereign state within bounds.

The paper proceeds as follows. In section 2 we will discuss some related literature in order to outline the context in which this study took place. Next, we will discuss the relevancy of sovereign bond exposures, sovereign yields and bank stock return volatility in the euro area. The methodology used in this paper is stipulated in section 4, whereas the data utilized is discussed thoroughly in the subsequent section. In section 6 we will review the results of our study, finally coming to the conclusions of the research in the seventh and last section.

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[4] David Haugh, Patrice Ollivaud and David Turner argue that an increase in illiquidity will significantly increase sovereign bond yields due to an inflated risk premium. (David Haugh Patrice Ollivaud and David Turner, 2009, What Drives Sovereign Risk Premiums?)

[5] The size and equity ratios of a countries banking sector are significant determinants of sovereign spreads in times of an increased aggregate risk factor. During periods of risk-aversion, the banking sector turns into a systematically relevant risk factor, which is reflected in the sovereign bond yields. (Stefan Gerlach, Alexander Schulz, Guntram B. Wolff, 2010, Banking and Sovereign Risk in the Euro Area)

2 RELATED LITERATURE

2.1 SOVEREIGN EXPOSURES OF BANKS

The research conducted during this paper is closely related to the research done by V. Acharya and S. Steffen in the paper 'The "greatest" carry trade ever? Understanding eurozone bank risks" (2014). In this paper, Acharya and Steffen show that during the eurozone banking crisis the behaviour of the European banks can be addressed as carry trade behaviour. Carry trade behaviour implies that a financial institution borrows at a cheap or decreased interest rate while lending at an expensive rate. In the case of European banks in the sovereign debt crisis, banks took long positions in long-term GIIPS bonds, funding these positions by using their access to short-term funding in the market, mainly through the wholesale markets. Under normal circumstances, this is a profitable strategy if the short-term funding remains cheap and readily available, and if the long-term positions remain safe and high-yielding.

At the onset of the financial and later sovereign crisis, the financial markets underwent certain changes. Several European banks defaulted, were acquired or nationalized (ABN AMRO, Fortis, Dexia, Bankia, etc.), effectively changing the financial landscape of the eurozone. Considering the high degree of involvement of the sovereign states, combined with the remarks surrounding the national finances, this created a feeble situation in the European market. Notwithstanding, since the market sentiment regarding the euro area was positive, the overall opinion on the sovereign bonds was that the yields on eurozone countries would converge. Through the unification of the market at the European level, as well as the political, social and economic importance of the European market, many assumed that it was only a matter of time before the situation normalized. The risk of default of both banks and sovereign would decrease, lowering the sovereign yields.

However, during the sovereign debt crisis, the environment did not evolve as anticipated. Both conditions, available, cheap short-term funding and safe, high-yielding bond positions, were infringed. Due to the macro-economic distrust between banks and sovereigns on the one hand and between banks internally on the other hand, short-term funding became increasingly difficult to obtain. Increasing interest rates and general unavailability of funding resulted in the decrease of the net interest margin of banks. In combination with the default of various long-term GIIPS bonds or highly elevated risk on these bonds, rendering the market value of the bonds almost non-existent, this completely nullified the remaining net interest margin on the carry trade.

Acharya and Steffen prove that European banks entered the first capital exercises with substantial exposures to GIIPS sovereign bonds, maintaining their high exposure until June 2012 when the sovereign crisis was already ongoing. European banks actively managed their bond portfolios by investing in and increasing their exposure to high-risk, high-yielding GIIPS bonds, while going short on less profitable yet safer German bunds in order to fund their long positions. Next to confirming the existence of carry trade behaviour in European banks, Acharya and Steffen analyse three possible channels through which the carry trade behaviour can be explained; (1) the home bias hypotheses, (2) moral suasion hypotheses and (3) the regulatory incentives of undercapitalized banks during the crisis.

The first explanation, the home bias hypotheses, indicates that on average banks will invest more in sovereign bonds of their home country compared to sovereign bonds of other European countries. The home bias has been empirically proven by L. Tesar[6] and more specifically relevant to the eurozone situation, by Niccolò Battistini, Marco Pagano, Saverio Simonelli[7]. The moral suasion hypotheses suggests that banks who have received any form of financial aid by their respective government are more inclined to increase their exposure to their sovereign state, compared to banks who did not receive any government funding. This motive is often expected or even required by the government, especially when the respective government experiences financial issues.

The third and final channel of the carry trade behaviour, the regulatory incentives, suggests that (riskier) banks invest more in high-yielding sovereign bonds due to two reasons; since the banks are undercapitalized, have a high short-term leverage and/or have high risk-weighted assets, investment possibilities in risky assets with higher yields are limited since the Basel II framework sets boundaries to the minimum capital ratio. Tier 1 capital is the central concept in Basel II, and is used in the following formula:

$$Tier\ 1\ Capital\ Ratio\ = \frac{Tier\ 1\ Capital}{Risk\ Weighted\ Assets\ (RWA)}$$

The tier 1 capital includes the bank's equity and disclosed reserves. Risk weighted assets (RWA) is the sum of the risk-adjusted assets of the bank. Each asset is classified under a pre-defined risk-class as indicated by the European Banking Authority (EBA). Secondly, due to the Basel II regulations, sovereign bonds received a 0% risk weight, making that exposures to even the worst-performing European sovereigns did not count against the total risk-weighted assets. Investments in these bonds thus increased the bank's capital/RWA ratio, while still receiving a considerable yield on the investments. This explanation, which is effectively a form of moral hazard, was also present in the motivation of euro area banks during the sovereign crisis.

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[6] Tesar, L. L., & Werner, I. M. (1995). Home bias and high turnover. Journal of International Money and Finance, 14(4), 467-492

[7] Battistini, N., Pagano, M., & Simonelli, S. (2013). Systemic risk and home bias in the euro area (No. 494). Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

In ‘Bank, Government Bonds, and Default: What do the Data Say?’, N. Gennaioli, A. Martin and S. Rossi investigate the underlying patterns and motives of banks’ sovereign bond holdings and whether these bond holdings affect banks’ lending behaviour in the private market. Specifically, the research and findings regarding the evolution of banks’ holding of government bonds during sovereign defaults are relevant to this paper.

The findings of this research can be summarized into three main conclusions; (1) banks hold a significant portion of their assets in sovereign bonds, mainly in bonds of their own sovereign state and particularly in less financially developed countries. On average, 9% of total assets are sovereign bonds. Secondly, during periods of sovereign distress or default, banks increase their investments in sovereign bonds by on average 1% of total assets. Although this increase is concentrated among larger and more profitable banks, this finding indicates that during sovereign crises banks pursue investments in sovereign bonds due to one or more reasons cited in the research of V. Acharya and S. Steffen[8]. Lastly, the paper concluded that the correlation between sovereign bond-holdings of a bank and its future loans in the private market is positive during normal times, but is inverse during adverse situations like sovereign defaults.

Although it may seem irrelevant to this paper, the conclusion of Gennaiolo, Martin and Rossi bears more relevancy than one would initially expect. Due to the important position of bank lending in most countries, changes in the lending behaviour of banks severely impacts the consumption and investments in a country’s real economy. If banks decide to lend less to companies and households, the economy (Gross Domestic Product, GDP) will be negatively impacted, thereby influencing the government’s tax returns. In a situation where a government is already under heavy duress, decreased government income could force a vicious circle, making it increasingly difficult for the governing body to stabilize government finances.

[8] Acharya, V. V., & Steffen, S. (2015). The “greatest” carry trade ever? Understanding eurozone bank risks. Journal of Financial Economics, 115(2), 215-236.

2.2 HOME BIAS

The paper 'Systemic Risk and Home Bias in the Euro Area', carried out by N. Battistini, M. Pagano and S. Simonelli as part of the Staff of the Directorate-General for Economic and Financial Affairs of the European Commission, focuses on the diverging debt market in the euro area during the sovereign crisis. According to the researchers, the conventional price-based measures of market segmentation, as used to investigate the differences between the core and periphery countries up to now, are inappropriate when solvency risk differs across countries in the sample. In the event of solvency risk differences, sovereign yields should automatically differ across these countries. These differences are thus not a proxy for segmentation, rather they are a reward for the issuer's credit risk. Next to the segmentation of the euro area market, they also investigate the relation between the home bias of banks' sovereign portfolios and yield differentials of sovereign bonds.

During their investigation, Battistini, Pagano and Simonelli found that when common-risk components increased, both core and periphery countries increase domestic exposures, confirming the home bias hypotheses (1). When country-specific risk components increase, banks in periphery countries react by increasing their domestic exposures. Banks in core countries however are not affected by the home bias (2). Finding (1) indicates that when systemic risk increases, banks from all countries ten to increase their home bias, while finding (2) suggests that there are differences in incentives between periphery and core countries banks when country-specific risk changes, illustrating the euro area market segmentation between the core and periphery banks.

The researches quote three reasons why the home bias during the sovereign crisis is expected. First, periphery countries may exert "moral suasion" on domestic banks. Governments are known for pressuring domestic banks into taking actions in line with the policies put in place by the government. As a reciprocal service for the financial assistance in the case of bailed-out banks especially, governments expect increased exposures to domestic sovereign bonds when demand is low and thus when increased sovereign yields afflict public finances. Secondly, as indicated by Acharya and Steffen[9], undercapitalized banks may bet on the survival of the euro area, engaging in carry trades in order to avoid a decreased capital on risk weighted assets ratio while still receiving a considerable return on investment. Thirdly, the researchers quote that in the event of a collapse of the euro, banks with considerable domestic sovereign exposures would experience a comparative advantage since the liabilities would de redenominated into new national currencies. Higher domestic exposures would mean a better hedged position against devaluation of the national currency versus other euro area currencies.

[9] Acharya, V. V., & Steffen, S. (2015). The "greatest" carry trade ever? Understanding eurozone bank risks. Journal of Financial Economics, 115(2), 215-236.

The above-mentioned reasons – the moral suasion, carry-trade and comparative advantage hypothesis – all indicate that the home bias in banks' sovereign bonds portfolios should be positively correlated with sovereign yield differentials. The moral suasion and carry-trade hypothesis suggest this correlation to be valid in the case of both country-specific and systemic risk changes; while the comparative advantage hypothesis only holds up in the case of changes in country-specific risk changes, not being affected by changes in systemic risk.

2.3 SOVEREIGNS AND BANK STOCK RETURNS

G. Kaminsky and S. Schmukler investigated the relationship between sovereign ratings, country risk and stock returns of companies with their headquarters in the respective country. During their research, they also found some very interesting features of the current financial markets. Although the research was conducted in 2001, the conclusions are still relevant today.

The results of the paper most relevant to our research can be split into four components. The first and most important conclusion is that in the case of a domestic downgrade, yield spreads of the downgraded country increase and that the stock returns of companies residing in the country decrease. Not only the actual ratings themselves, but outlook changes also have an impact on both yields and stock returns. Secondly, rating changes not only impact the graded country, but due to a series of spill-over or contagion effects, they also trigger changes in yield spreads and stock return in other emerging countries. Especially at the regional level these spill-over effects seem to be significant.

Thirdly, in the event of a downgrade of sovereign bonds, companies listed on the stock market can be adversely affected due to a possible increase in taxes as to neutralize the budgetary effects of higher interest rate. This indirect effect of a downgrade of sovereign bonds can have a serious impact on the stock return of companies since the possibility of higher taxes increases uncertainty concerning the profitability of the firms. These effects are also called 'cross-asset effects', since the impact of an event on one asset can affect another asset as well.

Lastly, it is shown that certain policies inserted by a governing body can significantly alter the volatility of a country's financial markets. Moral hazard inducing policies like bailouts by both national or international governments or institutions can lead to elevated financial volatility.

In the working paper 'Bank exposures and sovereign stress transmission', issued by the European Systemic Risk Board (ESRB), researchers conduct an investigation regarding the causes and effects of bank's sovereign exposures, both during and after the euro crisis. The results obtained by C. Altavilla, M. Pagano and S. Simonelli are highly relevant to the research in this thesis. Three conclusions can be made.

Firstly, consistently with the moral suasion hypothesis, domestic publicly-owned and recently bailed-out banks in stressed euro area countries tend to have significant larger domestic sovereign bonds positions than other banks. The connection with their government is most likely to explain this difference across countries. Secondly, banks in the periphery exposed to elevated positions to domestic bonds experience larger increases in solvency risk, reductions in loans and higher lending rates than other, less exposed banks. Finally, their research confirms the direction of causality between sovereign exposures and bank lending. Although in theory the causality could run from banks' loans to their sovereign holdings rather than reverse, in reality sovereign distress impacts loan demand and supply.

Overall, we can conclude that the domestic sovereign exposures of banks in the periphery emphasize the impact of the sovereign crisis during the period of 2007-2015. It is due to these increased exposures that the volatility of bank risk and lending in the periphery escalated. These findings are in accordance with the research by Archarya and Steffen which shows that sovereign exposures are responsible for the relation between downward repricing of sovereign debt and bank balance losses, increasing possibility of sovereign default and thereby validating the original downward repricing of the debt in the first place.

2.4 SOVEREIGN YIELD SPREADS IN THE EURO AREA

In 'Banking and Sovereign Risk in the Euro Area', S. Gerlach, A. Schulz and G. Wolff study the determinants of sovereign yield spreads in the eurozone. Although they investigate the determinants since the introduction of the euro, the main focus during this research is the evolution of the bond yield spreads during the sovereign crisis.

Under normal circumstances, a strong and well-developed banking sector is an important source of government revenue, economic growth and stability. Therefore, a strong banking sector leads to a reduction in sovereign spreads since it contributes to government revenues, facilitates private consumption and investments, and increases the competitiveness of domestic companies. It is under these conditions that the probability of governments having to intervene and support banks is deemed unlikely.

However, from the onset of the financial crisis in 2008, nearly all governments in the euro area provided major auxiliary packages to their domestic financial institutions. Both explicit aid in the form of recapitalization and financial guarantees as implicit guarantees were made in order to dispel the distrust in the financial markets. It is this evolution that has ensured that the banking sector, in addition to its current role in the real economy, claimed an even more important position in a country's financial landscape. Rather than providing stability, large domestic banking sectors become a liability to governments. Not only large banking systems cause an increase in sovereign risk by undercutting government stability, undercapitalized banking sectors provoke similar effects.

Next to the banking sector size, Gerlach, Schulz and Wolff look at fiscal policy as conducted by the government and its effect on sovereign spreads. Although debt measured at annual frequency, starting point during the research, did not provide any significant impact on sovereign spreads, the effects of forecasted deficits were however highly significant.

3 SOVEREIGN YIELDS & EXPOSURES IN THE EU

Since the onset of the sovereign crisis in 2010, interest rates on sovereign bonds became a topic of discussion at the European Central Bank (ECB). The diverging sovereign yields between the countries in the periphery and those of the core were so tangible at a certain moment in time, that the ECB was forced to intervene in order to avoid bankruptcy of their member states, bank runs at certain banks and the collapse of the European banking system as a whole. It was at the height of the sovereign crisis in mid-2012 that Mario Draghi – president of the ECB – promised to take thorough action to prevent further aggravation. With the words *"Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough"*, Draghi reassured governments and financial markets concerning the future of the euro, thereby relieving stress on most banks.

The impact of Draghi's speech is not to be underestimated. As can be seen in Figure B-1, sovereign yields – except for the Greek bonds – dropped significantly in the subsequent weeks and months. The yields on Greek bonds followed suit several months later due to the severe condition of the Greek public finances. After being close to bankrupt several times, Greece has finally come to the forefront of financial difficulties through the help of the ECB, the European Union and individual member states.

The main tools of the European Central Bank in the onslaught of the sovereign crisis were and still are the Quantitative Easing (QE) programmes. Quantitative easing can be defined as "an increase in the size of the balance sheet of the central bank through an increase it is monetary liabilities (base money), holding constant the composition of its assets. An almost equivalent definition would be that quantitative easing is an increase in the size of the balance sheet of the central bank through an increase in its monetary liabilities that holds constant the (average) liquidity and riskiness of its asset portfolio."[10] Put into practice, the ECB bought covered sovereign bonds from banks, effectively creating money and liquidity in the banking sector. The intended result was twofold; on the one hand, QE creates liquidity among banks. In the expectation that the increased liquidity would find his way downstream to loans to companies and households, the ECB intended to boost the real economy by stimulating investments and consumption. On the other hand, it was hoped that interest rate on bonds would fall due to the increased demand. As a direct result, governments are able to borrow cheaper.

This intended effect has yet another result; given the interconnectedness of government and domestic bank as mentioned above, decreased sovereign yields would have positive effects on the stability in the domestic banking sector. Severe mark-to-market losses are reduced due to the QE and the feedback effects, present between sovereign state and bank, are weakened. Since banks tend to have

[10] Buiter, W. (2008). Quantitative easing and qualitative easing: a terminological and taxonomic proposal. *Financial Times, Willem Buiter's mavercon blog*.

comparatively higher exposures to the home country, losses on these bonds would mean considerable losses on the entire sovereign bond portfolio. Also, due to the often-implied position as lender of last resort – as suggested by the implicit subsidies hypothesis – doubts regarding the repayment capabilities of a government affect the sentiment vis-à-vis the domestic banks, once these experience financial difficulties of any kind.

Not only banks are affected by the home bias hypothesis and its consequences, entire financial markets are strongly related to the domestic public finances. Since the sovereign crisis, a strong nexus has emerged between the credit risk in financial markets and the credit risk of their sovereigns. This relation has two causes; one being the under-capitalization of financial markets in the aftermath of the financial crisis in 2008, the other being the expectations of soon-to-be increased taxes due to the high sovereign debt, effectively crowding out incentives of the non-financial sector.

While the inclination to resolve the financial problems of domestic financial institutions is tempting, this results in the increase of the financial overhang related to sovereign debt. (Acharya, Drechsler & Schnabl, 2012) the reduction in growth prospects as a result of the increased sovereign debt and increased sovereign yields affects the risk profile of the domestic financial sector through direct bond holdings and indirectly through the implicit subsidies as discussed above. Acharya, Drechsler & Schnabl provide evidence for this nexus in the euro area during the sovereign crisis.

Considering all these findings, it is intelligible that sovereign yields, sovereign exposures and risk in financial markets are points of attention to the EBA and ECB. The home bias, moral hazard, moral suasion and implicit subsidy concepts are discussed in detail in academic research, but how these concepts are put into practice – specifically in the relation between sovereign yields and bank stock return volatility – is still unclear. During this paper, we intend to create a more clearer view on the relation between sovereign yields and the risk of domestic banks, while also investigating how sovereign exposures affect this relation.

4 METHODOLOGY AND EMPIRICAL APPROACH

During this dissertation, we will evaluate the behaviour of domestic bank stock returns when sovereign yields change. This relation is subject to certain differences in variables; the exposure to domestic sovereign bonds, the exposure to (other) GIIPS countries sovereign bonds, whether the bank is headquartered in one of the five GIIPS countries, and lastly, whether the bank has been bailed out by the domestic sovereign state.

In summary, the empirical research will focus on the following research questions:

(i) Are there differences in the way sovereign bond holding portfolios are composed between banks? Are there differences between core country banks, GIIPS country banks and control group banks?

(ii) To what extent did the sovereign crisis impact the sovereign bond holding portfolios of banks? Are there differences across certain types of banks? What was the role of the home bias hypothesis?

(iii) What is the impact of sovereign yield changes on bank stock return volatility?

In order to review the significance of the relation between stock return volatility and sovereign yields, we will assess the variables through regression analysis. As to gain greater insight in the first and second research question, we will use qualitative analysis rather than the quantitative analysis used for research question three.

4.1 QUALITATIVE ANALYSIS

Before we proceed to the regression analysis, we first have a closer look in the sovereign bond holding behaviour of banks. Assessing the sovereign bond portfolios, we obtain insight in how banks reacted during the sovereign crisis with special attention to the difference between core country banks and GIIPS country banks. The rationale behind this distinction is the assumption that GIIPS country banks tend to have larger exposures to their own sovereign states. Reasons for this assumption are the home bias, moral suasion and the moral hazard hypotheses.

Not only the relative position of the domestic exposure in the sovereign bond portfolio is discussed, also the evolution of domestic sovereign exposure on total assets and sovereign exposure on capital is determined. Sovereign bond portfolios have a different importance to different banks. If we assess the domestic sovereign exposure relative to the total assets and capital, we make sure that we account for these differences.

Next, we take a closer look to the sovereign exposure to GIIPS countries as a whole. In this way, we can evaluate whether certain banks or certain groups of banks were more exposed to devaluations on these sovereign bonds than others. The main motive for an increased GIIPS sovereign bond exposure is the carry trade hypothesis, as suggested by Acharya and Steffen (2014). Other motives may include moral hazard and regulatory incentives.

Hereafter we check the concentration in the sovereign bond portfolios. By calculating the Herfindahl–Hirschman Index[11] (HHI), we can detect heavily concentrated portfolios, implying increased relative exposures to certain countries. Again, in the situation of the GIIPS country banks, we expect this to be more of a problem considering the expectation of concentrated sovereign exposures to the domestic sovereign state. By performing the qualitative research, we expect to be able to confirm or reject the home bias, moral suasion and carry trade hypotheses.

