Essays on banks, government debt, and cross-border spillovers of risks and regulation

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Dipl.-Vw. Jana Ohls
aus Rendsburg

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Dekan:	Prof. Dr. Josef Schmid
1. Gutachterin:	Prof. Dr. Claudia M. Buch
2. Gutachter:	Prof. Dr. Werner Neus

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Introduction

The global financial crisis of 2008-2009 and the subsequent European sovereign debt crisis have revealed detrimental feedback effects between sovereign risk and risks in the financial sector.

The risk transmission from the financial to the public sector was fueled by the government bailouts of “too big to fail” financial institutions (Acharya, Drechsler, and Schnabl, 2014). While the bailouts aimed at mitigating contagion and preventing a credit crunch, the costs of these bailouts put a strain on government finances in a situation with already high public debt levels in many countries. The macroeconomic costs of the global financial crisis such as reduced growth and employment burdened the fiscal situation of many countries by lowering tax income and increasing expenditures for social benefits (Ball, 2014; Mourougane, 2017). Overall, these developments increased government debt ratios markedly since the onset of the financial crisis. For example, European Union (EU) member states’ general government debt relative to GDP rose on average from 58% in 2007 to 84% in 2016, although with notable variation between countries (Eurostat, 2017). Government bond yield spreads in Europe started to widen after a period of subdued differences in government interest rates that had not reflected differences in fiscal and macroeconomic fundamentals (De Grauwe and Ji, 2012).

The rise in sovereign risk premia for vulnerable countries, in turn, affected the financial system through several channels, most importantly through the government bond portfolios of financial institutions (CGFS, 2011). For one, the increase in sovereign risk immediately lowered the market value of banks’ holdings of risky government bonds which deteriorated the banks’ capital position (at least when bonds were marked-to-market) and increased banks’ default risk premia (Acharya et al., 2014; De Bruyckere, Gerhardt, Schepens and Vander Vennet, 2013). Also, the rise in sovereign risk affected the use of government bonds as collateral in banks’ funding and hedging operations (CGFS, 2011). In addition to these direct effects, banks also faced higher credit risks stemming from their private loan portfolio since the adverse effects of sovereign risk on economic growth and investment increased the default risk of domestic financial and non-financial firms (Ciocchini, 2002; Durbin and Ng, 2005). Whereas academics and policymakers focused on the vulnerability of banks, non-bank financial intermediaries including insurance companies were also exposed to the rise in sovereign risk through their government bond portfolios. While some countries, such as

Germany, experienced a flight to safety effect, banks' and non-banks' holdings of foreign risky government debt induced cross-border spillovers of risks (Buch, Koetter, Ohls, 2016; Duell, Koenig, Ohls, 2017). In sum, the increase in sovereign risk became a threat to financial stability in Europe.

A destabilizing feedback loop, the so-called "sovereign-bank-nexus", emerged as the elevated risks in the financial system increased the contingent liabilities of the sovereigns from (implicit or explicit) bail-out guarantees for domestic banks which triggered further increases in sovereign risk premia of vulnerable countries (Acharya et al., 2014).

Policymakers have implemented a number of changes to the institutional and regulatory framework in order to address the sovereign-bank-nexus. So far, more progress has been made in mitigating the spillover effects from the banking system to the sovereign than the other way around (European Commission, 2015). For instance, the establishment of the Banking Union with its Single Resolution Mechanism (SRM), complemented by the Bank Recovery and Resolution Directive (BRRD), aimed at facilitating a bank's resolution without relying on taxpayers' money. Furthermore, the resilience of the financial system was strengthened by increasing banks' capital and liquidity buffers and developing new macroprudential tools to address systemic risks. Going forward, the effectiveness of these policy reforms need to be evaluated to understand their (desired and undesired) effects and how they interact with each other. For example, in an integrated world, national regulatory measures may spur cross-border spillovers calling for an international coordination of prudential measures.

Progress in containing the spillovers from the sovereign sector to the financial system seems more limited. While the fiscal rules in the European Union have been reinforced, the regulatory treatment of sovereign risk has not been changed yet. Instead, banking and insurance regulations continue to grant a preferential treatment to domestic public relative to private debt (ESRB, 2015a). With respect to capital requirements, European banking regulation applies a zero risk weight and an exemption from large exposure rules to government debt issued by EU member states in domestic currency (Article 114(4) and Article 400 of the Capital Requirements Regulation (CRR)).[1] Similarly, European insurance regulation exempts government debt issued by European Economic Area (EEA) member

[1] While the zero risk weight applies in the in the standardized approach, banks that use the internal rating based approach (IRB) may opt for the "permanent partial use" with respect to sovereign exposures and follow the rules of the standardized approach (Article 150 CRR). With respect to liquidity requirements, domestic sovereign exposures count towards high quality liquid assets (HQLA) in the liquidity coverage ratio (LCR) in Basel III and the European CRR.

states in domestic currency from the spread and concentration risk modules in the standard formula (Solvency II, Delegated Regulation (EU) 2015/35). Banks' investments into home government debt, in particular, have been shown to play a prominent role in increasing the vulnerability of the financial system to sovereign risk in stressed euro area countries (Acharya et al., 2014; De Bruyckere et al., 2013). Policymakers and academics have therefore been striving for a better understanding of banks' incentives to hold government debt.

Against this backdrop, the thesis addresses research questions on the transmission of sovereign risk to the financial system, on banks' incentives to hold home and foreign government debt, and on cross-border effects of regulatory measures. Thereby, it contributes to an improved understanding of the "sovereign-bank-nexus", underlines the relevance of political factors in banking and contributes to the evaluation of regulatory reforms.

Chapter 1 complements the literature on banks' government bond portfolios - which mainly focuses on the countries directly affected by the sovereign crisis - by analyzing German banks' home and foreign government bond holdings and the implications of these holdings for bank risk. Chapter 2 sheds light on German banks' incentives for holding regional home government bonds and shows that the ownership structure of banks plays a special role in banks' investment decisions. Chapter 3 compares the vulnerability to sovereign risk between banks, insurance companies and non-financial firms and takes a closer look at the channels through which sovereign risk transmits to insurers. Finally, Chapter 4 studies cross-border effects of bank regulation through German banks' local and global lending activities. Thereby, it contributes to policy questions on the international coordination of prudential measures.

The remainder of this introduction discusses the contribution, empirical approach and results of each chapter in more detail.

Understanding the determinants and implications of banks' investments into government debt is a key issue for academics and policymakers. **Chapter 1**[2] addresses these questions from the point of view of German banks. The existing empirical literature focuses on large banks and on the period since the outbreak of the European sovereign debt crisis only (see, for instance, Acharya and Steffen, 2015). Also, previous studies assume that banks' government bond holdings are exogenous to bank risk (Acharya et al., 2014; De Bruyckere et al., 2013),

[2] Chapter 1 is based on the published article Buch, C.M., Koetter, M., and Ohls, J. (2016). Banks and sovereign risk: A granular view. Journal of Financial Stability, 25, pp. 1-15.The copyright of the original article is with Journal of Financial Stability, Elsevier B.V.

which gives rise to endogeneity concerns if banks' risk preferences determine their government bond holdings.

Chapter 1 contributes to the literature in several ways. The methodology explicitly controls for the self-selection of banks into holding government bonds and addresses endogeneity concerns by using predicted instead of observed government bond holdings when analyzing bank risk. To this end, the empirical methodology proceeds in two steps. First, a Heckman (1979) selection model is used to study banks' volume of government bond holdings from a particular issuer (outcome equation), conditional on the banks' decision to hold any bonds from this issuer (selection equation). Next, the predicted government bond holdings are aggregated per bank and quarter into three risk categories and included as explanatory variables in fixed effects regressions explaining bank risk. Using the predicted rather than observed government bond holdings is in the spirit of an instrumental variable approach, with the macroeconomic country variables serving as instruments.

The analysis provides empirical evidence on large as well as small German banks and crisis as well as tranquil times (Q4:2005 to Q3:2013). The comprehensive panel dataset is based on the *Securities Holdings Statistics* of the Deutsche Bundesbank (Amann et al., 2012, Bade et al., 2016), bank supervisory data and macroeconomic and market data providers (*Centralised Securities Database*, *MarkIT*, and the OECD). The dataset includes the end-of-quarter government bond holdings on the issuer level (29 OECD countries) for each German bank (1,970 banks, excluding foreign-owned and special-purpose banks) and the time period Q4:2005 to Q3:2013.

Chapter 1 has three main findings. First, not all German banks hold government bonds. In fact, around 15% of German banks did not invest into government bonds at all between Q4:2005 and Q3:2013. Another 25% of all German banks always hold some government bonds. The remaining banks enter and exit government debt markets frequently. Banks that are larger, have a lower capital ratio (and in this sense riskier banks) and banks that are more active in capital markets (i.e. have a larger securities portfolio or more securitized liabilities) are more likely to hold government bonds and hold a larger volume of these bonds.

Second, German banks did not differentiate much between countries based on macroeconomic and fiscal conditions prior to the 2008 financial crisis. This finding is in line with de Grauwe and Yi (2012), who argue that sovereign risk in the euro area was underpriced in the bond market before the crisis. After the collapse of Lehman Brothers, macroeconomic factors began to matter. With the outbreak of the European sovereign debt

crisis, German banks held fewer bonds of highly indebted and high yield sovereigns. This finding stands in contrast to the "search for yield" of large European banks documented by Acharya and Steffen (2015), but is in line with a "flight to safety" and a "flight home" by German banks (Hildebrand et al., 2012).

Third, the default risk of German banks increases with larger holdings of risky government bonds (rated BBB or worse). This result is driven by commercial banks and the sovereign debt crisis period mainly. Before 2010, only market based, not accounting based measures of bank risk respond to the banks' holdings of risky government bonds which might reflect the widespread absence of marking to market at the onset of the crisis. Finally, larger holdings of low risk government bonds (rated AAA) decrease the risk of savings and cooperative banks during the whole sample period but to a much smaller magnitude.

Overall, Chapter 1 stresses that banks' revealed risk preferences change over time and finds that German banks are not insulated against credit risk stemming from their government bond portfolio. This stands in contrast to the treatment of government bonds in current banking regulation that allows a zero risk weight and the exemption from large exposure limits for European government debt.

Whereas Chapter 1 analyses the overall government bond portfolio of German banks, **Chapter 2**[3] focuses on German state ("Länder") bonds to test the hypothesis that state governments use moral suasion on "home" banks (i.e. banks located in the state). The idea of moral suasion (Romans, 1966) is that governments - by means of explicit or implicit threats or through the banks' anticipation of the political will - persuade home banks to hold more home government debt than banks would do due to other incentives. Recent theoretical and empirical studies have argued that moral suasion is one driver behind European banks' large holdings of home government bonds during the sovereign debt crisis (Chari, Dovis and Kehoe, 2016; De Marco and Macchiavelli 2016; Ongena, Popov, and van Horen, 2016).

Chapter 2 complements these cross-country papers by studying the moral hypothesis at the regional level in Germany. The regional setting mitigates the differences in the institutional and regulatory framework that may have affected the earlier studies. Furthermore, the analysis is the first to account for the impact of moral suasion on the decision of banks for holding home government bonds at all and to control for unobserved time-varying bank-specific incentives for holding state bonds.

[3] Chapter 2 is based on Ohls, J. (2017) Moral suasion in regional government bond markets. Deutsche Bundesbank Discussion Paper Series, 33/2017.

The empirical approach in Chapter 2 uses differences in the fiscal conditions between states and over time as reported by the German Stability Council to identify differences in the states' incentive to use moral suasion. The banks' incentives to collude are captured by the location and ownership structure of banks (e.g. state ownership of Landesbanken and regional development banks) or membership of politicians in banks' supervisory boards.

Similar to Chapter 1, the baseline empirical model follows Heckman (1979) to study the impact of moral suasion on a bank's decision whether to hold any home state bonds (selection equation) and on the volume of a bank's home state bond holdings (outcome equation). In addition, the importance of a bank's holdings relative to the outstanding state bonds is estimated using a fractional logit model as proposed by Papke and Wooldridge (1996) and fixed effects regressions. The latter allow controlling for unobserved time-varying heterogeneity on the bank level and on the issuer level as well as for an unobserved bank-specific structural preference for a particular issuer (identification through heterogeneity).

The main component of the dataset is the *Securities Holdings Statistics* of the Deutsche Bundesbank (Amann et al., 2012, Bade et al., 2016), that gives the end-of-quarter bank holdings of 2,078 German state bonds of 2,024 banks (excluding foreign-owned banks)[4] over the time period Q4:2005 to Q2:2014. In addition, the German Stability Council provides information on the states' fiscal strength along four criteria, which is used to construct an indicator on the number of stability criteria that a state breaches.[5]

The results are in line with moral suasion on home (state-owned) banks by state governments. Home banks (i.e. banks located in the state that issues the bond) are more likely to hold and hold more home state bonds than "out-of-state" banks (i.e. banks located in another German state), especially when the state is in a *weak* fiscal condition and the home bank is *directly owned by the state government* (i.e. Landesbanken and regional development banks).

State-owned banks located in weak states hold more home state bonds than other banks located in weak states and than state-owned banks located in strong states. The intensity of state control also matters. Banks that are owned by one instead of several states and banks with a larger share of bank equity owned by the home government hold a larger amount of

[4] In contrast to Chapter 1, special-purpose banks are included in the analysis in Chapter 2 in order to cover regional development banks.

[5] The German Stability Council assesses the risk of an impending budgetary emergency of states and publishes its results annually. The stability criteria are the following: interest expense to tax income, outstanding state debt, structural net lending/borrowing, and the credit funding ratio.

home state bonds. Similarly, a larger share of state politicians on the bank's supervisory board increases the preference for home state bonds.

The findings remain in line with moral suasion after controlling for other (observed and unobserved) incentives of banks for holding home government debt, such as risk shifting (Farhi and Tirole, 2016), political endearing (Koetter and Popov, 2017), private lending opportunities (Gennaioli et al. 2014), and information asymmetries (Portes, Rey and Oh, 2001). Also, the findings are robust to using different empirical specifications and measures of a state's fiscal situation as well as to excluding the financial crisis period and specific types of states from the sample.

Chapter 2 suggests that political factors are important to consider when studying bank decisions. Also, it sheds light on banks' incentives to accumulate home government debt on their balance sheets and has implications for the effectiveness of fiscal institutions such as the German Stability Council in promoting market discipline.

Chapter 3[6] extends the view beyond banks by studying the transmission of sovereign risk to insurance companies' default risk. Insurers are large institutional investors managing roughly 12% of all global financial assets (IAIS, 2011) and European insurers invest about 22% of their assets in sovereign bonds (J.P. Morgan Cazenove, 2014). Yet, there is only little research on the effects of sovereign risk on insurance companies.

So far, the literature on the transmission of sovereign risk to the private sector has focused almost exclusively on either banks (Acharya et al., 2014; Altera and Schüler, 2012; Battistini, Pagano, and Simonelli, 2014) or (non-financial) firms (Ciocchini, 2002; Durbin and Ng, 2005). One notable exception is Billio, Getmansky, Gray, Lo, Merton, and Pelizzon (2013), who study the interconnections between banks', insurers', and governments' default risk based on Granger causality and network models. They find that sovereign risk is more likely to Granger cause insurance risk than vice versa. Billio et al. (2013) do however neither estimate a causal effect of sovereign risk on insurers nor analyse the channels through which sovereign risk is transmitted, which is what Chapter 3 does.

The analysis proceeds in three steps. First, it estimates the effect of sovereign risk on the default risk of domestic insurance companies. Then, it tests whether the effect on insurers is different from the one on banks and on non-financial firms. Finally, the channels of risk transmission are investigated.

[6] Chapter 3 is based on the published article Duell, R., Koenig, F., and Ohls J. (2017) On the exposure of insurance companies to sovereign risk - Portfolio investments and market forces. Journal of Financial Stability, 31, pp. 93–106. The copyright of the original article is with Journal of Financial Stability, Elsevier B.V.

The dataset covers a sample of sovereigns, insurance companies, banks and non-financial firms from nine countries (Belgium, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States) over the time period from 1 January 2008 to 1 May 2013. Detailed panel data on sovereign bond holdings of individual insurance companies are collected from quarterly publications by JP Morgan Cazenove (2014) to test for the channels of risk transmission.