After the introductory research as described above, we proceed with the quantitative analysis of the relation.

4.2 HIGH-FREQUENCY SOVEREIGN YIELDS AND STOCK RETURN VOLATILITY

We first assess the relation between sovereign yields and sovereign yield changes and the forward (ex-ante) stock return volatility on a weekly basis. Since high-frequency data of sovereign bond exposures on micro-level are not available, we cannot include this in the relation. Neglecting the sovereign bond exposures, we can however gain a first insight in how sovereign yields and bank stock return volatility are interrelated. The variables indicating if a bank has been bailed out by its government and whether the bank is part of the GIIPS banking sector can also be inserted in the relation. In summary, we investigate the following base equation:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t \quad (1)$$

In equation (1), $FSD_{i,t}$ is the forward standard deviation of bank *i* in time *t* as described in equation (25) in section 5.4.2 $SY_{c,t}$ is the average sovereign yield of country *c* – domestic country of bank *i* – as defined in equation (19), and MRI_t is the standard deviation of the market return indicator – being the STOXX Europe 600 banks index. Both these variables will return in all regressions performed during this research. Next we include the ex-post standard deviation variable in the equation.

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} \quad (2)$$

Lastly, we include the dummy variables D_G and D_{BO} in the regression.

[11] The Herfindahl-Hirschman Index (HHI), better known as the Herfindahl index, is a statistical measure of concentration originally designed to check to what extent a market is a monopoly. It is calculated by summing the squared market shares of each firm in an industry. In this study, we use the relative sovereign exposures as market shares. (An HHI of 0 indicates perfect competition, an HHI of 1 indicates an absolute monopoly)

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * D_G + \alpha_5 * D_{BO} \quad (3)$$

While D_G and D_{BO} are dummy variables, indicating whether the bank is headquartered in a GIIPS country (D_G) and whether it has been bailed-out (D_{BO}) respectively. The coefficient α_1 assesses the impact of sovereign yields on ex-ante volatility. Coefficient α_2 indicates the impact of the market volatility, α_3 measures the effect of the ex-post standard deviation, while coefficients α_4 and α_5 show the base forward volatility specifically attributed to the bank characteristics. The term α_0, the intercept in the regression, gives us the expected base volatility of the stock returns across all banks in the sample.

Alternatively, we use the variable $SY_{c,t}^{rel}$ – the yield spread compared to Germany – instead of $SY_{c,t}$. By changing this variable, we check whether the absolute sovereign yield impacts bank stock return volatility, or the relative difference with the European benchmark. This gives us the following regressions:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t \quad (4)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} \quad (5)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * D_G + \alpha_5 * D_{BO} \quad (6)$$

We will use a least squared dummy variable (LSDV) regression model in order to estimate these variables. The data used in these regressions ranges from start-2010 up to end-2016.

4.3 Sovereign exposures, yields and stock return volatility

Since high-frequency data of sovereign bonds exposures is not available on micro-level, we are limited in the number of observations to the moments at which data of sovereign bond exposures is accessible. All dates are depicted through means of timeline on Figure 4-1 below.

During the quantitative analysis we investigate the interaction between sovereign yields and bank stock return volatility, while also assessing the impact of the home bias exposure, exposure to (other) GIIPS countries and the features of the bank, being bailed-out or not and headquarter location. Since we will focus heavily on the distinction between core country banks and GIIPS country banks, we will conduct the quantitative analysis using two different procedures.

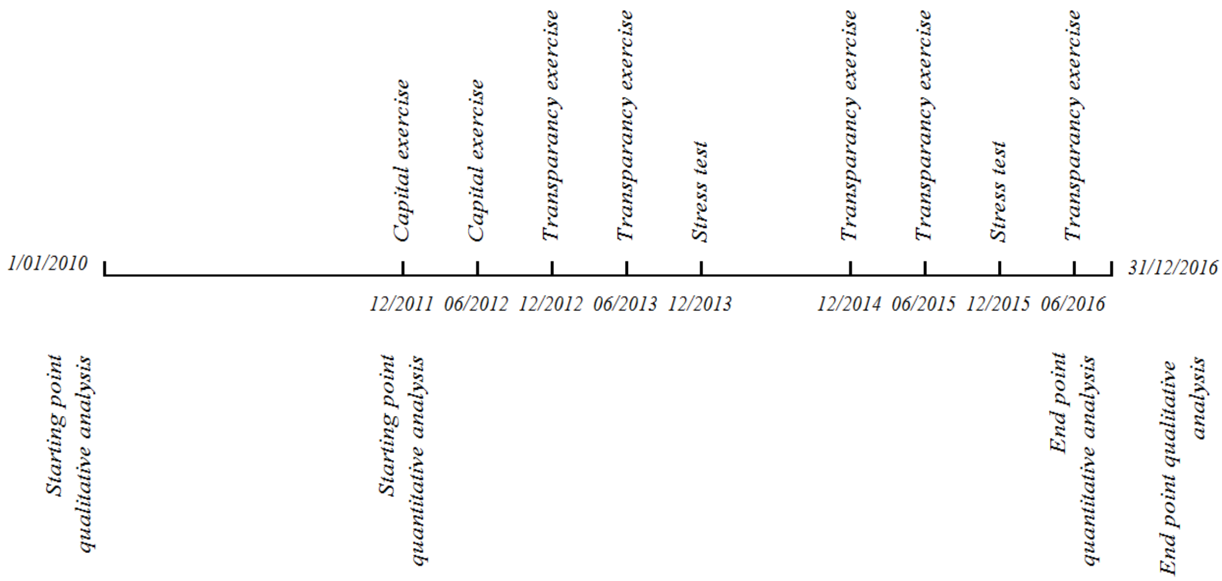


Figure 4-1: Timeline research

Firstly, we will use a pooled OLS regression model. In the pooled OLS regression model, we will simply pool all observations, neglecting bank features, and estimate an overall regression. Using this model we will ignore the cross-section nature of the data, meaning it will not inherently account for the differences in bank features. After the initial simple pooled OLS regression model, we will introduce dummy variable accounting for the differences in bank features. By using dummy variables, we do not only look at base differences in stock return volatility, we can also check whether certain variables are significant only in combination with bank features. We refer to this as the Fixed Effects Least Square Dummy Variable model (LSDV model). The LSDV provides us a between-group fixed effects model.

Thirdly, we will structure the data panel, allowing the use of a fixed or random effects model. Random and fixed effects models account for differences across banks rather than differences between groups. We refer to these models as within-group fixed effects models.

4.3.1 Pooled OLS regression model

In the pooled ordinary least squared (OLS) regression model, we combine time-series data of all banks into one general pool. The pooled OLS regression model assumes that the regression coefficients are identical for all banks, meaning they are equivalent for all groups as well. Given the fact that our data contains more cross-section units (banks) than temporal units, the pool we will use is conceptualized as cross-sectional dominant.

The generic pooled linear regression model estimable by the ordinary least squared (OLS) procedure is as follows:

$$y_{i,t} = \alpha_0 + \sum_{k=1}^{K} \alpha_k x_{kit} + e_{it}$$

Where $y_{i,t}$ is the dependent variable, x_{kit} is the explanatory variable, α_0 is the intercept, α_k are the coefficients associated with the explanatory variables and e_{it} is a random error. The terms *i* = 1, 2, …; N refers to the cross-sectional units and t = 1, 2, …; T refers to a time period. Lastly, k = 1, 2, …; K indicates specific explanatory variables.

Firstly, we will investigate whether the main variables – sovereign yield, market volatility and ex-post standard deviation – have a significant impact on the stock return volatility. Similarly to the regression discussed in the high-frequency research, the equations to be tested are as follows:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} \quad (7)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} \quad (8)$$

Unlike in the high-frequency research, we do not include the dummy-variables considering those will be implemented in the LSDV model below. The home bias and GIIPS exposures however are introduced in this section:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} + \alpha_5 * GIIPS_{i,t} \ (9)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} + \alpha_5 * GIIPS_{i,t} \ (10)$$

Where $HB_{i,t}$ is the home bias (HB) exposure and $GIIPS_{i,t}$ the GIIPS country exposure. As most GIIPS banks have high home bias exposures, their GIIPS exposure will automatically be high as well. In order to avoid multicollinearity within GIIPS banks, we introduce the dummy variable D_{CC}, being the reverse of D_G. By combining D_{CC} with $HB_{i,t}$, the home bias exposure is only effective when a non-GIIPS bank is evaluated:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} * D_{CC} + \alpha_5 * GIIPS_{i,t} \ (11)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} * D_{CC} + \alpha_5 * GIIPS_{i,t} \ (12)$$

Since we expect there to be fixed or random effects in the data, the OLS regression only provides an indicative estimation of the variables. After the OLS regression model, we will account for the fixed or random effects by means of a fixed effects least squared dummy variable (LSDV) regression model and within-group fixed effects (FE) or random effects (RE) regression model.

4.3.2 FIXED EFFECTS LEAST SQUARED DUMMY VARIABLE MODEL

The fixed effects least squared dummy variable model (LSDV) introduces dummy variables in the OLS regression model. By inserting dummy variables D_G and D_{BO}, we allow each cross-section group to have its own intercept. We will do this in all equations for the bailout dummy variable. The GIIPS dummy variable will only be used when GIIPS sovereign exposures are not included. The equations we will evaluate are the following:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_6 * D_G + \alpha_7 * D_{BO} \quad (13)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} + \alpha_5 * GIIPS_{i,t} + \alpha_7 * D_{BO} \quad (14)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} * D_{CC} + \alpha_5 * GIIPS_{i,t} + \alpha_7 * D_{BO} \quad (15)$$

With the yield spread instead of the absolute sovereign yield:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_6 * D_G + \alpha_7 * D_{BO} \quad (16)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} + \alpha_5 * GIIPS_{i,t} + \alpha_7 * D_{BO} \quad (17)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} * D_{CC} + \alpha_5 * GIIPS_{i,t} + \alpha_7 * D_{BO} \quad (18)$$

The LSDV model accounts for differences across groups, but does not take inherent differences across banks into consideration. Fixed and random effects regression models acknowledges these differences and enables each bank to have its own intercept.

4.3.3 FIXED AND RANDOM EFFECTS PANEL REGRESSION MODEL

Fixed effects within-group models allow variables to deviate from its mean value for all banks. In this way, the model accounts for differences across banks rather than differences across groups in the LSDV model. Random effects models (REM) consider the observations in the dataset as a subsection of possible values which one wishes to generalize to. (Newson, 2017) Considering we work with a subsample of all European banks, both fixed effects and random effects models could be useful – providing the data indicates the presence of one of these effects.

Using the Breusch-Pagan Lagrange Multiplier (LM) test, we check the data for omitted random and fixed effects. Afterwards, we use the redundant Likelihood Ratio (LR) and the Hausman test to examine whether we need a random or fixed effects model. Once we performed all tests, we can apply the appropriate model. Since dummy variables are not allowed in a random and fixed effects model, we will use the same equations as in section 4.3.1 (pooled OLS regression model). Base equations are as follows:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} \quad (7)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} \quad (8)$$

Including the home bias and GIIPS exposures:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} + \alpha_5 * GIIPS_{i,t} \ (9)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} + \alpha_5 * GIIPS_{i,t} \ (10)$$

Finally, accounting for the overlap between home bias exposures of GIIPS banks and their GIIPS exposure:

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} * D_{CC} + \alpha_5 * GIIPS_{i,t} \ (11)$$

$$FSD_{i,t} = \alpha_0 + \alpha_1 * SY_{c,t}^{rel} + \alpha_2 * MRI_t + \alpha_3 * PSD_{i,t} + \alpha_4 * HB_{i,t} * D_{CC} + \alpha_5 * GIIPS_{i,t} \ (12)$$

This will be our final and most conclusive model. The results of all models (pooled OLS, LSDV and random and fixed effects model) will be discussed in section 6.

5 DATA

5.1 BANK DATASET

To investigate the relation between sovereign yields and bank stock return volatilities, we construct an initial data set consisting of all publicly traded banks included in the stress tests and transparency tests conducted by the European Banking Authority (EBA). The stress tests and transparency tests are detailed analyses of banks in the euro area and non-euro area banks in order to assess and estimate how well banks react to sudden changes in bank-specific and macro-economic variables. During these tests, variables such as interest rate increases and drops in the Gross Domestic Product (GDP) are simulated as to evaluate the effect on the bank's balance sheet and to check the financial soundness of the financial institution. The reports on the tests were published in December 2011, June and December 2012, June and December 2013, December 2014, June and December 2015 and most recently June 2016. The most recent test (2016, transparency test) included 131 banks over 24 countries in the European Union. Aggregating all tests, 138 banks were evaluated in one or more tests or exercises.

Since we will focus on the stock return volatility of the banks, this requires that the shares of the banks are publicly traded. This is however not the case for all the banks evaluated during the stress and transparency tests.

Next to the shares being publicly traded, another requirement is that the banks in our sample must be assessed in all EBA stress and transparency tests. This is necessary in order to ensure representative data and to avoid including missing values in our dataset. This is important as we will work with panel data, as indicated in the previous section.

The last requirement for the dataset is that there should be information regarding the bank's sovereign exposures. This data is retrieved from the stress and transparency tests. Since a significant number of banks were not included in all tests, in addition to the fact that some of the banks are not publicly traded or did not survive the banking crisis, we can construct a dataset containing 33 banks divided over 15 countries in the European Union. Although a great deal of banks did not make the final dataset, the dataset itself contains banks from all core and periphery (GIIPS) countries, except for Greece. Even though Greek banks would provide us with interesting data, none of publicly traded banks has been assessed more than four out of the nine possible tests and exercises by the EBA. Due to this feature, none of the Greek banks provided enough data to be included in the final dataset.

Some of the most notable countries not included in the dataset are Luxembourg, Finland and Cyprus. Considering the fact that Cyprus can be regarded as a special case due to their government involvement in the banking sector, their economic adjustment programme and the financial sector reforms, the Cypriot banks would not have been representative. Luxembourg is not included given that none of the banks were assessed during all the tests. The only Finnish bank for which information regarding the sovereign exposures is available, OP-Pohjola Group, is not publicly traded, rendering the bank's information unusable. Other countries not included in the bank dataset are Bulgaria, Latvia, Poland, Romania and Slovenia. Since these countries possess only 1 or 2 banks (Slovenia), the omission of these countries will not affect the results of the research.

Although only 33 (23.91%) of the 138 banks are included in the dataset, these 33 banks account for 68.47% of the total exposure to sovereign bonds. Therefore we can conclude that even though we work with a relatively small sample, the banks included in the dataset are representative of the banking sector in the European Union.

A complete overview of banks included in our data sample is provided in Table A-1.

5.2 TIME FRAME

As previously mentioned, the time frame assessed during the course of this dissertation extends from begin 2010 up to the end of 2016 for the qualitative analysis and the high-frequency quantitative analysis, while we will evaluate the period December 2011 up to June 2016 for the quantitative analysis including the sovereign exposures. The first capital exercise conducted in 2011 marks the first year of the time range, while 2016 contains the most recent study on sovereign exposures. Although it would certainly be interesting to extend this study to the period before and during the start of the crisis, the lack of data regarding sovereign bond positions of banks limits us in the choice of time range.

An overview of the timeline is depicted on Figure 4-1in section 5.2.

5.3 DATA SOURCES

The data discussed and used during the course of this research is retrieved from multiple sources. The sovereign yields on government bonds were collected through the Datastream database. Although there are multiple sources of this kind of data, all with their advantages and disadvantages, the decision for Datastream has been made since Datastream provides a uniform reporting of the data and it offers a complete range of sovereign yields and stocks. Datastream is a database brought by Thomson Reuters[12] providing global statistics including financial and macro-economic information regarding companies, government bonds, currencies and various key economic indicators.

For the sovereign yields we will use the 10-year zero yields provided by Thomson Reuters. The appropriate Datastream code is TRXXZ10(ZY) where XX stands for the abbreviation of the respective

[12] Thomson Reuters is a Canada and United States based company active in the information and media business, specialized in financial information and reporting. It is regarded as one of the leading companies in financial reporting.

country. The stock returns will also be obtained through the Datastream database. Focus will be on the return index of the bank shares.

The return index (RI) of the bank shares includes the reinvestment of dividends, taking into account differences in dividends across banks. Using stock prices as the base for the research would omit these important differences, rendering us unable to cope with potential important asymmetries between banks.

The sovereign exposures of banks are deducted from the results of the periodic stress and transparency tests. In these results we find the exposures of the banks to all European and most non-European countries or groups of countries. For example, African and Middle Eastern countries are combined in the groups 'Africa' and 'Middle East' rather than each country separately, given the limited exposure of most European banks to those countries. An important remark can be made regarding the first 2 dates (capital exercises, December 2011 and June 2012); only exposures to European countries are available. However, the lack of information on the exposures to American, African, Asian and Australian sovereigns is no issue since the focus will be on exposures to the bank's own bank and the exposure to GIIPS countries. Since we will not discuss non-European banks, this lack of information is not relevant.

Another variable that will be evaluated in the course of this research is whether the bank has been bailed-out by its government or not. This will be done by including the 'bailed-out' dummy variable in the regressions. Information regarding the bank's history will be obtained through multiple sources; the bank's annual reports, ECB and EBA reports and various other sources. The relative size of the financial aid is of underlying importance.

5.4 VARIABLES

Main variables during this research will be the standard deviation of the stock returns, sovereign yields and yield spreads compared to the German bund yields, and sovereign exposures, particularly exposures to GIIPS countries and the home bias exposures. Next to these variables, we will also include a market volatility indicator, being the standard deviation of the STOXX Europe 600 banks index. Through this market indicator we will account for changes in macro-economic and general bank-related volatility. The ex-post standard deviation will also be included considering the existence of momentum effects in stock-return volatility (Lamoureux, C. G., & Lastrapes, W. D. (1994)). Lastly, we will include dummy variables during certain parts of the research as to make the distinction between GIIPS and non-GIIPS banks, bailed-out and non-bailout banks respectively.

In summary, we expect the variables to have the following impact on the standard deviations of bank stock returns:

Variable	Figure	Impact
Sovereign yield	$SY_{c,\ t}$	+
Yield spread	$SY_{c,t}^{rel}$	+
Market return indicator	MRI_t	+
Ex-post standard deviation	$PSD_{i,t}$	+
Home bias exposure	$HB_{i,t}$	+
GIIPS exposure	$GIIPS_{i,t}$	+
GIIPS dummy variable	D_G	+
Bailout dummy variable	D_{BO}	+

Table 5-1: Expected impact variables

Considering all variables included in this research are expected to have a positive relationship with the dependent variable – being forward standard deviation – we expect the intercept to be negative or zero.

In the remainder of this section we will discuss all variables in detail, give definitions and explain formulas used to calculate the variables. In addition, we will give some descriptive statistics and graphs to illustrate the variables in practice.

5.4.1 SOVEREIGN YIELDS

We will focus on the 10-Year Zero Yield (ZY) of sovereign bonds as sovereign yield variable. The decision to use this specific statistic can be split into two parts; the choice for the 10-year term is evident considering this is the most commonly-used statistic when discussing sovereign bonds. We will use the zero yield rather than the interest yield itself since the zero yield takes compounding into account.

The zero yield, zero coupon yield or spot yield of a bond is equal to the current market rate at which a zero-coupon bond would trade for with the same maturity as the original bond. By adjusting for the periodic coupon payments of the different bonds, the zero yields facilitate the comparison between bonds with different payment structures.

During this research we will be using the average sovereign yield over a certain period. We do this in order to evaluate both sovereign yields and stock returns over the same identical period. For the weekly data, this means the following variable will be used:

$$SY_{c,t} = \frac{\sum_{t}^{t+4} r_{c,i}}{5} \quad (19)$$

Where $SY_{c,t}$ is the average sovereign zero coupon yield over the period [t, *t+4*] for country c and $r_{c,i}$ is country *c*'s zero-coupon yield for day *i*. During the third part of the research, as described in section 4.3, the formula is adapted to account for longer periods:

$$SY_{c,t} = \frac{\sum_{t}^{T-1} r_{c,i}}{(T-1-t)} \quad (20)$$

Next to the absolute sovereign yield averages, yield spreads between country c and the yield on German bunds are used. Germany is considered the benchmark in Europe in the twenty-first century when it comes to public finances and sovereign debt. These relative differences are therefore used to indicate diverging interest rates. If sovereign yields increase slightly when at the same time yields on German bunds increase even more, this does not indicate increased country-specific risk, rather it could indicate a more widespread systemic-risk increase. The effects of this yield increase should therefore not be attributed to the sovereign yield itself, as it will affect the stock return volatility through an increased volatility in the market. The yield spread (relative sovereign yield) is defined as follows:

$$SY_{c,t}^{rel} = SY_{c,t} - SY_{Germany,t} \quad (21)$$

5.4.2 STOCK RETURNS

Central in this research will be the stock return index (RI), considering this figure takes possible dividends into account. The return index or total shareholder return index assumes that possible cashflows from the investment, dividends in the case of shares, are reinvested in the company in order to acquire additional shares. The total return index is a more accurate and representative way of evaluating a stock's performance since it adjusts for differences in dividend policies across companies, effectively improving worse performing dividend-paying shares while punishing better performing non-dividend paying stocks. Using solely the stock price of a stock therefore would be misleading given these differences.