In the baseline specification, the insurers' credit default swap (CDS) spread is regressed on the home sovereign CDS spread and on control variables for economic growth, uncertainty and the banking sector's default risk. The regression is performed in log changes to purge any unobservable time-invariant heterogeneity in the business model and risk preference of insurers. A similar specification has been applied by Acharya et al. (2014) to study risk spillovers between sovereigns and domestic banks. Chapter 3 also implements an instrumental variable (IV) approach as in Bedendo and Colla (2013) to address the potential concern that implicit guarantees for insurers might induce reverse causality in the baseline specification. Domestic sovereign and banking system risk are instrumented with average foreign sovereign and banking system risk respectively and the interbank lending rate serves as overidentifying restriction.

The results suggest that a larger rise in sovereign risk leads to a larger rise in domestic insurers' default risk significantly. This finding is robust to using stock prices or expected default frequencies instead of CDS spreads as measure for insurer risk. The sensitivity of insurers to a rise in domestic sovereign risk is not significantly different from the sensitivity of banks but larger than for non-financial companies. This result is not driven by any specific non-financial sector. The difference to non-financial companies can be attributed to those insurers that have later been classified as systemically important by the Financial Stability Board (FSB). Chapter 3 further documents that the transmission of sovereign risk to domestic insurers is non-linear as it increases with the level of sovereign risk. Similar to Chapter 1, Chapter 3 highlights heterogeneity in market perceptions over time. Insurers' CDS spreads did not respond to an increase in domestic sovereign risk before the outbreak of the recent financial crisis, but only thereafter.

The analysis then makes use of the detailed portfolio data to test for the importance of the insurers' sovereign bond holdings in sovereign risk transmission (portfolio channel). An increase in the credit risk of an insurer's sovereign bond portfolio increases the market's

expectation of the insurer's default risk significantly, even after controlling for unobserved time-varying heterogeneity between countries.

The findings of Chapter 3 have implications for the regulatory treatment of sovereign bonds. While market participants account for credit risk stemming from the government bond portfolio when assessing an insurer's default risk, insurance regulation – similar to banking regulation - assumes that sovereign bonds are credit risk free. Solvency II, which came into effect in Europe in 2016, exempts sovereign bonds issued by EU member states from the spread and concentration risk modules when calculating solvency capital requirements. Furthermore, Chapter 3 addresses a gap in the academic literature which focused almost exclusively on banks and only recently accounts for the role of non-bank financial intermediaries such as insurers for financial stability.

While the first three chapters of this thesis focus on banks' demand for government debt and on the spillovers of sovereign risk to the broader financial system, **Chapter 4**[7] analyses the cross-border effects of regulatory changes through German banks' local and global lending behavior. In response to the recent financial crisis, policymakers and regulators have developed macroprudential instruments that target the stability of the financial sector as a whole. In integrated banking markets, banks can respond to these regulatory changes in one country by shifting their activities between countries. This can weaken the effectiveness of national prudential instruments and create cross-border spillovers. The European Systemic Risk Board (ESRB), which is responsible for the macroprudential oversight of the EU financial system, has therefore recommended an annual assessment of the cross-border effects of these measures (ESRB, 2015b).

The empirical literature on cross-border effects of prudential measures is relatively new but has been growing recently. Typically, these papers are constrained either to one country and make use of detailed bank-level information to identify the effects of regulation (Aiyar, Calomiris, and Wieladek, 2014; Jiménez, Ongena, Peydro, and Saurina Salas, 2012; Danisewicz, Reinhardt and Sowerbutts, 2015), or to aggregate country-level data in a cross-country setting (Claessens, Ghosh, and Mihet, 2013; IMF 2011).

[7] Chapter 4 is based on Ohls, J., Pramor, M., and Tonzer, L. (2016) International Banking and Cross-Border Effects of Regulation: Lessons from Germany. Deutsche Bundesbank Discussion Paper Series, 27/2016. The paper has been published in a shorter version as Ohls, J., Pramor, M., and Tonzer, L. (2017) International Banking and Cross-Border Effects of Regulation: Lessons from Germany. International Journal of Central Banking, 13 s1, pp.129-162. The copyright of the original article is with the Association of the International Journal of Central Banking.

The analysis in Chapter 4 is part of the International Banking Research Network (IBRN)[8], an initiative that addresses this trade-off between identification from micro data and cross-country results in a two-step approach. First, research teams from national central banks apply a common methodology to their detailed but confidential bank-level datasets in separate country studies. Second, a meta-analysis (Buch and Goldberg, 2017) is conducted on the non-confidential results from the country studies to draw conclusions that apply not only to one country, but more generally. Chapter 4 is the country study for Germany and is one of 15 country studies (and one cross-country study) that evaluate the cross-border spillovers of regulation.

It uses detailed micro-level data on the domestic and international lending activities of German parent banks, their foreign branches and subsidiaries taken from the *External Position Report* of the Deutsche Bundesbank (Fiorentino, Koch and Rudek, 2010) and on domestic lending activities by foreign affiliates located in Germany taken from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank.[9] The granular data are merged with the *IBRN Prudential Instruments Database* (Cerutti, Correa, Fiorentino and Segalla, 2017), a new cross-country database on changes in eight prudential instruments (e.g. general and sectoral capital requirements and loan-to-value ratios).

The common methodology developed within the IBRN employs variation in banks' exposure to foreign regulation through banks' international activities and variation in banks' balance sheet conditions to identify the effect of regulatory changes on local and cross-border loan growth. The bank-level data mitigate endogeneity concerns, since regulation is unlikely to respond to the behavior of an individual foreign bank. The baseline regressions are conducted in log changes and control for unobserved heterogeneity at the bank and at the time level. The prudential indicators are included contemporaneously as well as their first two lags to allow for sluggish adjustment of banks' loan growth.

The findings of Chapter 4 highlight that the direction and magnitude of the regulatory spillovers vary between instruments and types of banks. For instance, changes in *foreign regulation* affect lending *to the German economy* in two opposite ways. On the one hand, German-owned banks increase their domestic loan growth if foreign countries that they are exposed to tighten general capital requirements and loan-to-value ratios. On the other hand, foreign-owned affiliates located in Germany reduce their loan growth to the German economy

[8] For more information on the IBRN please see https://www.newyorkfed.org/IBRN/index.html.
[9] For more information on the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank, please see https://www.bundesbank.de/Redaktion/EN/Standardartikel/Service/Reporting_systems/monthly_balance_sheet_statistics.html?https=1

if sector-specific capital buffers, local reserve requirements and loan to value ratios are tightened in their home country. This withdrawal from the German lending market is less pronounced for foreign affiliates that are larger, have a higher capital ratio and more illiquid assets suggesting that these foreign affiliates are less prone to shift resources to the parent banks in response to higher regulatory pressure at home.

In addition to the common regressions that are applied by all IBRN research teams, Chapter 4 also investigates the impact of German banks' organizational structure on the regulatory spillovers across borders. Foreign subsidiaries of German parent banks are typically subject to host country regulation, while foreign branches are subject to home country (i.e. German) regulation. Chapter 4 shows that only foreign subsidiaries, not foreign branches respond to a tightening in regulation in the host country by reducing local lending. There is no evidence for regulatory leakages since foreign branches do not significantly increase their local lending in these situations.

Chapter 4 highlights the need for evaluating cross-border spillovers of regulation when implementing national prudential measures. It shows that spillovers are state-dependent and are mitigated by higher capital and liquidity buffers of banks.

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Chapter 1: Banks' government bond holdings and bank risk[1]

1.1 Introduction

Banks are important investors on domestic and foreign government bond markets. During the European government debt crisis, the patterns of such investments have changed as banks have tended to withdraw from foreign markets. Changes in the investment patterns of banks have given rise to the debate on how the risk of banks and sovereigns are linked and how this "bank-sovereign nexus" affects financial stability in the Euro Area. Since the outbreak of the European government debt crisis, government bonds issued by periphery countries in the Euro Area (i.e. Greece, Ireland, Italy, Portugal, and Spain) were reallocated from foreign investors towards domestic banks (Battistini, Pagano, and Simonelli, 2014). The mirror-image of this pattern is a withdrawal of foreign investors, including German banks, from risky European government debt, which is what we study.

This chapter analyses the investment behavior of German banks by answering two questions. Why do banks invest into government bonds? And do holdings of government debt affect bank risk? Empirical work on these questions faces two challenges. First, sufficiently detailed information on government bond portfolios of banks are usually confined to the largest banks and to the period after the outbreak of the European government debt crisis. Second, banks do not hold government debt randomly. They actively choose whether, how much, and which government bonds to hold, conditional on banks' assessments of the sovereign risk, on regulatory costs, and on bank-level characteristics.

We analyse the relationship between government bond holdings and observed risk of all German banks while taking the selection of banks into holding government debt explicitly into account. Our analysis uses the *Securities Holdings Statistics* of the Deutsche Bundesbank. This database provides quarterly, granular data of the security portfolios of all German banks, including holdings of government bonds, bank-by-bank, and security-by-security from Q4:2005 until Q3:2013 (Amann, Baltzer, and Schrape, 2012; Bade, Flory, and

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Schönberg, 2016). Thus, the data cover the pre-crisis period, the global financial crisis, and the government debt crisis in the Euro Area. We combine sovereign risk exposures with detailed micro-prudential supervisory and issuer-country data. Thereby, our model exploits the rich cross-sectional variation across commercial, savings, cooperative, and mortgage banks in Germany. The granular data employed in this chapter reveal the following stylized facts (for details, see Section 1.2.3.):

First, a certain fraction of German banks, namely 15%, *never* hold government bonds during the entire sample period. Another 25% of all German banks *always* hold some government debt. Other banks actively move into and out of investments into government bonds. On average, two thirds of all German banks hold government debt in each quarter. Participation in government bond markets varies considerably across banking groups. Average government bond portfolios account for about 5% of total assets across all German banks. These shares are the lowest for commercial and cooperative banks (3.5%) and the largest (13%) for mortgage banks. But some of the larger banks hold up to 20% of their assets in the form of government debt.

Second, savings and cooperative banks did not have a significant exposure to Euro Area peripheral debt to begin with. German mortgage banks, which specialize in the securitzation of public and private debt, continue to hold substantial volumes of risky government debt. During the government debt crisis, German commercial banks reduced their exposure to debt issued by governments in Greece, Italy, Ireland, Portugal, or Spain, and they largely replaced these investments with domestic German government debt.

Analysing the drivers of these adjustments and the impact on bank risk is the purpose of this chapter. Our empirical model proceeds in two steps. In a first step, we analyse the determinants of government bond holdings of German banks. We specify a Heckman selection model to estimate the likelihood that banks hold certain government bonds and how much they hold conditional on this selection choice. In a second step, we assess the impact of government bond holdings on bank risk, measured through market-based (CDS spreads) and accounting-based measures (*z-score*).

As regards the determinants of banks' government bond holdings, several factors have been stressed in the literature. Banks may hold government debt to diversify asset portfolios (Rochet, 2008), as collateral for interbank refinancing operations (Bolton and Jeanne, 2011), or as a means to store liquidity (Gennaioli, Martin, and Rossi, 2014). Recent empirical papers explain the increase in domestic government bond holdings by Euro Area periphery banks

with a search for yield (Acharya and Steffen, 2015), moral suasion (Becker and Ivashina, 2017; De Marco and Macchiavelli, 2016; Horváth, Huizinga, and Ioannidou, 2015; Ongena, Popov, and van Horen, 2016), or gambling for resurrection (Ari, 2016; Horváth et al., 2015). Most of these studies are based on data released together with the stress test results of the European Banking Authority (EBA).

The perspective taken in this chapter differs from previous work for two reasons. First, we study the investment behavior of German banks rather than the behavior of banks in (risky) peripheral countries. Second, we have granular data for all German banks, not only the large banks covered by the EBA stress tests. Our results show that accounting for heterogeneity across banks is indeed important. Large, weakly capitalized banks, and banks which are more active on capital markets[2] hold more government bonds.

With respect to country characteristics, we find that German banks did not respond much to macroeconomic risk factors before the collapse of Lehman Brothers in 2008. Between 2008 and 2010, German banks reduced their government bond holdings of small and high inflation countries that participated in an IMF programme. With the outbreak of the European government debt crisis, German banks reduced bond holdings of high indebted and high yield sovereigns. Also, domestic government bonds started playing a more prominent role. In contrast to evidence for the sample of the largest European banks (Acharya and Steffen, 2015), we thus do not find a search for yield by the average German bank in government bond markets. Instead, our results indicate a "flight to safety" and to the home market akin to Hildebrand, Rocholl and Schulz (2012).

The second part of our analysis focuses on the effects that government bond exposures have on bank risk. Given that German banks have withdrawn from risky markets during the crisis we expect, a priori, that increasing domestic government exposures have stabilized rather than destablized banks. Hence, the perspective taken in this chapter differs from previous work that focuses on the link between bank (in)stability and sovereign indebtness (Acharya, Drechsler, and Schnabl, 2014; Alter and Schüler, 2012), a reduced effectiveness of bank rescues and guarantees (König, Anand, and Heinemann, 2014; van der Kwaak and van Wijnbergen, 2014), and crowding out of private sector credit (Albertazzi, Ropele, and Sene, 2014; Bedendo and Colla, 2015). Existing literature focuses on sovereign and/or bank CDS

[2] Banks active on capital markets are those using market-based funding, having large security, and small customer loan portfolios.

spreads to provide evidence on the existence of a bank-sovereign risk nexus (Alter and Beyer, 2014; De Bruyckere, Gerhardt, Schepens, and Vander Vennet, 2013).

In order to study the effects of government bond holdings on bank risk, we need to take into account that this choice is endogenous. We use predicted rather than observed bond exposures as a function of issuer country-specific macro factors and of bank-specific covariates to mitigate endogeneity concerns. Our main indicator of bank risk is the *z-score*. We find that a larger share of high-risk bonds is associated with higher bank risk for commercial banks but not for cooperative and savings banks after 2010. Holdings of low-risk bonds are associated with lower bank risk for savings and cooperative banks for the entire sample period. These risk effects are stronger when considering CDS spreads that are available for a subsample of (larger) banks as an alternative risk proxy. Holdings of risky government debt also increased banks' CDS spreads during the entire sample period, not just after 2010. These risk effects were not visible based on the accounting-based risk measure before 2010, probably due to the widespread absence of marking to market at the time.

In Section 1.2, we present and describe the data for German banks' government bond holdings. In Section 1.3, we analyse the determinants of banks' government bond holdings. In Section 1.4, we analyse the impact of these holdings on bank risk. Section 1.5 concludes.

1.2 Holdings of securities by German banks

1.2.1 Banks included in the sample

The data used in this chapter include 1,970 banks, which covers almost the entire population of German banks. Affiliates of foreign banks operating in Germany are omitted because we do not observe the government portfolios held by their foreign parent banks. Furthermore, we exclude special-purpose banks, such as regional development banks, since – unlike in Chapter 2 – we do not account for the political dimension in this chapter.

The German banking system consists of three banking groups (commercial, savings, and cooperatives), which operate as universal banks, as well as specialized mortgage banks (Koetter, 2013; Krahnen and Schmidt, 2004).

Commercial banks are privately owned, but only a few are stock market listed.

Savings banks are owned by municipalities and own, in turn, their head institutions, the *Landesbanken*. Regional savings banks are *de jure* confined to stipulated local markets and focus on retail deposit taking and lending. Head institutions act as clearing house and gateways to international capital markets and to investment banking services for their owners.

Cooperative banks are mutually-owned by member-depositors. They pursue a *de facto* regional segmentation of banking markets and are the smallest universal banks. During the sample period, they featured two head institutions, which pursued activities roughly comparable to those conducted by the large commercial banks and the *Landesbanken*. Akin to the U.S. (Goddard, McKillop and Wilson, 2014), the cooperative and the savings bank sector faced substantial competitive pressure and exhibited substantial consolidation. Since the year 1993, the number of cooperative and savings banks declined by 40% and 60%, respectively (Koetter, 2013).[3]

Mortgage banks are specialized institutions that focus on long-term maturity transformation by originating real estate mortgages. They also specialize on issuing covered bonds ("*Pfandbrief*"), which are often collateralized by government bonds. The aggregate market share in terms of total assets of mortgage banks is around 8%.