Another benefit of using stock returns indices instead of, for example, price, is the fact that stock returns indices are normalized. The base of the return index in Datastream is 100 and evolves from there on from day to day due to the daily returns. By measuring all variables in a comparable metric rather than dissimilar data like price, we enable analytic evaluation of two or more variables even though they originate from different values.

The basic formula for the total return index for bank *i* at time *t* provided by Datastream and used throughout this dissertation is as follows:

$$RI_{i,t} = RI_{i,t-1} * \frac{P_{i,t}}{P_{i,t-1}} \qquad (22)$$

Where $RI_{i,t}$ is the total return index for bank *i* at time *t*, $RI_{i,t-1}$ is the total return index of bank *i* at the previous day and $P_{i,t}$ and $P_{i,t-1}$ are the prices of the stock at day *t*, day *t-1* respectively. The formula holds up, except when day *t* is the ex-date of a dividend payment. In that case, the formula is adapted accordingly:

$$RI_{i,t} = RI_{i,t-1} * \frac{P_{i,t} + D_{i,t}}{P_{i,t-1}} \qquad (23)$$

Where $D_{i,t}$ is the aforementioned dividend.

According to the Jarque-Bera test[13], the stock returns of the banks are normally distributed[14]. This means that we can calculate the stock return differences by applying the logarithmic subtraction. Logarithmic returns are superior to ordinary returns considering the advantageous characteristics: logarithmic returns

[13] In Table B-4, Table B-5 and Table B-6, descriptive statistics including the Jarque-Bera test are depicted.

[14] According to the research conducted by Bera, A. K., & Jarque, C. M. (1980) in 'Efficient tests for normality, homoscedasticity and serial independence of regression residuals', the normality of a dataset can be determined by the Jarque-Bera test. Applying this to the stock returns, we get exceptionally high statistics, indicating normal distributions.

are symmetric, meaning an equal positive and negative percentage change cancel out, while this is not the case for ordinary returns. A second advantage is that logarithmic returns aggregate across time. This is convenient when calculating the returns over larger time periods. The downside in using logarithmic returns is the fact that over larger time periods, the ordinary return and logarithmic return tend to diverge. The definition of the stock return changes is as follows:

$$\delta RI_{i,t} = \ln\left(\frac{RI_{i,t}}{RI_{i,t-1}}\right) = \ln RI_{i,t} - \ln RI_{i,t-1} \quad (24)$$

The volatility of the stock return changes, the focal point during this research rather than the stock returns themselves, can be evaluated in different ways. In this research, we opted for the forward standard deviation rather than the realized or historical standard deviation. Since we want to evaluate the reaction of stock returns on changes in sovereign yields, the standard deviation of the stock returns in the upcoming days after the change will be calculated.

Based on the results obtained through equation (24), we can calculate the weekly forward standard deviations. For every Monday we will calculate the standard deviation of the respective ensuing week. The weekly forward standard deviations for bank t is derived through the formula:

$$FSD_{i,t} = \sigma_{i,t} = \sqrt{\frac{\sum_t^{t+4}(\delta RI_{i,j} - \overline{\delta RI_\iota})^2}{5-1}} \quad (25)$$

In equation (25), $\sigma_{i,t}$ or $FSD_{i,t}$ is the forward (ex-ante) standard deviation of the change in stock returns for bank t on day i for a 5-day forward period, $\delta RI_{i,j}$ is the percentage change in stock return as described in equation (24) and $\overline{\delta RI_\iota}$ is the average change of the stock returns. The reason we take a 5-day forward period is that in this way we will be able to capture the increased or decreased volatility in the stock returns caused by the change in sovereign bond yields. We will take a 5-day period rather than a longer period since we feel that the most important effects will materialize in the first few days after the initial event.

For the research as described in section 4.3, we need to change the definition of the forward standard deviation as to adapt to the extended period. Instead of weekly data, we need semi-annual or annual data for this part of the research. The formula is therefore as follows:

$$FSD_{i,t} = \sigma_{i,t} = \sqrt{\frac{\sum_t^{T-1}(\delta RI_{i,j} - \overline{\delta RI_\iota})^2}{(T-1-t)-1}} \quad (26)$$

Considering the period differs between the observations, *T – 1* indicated the day prior to the start of the next period.

Momentum effects of stock returns are an extensively discussed topic in the world of finance. Not only the stock returns themselves, but also the volatility of stock returns is influenced by these momentum effects, as examined by Lamoureux and Lastrapes (1994). Therefore we will include the ex-post standard deviations during some parts of our research.

The ex-post standard deviation or past standard deviation (PSD) is defined as the ex-ante standard deviation of the previous period, being:

$$PSD_{i,t} = FSD_{i,t-1} = \sigma_{i,t-1} \quad (27)$$

Next to the stock return indices we will also include a market indicator. The STOXX Europe 600 banks index provides the best fit with the data in our research. Similarly to the bank stock return indices, we calculate the return index change and index volatility of the Market Return Indicator (MRI):

$$\delta ES600_t = \ln\left(\frac{ES600_t}{ES600_{t-1}}\right) = \ln ES600_t - \ln ES600_{t-1} \quad (28)$$

$$MRI_t = \sigma_{ES600,t} = \sqrt{\frac{\sum_t^{t+4}(\delta ES600_t - \overline{\delta ES600})^2}{5-1}} \quad (29)$$

For the weekly data, respectively for the semi-annual and annual data:

$$MRI_t = \sigma_{ES600,t} = \sqrt{\frac{\sum_t^{T-1}(\delta ES600_t - \overline{\delta ES600})^2}{(T-1-t)-1}} \quad (30)$$

5.4.3 SOVEREIGN EXPOSURES

During this research, special attention will be given to the sovereign exposures of banks during the crisis. Given the special relationship between bank and government, it is important to capture this link quantitatively on the basis of the exposure of banks to both their own sovereign state, as well as to GIIPS countries in general.

Unfortunately, high-frequency data of sovereign bonds positions on micro-level are not available. This information would have been exceptionally useful when discussing and analysing the impact of the changes in sovereign yields on the domestic banks based on the current positions of the banks regarding the respective sovereign bonds. Therefore we will work with discrete data, available on specified moments in time. As mentioned in the previous section, all information regarding the sovereign exposures is extracted from the transparency and stress tests by the EBA. All exposures are published on the website of the EBA.

The home bias exposure and the exposure to GIIPS countries will be considered in the form of their relative position in the sovereign bond portfolio. Using the relative importance of these bonds in the overall portfolio for every bank, the home bias exposure and GIIPS exposure are defined as:

$$HB_{i,t} = \frac{Exp_{i,t}^{hb}}{\sum_1^n Exp_{i,t}^{j}} \quad (31)$$

$$GIIPS_{i,t} = \frac{Exp_{i,t}^{Greece} + Exp_{i,t}^{Ireland} + Exp_{i,t}^{Italy} + Exp_{i,t}^{Portugal} + Exp_{i,t}^{Spain}}{\sum_1^n Exp_{i,t}^{j}} \quad (32)$$

$HB_{i,t}$ and $GIIPS_{i,t}$ are the relative exposures to the domestic sovereign state and GIIPS respectively for bank *i* at time *t*, $Exp_{i,t}^{hb}$ is the absolute home bias exposure at time *t*, whereas $Exp_{i,t}^{Greece}$, $Exp_{i,t}^{Ireland}$, $Exp_{i,t}^{Italy}$, $Exp_{i,t}^{Portugal}$ and $Exp_{i,t}^{Spain}$ are the absolute exposures to the respective GIIPS countries.

5.5 DESCRIPTIVE STATISTICS

5.5.1 SOVEREIGN YIELDS

The countries in the dataset will be divided into three groups; first we have the core countries including Austria, Belgium, France, Germany and Netherlands. These countries are regarded as more stable during the financial and sovereign crisis, with Germany as the benchmark in the euro area. The second group consists of the periphery countries; Greece, Ireland, Italy, Portugal and Spain. This group, the GIIPS group, has been the main subject of the problematic situation during the sovereign crisis. It were those countries which experienced increased sovereign yields and severely impacted banking sectors. Due to the often-extreme nature of the Greek situation, a distinction will ofttimes be made between the entire GIIPS group and the IIPS group, excluding Greece. This prevents distortions due to extreme values of Greece. Finally we have the control group, countries who were in the background during the crisis. This group consists of Denmark, Hungary, Malta, Norway, Poland, Sweden and the United Kingdom. Although several of these countries also experienced problems during the crisis, with special attention to the situation in Hungary and Poland, none of these countries were as scrutinized as the countries in the GIIPS group.

In order to gain a first insight into the order of magnitudes of the sovereign yields, you will find a brief summary of some descriptive statistics. In Table 5-2, the descriptive statistics of the three original group supplemented with the IIPS group are inserted. All values are expressed in percentages (%). Each column symbolizes the average sovereign zero yield of all countries in the respective group.

	Core group	*GIIPS group*	*IIPS group*	*Control group*
Mean	1.9824	5.9522	4.5401	3.0663
Median	2.0886	5.5060	4.6589	3.2741
Maximum	3.9376	13.3337	9.3149	4.8847
Minimum	-0.0187	2.6971	1.1925	1.1512
Std. Dev.	1.1336	2.7665	2.2661	1.0336
Observations	1826	1826	1826	1826

Table 5-2: Descriptive statistics average sovereign yields main groups

At first glance, we can see the significant differences between the two most important groups; the core countries and the GIIPS countries. With a mean zero yield of approximately 5.95%, nearly tripling the 1.98% yield of the core group, it is clear why the GIIPS countries received considerable attention during the sovereign crisis. Not only the mean yield, but also the standard deviation indicates an increased risk during the period. Notable is when exclude Greece from the GIIPS group, we observe a substantial decrease in the mean sovereign yield and standard deviation. Therefore, the distinction is being made between both the GIIPS countries including and excluding Greece.

The control group performs on average better than both the GIIPS and IIPS group - albeit only slightly better than the IIPS group - and worse than the core group. Remarkably, the standard deviation of the control group is lower than the standard deviation of the core group, implying a more stable evolution of the sovereign yields in the control group.

If we look at the sovereign yields over time in Figure 5-1, we notice several remarkable facts. Firstly, the sovereign yields of the four main groups are very similar at the start of 2010. At this point in time, the financial crisis had already hit Europe, yet the sovereign crisis did not. During the course of 2010 and 2011, interest rates diverged and the spreads between the core and GIIPS countries increased. The control group countries follow a very similar path to the core countries, albeit slightly higher.

Secondly, sovereign yields for the IIPS countries start to decrease mid-2012 after the announcement of Mario Draghi, while sovereign yields for the GIIPS group initially continuous to rise. This contrast can be explained by the only difference between both groups; Greece. As indicated in section 3, the specific situation of Greece hampered the country's progress.

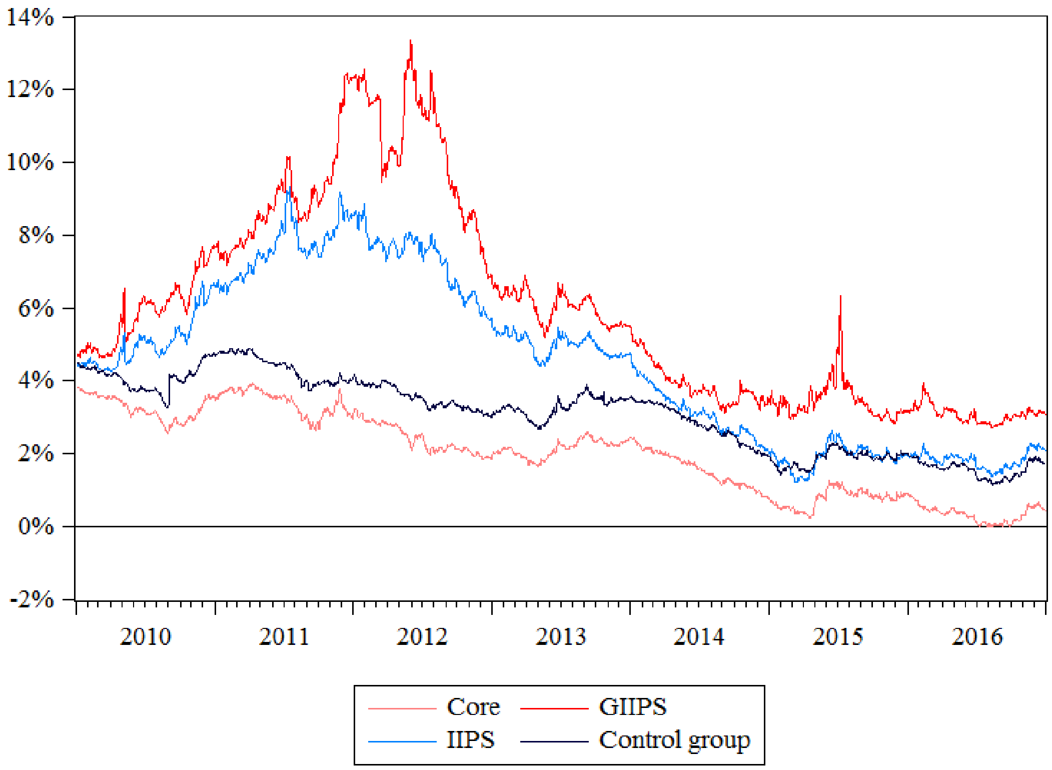


Figure 5-1: Graph average sovereign yields main groups

Thirdly, as of 2014, the average yield of the control group countries and IIPS countries strongly converged. So although IIPS countries are still regarded as less financially stable, they do not differ as much as one might think compared to other non-core countries. Lastly, during some moments in 2016, the average yield on core countries bonds was equal to or even lower than the symbolic 0%-benchmark. This finding has been reason for extensive discussion by policy makers at the European level.

When we take a closer look to the sovereign yields of the countries individually, we see that the Nordic countries (Denmark, Norway and Sweden) and the United Kingdom excel both in mean yield as in the standard deviation. This is expected since these countries remained mostly unaffected during the crisis. As illustrated in Figure B-1, the sovereign yields of these countries form the lower limit in the EU. Greece, Portugal and Ireland on the other side of the spectrum demonstrate severely increased means and standard deviations. Since February 2010, the start of the first concerns regarding the public finances of Greece, the sovereign yield of Greece increased followed by Ireland and later Portugal. At the height of the crisis, sovereign yields on Greek bonds were above 30%, an unimaginable figure before the crisis. Although to lesser extent with the Portuguese and Irish bonds, yields of more than 10% (15% for Portuguese bonds) were no exception.

For an overview of the descriptive statistics of all countries separately, we refer to Table B-1, Table B-2 and Table B-3. For the corresponding graph, we refer to Figure B-1.

A first indication of the relation between sovereign yields and stock returns can be obtained through a scatterplot. Figure B-2 signals a slightly positive relation between both variables, although it does not appear to be very strong. Most observations are clustered together, with the outliers implying a positive relation.

5.5.2 STOCK RETURNS

The stock return indices of the banks in our data sample are normalized to 100 at 1/01/2010 for reasons described in section 5.4.2. For the sake of clarity, we again make the distinction between core, GIIPS and control group banks.

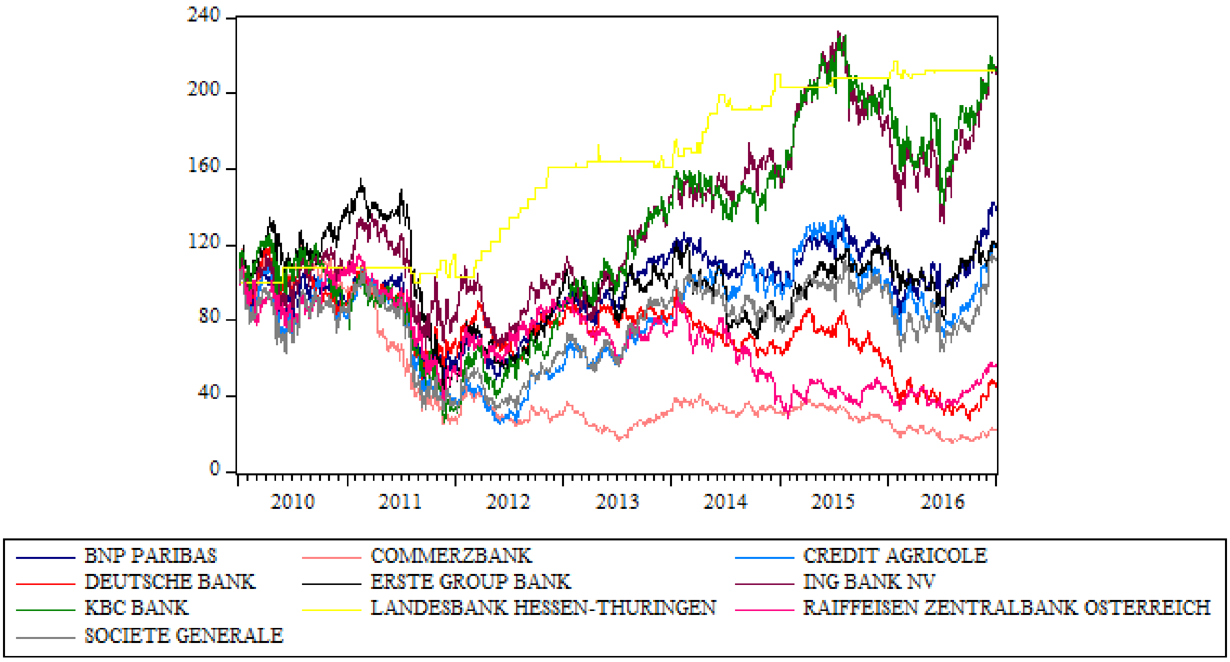


Figure 5-2: Stock returns core group banks

Depicted above in Figure 5-2, we see the core banks stock returns over the period 2010-2016. Even between core banks there is a clear divergence of stock returns. Noticeably, two out of three German banks (Commerzbank, Deutsche bank) and the Austrian bank Raiffeisen Zentralbank perform significantly worse than their core competitors. However, these findings are due to bank-specific circumstances such as profitability[15], legal issues[16] or moderate asset quality[17] rather than country-

[15] The Economist (2014). *A weary lender* (The Economist Group Limited, Frankfurt, Germany). Available at http://www.economist.com/news/finance-and-economics/21629559-germanys-flagship-bank-trouble-some-its-own-making-weary-lender.

[16] Shotter, J. (2015). *Commerzbank warns of future challenges* (The Financial Times Limited, Frankfurt, Germany). Available at https://www.ft.com/content/31397994-b280-11e4-b234-00144feab7de

[17] Metzler, S., Hendricks, A., & Schuler, C. (2017). *Raiffeisen Bank International AG Credit Opinion.* Moody's.

related or systemic conditions. Overall, most core banks perform as well or even better by the end of 2016 than their 2010 levels.

The GIIPS banks however perform – with the exception of Intesa Sanpaolo – considerably worse than their peers in the core. Except for Intesa Sanpaolo, none of the GIIPS banks were able to reach their 2010 levels of performance, with Permanent TSB, Allied Irish Banks and Banca Monte Dei Paschi as absolute lower bounds. When we look at the descriptive statistics in Table B-6, the minimum stock returns of these banks – being situated at the end of the evaluated period – are not even in the same order of magnitude compared to the other banks.