1.2.2 Data on government bond holdings

Government bond holdings of German banks are reported to the Deutsche Bundesbank in the *Securities Holdings Statistics* by each bank located in Germany (Amann et al., 2012; Bade et al., 2016). Each bank reports its entire securities portfolio including government bonds on a security-by-security basis. We focus on investments in government bonds, defined as general government bonds rather than central government bonds only. Focusing on the general government level ensures comparability across different federal structures and consistency to studies based on EBA stress test data (Acharya and Steffen, 2015). Aggregating across different federal levels might however also hide important variation as I show in Chapter 2. Therefore we test the robustness of our results for a restriction to central government bonds in Section 1.1.3.5. We exclude public covered bonds from the sample, which are mostly issued by mortgage banks and are collateralized by government securities, because we do not observe the identity of government bonds that are pledged as collateral.

The *Securities Holdings Statistics* data are available to us on a quarterly basis as of Q4:2005 until Q3:2013 and cover around 9,540 government bonds at the end of the sample period. We make two sampling choices. First, we consider only banks' own securities holdings ("*Depot-A-Geschaeft"*). Positions held on behalf of clients and the exposures of

[3] Similar to the U.S., where corporate or "central" credit unions were important holders of subprime debt, head institutions of both savings and cooperative banks differ considerably in size and scope of activities from their associated regional banks.

banks' foreign affiliates are excluded. We cannot distinguish between held-to-maturity and available-for-sale holdings, which have been reported separately only since early 2014. Securities include all traded securities as well as repurchase agreements. For each security, we observe the ISIN number, currency, volume of investment, price, type of security, sector of the issuer, country, maturity, coupon type, frequency of coupon payments, and coupon payments.[4]

Second, we use government bond holdings from OECD countries, which dominate the government bond portfolio of German banks. Securities denominated in foreign currency are converted at daily official Bundesbank exchange rates to Euros. Only 3.7% of government bonds held by German banks were not denominated in Euros as of Q3:2013. Because we are interested in the macroeconomic features that affect banks' investments in certain government bonds, we aggregate the data per country. For issuers like France, for instance, we have a total of 812 different securities at each point in time, which differ in terms of maturity and return. We aggregate these securities into a composite French government bond and use the yield on the 10-year French government bond as a return measure. The average maturity in our sample is 11 years and thus fairly close to the 10-year benchmark yield.

The data report notional and market values where the former equals the nominal value of a security multiplied by the number of securities held and the latter is multiplied with the price of the security as obtained from the Centralized Securities Database of the ESCB (Amann et al., 2012). We focus on market values to gauge possibly deteriorating bank profitability or increasing volatility.

Different accounting standards and the treatment of losses from security trading may affect our analysis as well. Government bonds held for trading or available-for-sale are evaluated at fair value. Therefore, large price fluctuations will directly impact the level and the volatility of bank profits, and thereby also an accounting-based measure of risk, such as the *z-score*. In contrast, government bonds that are held-to-maturity are evaluated at amortized costs. We do not observe the trading book and the banking book separately during the estimation sample period. Our results thus show the average effect for both accounting categories and should be

[4] We sample coupon and zero coupon bonds. The latter are evaluated at purchase price plus accrued interest. Only 8% of all observations pertain to these bonds. The use of aggregate country-level data implies that short positions are mostly netted. Around 5% of all observations at the security level (ISIN) are short positions (as of Q3:2013), with large commercial banks (20%) and Landesbanken (11%) exhibiting the largest shares. But at the aggregate country level, this share is negligible (0.7% of observations as of Q3:2013).

higher for the (unobservable) subgroup of government bonds, which are marked to market. Robustness tests yield no sensitivity of regression results reported below for the choice of nominal versus market value of government bonds.

1.2.3 Government bond portfolios of German banks

The granular data from the *Securities Holdings Statistics* show that not all German banks hold government debt. Averaged over the sample period, around 15% of all German banks are never active in government bond markets whereas around a quarter are always active. Among the banks that never hold government bonds are primarily cooperative banks, while mortgage banks always hold government debt. Non-participating commercial banks tend to be better capitalized, much smaller, and more engaged in interbank lending compared to participating banks. These features may explain a reduced need for government bonds. The remaining banks enter and exit the government bond markets frequently.

Figure 1.1 shows the different evolution of participation rates in government bond markets across banking groups. Differences in banks' business models imply a different need for government bonds across these groups. Despite the variation participation rate levels, there is a common trend across banking groups towards a higher participation rate, which is consistent with the EBA (2015) data for large European banks.

Table 1.1 provides a snapshot on the importance of the security portfolio in German banks' balance sheets at the end of our sample (Q3:2013). On average, German banks held 18% of their total assets in securities, ranging from 11% for commercial banks to 27% for mortgage banks in Q3:2013 (Column 6). About 5% of total assets were invested in government bonds, ranging from 3.5% for commercial banks to 13% for mortgage banks in Q3:2013 (Table 1.1, Column 7).

Figure 1.2 depicts the decomposition of the government bond portfolio as percentage share of total assets over time and per banking group. Since 2008, savings and cooperative banks increased their investments in government bonds. Starting from higher levels, mortgage banks decreased their government exposures from 2006 onwards. Across banking groups, portfolios were concentrated towards Germany and the Euro Area. Changes in the size of the government portfolio were primarily driven by adjustments in the German government bond holdings. Commercial banks withdrew from the Euro Area periphery countries (Greece, Italy, Ireland, Portugal and Spain) since the beginning of 2010 and reallocated their assets towards Germany and other core countries. Mortgage banks held an exceptionally high share of bonds issued by European periphery countries, namely 41% of their total government portfolio

(Q3:2013). Also, they increased their investment in other Euro Area countries and in OECD countries outside the Euro Area since the outbreak of the European government debt crisis. Hence, mortgage banks hold the most diversified government bond portfolios compared to other banking groups. While mortgage banks held government bonds of eight countries on average in Q3:2013, the other banking groups held exposures towards two (cooperatives) to three countries (commercial banks) only. However, the five largest (commercial) banks held government bonds in 25 countries on average. Thus, the sheer size of countries seems to be an important determinant for diversification strategies.

Figure 1.3 illustrates the evolution of aggregate German bank exposures to selected countries over time. After the fall of Lehman in Q3:2008, we observe a steep increase in German bond holdings and, to a lesser extent, in French bonds. This increase is accompanied by continuously declining positions vis-à-vis distressed Euro Area peripheral countries, which was amplified after the outbreak of the government debt crisis in Q2:2010. Thus, the data strongly suggest a pattern to increase holdings of domestic government bonds in line with the "flight to safety" effect in Hildebrand et al. (2012).

In sum, the descriptive statistics reveal a couple of interesting patterns in the data. First, a significant fraction of German banks do not invest in government bonds at all. Second, with 5% of the total, government bonds account for a relatively small share of banks' total assets (Q3:2013). Third, in particular the government bond portfolios of smaller banks are not very diversified and a large share is held in Euro Area bonds.

1.2.4 Country- and bank-level controls

Table 1.2 shows descriptive statistics for both the macroeconomic variables (Panel A) and the bank-level variables (Panel B) with which we complement the *Securities Holdings Statistics*. Consider first the country-level information, which is drawn from the Centralised Securities Database (CSDB), MarkIT, and the OECD, to measure market size, returns, and risk.

The left-hand panel pertains to 1,632,540 bank-country-quarter observations and the unconditional probability that bank *i* holds bonds issued by country *j* at time *q* is around 5%. The right-hand panel shows the sample with non-zero government bond holdings only. These data comprise 83,698 bank-country-quarter observations, corroborating the self-selection of banks into holding specific government bonds. The mean volume of government bond holdings of an issuer by a bank in the regression sample is 100 million Euros.