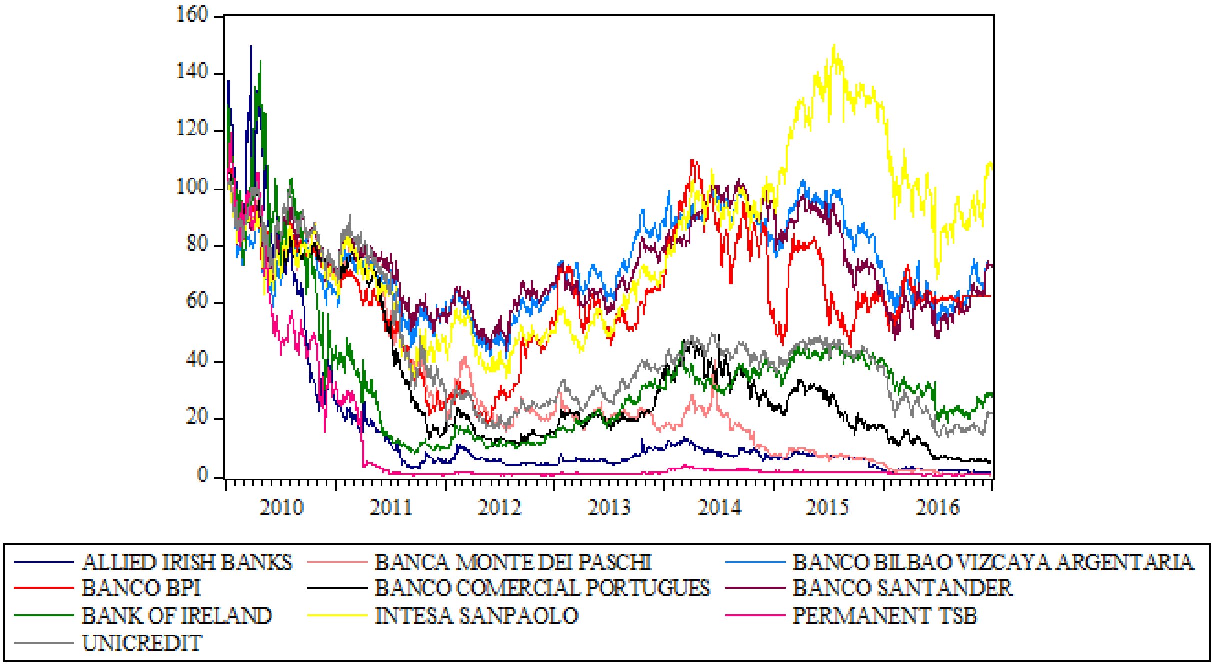


Figure 5-3: Stock returns GIIPS banks

When we look at the performance of the control group banks in Figure B-4, we notice how similar the paths of the banks evolve over the course of the first 2 years. Starting end-2011 - start-2012, the performances diverge, however maintaining a strong analogy between banks trend-wise. Noteworthy is the fact that the best-performing banks on the one hand and the worst-performing banks on the other hand come from specific regions or countries. The best-performing (Swedbank, Skandinaviska Enskilda Banken, Svenska Handelsbanken and DNB Bank) all originate from Nordic countries, while the worst-performing (Royal Bank of Scotland, Barclays, HSBC and Lloyds Banking Group) all stem from the United Kingdom. Nordic banks benefit from strong government financials[18], while the United Kingdom-based banks were heavily affected by the nation-wide recession in 2011-2012 due to the financial

[18] Dosanih, K., Carlson, S., & Lemay, Y. (2013). *Credit focus: Denmark, Finland, Norway and Sweden: Peer comparison.* Moody's.

crisis[19]. Overall, almost all banks – apart from Royal Bank of Scotland and Barclays – reached their 2010 performance level.

For a complete overview of some descriptive statistics of all banks included in our sample, we refer to the appendix, Table B-4, Table B-5 and Table B-6.

As mentioned in section 5.4, momentum effects are generally present in the volatility of stock returns. As a result, we include the ex-post standard deviation as variable. In order to check for the existence of this effect, we again use a scatterplot. Figure B-4 demonstrates a strong and very precise relation between both variables.

Lastly, Figure B-5 and Figure B-6 mark the relation between the forward standard deviation (FSD) and the volatility of the market return index (MRI). As can be seen in Figure B-5, there is a slight upward slope in the regression slope. When we remove the 5% outliers of the FSD observations in Figure B-6, the slope grows steeper.

5.5.3 SOVEREIGN EXPOSURES

The main sovereign exposure variable we use during the course of this dissertation is the relative home bias variable, defined in equation (31). By looking at this variable across banks, we see how strongly a bank is related to its domestic government. Figure 5-4 depicts the home bias exposures of all banks in the dataset corresponding to group. On the top left of the figure, we see the home bias exposures of the core countries over time, while on the top right we see the exposures of the GIIPS banks. This is a first indication of the difference in home bias between the two groups, confirming the findings of Acharya and Steffen (2014). Although the exposures are still high compared to the core group, it is noteworthy that most banks in the GIIPS countries structurally reduced their positions in relation to their own country. Overall, the core banks maintained their exposures relatively constant between 60% and 10% throughout the sample period. The only exception, Landesbank Hessen-Thuringen, is strongly anchored at the regional level through its history and ownership.

On the bottom left of the figure we see the home bias exposures of the control group banks. This group shows more diversity and volatility over time than both the GIIPS and core groups. Especially Svenska Handelsbanken (cyan) and DNB Bank (black) change drastically over time. Finally, on the bottom right we see the average home bias exposure of the different groups. As expected, the GIIPS home bias exposure is considerably higher than those of the core and control groups, albeit in descending fashion. The core banks show the lowest relative exposure, while the control group average balances between the core and GIIPS's averages.

[19] Chowla, S., Quaglietti, L., & Rachel, Ł. (2014). *Quarterly Bulletin*. Bank of England, London, United Kingdom.

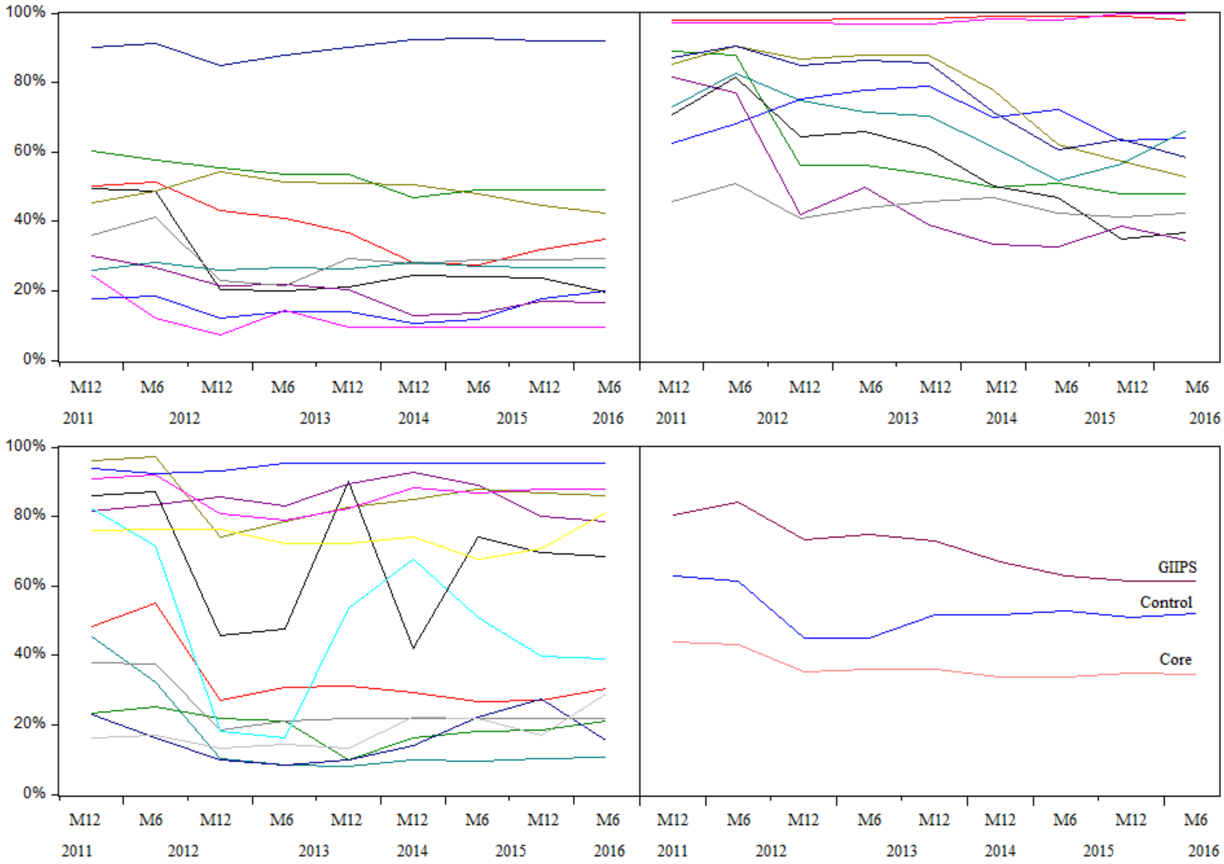


Figure 5-4: Relative home bias exposures (t.l.b.r.): core banks, GIIPS banks, control group banks and group averages.

In Table B-7, Table B-8 and Table B-9, descriptive statistics of the home bias exposures of all banks in the dataset can be found.

6 RESULTS

6.1 QUALITATIVE ANALYSIS

The composition of sovereign bond portfolios differs across groups and banks specifically. As indicated in section 5.5.3 and Figure 5-4, GIIPS banks tend to have larger home bias exposures compared to their peers in the core and control group. This comes to no surprise, as extensive research has been conducted on the difference in home bias between core country banks and banks in the periphery. Next to the distinction between GIIPS and non-GIIPS banks, we can also split the banks in our dataset according to whether they have been bailed-out or not at some point in time during the financial or sovereign crisis. As research has indicated that banks which received government aid generally hold larger amount of domestic sovereign bonds, we expected this to be present in our data as well.

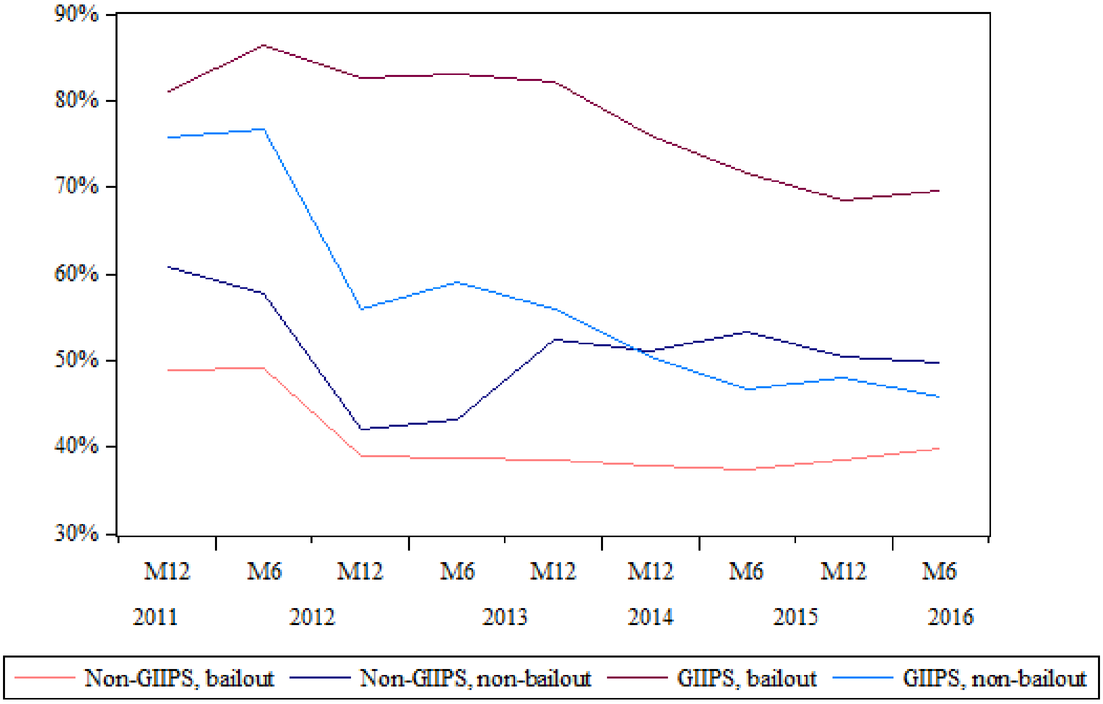


Figure 6-1: Average relative home bias exposures according to bank features

We can divide all banks in four quadrants according to bank features; whether a bank has been bailed out on the one hand and whether a bank is headquartered in a GIIPS country on the other hand. Using these four quadrants and calculating averages of each quadrant gives us figure 6-1. As we can see, bailed-out GIIPS banks hold relatively more domestic sovereign bonds than their non-bailout counterparts. Counterintuitively, bailed-out banks in the core and control groups hold less domestic sovereign bonds relative to their portfolio than the non-bailout banks. Even more odd is the fact that non-bailout banks in core and control group countries hold more domestic debt than those in GIIPS countries. The main reasons for these observations are the exceptionally high exposures of Landesbank

Hessen-Thuringen and Bank of Valletta. Both banks are heavily locally rooted, explaining these increased exposures. To further illustrate the difference between the GIIPS banks and core banks; the minimum domestic sovereign exposure during any period of time of any bank in the GIIPS group (32.7013%, Banco Santander) exceeds the maximum domestic exposure of almost half of the core banks, while exceeding more than 60% of the averages of the core banks. This indicates a first confirmation of the differences between GIIPS and core banks.

Not only the relative importance of domestic sovereign exposures is relevant, the importance of domestic sovereign exposure compared to capital differs across banks as well. In Figure 6-2 and Figure 6-3 we see the four different groups of banks based on bank features.

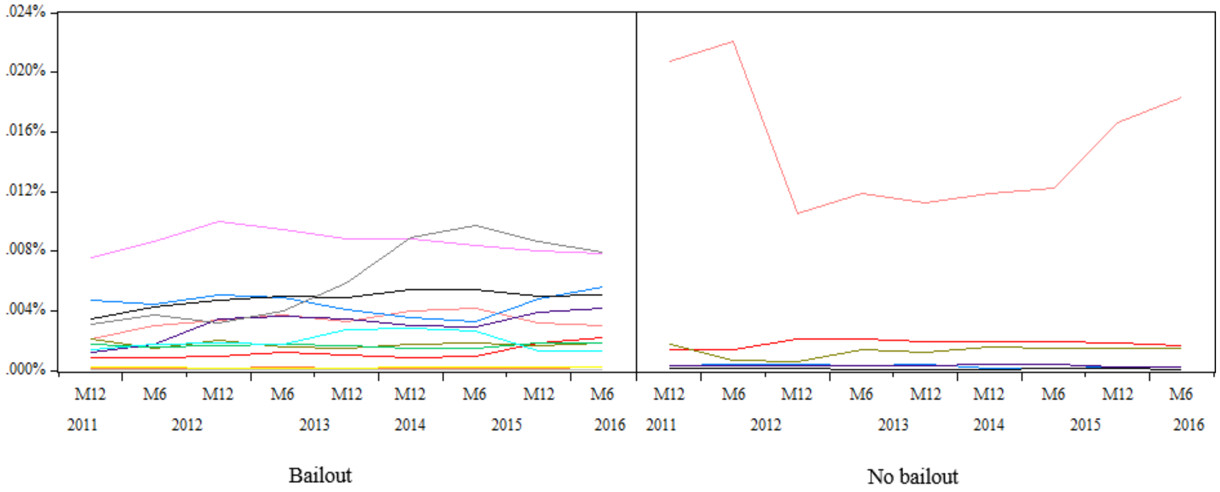


Figure 6-2: Home bias exposures relative to capital - core and control banks

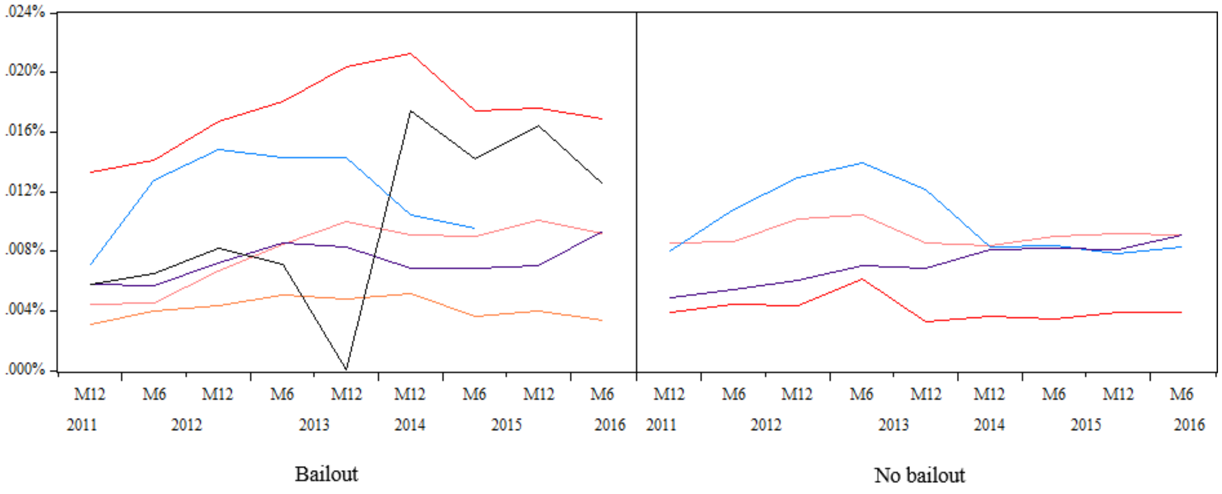


Figure 6-3: Home bias exposures relative to capital - GIIPS banks

Both between the GIIPS banks and the core and control banks, as well as between the bailed-out and non-bailout banks there are considerable differences noticeable. The home bias exposures – compared to capital – are on average lower in the two upper graphs (core and control banks) than those in the lower graphs (GIIPS banks). This implies GIIPS banks to be holding comparatively sovereign debt compared to banks in core and control countries. The same conclusion can be made on the difference between bailed-out banks and non-bailout banks. As in both figures the left part shows increased domestic sovereign exposures compared to the right parts, we can conclude that bailed-out banks hold more domestic sovereign bonds. The only exception in the non-bailout, core and control group is again Bank of Valletta (pink, right upper hand graph). Reason for the increased sovereign exposure has already been mentioned above.

The same conclusions can be made when we take the domestic sovereign exposure to total assets ratio. Figure C-1 and Figure C-2 illustrate a very similar situation to those in Figure 6-2 and Figure 6-3. Again, both the GIIPS group compared to the core and control group, as the bailed-out banks compared to the non-bailout banks show increased sovereign exposures.

Based on these findings, we can make several conclusions. Firstly, we can conclude that GIIPS banks approach sovereign debt differently compared to their peers in core and control countries. They do not only hold relatively more domestic debt in their sovereign bond portfolio, they also hold more relative to their tier 1 capital and total assets. This is not only the case for undercapitalized banks and/or banks in distress, but is widespread over all GIIPS banks.

Secondly, bailed-out banks hold on average more domestic sovereign debt compared to the non-bailout banks, both in GIIPS countries as in countries from the core and control group. This and our first conclusion confirm the moral suasion hypothesis as suggested by Battistini, Pagano and Simonelli; government-aided banks reciprocate their governments by holding more sovereign debt than they normally would and should. This effect is more pronounced in the periphery, as was also proposed by the researchers.

The qualitative analysis thus provides evidence for the important relation between governments and domestic banks, while also confirming the moral suasion and home bias hypotheses. Whether this relation impacts the risk of bank stock returns will be discussed in the quantitative research in sections 6.2 and 6.3.

Similarly to the home bias exposure research, we also take a look at the GIIPS exposure as a whole. Considering GIIPS banks already hold considerable domestic sovereign debt, we look at both the total GIIPS exposures as well as at total exposure minus home bias exposure. We expect – due to the carry trade hypothesis as proposed by Acharya and Steffen (215) – the GIIPS exposures of core and GIIPS countries to be high. GIIPS exposures of the control group banks are assumed to be high as well, but due to the more prudent approach of, for example the Nordic banks, lower than those of core country banks.

In Figure 6-4 and Figure C-4 we see the GIIPS exposures relative to the total sovereign bond portfolio of the core and control group banks respectively. In Figure C-3 the GIIPS exposures of the GIIPS banks are illustrated, however Figure 6-5 we see the adjusted exposures – minus home bias exposures.

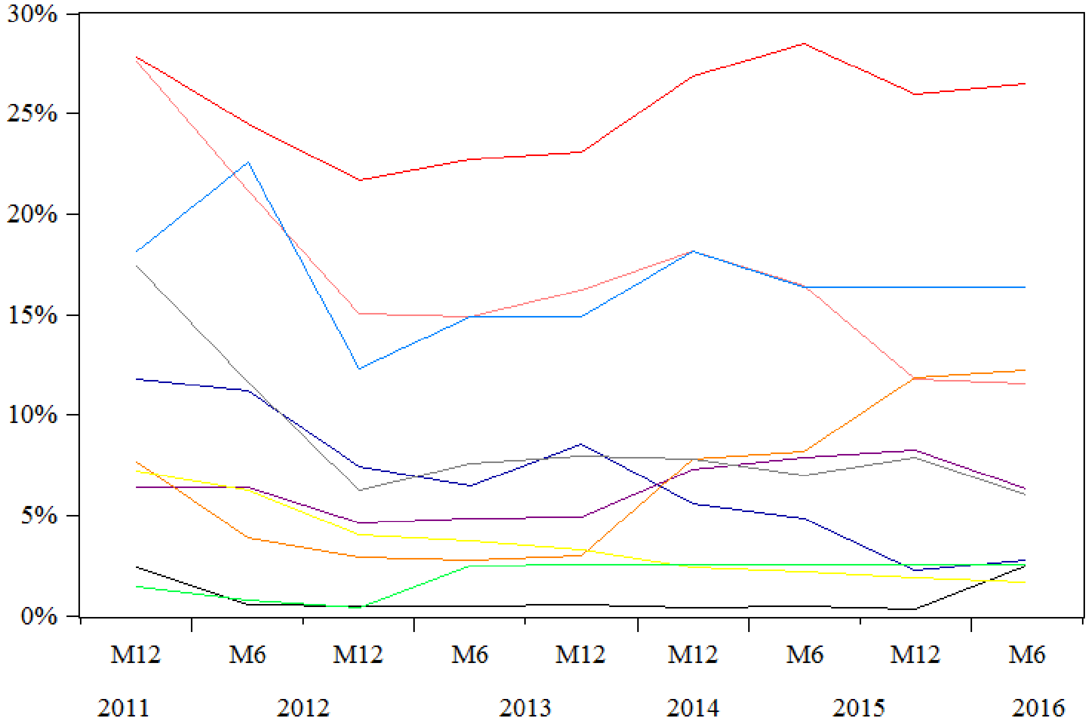


Figure 6-4: GIIPS relative exposure core country banks

Notable are the high exposures of core country banks compared to those in GIIPS countries. This finding confirms both the carry trade behaviour hypothesis as does it the home bias and moral suasion hypotheses: during the start of the sovereign crisis, core country banks acquired considerable amounts of GIIPS sovereign bonds due to the carry trade hypothesis, while GIIPS banks were stocking domestic sovereign debt considering the precarious situation of their domestic countries. Starting 2012, when the sovereign bond prices tumbled, exposures to GIIPS countries decreased for all banks, mainly due to the price-effect. The control group banks started similar to core group banks with high exposures – albeit not in the same magnitude – before drastically reducing their exposures. This has been done by both selling sovereign GIIPS bonds, as well as the price-effect. Contrary to core group banks, sovereign GIIPS exposures remained low up to date.

GIIPS countries hold only low relative positions to other GIIPS countries, mainly due to the fact that these banks hold considerable domestic debt exposures. Only exception in Figure 6-5 is Banco BPI. Inconsistent with its GIIPS peers, Banco BPI held large relative exposures to other GIIPS countries, especially Italy. The decrease starting 2012 is however not by actively selling or passively managing

Italian bonds, but is a result of the significant increase in home bias exposure. Between December 2011 and December 2012, Banco BPI doubled its home bias exposure, almost halving its relative position towards Italy.

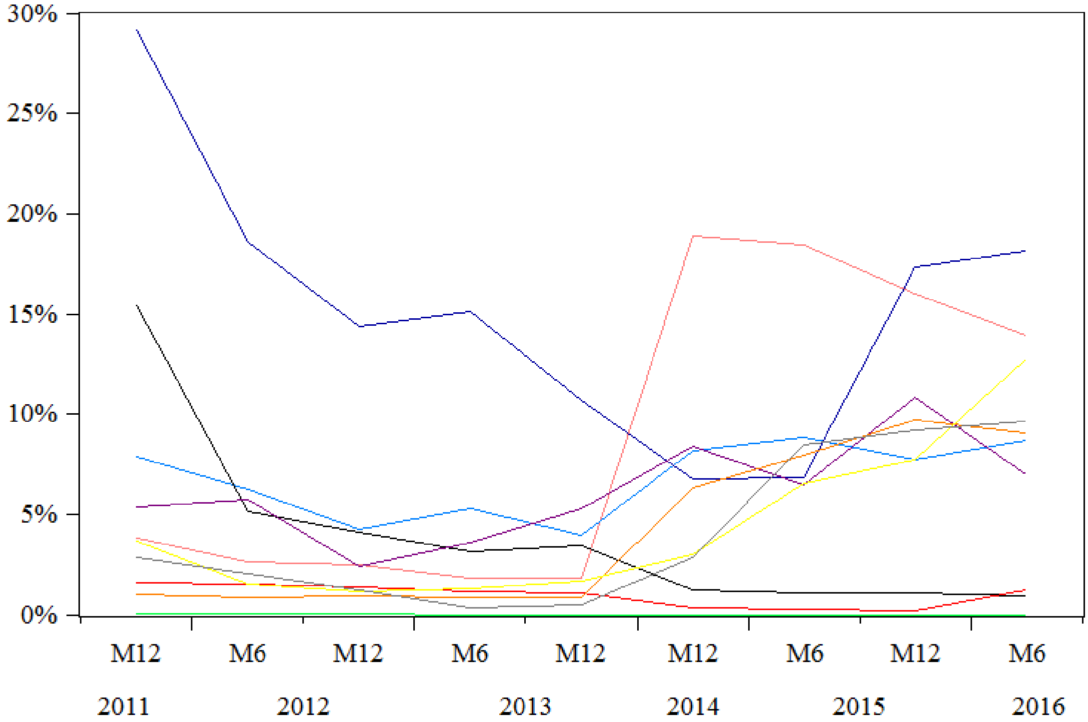


Figure 6-5: Adjusted GIIPS relative exposure GIIPS banks

Lastly, the concentration of the sovereign debt exposures differs substantially between banks and groups. In Figure C-5 and Figure C-6 we see the Herfindahl-Hirschman-index of the core and GIPS banks respectively. What stands out immediately is the diversity in the portfolios of core banks, indicated by low HH-indices, compared to those of GIIPS banks. Except for Landesbank Hessen-Thuringen – for aforementioned reasons, all core banks hold a well-diversified portfolio, not exceeding a HHI of 0.4 during any period of time. GIIPS banks on the other hand carry severely concentrated portfolios, with Permanent TSB (red, Ireland) and Banca Monte dei Paschi (green, Italy) showing a HHI close to 1 during the entire period. Both banks almost solely hold domestic sovereign debt, as has already been established in the home bias discussion.

This ill-considered concentration proved to be disastrous for Banca Monte dei Paschi as Italian debt became increasingly risky, evaporating the bank's profit starting 2011 and inducing reluctance of private investors towards the bank (Birnbaum, 2012). In the first half of 2012, Banca Monte dei Paschi recorded for $2 billion in losses, mainly due to the accumulated impairments on domestic sovereign debt. It was during this period Banca Monte dei Paschi's stock tumbled as can be seen in Figure 5-3.

Except for Banca Monte dei Paschi and Permanent TSB, all GIIPS banks however decided to lower their concentrations and diversify more when it comes to sovereign debt. The structural reduction of home bias exposures as can be seen in Figure 5-4 is the main driver of these increased diversification.

In Figure C-7 we see the concentration of portfolios of the control group banks. In contrast to what one might expect, control group banks do not diversify as well as core group banks, even though most control countries were not hit as hard as core countries during the crisis. We can divide the banks in three groups; Bank of Valletta, Jyske bank, OTP Bank and Lloyds Banking Group hold the highest concentrated portfolios, Barclays, Dankse Bank, Royal Bank of Scotland, HSBC Holdings and Nordea Bank hold the lowest concentrated portfolios, while DNB Bank, Swedbank, Svenska Handelsbanken and Skandinaviska Enskilda Banken are positioned in between. It is important to nuance the higher concentrations, considering OTP Bank and Jyske Bank hold significant little sovereign debt relative to assets and capital compared to other banks. It appears that sovereign debt is not included in these banks' strategies. Bank of Valletta's high concentration is attributable to home bias exposure, as is the case for Lloyds Banking Group.

The Scandinavian banks' sovereign debt portfolios consist of investments in domestic sovereign bonds, other Scandinavian sovereign bonds, German and in some cases Baltic sovereign debt. All aforementioned countries and regions are considered safe investments – at this moment. So although Scandinavian banks do not diversify as well as banks in core countries, their investments are well-balanced across safer countries and deemed dependable in the current conditions.

The qualitative research presented us with prove of the existence of the home bias, moral suasion and carry trade hypotheses. Domestic and GIIPS sovereign exposures differed across banks, depending on where the bank is headquartered, as well as whether the banks has been bailed out. Given these differences between banks and their respective bank features, it is compelling to assume sovereign exposures impacted bank risk during the sovereign crisis. Considering the relation between bank characteristics and sovereign exposures on the one hand and sovereign debt and sovereign yields on the other, the qualitative research provided a first indication of the relation between sovereign yields and bank stock return volatility. The quantitative analysis tries to answer the question to what extent this relation exists and in what magnitude sovereign yields impact bank stock return risk.

6.2 HIGH-FREQUENCY SOVEREIGN YIELDS AND STOCK RETURN VOLATILITY

The results of the high-frequency LSDV model can be found in Table 6-1. Equations (1) and (4), without the past standard deviation variable, express autocorrelation. This can be observed through the Durbin-Watson statistic (not included in the table), which deviate significantly from the benchmark (2). These regressions will therefore not be used during the discussion of the results, considering autocorrelation renders the coefficients of variables uncertain and inconsistent.

On the short term, both absolute sovereign yields and sovereign yield spreads significantly impact the forward stock return volatility of banks, confirming our hypotheses. Based on Table C-1, depicting the quality of models used in the high-frequency model, equation (3) is preferred and best-fitted compared to the other equations. In equation (3), all variables are significantly different from 0.

Explanatory variables	Alternative specifications (High-frequency)					
	(1)†	(2)	(3)	(4)†	(5)	(6)
Intercept	0.1852***	-0.1601***	-0.3588***	0.5257***	0.0376	-0.2500***
	(5.3630)	(-5.1305)	(-10.7066)	(17.5998)	(1.3450)	(-7.9311)
Sovereign yield	0.2600***	0.1476***	0.07113***			
	(35.3781)	(21.6882)	(9.2001)			
Yield spread Germany				0.3248***	0.1833***	0.06421***
				(36.4564)	(22.0671)	(6.1158)
Market return index	0.8771***	0.6859***	0.7154***	0.8673***	0.6829***	0.7134***
	(53.7141)	(46.1302)	(48.9691)	(53.2391)	(45.9693)	(48.6984)
Past standard deviation		0.4269***	0.3784***		0.4235***	0.3824***
		(56.4576)	(49.1202)		(55.7858)	(49.6641)
Dummy GIIPS			0.6205***			0.6339***
			(17.9227)			(16.5040)
Dummy Bailout			0.4572***			0.4583***
			(16.3535)			(16.1890)
Observations	11576	11545	11545	11576	11545	11545
R-squared	0.26944	0.42775	0.45212	0.27383	0.42854	0.44988
Adjusted R-squared	0.26932	0.42760	0.45188	0.27370	0.42839	0.44964

* (**, ***) indicates significance at the 10% (5%, 1%) level

† Durbin-Watson statistic indicates autocorrelation

The dependent variable is the ex-post (forward) stock return volatility (FSD). The table reports the estimated coefficients for the respective explanatory variables using the high-frequency (weekly) model. The Durbin-Watson statistics of regressions (1) and (4) are 1.026444 and 1.031864 respectively, indicating autocorrelation in the data.

Table 6-1: Regression estimates high-frequency model

The intercept of the bank stock return volatility is -0.3588%, while GIIPS banks' volatility is increased with on average 0.6205 percentage points, making it 0.2660%. Being bailed-out also impacts the standard deviation, increasing volatility with on average 0.4572 percentage points. A bailed-out GIIPS bank thus experiences increased stock return volatility by approximately 1.0778 percentage points compared to non-bailout core and control banks. These differences across banks are the between-groups fixed effects of the model.

Momentum effects are present in the bank stock returns, considering the impact of the past standard deviation is highly significant. An ex-post standard deviation increase of 1%-point increases the ex-ante standard deviation on average with 0.3784 %-points. The majority of the forward standard deviation however is caused by the market return index. A 1%-point increase in the market volatility implies – on average – a 0.7154%-point increase in the ex-ante standard deviation. Hence, bank stock returns are heavily related to their peers and the market. As aforementioned, sovereign yields also affect the forward standard deviation significantly. Whenever sovereign yields of a bank's domestic country increase/decrease, bank stock return volatility is expected to increase/decrease on average with 0.07113 percentage points.

Interestingly, the coefficients of the sovereign yield and yield spread variables diminish considerably once we introduce the dummy variables. The coefficient of sovereign yields halves when we introduce the dummies, while the coefficient of the yield spreads is only one third with dummies compared to the regression without dummies. This illustrates the structural yield spreads of GIIPS countries compared to the European benchmark. Since all countries in the periphery experience elevated sovereign yields compared to Germany, a fixed part of the impact of sovereign yields can be attributed to this bank characteristic.

Due to the reduction in coefficients of sovereign yields and yield spreads, the economic relevance of both variables decreases accordingly. A 1%-point increase of sovereign yields of yield spreads results on average in a 0.07113 or 0.06421%-point increase in forward standard deviation respectively. Since changes in sovereign yields in short term periods are – under normal circumstances – rarely larger than a percentage point, only small parts of changes in the ex-ante standard deviation can be attributed to sovereign yield changes.

However, for countries such as Greece and Portugal, and during periods of crisis with high sovereign yields or sovereign yield spreads, sovereign yields do impact volatility of bank stock returns significantly. Especially during periods where sovereign yields surpass 10%, as was the case for Portugal and Greece during extended periods in the crisis, the link government-domestic banks becomes increasingly important and quantifiable.

6.3 SOVEREIGN EXPOSURES, YIELDS AND STOCK RETURN VOLATILITY

6.3.1 POOLED OLS REGRESSION MODEL

The results for the pooled OLS regression model are reported in Table C-2. The market return index (MRI) and past standard deviation (PSD) are highly significant in all equations, confirming the momentum effects as proposed by Lamoureux and Lastrapes (1994), and the individual stock-stock market interdependence. Remarkably, the intercept is initially significant at the 5%-level, but after introduction of the home bias and GIIPS exposures, the coefficient becomes insignificant. In return, the GIIPS exposure becomes highly significant (1%-level), while the home bias exposure is only slightly significant (10%-level) in equation (12). The sovereign yields are never significant, however the yield spreads are highly significant in equation (8), before the introduction of the exposures.

The coefficient of determination (R-squared) is relatively constant across equations, somewhat favoring equations (9) up to (12). This can be attributed to the introduction of the extra variables. When we take a look at the quality of models to further determine the most suitable model in Table C-3, we also see the slight favour towards equations (9) up to (12). Between these models only marginal differences are notable.

Considering the model does not account for fixed or random effects, we will not further discuss the pooled OLS model.

6.3.2 LEAST SQUARED DUMMY VARIABLE MODEL

The results of the LSDV regression model, allowing the groups based on bank characteristics to have their own intercepts, can be found in Table 6-2. Similar to the high-frequency research and the OLS regression model, the market return index and past standard deviation remain highly significant. Before introducing the exposures, both dummy variables are also highly significant, implying considerable differences across groups. Again, the intercepts are initially significant (equations (13) and (14)), before becoming insignificant once we introduce the exposures. GIIPS exposures are again notably significant.

According to the Akaike and Hannan-Quinn criteria in Table C-6, equations (15) and (17) provide the best model-fit. Both regressions indicate that increased GIIPS exposures result in increased standard volatility in the subsequent period. Using the coefficients from equation (17) – best-fitted according to both criteria – a percentage-point increase in GIIPS exposure relative to total sovereign exposure increases the standard deviation on average with 0.0062 percentage points. Since increases and decreases of 5%-points and sometimes 10%-points are no exceptions, and considering the average change in forward standard deviation over the periods is 1.318821%, changes in GIIPS exposures can have a notable impact on bank stock return volatility.

Explanatory variables	Alternative specifications (LSDV)					
	(13)	(14)	(15)	(16)	(17)	(18)
Intercept	-0.2592**	-0.3425***	-0.1753	-0.2392*	-0.1625	-0.2245
	(-1.8531)	(-2.6172)	(1.2097)	(-1.7161)	(-1.1136)	(-1.5975)
Sovereign yield	-0.0316**		-0.0287		-0.0283	
	(-1.6789)		(-1.5206)		(-1.5013)	
Yield spread Germany		-0.0207		-0.0073		-0.0077
		(-1.2083)		(-0.4901)		(-0.5197)
Market return index	0.4219***	0.4556***	0.4368***	0.4666***	0.4416***	0.4717***
	(5.4165)	(6.0266)	(5.6631)	(6.2161)	(5.7147)	(6.2937)
Past standard deviation	0.7187***	0.7066***	0.6956***	0.6872***	0.6938***	0.6853***
	(25.2223)	(25.1377)	(23.7448)	(23.6849)	(23.6479)	(23.6116)
Home bias exposure			-0.0016	-0.0019		
			(-1.3767)	(-1.6359)		
Home bias exposure* D_CC					-0.0019	-0.0022*
					(-1.5445)	(-1.8045)
GIIPS exposure			0.0079***	0.0078***	0.0062***	0.0058***
			(6.3400)	(5.2451)	(4.3597)	(3.5548)
Dummy GIIPS	0.4811***	0.5359***				
	(5.6657)	(4.4900)				
Dummy Bailout	0.1953***	0.2217***	0.1321**	0.1379**	0.1391**	0.1464**
	(2.8923)	(3.0511)	(2.0160)	(2.0527)	(2.1307)	(2.1929)
Observations	297	297	297	297	297	297
R-squared	0.8307	0.8299	0.8351	0.8339	0.8354	0.8342
Adjusted R-squared	0.8277	0.8269	0.8311	0.8305	0.8320	0.8308

* (**, ***) indicates significance at the 10% (5%, 1%) level

D_CC is a core and control group dummy variable

The dependent variable is the ex-post (forward) stock return volatility (FSD). The table reports the estimated coefficients for the respective explanatory variables using the LSDV model.

Table 6-2: Regression estimates LSDV model

The models including sovereign exposures provide no credible evidence that sovereign yields – central during this research – are significant in both absolute values as relative to Germany. We can therefore not reject the null hypothesis of the variable being different from 0. In the long term LSDV research, sovereign yields thus do not influence bank stock return volatility in accordance with the data used.

Finally, the bailout dummy is significant on at least 5% in all models. In equation (17), a bank which has been bailed-out encounters on average a 0.1319%-points standard deviation compared to their non-bailout counterparts. Domestic country of banks does not appear to affect bank stock return standard deviations.

6.3.3 *FIXED AND RANDOM EFFECTS PANEL REGRESSION MODEL*

Next to the between-groups model provided by the fixed effects LSDV model, we also investigate whether there are within-group effects. This is done by a fixed or random effects panel regression model. Before we can apply our fixed or random effects model, we must first check for these effects by means of the Breusch-Pagan test. The Breusch-Pagan test[20] verifies whether random effects are present in the data. Under the null hypothesis, the data is homoscedastic, meaning there are no random effects. Table C-4 the resulting statistics applied on equations (7) – (12). Concluding from the table, there are no cross-sectional random effects, or period random effects. Before we can proceed with the panel data analysis, we hereafter apply the likelihood ratio test for fixed effects and the Hausman test for random effects to further analyse effects in the data.

In Table C-5 the results from the likelihood ratio and Hausman tests are depicted. Under the null-hypothesis of the likelihood ratio test, fixed effects are redundant. According to the F and chi-square statistics, this is not the case for the cross-section, implying cross-sectional fixed effects. Since we use a general variable (Market Return Index, MRI) for all banks for a certain period, period fixed effects are not possible.

The null-hypothesis of the Hausman test indicates that the random effects (RE) estimator is a consistent and efficient estimator compared to the fixed effects (FE) estimator, which is consistent yet inefficient. Since the null-hypothesis is rejected, the test indicates the RE estimator to be inconsistent. As a result, we cannot use period random effects. The resulting regression model is the cross-section fixed effects panel regression model.

We will include White period standard errors and covariance since serial correlation within cross-section will be a problem considering the data used. This is confirmed by the Breusch-Pagan LM and Pesaran LM tests for residual cross-section dependence. The White period standard errors and covariance are appropriate for the data conceptualized as cross-sectional dominant. The final regression table can be found in Table 6-3.

According to Table C-7, little difference is to be found between different models in terms of best fitted-model. The best model, equation (8), does not include sovereign exposures but does exhibit significant market return index and past standard deviation variables, corresponding to the findings in our high-frequency research and in between-groups fixed effects LSDV models. The best model including the sovereign exposures, equation (10), demonstrates the recurrent highly significant market return index and ex-post standard deviation, while also demonstrating significant GIIPS exposures.

[20] The Breusch-Pagan test is a test for heteroscedasticity in general linear regression models.

Explanatory variables	Alternative specifications (Cross-section fixed effects (FE) model)					
	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	0.1049	-12.8257	0.1978	-13.8685*	0.1479	-14.3234*
	(0.3762)	(-1.6458)	(1.0166)	(-1.7954)	(0.7616)	(-1.8748)
Sovereign yield	0.01415		0.00729		0.00646	
	0.96437		(0.2790)		(0.2417)	
Yield spread Germany		5.56920		6.0061*		6.1834*
		(1.6867)		(1.8505)		(1.9212)
Market return index	0.5205***	0.4907***	0.5143***	0.4935***	0.5207***	0.4996***
	(4.7049)	(4.4534)	(4.4605)	(4.5421)	(4.5395)	(4.5998)
Past standard deviation	0.5679***	0.5766***	0.5825***	0.5824***	0.5788***	0.5787***
	(4.6444)	(4.9365)	(4.8676)	(4.887)	(4.7619)	(4.8088)
Home bias exposure			-0.00571	-0.00486		
			(-1.4459)	(-1.239)		
Home bias exposure * D_CC					-0.00386	-0.00336
					(-1.2001)	(-1.0870)
GIIPS exposure			0.00741	0.00977*	0.00261	0.00568
			(1.2241)	(1.6828)	(0.3968)	(1.0169)
Observations	297	297	297	297	297	297
R-squared	0.8571	0.8593	0.8582	0.8607	0.8576	0.8603
Adjusted R-squared	0.8379	0.8404	0.8379	0.8408	0.8372	0.8404

White period standard errors & covariance (d.f. corrected)

D_CC is a core and control group dummy variable

* (**, ***) indicates significance at the 10% (5%, 1%) level

The dependent variable is the ex-post (forward) stock return volatility (FSD). The table reports the estimated coefficients for the respective explanatory variables using the cross-section fixed effects model.