To measure country size, we use log GDP, measured in constant and seasonally adjusted prices. To gauge expected returns and country risk, we include consumer price inflation. Higher inflation reduces real returns on outstanding government debt. Second, we specify bond yields to capture the compensation that banks receive for holding risky government debt. Third, we use the ratio of debt issued by the general government relative to GDP as an indicator of the indebtedness of a sovereign. Fourth, we specify an indicator variable if a country was part of a support program by the International Monetary Fund (IMF). Data are obtained from the homepage of the IMF and include Extended Fund Facilities, Extended Arrangements, and Stand-by-Arrangements. This indicator equals one as of the start dates of IMF programs.[5] GDP, government debt and inflation data are all obtained from the OECD database and the average yield on a 10-year government bond is calculated from Markit data.

Finally, there are several regulatory incentives for banks to hold government debt. We include an indicator variable equal to one for member countries of the European Monetary Union (EMU) because prudential regulation in Europe favors banks' investments in government debt issued by Euro Area governments. Government bonds denominated in Euros need not be backed by equity capital under the Credit Risk Standardized Approach (CRSA) of the regulatory framework.[6] This treatment of government bonds is maintained under the Basel III regime.[7] Also, investments in government bonds, that carry a zero risk weight, are exempt from large exposure rules.

Since we include country fixed effects to capture structural differences between government issuers, the EMU dummy captures accessions to the Euro Area (Slovenia, Slovak Republic). Finally, we report the effect of the Germany dummy to capture the importance of the home market.

Panel B in Table 1.2 depicts descriptive statistics for bank-specific control variables, which are generated from financial data reported to Deutsche Bundesbank, for the selection equation (left-hand panel) and for the outcome equation (right-hand panel).

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[5] These OECD countries are Greece (Q2:2010), Hungary (Q2:2008), Ireland (Q4:2010), Mexico (Q2:2008), Poland (Q1:2013), and Portugal (Q2:2011).

[6] Banks might use internal models instead of CRSA to gauge the risk and corresponding capital buffers for their exposures (Internal Ratings Based Approach, IRBA). For government bonds, IRBA banks may use the CRSA for government debt investments under certain circumstances ("permanent partial use").

[7] See Brussels, 20 July 2011, COM(2011) 452 final, 2011/0202 (COD), Proposal for a Regulation of the European Parliament and of the Council on prudential requirements for credit institutions and investment firms, Article 109(4): "Exposures to Member States' central governments and central banks denominated and funded in the domestic currency of that central government and central bank shall be assigned a risk weight of 0%."

We control for *size* with the logarithm of total assets because large banks were pivotal to absorb government bonds during the government debt crisis (Becker and Ivashina, 2017). Government debt has an important impact on the liquidity position of banks (Gennaioli et al., 2014). We measure *liquidity* as the ratio of cash and overnight interbank lending relative to total assets. We control for bank *asset structure* because different degrees of retail versus financial market activities are characteristic for alternative business models (Boot and Ratnovski, 2012). On the asset side of banks' balance sheets, we include the shares of customer loans (i.e. retail activities) and securities portfolios (i.e. wholesale activities) relative to total assets. We account for the *funding structure* of banks because wholesale funding reliance turned out to be more vulnerable during the crisis (Huang and Ratnovski, 2011). To this end, we include core capital and retail deposits, both scaled by total assets. We also include securitized liabilities relative to total assets as a proxy for the need for collateral. These liabilities may contain both funding obtained at the secured interbank market as well as from central bank operations. Bank *profitability* is measured by return on equity and by banks' cost-to-income ratios. The impact on bank risk is ambiguous. More profitable and efficient banks should retain higher capital buffers and be better able to buffer shocks. Alternatively, higher profitability may also imply that banks search for yield and are willing to take on higher risks. We account for difference in the *income structure* across banks by including fee over interest income.

1.3 Determinants of banks' government bond holdings

In this section we adress which factors determine banks' investments in government bonds. The associated implications for bank risk are the subject of Section 1.4.

1.3.1 Empirical Methodology

We model the decision whether to invest in government bonds and which volume of bonds to hold using a Heckman (1979) selection model. First, we model whether a bank *i* holds government bonds of country *j* in period *q* (extensive margin, *EXP*). Second, we explain the size of exposures in terms of the Euro volume of government bonds (intensive margin, *SOV*).

We specify a selection equation (1) and an outcome equation (2):

$$\Pr(EXP_{ijq} = 1) = \Phi(\alpha_{1g} + \alpha_{1j} + \alpha_{1q} + \beta_{11}X'_{iq-4} + \beta_{12}X'_{jq}) \quad (1)$$

$$Sov_{ijq} = \alpha_{2i} + \alpha_{2j} + \alpha_{2q} + \beta_{21}X'_{iq-4} + \beta_{22}X'_{jq} + \eta IMR + \varepsilon_{ijq} \quad (2)$$

In the selection equation (1), EXP_{ijq} is an indicator variable equal to 1 if bank *i* (1,970 banks) holds government bonds of a specific country *j* (29 countries) in time period *q* (quarterly data from Q4:2005 to Q3:2013) and 0 otherwise. The estimation sample comprises 1,632,540 bank-quarter-country observations. Φ(.) is the standard normal distribution function, X_{iq-4} are bank-specific, and X_{jq} are country-specific control variables. We include dummies for banking groups, quarter, and country (α_{1g}, $\alpha_{1j,}$ α_{1t}) in equation (1). In the outcome equation (2), we include fixed effects for bank, quarter, and country. We specify banking group instead of bank dummies in the selection equation (1) to avoid the incidental parameters problem in Probit estimations. Bank-specific variables are lagged by four quarters to alleviate simultaneity concerns. Country-specific variables enter the equations contemporaneously.

Identification would ideally hinge on a variable that represents a valid exclusion restriction, i.e. variables *W* that correlate only with the likelihood of bond holdings in a given country in a given quarter, but not the volume of such an exposure. Because there are neither quantitative restrictions on specific government bond exposures nor changes in central bank eligibility for our sample and as existing regulations may affect both the extensive and the intensive margin, we cannot specify such variables *W*. Therefore, the model is identified based on functional form and on differences in the set of dummies as explained above. Based on the predicted likelihood of observing an exposure of bank *i* in country *j* at time *q*, we then calculate the inverse Mills ratio (*IMR*). Together with the same bank-specific and country-

specific control variables (X_{iq} and X_{jq}), the IMR is specified in the outcome equation (2) to explain differences across banks' observed government debt exposure levels (*SOV*). The coefficient η indicates if self-selection bias of banks into holding government bonds is significant.

1.3.2 Main results

Column 1 of Table 1.3 shows the results for the intensive margin (i.e. outcome equation) of the Heckman model on the determinants of banks' government bond holdings. Column 2 shows the results for the extensive margin (i.e. selection equation). Column 3 provides marginal effects for the extensive margin. This model explains government bond holdings of German banks well. The adjusted R^2 of the outcome equation is 0.75. Even without bank, time, and country fixed effects, the adjusted R^2 still equals 0.55 (unreported).

Consider first the importance to account explicitly for systematic selection by banks whether to hold bonds issued by a certain country in a given quarter. The inverse Mills ratio in column 1 is significant at the 1% level. Therefore, the choice whether to invest in a particular market also affects the decision on the volume of investment. Our results based on this comprehensive sample comprising all German banks underpin the importance to analyse not only selected groups of systemically relevant banks, such as in the EBA stress tests, but to account for the non-random determinants of government holdings when assessing the implications for bank risk.

1.3.2.1 Country-level determinants

For the entire sample, virtually all country-level covariates exhibit a statistically significant impact on government bond holdings, both for the extensive and the intensive margin.

With respect to macro covariates capturing expected return and risk, we find that banks hold more government debt from countries with high inflation, high government debt-to-GDP ratios and low bond yields, which contrasts expectations. Below we show that these aggregate effects are hiding important differences between pre- and post crisis periods. After the outbreak of the government debt crisis German banks hold more bonds of lowly indebted sovereigns, which pay a low yield. Hence, we do not observe a "search for yield" of German banks in government bond markets. Instead, the increasing sovereign risk that came with higher bond yields seems to have dominated the return effect. Due to multicollinearity we are not able to jointly include bond returns and CDS spreads in the regression. As a robustness

check, we replace returns with sovereign CDS spreads or ratings. The negative coefficient on risk remained unchanged and results are shown in Table 1.11 in the appendix.