Table 6-3: Regression estimates cross-section FE model

In both models, the market return index volatility and ex-post standard deviation are highly significant. This implies and proves the persistence of both variables in ex-ante standard deviations. Unexpectedly, home bias exposures do not contribute to increased bank stock return volatility in either models. The logical inference would be that home bias does not matter when it comes to bank stock risk, however we must remain cautious before coming to this conclusion as home bias exposures proved to be catastrophic for, for example, Banca Monte dei Paschi. Absolute sovereign yields also bear no significance on bank stock return volatility in the long run.

The differences between the LSDV model and the fixed effect model are illustrated in bold in Table 6-4. Notably, both the intercept and the yield spreads are significant in the FE model, while this is not the case in the LSDV model. On the other hand, the bailout dummy is significant in the LSDV model while this is not included in the FE model, considering this is a within-group model rather than a between-groups model.

Variable	Figure	LSDV	FE
Intercept		No	**10%**
Sovereign yield	$SY_{c,\ t}$	No	No
Yield spread Germany	$SY_{c,t}^{rel}$	No	**10%**
Market return indicator	MRI_t	*1%*	*1%*
Ex-post standard deviation	$PSD_{i,t}$	*1%*	*1%*
Home bias exposure	$HB_{i,t}$	No	No
GIIPS exposure	$GIIPS_{i,t}$	*1%*	*10%**
GIIPS dummy variable	D_G	No	n/a
Bailout dummy variable	D_{BO}	**5%**	n/a

Important differences between models indicated in **bold**. Significant variables in both models in *italic*. *only significant in one of the regressions.

Table 6-4: Differences between models

This brings us to the interesting finding that the impact of sovereign yields and more specifically sovereign yield spreads depends heavily on the bank itself. The differences between banks determine whether a bank's stock return volatility is impacted by yield spreads or not. As yield spreads are not significant in the LSDV model, this means not all banks are affected, and definitely not to the same extent. Part of these differences can be attributed to the bailout dummy variable; considering the significance in the LSDV model, differences based on this dummy variable could affect the relation volatility-sovereign yield.

GIIPS exposures remain significant in both models, indicating the importance of due diligence and proper sovereign debt policies of banks. Banks holding more GIIPS sovereign exposures will show increased volatility. This is expected as GIIPS sovereign debt is considered more risky than other sovereign debt in the euro area.

7 CONCLUSIONS

7.1 MAIN CONCLUSIONS

The final goal of this thesis is the demonstration of the connection between sovereign yields and bank stock return volatility, and how sovereign exposures impact this relation. We focused on banks in the European Union and more specifically on the differences between banks in the periphery and banks in core countries. The distinction between bailed-out banks and non-bailout banks has been made, complementary to the core-periphery distinction.

The qualitative segment of our research confirms previous research regarding sovereign exposures in the euro area. Firstly, we found that home bias was present since the start of the crisis and it is still relevant up to date, however its importance is gradually receding. Especially in the GIIPS countries, home bias posed problems for many banks, as was the case in, for example, Banca Monte dei Paschi. Secondly, the moral suasion as suggested by Battistini, Pagano and Simonelli (2013) proved to be present as well considering the elevated sovereign exposures of bailed-out banks compared to non-bailout banks. Banks were implicitly or explicitly obliged to record increased domestic sovereign exposures. Thirdly, the carry trade hypothesis as suggested by Acharya and Steffen (2015) also impacted bank sovereign exposures, as was the case for mainly core country banks. The increased sovereign yields combined with 0%-risk weights persuaded banks into buying GIIPS sovereign debt.

The quantitative part of this paper provides empirical evidence on the relation between sovereign yields and bank stock return volatility. We find that in the short term, sovereign yields significantly impact domestic bank stock return volatility as indicated by our high-frequency model. Increased sovereign risk thus causes an increase in domestic bank stock risk. This is an important finding which confirms the relation between sovereign states and their banks. The market return indicator and past standard deviation are the main causes of forward standard deviation, while country of origination and being bailed-out or not also impact bank stock return volatility in the short term.

In the long term, market indicators and ex-post standard deviation remain the biggest contributors to ex-ante standard deviation. Contrary to the short term, absolute sovereign yields do not impact domestic bank stock return volatility. Depending on bank, yield spreads however do impact stock return volatility significantly over longer periods. This relation is subject to bank characteristics; being bailed-out or not and country of origin. Counterintuitively, we find no empirical evidence on the negative impact of increased home bias exposures on bank stock return volatility. Although home bias exposure does not impact bank risk directly, it is strongly related considering bailed-out and GIIPS banks tend to have larger domestic sovereign debt positions, as indicated by the qualitative part of the research. Home bias exposure affects forward standard deviation indirectly through bank characteristics and GIIPS exposures. Finally, GIIPS exposures of banks also impact ex-ante standard volatility significantly. Banks with larger exposures to GIIPS countries tend to encounter higher risk.

The aforementioned findings bring us to the conclusion that the relation between sovereign yields and bank stock return volatility exists and is quantifiable. In the short term, this relation is significant and outspoken, while in the long term this relation is contingent upon bank characteristics. This leads us to the question how this feedback effect can be contained and regulated in the future. Similarly, how do governing bodies such as the ECB and EBA must treat home bias, GIIPS and other sovereign exposures when evaluating bank balance sheets, as they prove to be influencing bank risk?

7.2 POLICY RECOMMENDATIONS

Several policy recommendations can be made based on the results in this paper. First, governments should be encouraged and pushed to sort out their public finances. Considering the relation between sovereign yields, bank risk, moral suasion and home bias, governments are responsible for a great share in bank stock return volatility. Therefore it is straightforward that when sovereign states have their finances in order, banks will follow suit. This also strengthens both countries and banks' stability in times of economic downturn.

Secondly, the EBA and ECB must approach sovereign debt differently in stress tests, capital and transparency exercises. As our research showed, domestic and GIIPS sovereign bonds are not riskless, since they increase bank risk. The EBA could introduce non-zero risk-weights for sovereign bonds of certain regions or countries, yet which countries to include at which risk-weight remains up for discussion. Since financial crises are hard to anticipate and estimating their magnitude is even harder, assigning risk-weights to sovereign bonds may be in vain considering once the extent of the situation is known and the respective risk-weights deemed to be underestimated, it's too late. We therefore opt for the introduction of sovereign exposure 'caps'. With the introduction of maximum caps, banks would be obliged to structurally decrease their exposures to certain countries and regions, diversifying their sovereign debt portfolio as to reduce risk in the case of country- or region-specific crises.

Although home bias exposures are not significant in the quantitative research segment, it is in banks and governments best interest to impose maximums on home bias exposures as well. The feedback effects between bank and state create a vicious circle, causing problems for both governments and banks. Since certain banks invest more in sovereign debt than others, caps based on home bias exposure to total assets or capital are more appropriate than relative home bias exposures. In this way, the difference between smaller banks with large sovereign debt portfolios and large banks with smaller sovereign debt portfolios are accounted for. Accordingly, procyclical behaviour of sovereign debt and bank stock return risk is reduced.

7.3 FURTHER RESEARCH

Given the relatively small sample of European banks, additional research including more banks over a wider variety of countries would increase understanding of the relation between sovereign yields and bank stock return volatility. Since this research only included publicly-traded banks of which data of all tests was available, the data sample could be expanded once more data on sovereign exposures becomes available. Even preferable, high-frequency micro-economic data on sovereign exposures would allow researchers to conduct more meaningful research compared to the semi-annual or annual data used during this paper. As this is not yet available up to date, we hope this changes in the near future.

As a result of the research, we suggested the introduction of maximum sovereign exposure caps, both on domestic sovereign exposures as towards other countries and regions. The determination of appropriate restraints provides an excellent point of discussion, paving the way for additional research. Furthermore, the proposed risk-weights should be determined as well. Determining fitting risk-weights according to country-related and region-specific variables will be a very interesting topic for future researchers.

Next to sovereign debt exposures, banks are generally exposed to countries in other ways; e.g. through credit default swaps, private lending, corporate investments, etc. Especially banks present in multiple countries will face exposure towards other countries in more than one manner. It would be interesting to incorporate these exposures in future research additional to sovereign debt. Hence, a more complete view on the relation bank-sovereign can be presented.

8 REFERENCES

Acharya, V. V., Drechsler, I., & Schnabl, P. (2012). A Tale of Two Overhangs: The Nexus of Financial Sector and Sovereign Credit Risks. *Financial Stability Review, 16*(2012).

Acharya, V. V., Eisert, T., Eufinger, C., & Hirsch, C. W. (2016). *Real effects of the sovereign debt crisis in Europe: Evidence from syndicated loans.* Retrieved from SSRN: https://ssrn.com/abstract=2612855

Acharya, V. V., & Steffen, S. (2015). The "greatest" carry trade ever? Understanding eurozone bank risks. *Journal of Financial Economics, 115*(2), 215-236.

Andritzky, J., Gadatsch, N., Körner, T., Schäfer, A., & Schnabel, I. (2016). *A proposal for ending the privileges for sovereign exposures in banking regulation* (German Council of Economic Experts). Retrieved from: http://voxeu.org/article/ending-privileges-sovereign-exposures-banking-regulation

Battistini, N., Pagano, M., & Simonelli, S. (2013). *Systemic risk and home bias in the euro area* (No. 494). Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Bera, A. K., & Jarque, C. M. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, 6(3), 255-259

Birnbaum, M. (2012). *World's oldest bank meets a formidable foe* (The Washington Post, Brussels, Belgium). Retrieved from https://www.washingtonpost.com/world/europe/worlds-oldest-bank-meets-a-formidable-foe/2012/09/01/c42e85b6-f1dd-11e1-adc6-87dfa8eff430_story.html?utm_term=.ff701ab00f3a

Bongaerts, D., & Schoenmaker, D. (2017). *A call for uniform sovereign exposure limits (Bruegel).* Retrieved from http://bruegel.org/2017/03/a-call-for-uniform-sovereign-exposure-limits/

Buiter, W. (2008). Quantitative easing and qualitative easing: a terminological and taxonomic proposal. *Financial Times, Willem Buiter's mavercon blog*.

Choudhry, M. (2008). *The yield curve, and spot and forward interest rates* (Paper, London Metropolitan University, London, United Kingdom). Retrieved from http://www.yieldcurve.com/mktresearch/files/choudhry_introtoyieldcurve_jan2008.pdf

Chowla, S., Quaglietti, L., & Rachel, Ł. (2014). *Quarterly Bulletin*. Bank of England, London, United Kingdom.

De Marco, F., & Macchiavelli, M. (2016). *The Political Origin of Home Bias: The Case of Europe*. Retrieved from SSRN: https://ssrn.com/abstract=2441981

Durante, F., Foscolo, E., & Weissensteiner, A. (2015). *Dependence between Stock Returns of Italian Banks and the Sovereign Risk.* Retrieved from SSRN: https://ssrn.com/abstract=2124934 or http://dx.doi.org/10.2139/ssrn.2124934

Dosanih, K., Carlson, S., & Lemay, Y. (2013). *Credit focus: Denmark, Finland, Norway and Sweden: Peer comparison.* New York City: Moody's . Retrieved from http://kommunekredit.com /Files/Filer/KK_dk/nyheder/Nordic%20sovereigns.pdf

The Economist (2014). *A weary lender* (The Economist Group Limited, Frankfurt, Germany). Retrieved from http://www.economist.com/news/finance-and-economics/21629559-germanys-flagship-bank-trouble-some-its-own-making-weary-lender

European Banking Authority (2015). *Report – 2015 EU-wide transparency exercise* (EBA Aggregate report (2015)). London: European Banking Authority. Retrieved from the European Banking Authority website: https://www.eba.europa.eu/documents/10180/1280458/2015+EU-wide+Transparency+Exercise+Report+FINAL.pdf

European Commission Staff (2016). *Country Report Cyprus 2016* (Commission Staff Working Document SWD (2016) 120). Brussels: European Commission. Retrieved from the European Commission website: http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_cyprus_en.pdf

Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics. McGraw-Hill International Edition, fifth edition.* New York: McGraw-Hill.

Haugh, D., Ollivaud, P., & Turner, D. (2009). *"What Drives Sovereign Risk Premiums?: An Analysis of Recent Evidence from the Euro Area"*, OECD Economics Department Working Papers, No. 718, OECD Publishing, Paris. http://dx.doi.org/10.1787/222675756166

Kasman, S., Vardar, G., & Tunç, G. (2011). The impact of interest rate and exchange rate volatility on banks' stock returns and volatility: Evidence from Turkey. *Economic Modelling, 28*(3), 1328-1334.

Kloeck, A. (2014). *Implicit subsidies in the EU banking sector. An Intermediary Report which is Part of the Forthcoming Study: "Banking Structural Reforms: A Green Perspective*", Study commissioned by the Greens/EFA group in the European parliament.

Koenker, R. (1981). A note on studentizing a test for heteroscedasticity. *Journal of Econometrics 17*(1981), 107-112.

Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). *The effects of quantitative easing on interest rates: channels and implications for policy* (NBER Working Paper No. 11906). Massachusetts: National Bureau of Economic Research.

Lamoureux, C. G., & Lastrapes, W. D. (1994). Endogenous trading volume and momentum in stock-return volatility. *Journal of Business & Economic Statistics*, *12*(2), 253-260.

Lenarčič, A., Mevis, D., & Siklós, D. (2016). *Tackling sovereign risk in European banks (European Stability Mechanism).* Retrieved from the ESM website: https://www.esm.europa.eu/sites/default/files /21032016esmdiscussionpaper1final.pdf

Machtelinckx, W. (2014). *Bank risk and sovereign exposures* (Master's thesis, Ghent University, Ghent, Belgium). Retrieved from http://lib.ugent.be/fulltxt/RUG01/002/164/989/RUG01-002164989 _2014_0001_AC.pdf

Metzler, S., Hendricks, A., & Schuler, C. (2017). *Raiffeisen Bank International AG Credit Opinion.* Moody's.

Noss, J., & Sowerbutts, R. (2012). *The implicit subsidy of banks*. Retrieved from SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2071720

Officer, R. R. (1972). The Distribution of Stock Returns. *Journal of American Statistical Association*, 67(340), 807-812

Ongena, S., Popov, A., & Van Horen, N. (2016). *The invisible hand of the government: "Moral suasion" during the European sovereign debt crisis* (ECB Working Paper No. 1937). Frankfurt: European Central Bank. Doi: 10.2866/876475

Podestà, F. (2002). Recent developments in quantitative comparative methodology: The case of pooled time series cross-section analysis. *DSS Papers Soc, 3*(2), 5-44.

Riksbank Sweden (2010). *Financial Stability Report 2010/1.* Stockholm: Riksbank Sweden. Retrieved from http://www.riksbank.se/Upload/Dokument_riksbank/Kat_publicerat/Rapporter/ 2010/FSR1/FS_2010_1_eng_box1.pdf

Shotter, J. (2015). *Commerzbank warns of future challenges* (The Financial Times Limited, Frankfurt, Germany). Retrieved from https://www.ft.com/content/31397994-b280-11e4-b234-00144feab7de

Tesar, L. L., & Werner, I. M. (1995). Home bias and high turnover. *Journal of International Money and Finance*, 14(4), 467-492

A. LIST OF BANKS

Country	Bank	Bailout	Mnemonic Datastream
Core country banks			
Austria	Erste Group Bank AG	Yes	O:ERS
	Raiffeisen Zentralbank Osterreich AG		O:RAI
Belgium	KBC Bank	Yes	B:KB
France	BNP Paribas	Yes	F:BNP
	Credit Agricole	Yes	F:CRDA
	Société Générale	Yes	F:SGE
Germany	Commerzbank AG	Yes	D:CBK
	Deutsche Bank AG		D:DBK
	Landesbank Hessen Thuringen		D:HLQ1
Netherlands	ING Bank NV	Yes	H:INGA
GIIPS country banks			
Ireland	Allied Irish Banks PLC	Yes	AIB1
	Bank Of Ireland	Yes	BKIR
	Permanent TSB	Yes	IL0A
Italy	Banca Monte Dei Paschi	Yes	I:BMPS
	Intesa Sanpaolo S.p.A.		I:ISP
	Unicredit S.p.A.		I:UCG
Portugal	Banco BPI	Yes	P:BPI
	Banco Comercial Comercial Portugues	Yes	P:BCP
Spain	Banco Bilbao Vizcaya Argentaria		E:BBVA
	Banco Santander		E:SCH
Control country banks			
Denmark	Danske Bank	Yes	DK:DAB
	Jyske Bank		DK:JYS
Hungary	OTP Bank	Yes	HN:OTP
Malta	Bank Of Valletta		MT:BOV
Norway	DNB Bank		N:DNB
Sweden	Nordea Bank AB		W:NDA
	Skandinaviska Enskilda Banken AB		W:SEA
	Svenska Handelsbanken Handelsbanken AB		W:SVK
	Swedbank AB	Yes	W:SWED
United Kingdom	Barclays PLC	Yes	BARC
	HSBC Holdings PLC	Yes	HSBA
	Lloyds Banking Group PLC	Yes	LLOY
	Royal Bank of Scotland Group PLC	Yes	RBS

Table A-1: List of banks

In table A-1 we find all banks incorporated in the data sample, divided over the three groups. The column 'Mnemonic Datastream' indicates the code through which all used data is available on Datastream. The column 'bailout' indicates whether a bank has been bailed out by its government.

B. DESCRIPTIVE STATISTICS & GRAPHS

B.1 SOVEREIGN YIELDS

	Austria	Belgium	France	Germany	Netherlands
Mean	2.0138	2.3737	2.1151	1.5855	1.8241
Median	2.0859	2.4926	2.3171	1.5952	1.8867
Maximum	4.0723	5.7925	3.9570	3.6387	3.8262
Minimum	-0.0227	0.0894	0.0910	-0.2259	-0.0703
Std. Dev.	1.1611	1.3598	1.1060	1.0306	1.0735
Observations	1826	1826	1826	1826	1826

Table B-1: Descriptive statistics sovereign yields core countries

	Greece	Ireland	Italy	Portugal	Spain
Mean	11.6008	4.3670	3.7548	6.1410	3.8975
Median	10.1018	4.2741	4.1271	5.5506	4.2625
Maximum	34.5318	12.4572	7.4034	16.8758	7.6002
Minimum	5.6644	0.3892	1.1389	1.5596	0.9924
Std. Dev.	5.8325	2.9175	1.5919	3.2538	1.7360
Observations	1826	1826	1826	1826	1826

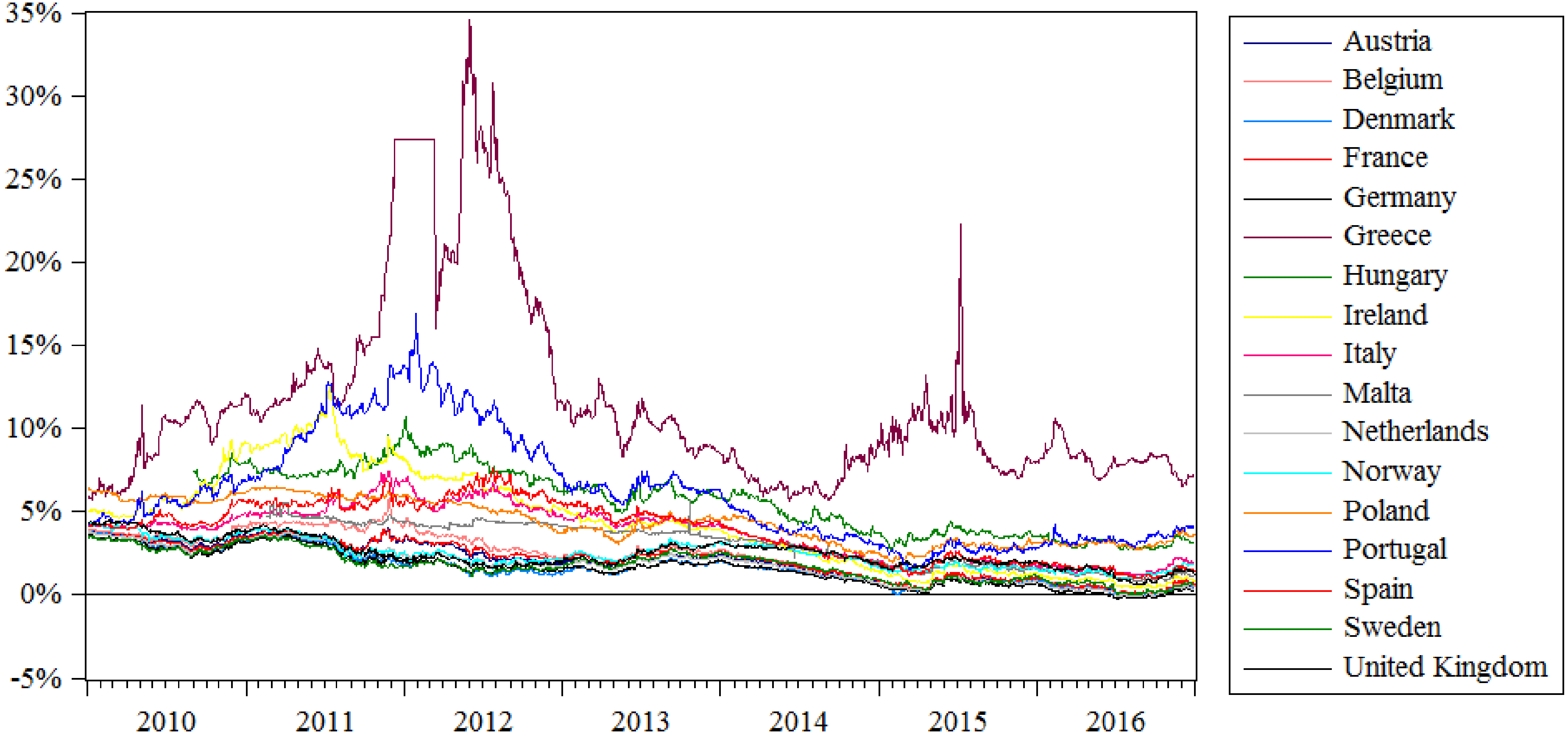
Table B-2: Descriptive statistics sovereign yields GIIPS countries

	Denmark	*Hungary**	*Malta***	*Norway*	*Poland*	*Sweden*	*United Kingdom*
Mean	1.6540	5.6349	3.0185	2.4631	4.3928	1.7819	2.4909
Median	1.5278	5.8717	3.3517	2.4175	4.3285	1.7731	2.2750
Maximum	3.8181	10.7042	5.7679	4.3577	6.4739	3.5792	4.5600
Minimum	-0.0253	2.7181	0.8320	0.9042	1.9648	0.0072	0.5940
Std. Dev.	1.0270	1.9572	1.3101	0.8399	1.3008	0.9226	0.8858
Observations	1826	1652	1531	1826	1826	1826	1826

* Data on sovereign yields of Hungary available starting 2/09/2010.

** Data on sovereign yields of Malta available starting 18/02/2011.

Table B-3: Descriptive statistics sovereign yields control countries


35%
30%
25%
20%
15%
10%
5%
0%
-5%
2010
2011
2012
2013
2014
2015
2016
Austria
Belgium
Denmark
France
Germany
Greece
Hungary
Ireland
Italy
Malta
Netherlands
Norway
Poland
Portugal
Spain
Sweden
United Kingdom

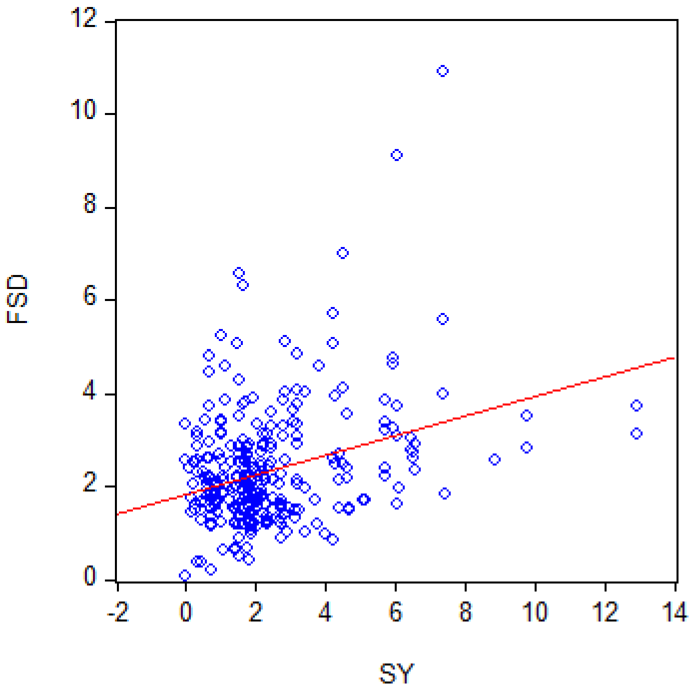


Figure B-2: Scatterplot forward standard deviation and sovereign yield

B.2 BANK STOCK RETURNS

Core group banks	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque-Bera
BNP Paribas	96.9028	99.5926	142.1218	44.2993	19.6691	93.26569*
Commerzbank	44.3459	32.4341	124.8971	15.1966	29.4312	566.3577*
Credit Agricole	82.4164	87.8678	135.0035	25.5625	25.6565	74.26062*
Deutsche Bank	74.2893	76.5197	121.6819	26.7724	19.0757	62.18337*
Erste Group Bank	99.6521	101.4899	154.5833	42.5884	22.1465	15.85548*
ING Bank	132.9043	126.5223	232.3642	65.1029	40.8389	108.1451*
KBC Bank	125.8265	118.4609	230.9659	25.9720	51.0834	80.94525*
Landesbank Hessen-Thuringen	158.4706	164.1329	216.6246	99.8140	42.7139	196.0436*
Raiffeisen Zentralbank	67.1701	69.2706	114.8934	28.3557	21.3787	92.09049*
Societe Generale	77.3551	82.0094	115.0676	32.1535	20.0280	160.3778*

* significant at 1%-level

Table B-4: Descriptive statistics bank stock returns core group

Control group banks	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque-Bera
Bank of Valletta	148.7758	138.4391	224.0123	84.7511	38.2093	166.213*
Barclays PLC	99.0977	102.9737	139.4942	51.9491	18.5175	119.9398*
Danske Bank	128.8294	115.5932	216.8071	58.3827	41.3192	134.7393*
DNB Bank ASA	166.3641	170.1890	271.6775	87.7631	48.1648	121.3099*
HSBC Holdings PLC	99.4111	98.5705	135.4640	70.5492	12.3943	19.14393*
Jyske Bank	123.4355	123.7037	190.1235	64.8395	31.3770	119.1542*
Lloyds Banking Group PLC	121.1576	129.1298	177.2494	43.0925	33.7405	157.1693*
Nordea Bank AB	126.8284	124.2484	196.3342	70.7228	33.1413	129.0857*
OTP Bank NYRT	98.8313	91.7449	178.6916	51.9078	26.4963	237.4649*
Royal Bank of Scotland	110.3437	112.6026	198.8012	50.9931	27.8235	29.95268*
Skandinaviska Enskilda Banken AB	182.2630	177.1935	310.4951	74.0085	67.3834	173.0517*
Svenska Handelsbanken AB	163.9904	164.7617	270.7822	79.6854	53.5044	161.1645*
Swedbank AB	239.2146	249.9972	436.7327	88.3094	95.0247	149.0465*

* significant at 1%-level

Table B-5: Descriptive statistics bank stock returns control group

GIIPS banks	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque-Bera
Allied Irish Banks	17.0957	6.8334	149.1668	1.5670	27.9320	5441.075*
Banca Monte Dei Paschi	30.1953	21.2654	108.3861	0.5835	28.0745	341.1827*
Banco Bilbao Vizcaya Argentaria	73.7640	72.6625	103.2996	41.2776	14.6874	69.4412*
Banco BPI	62.7081	62.6073	110.2703	18.8634	19.9981	15.7731*
Banco Comercial Portuguese	33.8377	22.7411	109.3459	4.8467	25.4808	375.35*
Banco Santander	73.4259	72.9225	103.7224	43.4829	14.5548	96.2981*
Bank of Ireland	35.3830	31.2274	144.1509	8.1359	25.4316	1841.55*
Intesa Sanpaolo	80.2695	79.1753	149.8277	31.8509	27.9834	80.3598*
Permantent TSB	11.0963	1.3951	119.3349	0.4727	23.9129	4970.409*
Unicredit	44.1954	39.9072	103.2843	13.6335	23.1855	269.2107*

* significant at 1%-level

Table B-6: Descriptive statistics bank stock returns GIIPS countries

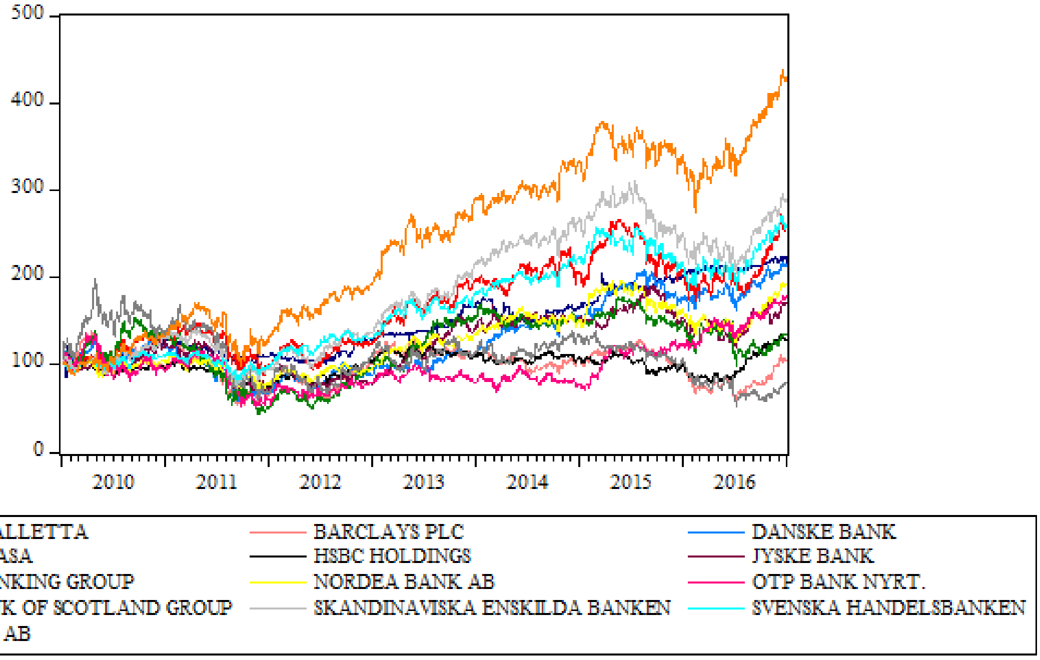


Figure B-3: Stock returns control group banks

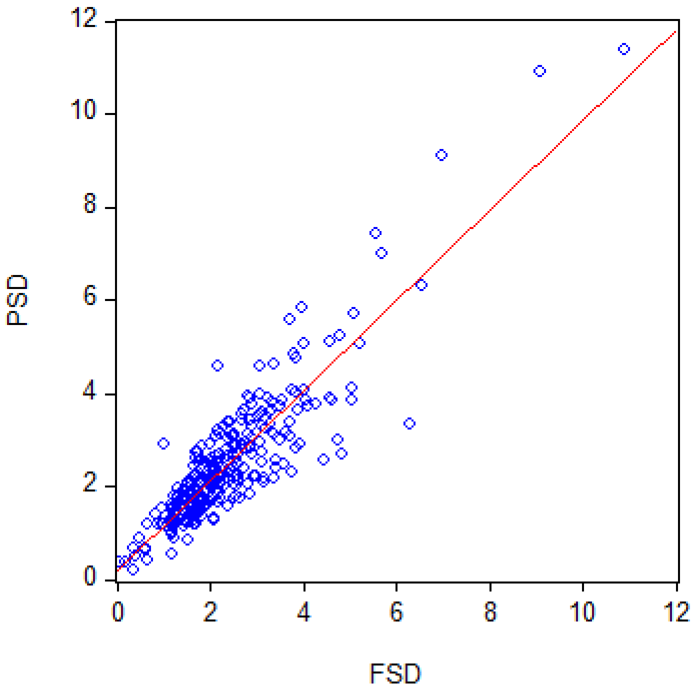


Figure B-4: Scatterplot forward standard deviation and ex-post standard deviation (PSD)

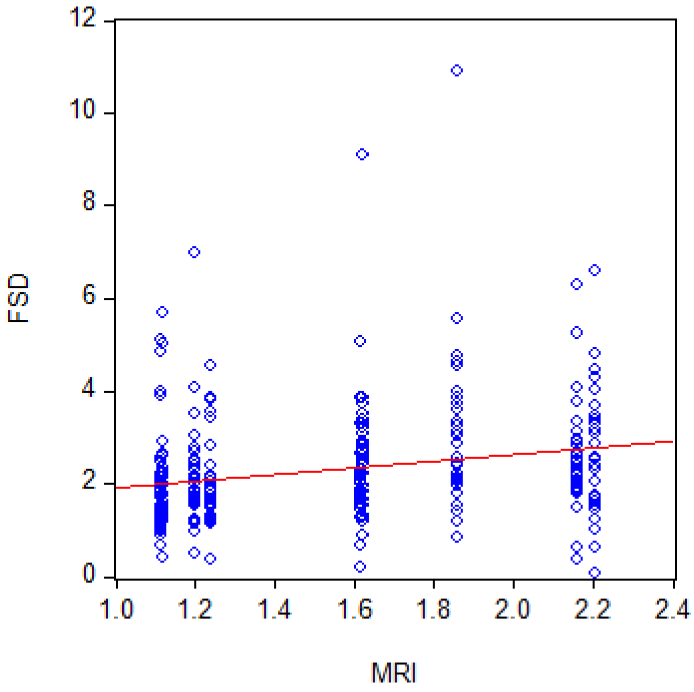


Figure B-5: Scatterplot forward standard deviation and market return indicator (MRI)

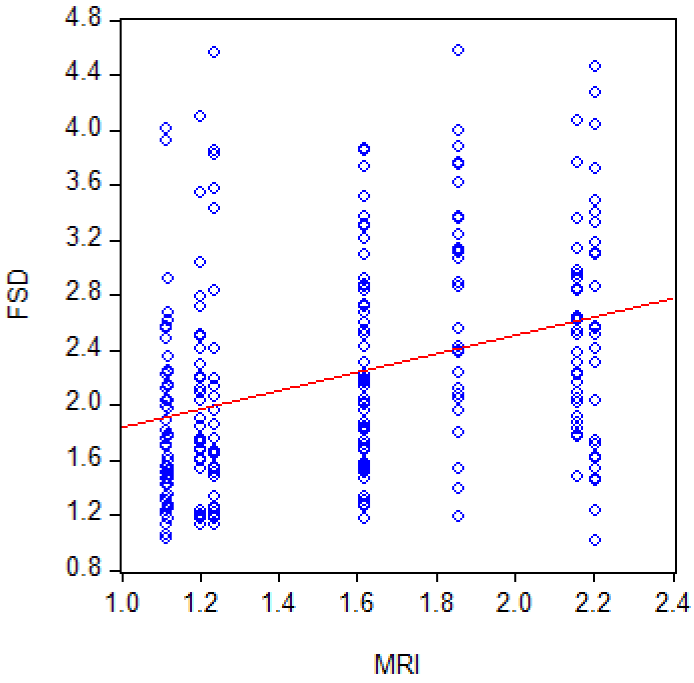


Figure B-6: Scatterplot forward standard deviation and MRI – minus outliers

B.3 Sovereign exposures

Core group banks	Mean*	Median*	Maximum*	Minimum*	Std. Dev.*
BNP Paribas	15.1159	13.9205	19.9381	10.5828	3.3943
Commerzbank	38.2186	36.7456	51.2826	27.4046	8.8239
Credit Agricole	52.6695	53.7203	60.2805	46.7460	4.5917
Deutsche Bank	27.8881	23.7883	49.5120	19.4272	12.1607
Erste Group Bank	26.8639	26.6697	28.2996	25.7673	0.9156
ING Bank	20.0852	20.2632	29.9232	12.7979	5.7370
KBC Bank	48.4824	48.7410	54.3851	42.3261	3.8122
Landesbank Hessen-Thuringen	90.3399	91.0471	92.7141	84.7955	2.5801
Raiffeisen Zentralbank	11.7458	9.5257	24.2862	7.3772	5.0968
Societe Generale	29.5387	29.0990	41.2821	21.4883	6.0718

* in percentages

Table B-7: Descriptive statistics home bias exposure core group banks

GIIPS banks	Mean*	Median*	Maximum*	Minimum*	Std. Dev.*
Allied Irish Banks	70.2153	69.8377	78.9007	62.5186	6.2312
Banca Monte Dei Paschi	98.3991	98.2011	99.0828	97.9834	0.4643
Banco Bilbao Vizcaya Argentaria	59.9705	53.4841	88.9461	48.0656	16.4518
Banco BPI	56.8553	60.8473	81.4001	35.0622	15.6607
Banco Comercial Portuguese	67.5807	70.3204	82.6791	51.8003	9.6452
Banco Santander	47.6521	39.1466	81.5167	32.7013	18.7096
Bank of Ireland	76.4042	85.1377	90.3376	52.8253	14.8194
Intesa Sanpaolo	76.5031	84.8419	90.5419	58.3104	12.9015
Permanent TSB	97.9928	97.2854	100.0000	96.9604	1.2158
Unicredit	44.4328	43.7971	51.0299	40.8965	3.2918

* in percentages

Table B-8: Descriptive statistics home bias exposure GIIPS banks

Control group banks	Mean*	Median*	Maximum*	Minimum*	Std. Dev.*
Bank of Valletta	94.5010	95.2292	95.2292	92.3032	1.1491
Barclays PLC	34.0020	30.2602	54.9064	26.8057	10.2873
Danske Bank	19.4357	20.9119	25.2542	9.9287	4.4735
DNB Bank ASA	67.8411	69.5351	90.1004	41.7917	18.6982
HSBC Holdings PLC	16.1089	10.2220	45.2461	8.1023	13.2349
Jyske Bank	84.8701	83.4823	92.8017	78.4721	4.7601
Lloyds Banking Group PLC	85.9942	85.9027	97.1474	74.0088	7.4383
Nordea Bank AB	16.3038	15.6144	27.5821	8.2716	6.7165
OTP Bank NYRT	86.2519	87.8684	92.0220	79.0949	4.5081
Royal Bank of Scotland	24.8803	21.8324	37.8234	18.6508	7.2801
Skandinaviska Enskilda Banken AB	18.2177	16.9883	29.0755	13.0833	5.2211
Svenska Handelsbanken AB	48.8378	51.0948	82.4612	16.3118	22.8955
Swedbank AB	74.0888	74.1790	81.1467	67.6376	3.9213

* in percentages

Table B-9: Descriptive statistics home bias exposure control group banks

C. Results

C.1 Qualitative analysis

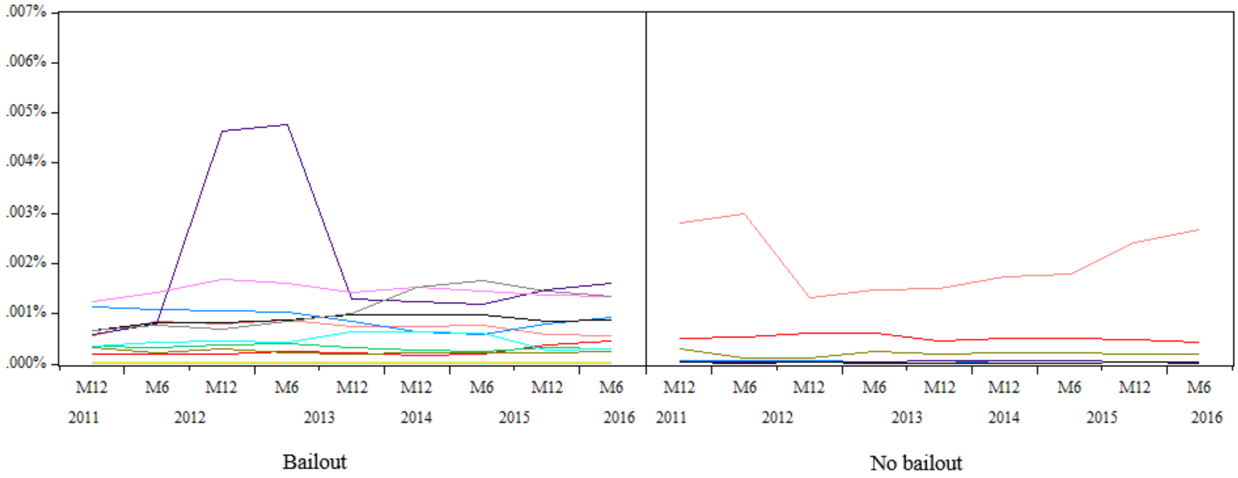


Figure C-1: Home bias exposures relative to total assets - core and control banks