Banks withdraw from countries that are covered by an IMF program. In unreported tests, we check whether banks hold relevant exposures to these countries to begin with. German banks held 6-13% of total government exposure towards debt of IMF program countries prior to the start of the average program. In the quarter following the announcement of an IMF program, all banking groups reduce their exposures. Mortgage banks exhibit the most significant decline, namely by 22% of their exposure prior to the announcement.

In addition to these macro variables, we also find a positive home (i.e. Germany) and Euro Area effect (Table 1.3). In order to capture time invariant country characteristics, we include a set of country dummies (not reported), defining Austria as the baseline category. The average volume of bonds in German banks' government portfolios increases by 118% if it is the domestic country relative to the baseline country. Most other country dummies are significantly negative or smaller than the Germany dummy with a few exceptions for small and comparatively risky countries (Czech Republic, Hungary, Iceland, Slovenia, Slovak Republic).

We also find a positive effect for Euro Area membership. The time variation in the Euro Area dummy variable is driven by accessions to the Euro Area during our estimation sample (Slovenia, Slovak Republic). The positive Euro Area effect may reflect the absence of exchange rate risk, the preferential regulatory treatment of government Euro Area bonds or eligibility for ECB refinancing.

To interpret the size of the parameters in the selection equation, we calculate average marginal effects from the Probit model in column 3, Table 1.3. Inflation, country size, and membership in the Euro Area affect the probability of government bond holdings the most.

Regarding the outcome equation, Euro Area membership, the government debt ratio and government bond yields are the determinants with the largest economic impact. We assess economic magnitudes by calculating the percentage increase in government bond holdings for an increase in the macroeconomic variable from the 25^{th} percentile to the 75^{th} percentile of its distribution. The average holding of government bonds (per bank and country) is 100 million Euros (see Table 1.2). For example, bond holdings of the average German bank is 22 percent or 22 mn € higher if the debt ratio of the sovereign is at the 75^{th} percentile compared to the 25^{th} percentile. Similarly, an increase in GDP, CPI inflation and government bonds yields from the 25^{th} percentile to the 75^{th} percentile of the distribution would lead to a 4.4%, a 4.8%

and a -22.8% change in bond holdings by the average bank. The Euro Area membership is the most important indicator with an increase of roughly 200% in bond holdings, if a country joins the Euro Area.

1.3.2.2 Bank-level determinants

Correlations of proxies for business models of German banks and banks' investments into government bonds are shown in the lower panel of Table 1.3. Results for the selection equation show that larger, less well capitalized banks, banks with larger securities portfolio, and banks with a low share of customer loans are more likely to hold government debt. The results for the outcome equation confirm these findings. The results are in line with Acharya and Steffen (2015), who find that larger banks and banks with lower capital ratios invest more in government bonds. The negative impact of the capital ratio could reflect a risk effect: banks with low capital buffers may invest more in safe assets.

We find that banks with a larger share of liquid assets (i.e. cash and overnight interbank loans) are also more likely to invest in government bonds. This indicates that government bonds are not used as a substitute for other liquid assets but rather as an additional source of liquidity. The share of retail deposits does not affect the likelihood to invest in government bonds significantly, but it correlates positively with the volume of government bonds held. Furthermore, government bonds are an important source of collateral to obtain interbank funding. Thus, government bonds play a more important role for banks with a large share of securitized funding.

We also assess the economic effects of these findings. The security portfolio to total assets is the most important variable. An increase by one standard deviation in the share of the security portfolio results in an increase of average government bond holdings by 60% or 60 million Euros per bank and sovereign. An increase by one standard deviation in the securitized liabilities ratio and the core capital ratio results in an increase of 38% and a decrease of 8% respectively.

1.3.3 Are determinants of bond holdings stable over time?

So far, we assumed that the determinants of banks' investments into government bonds remained unchanged over time. But during the crisis, perceptions of sovereign default have changed markedly, low interest rates induced a search for yield, and banks needed collateral to cushion liquidity shocks.

Table 1.4 shows three separate time periods: the pre-Lehman period (Q4:2005-Q2:2008), the period since then until the outbreak of the Euro Area sovereign crisis (Q3:2008-Q1:2010), and the period of the sovereign crisis (Q2:2010-Q3:2013). The impact of macroeconomic factors varies substantially over time, whereas the impact of bank characteristics remains rather stable.

Prior to the financial crisis, macroeconomic factors had virtually no impact on banks' government bond investments. Results reported in Table 1.3 for the full sample are thus largely driven by the period after 2008, which provide evidence of active restructuring of banks' government debt portfolios. This result is in line with previous literature on the determinants of government bond spreads for the Euro Area countries, which attributes little explanatory power to macroeconomic factors before the crisis but considerable responses during the crisis (De Grauwe and Ji, 2012).

The impact of macro factors on German banks' government bond holdings has changed in three significant ways.

First, German banks became more risk averse in government debt markets with the start of the financial crisis. After Q3:2008 and until the outbreak of the European government debt crisis German banks hold less bonds of high inflation countries which take part in an IMF program. These effects reverse afterwards. While the government debt ratio is insignificant up until the outbreak of the government debt crisis, German banks strongly withdraw from highly indebted sovereigns since then. In line with expectations, high debt levels seem to serve as a signal of higher risk since Q2:2010. Below, we will show that (predicted) holdings of government debt in risky categories correlate positively with bank risk since the outbreak of the sovereign crisis.

Second, high government yields increased the probability of holding a government bond in the financial crisis period, possibly reflecting a search for yield, coupled with regulatory incentives (Acharya and Steffen, 2015). This effect is mainly driven by cooperative and savings banks (Table 1.5). Since Q2:2010, all German banks have avoided high-yield government bonds potentially due to adapted expectations about sovereign default probabilities.

Third, while Euro Area membership increased the government bond holdings of German banks before the European debt crisis, it becomes insignificant afterwards. Instead, the Germany dummy (home effect) becomes positively significant. A flight home effect has been observed in a wide range of European countries (EBA, 2015).

In sum, banks responded quite differently to macroeconomic factors before and after the collapse of Lehman Brothers. Before that event, banks did not differentiate much between government debt on grounds of macro fundamentals. These factors became relevant afterwards, and much of the adjustment is in line with expectations as banks became more sensitive to underlying risk factors. Bank-level determinants of banks' investments into government bonds, in contrast, have remained much more stable over time.

1.3.4 Do banks' business models matter?

Next, we investigate differences within the four banking groups to account more explicitly for the heterogeneous business models. Our results from pooled regressions are not primarily driven by differences in business models *between* banking groups, but rather mirror differences in business models *within* banking groups.

While the effect of macroeconomic factors varies over time, it remains rather similar between different banking groups. One exceptions are mortgage banks, which have the largest government bond exposures but are not much affected by macro factors except yields and inflation. Instead, investments by mortgage banks depend mostly on bank-specific factors.

With respect to bank-level variables, two factors exert identical effects across banking groups: larger banks and banks with larger shares of security portfolios hold more government debt. The effects of other bank-level variables differ across banking groups.

First, the result that weakly capitalized banks hold more government bonds is primarily driven by savings banks and mortgage banks. Capitalization does not play a role for cooperative banks, and it has an opposite effect for commercial banks since the government debt crisis.

Second, the specialized mortgage banks and their predominant role in the covered bond segment do not drive the positive effect of securitization activity on bond holdings. In fact, privately owned universal banks, i.e. commercial and cooperative banks, drive this result, in particular after the outbreak of the government debt crisis.

Third, for savings and cooperative banks, the effects of bank-level variables are rather stable over time. For commercial and mortgage banks, in contrast, signs and significant levels of bank-level variables change with the outbreak of the sovereign crisis, indicating that the turmoil of the government debt crisis affected the business models of these banks the most.

1.3.5 Robustness tests

We test the robustness of our results from the Heckman model in several ways and show results in the appendix to this chapter. Overall, our main results regarding the impact of country and bank variables on banks' government bond holdings remain robust.

We use different measures for sovereign risk, the average country rating of Moody's, Standard and Poor's and Fitch and 5 year CDS spreads (Table 1.11). In Table 1.12 we constrain our sample to foreign government bonds in order to ensure that German bonds are not dominating the aggregate findings. In Table 1.13, we restrict our sample to bonds issued by the central government as opposed to the general government. While the overall results concerning the macroeconomic and risk factors remain very stable, the home effect reverses. German banks hold 90% of their domestic government bond exposure towards regional states and not the central government (as of Q3:2013). Excluding the regional states from the analysis therefore yields a negative Germany dummy. Chapter 2 investigates the incentives of German banks to hold state government bonds in greater detail.