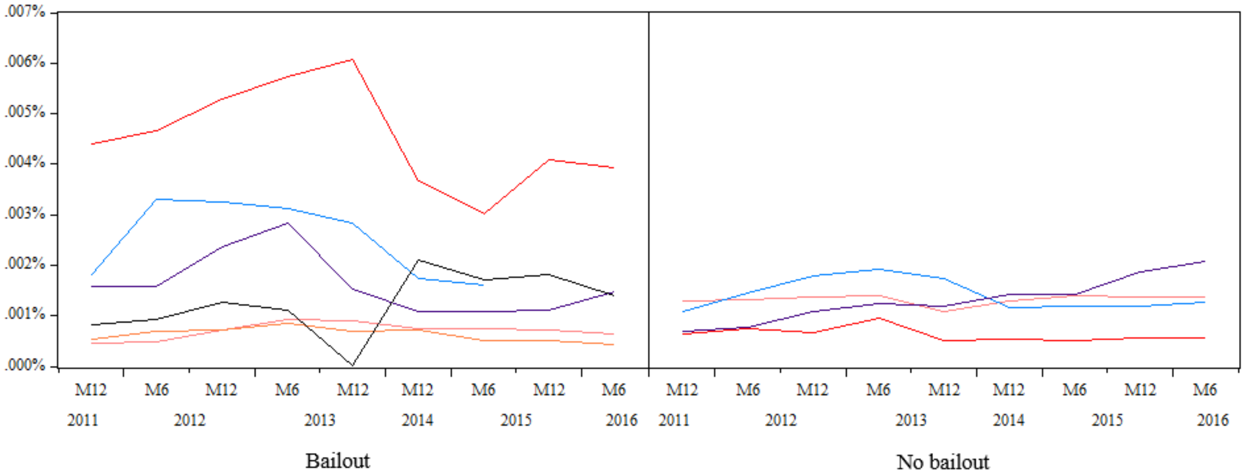


Figure C-2: Home bias exposures relative to total assets - GIIPS banks

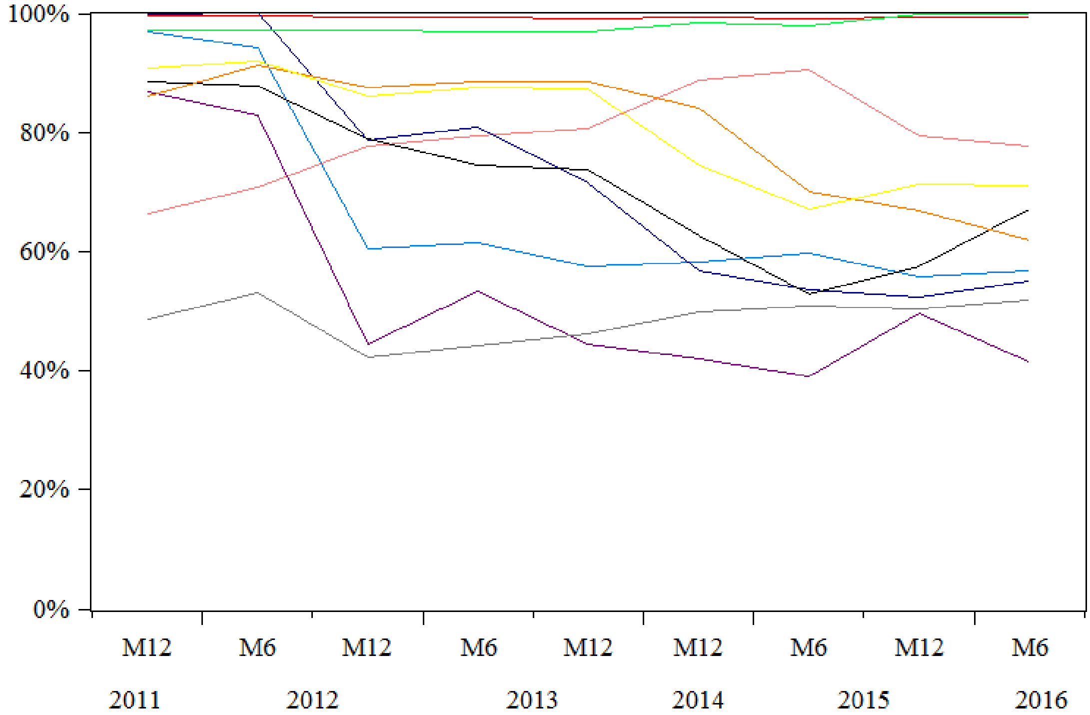


Figure C-3: Unadjusted GIIPS relative exposures GIIPS country banks

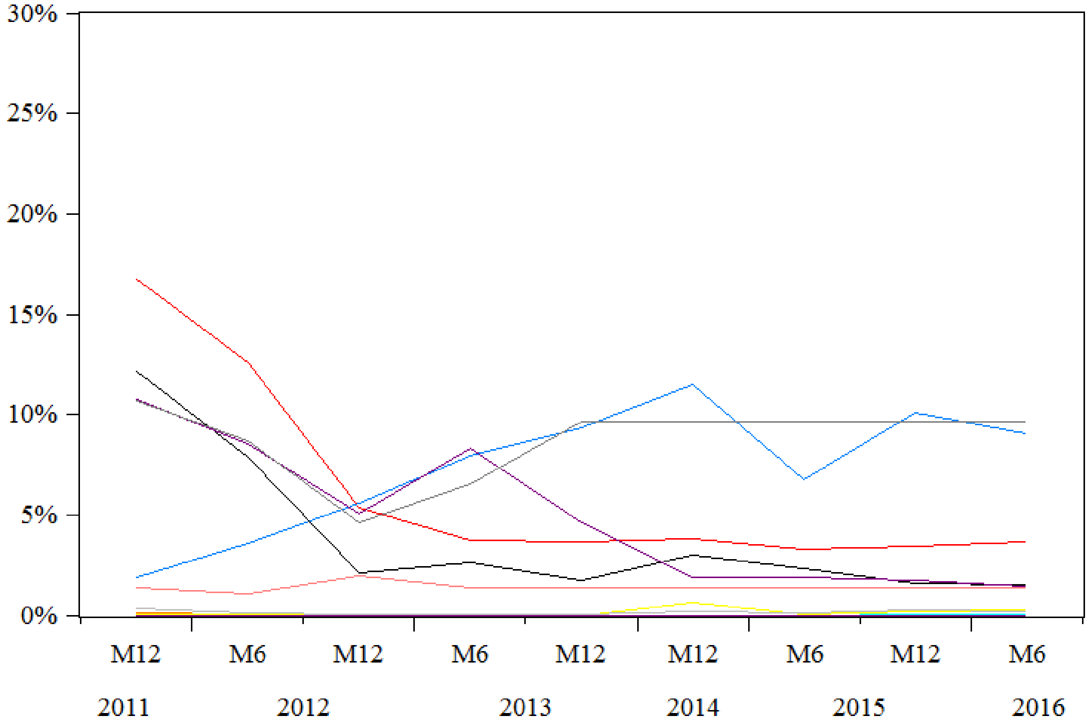


Figure C-4: GIIPS relative exposure control country banks

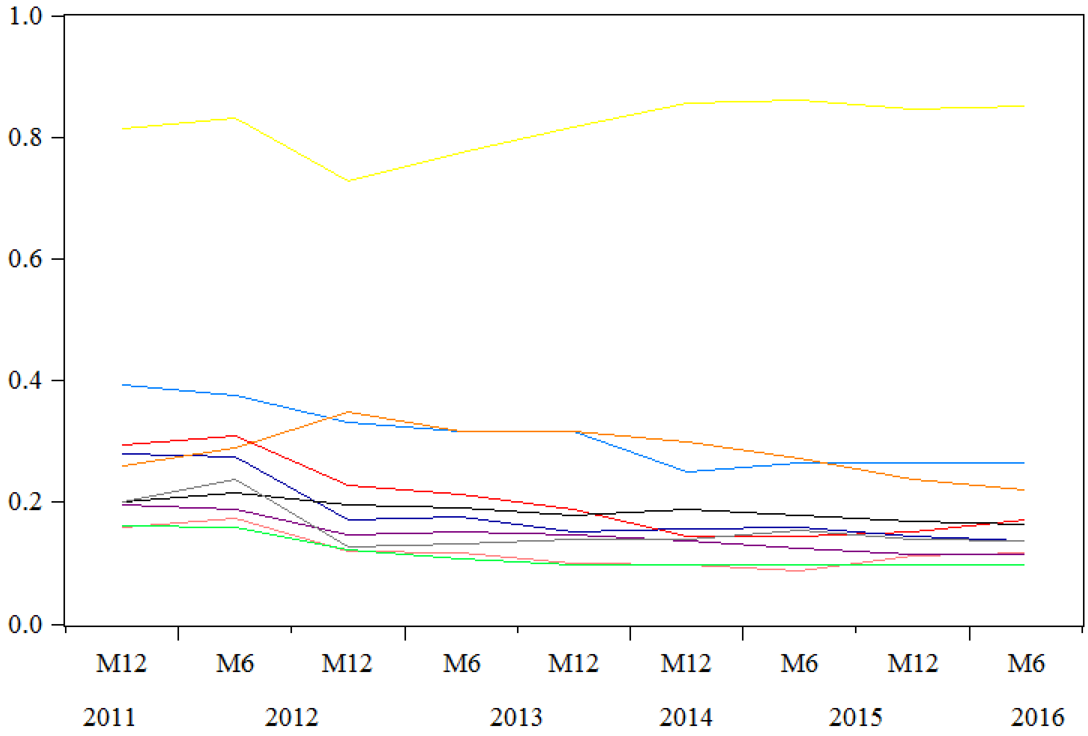


Figure C-5: Concentration sovereign bond portfolio core banks

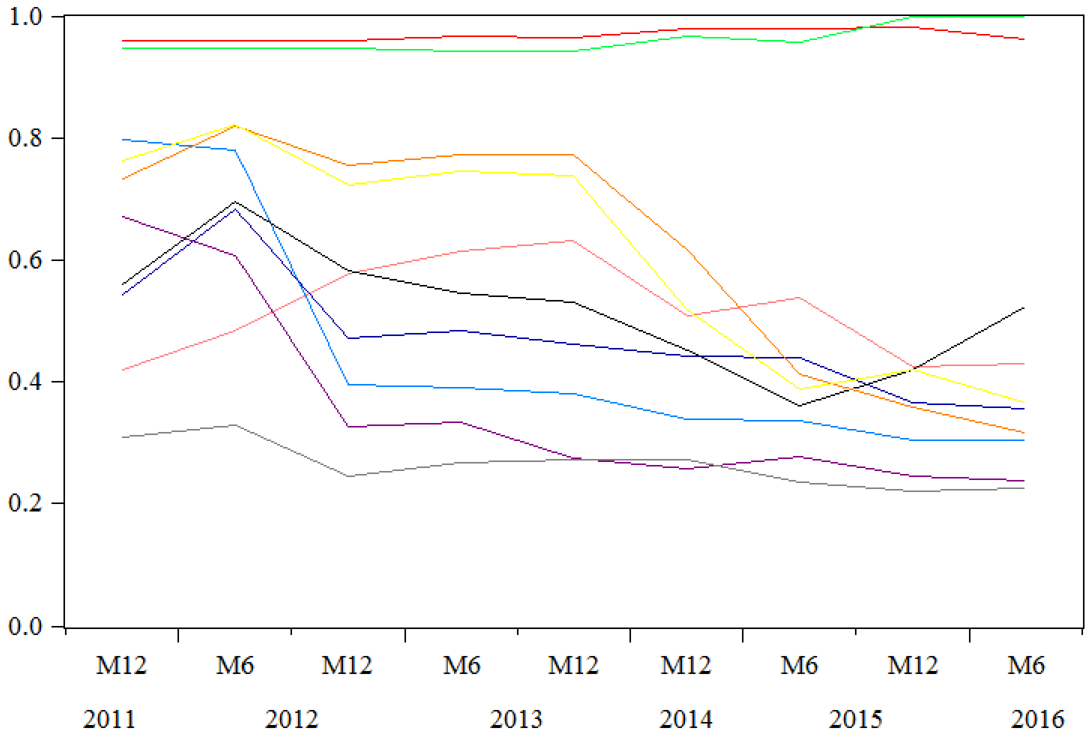


Figure C-6: Concentration sovereign bond portfolio GIIPS banks

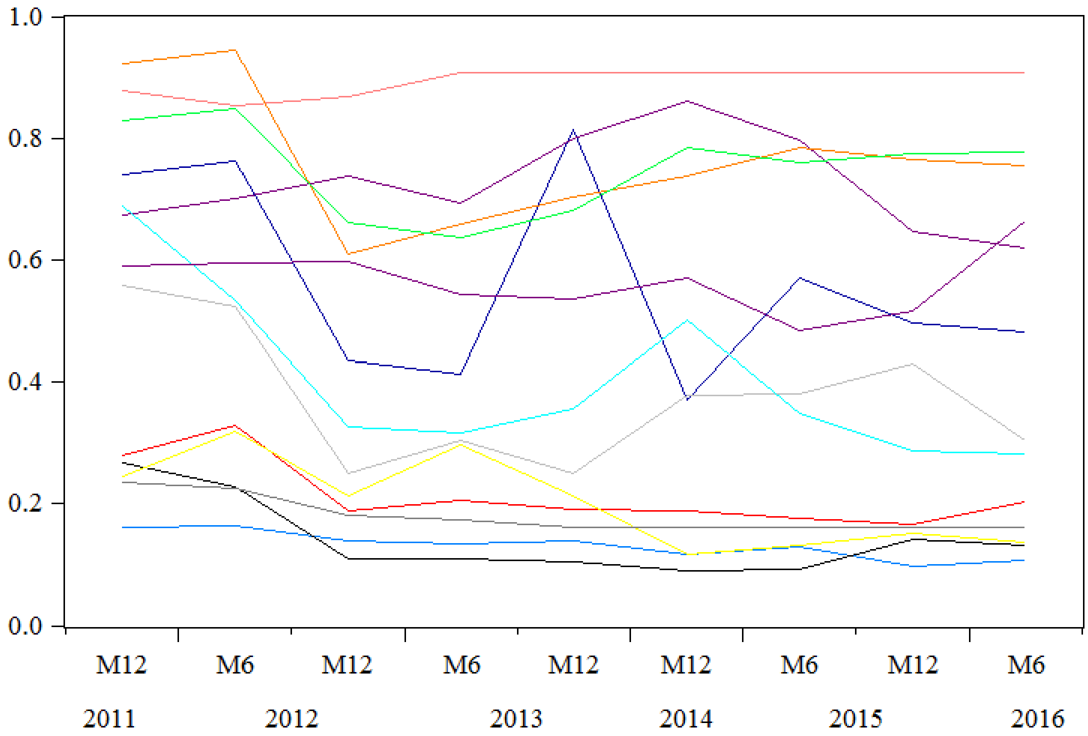


Figure C-7: Concentration sovereign bond portfolio control group banks

C.2 HIGH-FREQUENCY ANALYSIS

Model quality statistics	Alternative specifications (High-frequency LSDV)					
	(1)†	(2)	(3)	(4)†	(5)	(6)
Akaike info criterion	3.81352	3.57057	3.52741	3.80750	3.56919	3.53148
Schwarz criterion	3.81543	3.57312	3.53123	3.80941	3.57174	3.53530
Hannan-Quinn criterion	3.81416	3.57143	3.52869	3.80814	3.57005	3.53276

† Durbin-Watson statistic indicates autocorrelation

Table C-1: Quality of models high-frequency LSDV model

C.3 SOVEREIGN EXPOSURES, YIELDS AND STOCK RETURN VOLATILITY

Explanatory variables	Alternative specifications (OLS)					
	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	-0.2919**	-0.2959**	-0.1160	-0.1782	-0.1066	-0.1680
	(-2.0291)	(-2.2315)	(-0.8133)	(-1.3012)	(-0.7385)	(-1.2081)
Sovereign yield	0.007388		-0.0284		-0.0286	
	(0.402)		(-1.4938)		(-1.5051)	
Yield spread		0.03870***		-0.0011		-0.0014
		(3.3176)		(-0.07295)		(-0.09345)
Market return index	0.4277***	0.4326***	0.4308***	0.4599***	0.4344***	0.4644***
	(5.2121)	(5.5486)	(5.5600)	(6.1093)	(5.5931)	(6.1622)
Past standard deviation	0.7996***	0.7679***	0.7128***	0.7051***	0.7124***	0.7046***
	(30.7332)	(30.0567)	(25.2995)	(25.3535)	(25.265)	(25.3191)
Home bias exposure			-0.0018	-0.0022*		
			(-1.5305)	(-1.8415)		
Home bias exposure*					-0.0019	-0.0023*
D_CC					(-1.5365)	(-1.8383)
GIIPS exposure			0.0079***	0.0074***	0.0060***	0.0052***
			(6.2412)	(4.9709)	(4.2274)	(3.2145)
Observations	297	297	297	297	297	297
R-squared	0.8102	0.8170	0.8328	0.8315	0.8328	0.8315
Adjusted R-squared	0.8083	0.8151	0.8299	0.8286	0.8299	0.8286

* (**, ***) indicates significance at the 10% (5%, 1%) level

D_CC is a core and control group dummy variable

Table C-2: Regression estimates OLS model

Model quality statistics	Alternative specifications (OLS)					
	(7)	(8)	(9)	(10)	(11)	(12)
Akaike info criterion	1.67171	1.63539	1.55878	1.56640	1.55872	1.56644
Schwarz criterion	1.72146	1.68513	1.63340	1.64102	1.63334	1.64106
Hannan-Quinn criterion	1.69163	1.65530	1.58865	1.59627	1.58859	1.59631

Table C-3: Quality of models OLS regression model

Regressions	Breusch-Pagan LM test				
	Cross-section	Period		Both	
(7)	0.94845	38.58975		39.53820	
	(0.3301)	(0.0000)	***	(0.0000)	***
(8)	1.130428	26.1632		27.2936	
	(0.2877)	(0.0000)	***	(0.0000)	***
(9)	0.0138	13.7195		13.7333	
	(0.9065)	(0.0002)	***	(0.0002)	***
(10)	0.054978	17.0475		17.1025	
	(0.8146)	(0.0000)	***	(0.0000)	***
(11)	0.0057	13.7097		13.7154	
	(0.9399)	(0.0002)	***	(0.0002)	***
(12)	0.0372	16.9437		16.9809	
	(0.8471)	(0.0000)	***	(0.0000)	***
Conclusion	No	Yes		Yes	

Breusch-Pagan Lagrange multiplier tests for random effects. Null-hypotheses: no random effects. T-statistics are given, probabilities are given in parentheses.

* (**, ***) indicates significance at the 10% (5%, 1%) level.

Table C-4: Breusch-Pagan Lagrange multiplier test for random effects

Effects test		Cross-section		Period
		F	Chi-square	Chi-square
Fixed effects (Likelihood Ratio)	(7)	2.67232 ***	84.17088 ***	N/A
	(8)	2.44774 ***	77.94628 ***	
	(9)	1.44835 *	48.89244 **	
	(10)	1.69834 **	56.57342 ***	
	(11)	1.40925 *	47.67300 **	
	(12)	1.67101 **	55.74327 ***	
		F	Chi-square	Chi-square
Random effects (Hausman test)	(7)	N/A	0.00000	23.00914 ***
	(8)		0.00000	19.54606 ***
	(9)		0.00000	16.65420 ***
	(10)		0.00000	20.14710 ***
	(11)		0.00000	12.41407 **
	(12)		0.00000	16.21239 ***

Likelihood Ratio (fixed effects) test and Hausman (random effects) test.

Null-hypothesis Likelihood Ratio test: fixed effects are redundant.

Null-hypothesis Hausman test: random effects (RE) estimator is consistent and efficient, fixed effects (FE) estimator is consistent and inefficient.

T-statistics are given.

* (**, ***) indicates significance at the 10% (5%, 1%) level.

Period fixed effects not possible due to singular matrix (MRI identical over all banks).

Table C-5: Likelihood Ratio (FE) and Hausman (RE) tests

Model quality statistics	Alternative specifications (LSDV)					
	(13)	(14)	(15)	(16)	(17)	(18)
Akaike info criterion	1.57140	1.57604	1.55160	1.55871	1.54992	1.55673
Schwarz criterion	1.64602	1.65066	1.63865	1.64577	1.63697	1.64379
Hannan-Quinn criterion	1.60127	1.60591	1.58645	1.59356	1.58477	1.59158

Table C-6: Quality of models LSDV regression model

Model quality statistics	Alternative specifications (Cross-section fixed effects (FE) model)					
	(7)	(8)	(9)	(10)	(11)	(12)
Akaike info criterion	1.60380	1.58843	1.60965	1.59140	1.61369	1.59424
Schwarz criterion	2.05152	2.03615	2.08224	2.06400	2.08629	2.06684
Hannan-Quinn criterion	1.78304	1.76767	1.79884	1.78060	1.80289	1.78344

Table C-7: Quality of models FE regression model