Furthermore, the results (not reported for the sake of brevity) are robust against different specifications and data cleaning approaches such as using the one year lags of macroeconomic and bank variables, using bankgroup instead of bank fixed effects in the outcome equation, winsorizing all covariates at the 1% and 99% quantiles and using notional instead of market values of banks' government bond holdings.

1.4 Do government debt exposures affect bank risk?

1.4.1 Empirical Methodology

Our second main research question is how banks' government bond holdings affect bank risk. To this end, we estimate a fixed effects model for a panel of 1,612 banks for which we obtained annual micro-prudential supervisory financial accounts data between 2005 and 2012. Only banks that hold government bonds are included. Our main measure of bank risk is the *z-score*, which is defined in the data appendix 1.A, and we estimate:

$$zscore_{it} = \alpha_i + \alpha_t + \beta_1 X_{it-1} + \beta_2 \hat{SOV}_{it-1} + \varepsilon_{it}, \qquad (3)$$

where α_i and α_t are bank- and year-fixed effects, X_{it-1} is a vector of bank-level controls lagged by one year to avoid simultaneous correlation by construction, and $\hat{SOV}_{it-1}$ is a vector of predicted values of banks' government bond exposures relative to total assets. We use clustered standard errors at the bank level.

We aggregate predicted government bond positions within three risk categories, thereby eliminating the country dimension from our data: all bond holdings of sovereigns rated AAA represent low risk government bond holdings. Bonds rated AA or A are intermediate risk holdings, and sovereigns rated BBB or worse fall into the high-risk category. The rating is an average rating of Moody's, Standard and Poor's and Fitch. We then take end-of-year values for the government bond holdings. Table 1.6 tabulates the sovereigns by risk category. Note that some countries "migrate" across categories over time. As we observe stocks of outstanding government debt rather than flows, changes in holdings of high-risk debt might thus be the result of a re-classification of some countries' debt.

Government bond exposures are scaled by total assets of banks to capture the *relative* exposure towards sovereign risk. This sample comprises 7,708 bank-year observations and summary statistics are very much in line with the bank-country-quarter sample shown in Table 1.2.

The parameter of interest in equation (3) is β_2, which indicates whether and to what extent government debt holdings influence bank risk.

We use predicted rather than observed government bond holdings for two main reasons. First, conditional government bond holdings from the Heckman estimation account for the selection bias because banks systematically choose whether and which bonds to hold. Second, using predicted government bond holdings mitigates concerns arising from possible reverse causality. The risk appetite of banks, born out for example by different business models, may affect government bond holdings. Government bond exposures, in turn, are correlated with observable risk traits that are part of the risk measure. The use of *predicted*, aggregated exposures is thus in the spirit of an instrumental variable approach, with country specific macro factors X_{jt} being excluded in the second stage regressions on bank risk. In both stages, when explaining government debt holdings and bank risk, we use CAMEL covariates to control for the risk (appetite) of a bank.

Because the dimensions of the selection model (bank-country-quarter) differ from those of the bank risk sample (bank-year), we cannot apply the conventional tests for the adequacy of "instruments". But we conduct some plausibility tests. Country covariates predict the intensive margin *SOV* accurately and according F-tests for joint insignificance are rejected at the 1% significance level. A regression with country covariates only still yields a high adjusted R^2 of 0.341. At the same time, macro covariates should be uncorrelated with realizations of bank risk, that is country-specific factors should be orthogonal to the individual

German bank. This seems plausible, given that even banks with large foreign exposures only hold small fractions of individual issuer countries debt. Therefore, a shock in one particular issuer country should be fairly uncorrelated with banks' realizations of risk on average.

To test this, we use each bank's bond portfolio share towards issuer country *j* in quarter *q* to generate exposure-weighted macro covariates per bank and year. With the exception of IMF measures, all of these variables are not significantly correlated with the *z-score*, our measure of risk. Correlations are weakly significant at the 10% level when using observed portfolio rather than predicted portfolio shares, but very small regarding magnitudes and, as argued above, possibly contaminated with neglected selection bias. Therefore, we use predicted government bond shares in the three risk-categories to analyse the relationship with bank risk.

1.4.2 Measuring bank risk

We measure bank risk using the banks' *z*-score (Laeven and Levine, 2009), which is defined as the return on assets plus equity over assets, divided by the standard deviation of return on assets:

$$z = \frac{(E/A + RoA)}{\sigma_{RoA}}$$

where E/A is the capital-asset ratio, *RoA* denotes return on assets, and σ_{RoA} denotes the standard deviation of *RoA*. *Z-scores* measure the extent to which bank equity is sufficient to cover losses. A higher *z-score* reflects a higher distance to default and thus lower risk. Given the definition of *z*-scores, we do not specify capitalization and profitability as explanatory variables.

To obtain a bank-time specific measure for volatility of *RoA*, we regress *RoA* on bank and time fixed effects. The residuals of this regression give the volatility of *RoA* of bank *i* in year *t* that cannot be explained by bank or time common effects. The residuals are winsorized and taken in absolute terms as measure for σ_{RoA}. This methodology is in the spirit of Loutskina and Strahan (2015) who applied it to house price changes. As a robustness check, the standard deviation of *RoA* is calculated using a rolling window of seven years and results are very similar. We winsorize the *z-scores* at the 0.1% level to account for outliers.

The use of *z-scores* as a measure of risk has the advantage that it is based on prudential supervisory data and therefore available for all banks, listed as well as non-listed ones. An important disadvantage is the backward looking nature of this measure, which is typical for

accounting-based risk measures. Therefore, we specify in addition two alternative measures of risk, the log of Credit Default Swap (CDS) spreads of each bank and an indicator equal to one if a bank was ranked in the top decile of distribution of non-performing loans (NPL) relative to total loans in a given year.[8] We choose such a discrete indicator instead of continuously measured NPL shares because the definition of NPL changed during our sample period, giving rise to statistical breaks in the level of NPL (Koetter, 2013).

Our main measure of bank risk, the z-score, varies across banking groups and over time (Table 1.8, Panel A). Commercial banks and mortgage banks are, on average, the most risky banking group. However, the standard deviation, and thus the heterogeneity of our risk indicator, is also highest within the group of commercial banks. Savings and cooperative banks are less risky and much more homogenous regarding their risk profile. Our alternative risk measures, the NPL indicator and CDS spreads confirm these trends (Table 1.8, Panel B and C). CDS spreads increased steadily from 2005 until 2012, but started to decline in 2013 (not reported).

1.4.3 Main results

Table 1.9 presents the results for the risk equation using the (log) *z-score* as the dependent variable. Results are reported for the entire sample period in Panel A and seperately for the periods before the European sovereign crisis (Panel B) and since the sovereign crisis (Panel C). In addition to the results for the entire German banking system (Column 1), we estimate bank risk separately for commercial banks (Column 2), savings banks (Column 3) and cooperative banks (Column 4). Due to small sample size, we cannot analyse mortgage banks separately.

Parameters on bank control variables are estminated but not reported for the sake of brevity. A full set of results for the full sample can be found in Table 1.14 in the appendix to this chapter. In this chapter, we focus on our main variables of interest, the predicted volumes of government bonds per risk category relative to total assets. For the entire sample period and the entire German banking system (Column 1 in Panel A of Table 1.9), we find no evidence of a statically significant relationship. But when we split our sample along the banking group and time dimensions, two important qualifications are noteworthy.

[8] Note that we define deciles on the basis of the entire population of banks, i.e. including those without sovereign exposures or missing data that precluded certain observations from the estimation sample.

First, the group of commercial banks is particularly affected by sovereign risk. After 2010, a larger share of intermediate-risk and especially high-risk government debt has a statistically and economically significant impact on the risk of commercial banks (Column 2 in Panel C of Table 1.9). For instance, the z-score of commercial banks decreases in the sovereign crisis period by 7.43% if the ratio of high government debt holdings to total assets increases by one standard deviation. Intuitively, losses on government bond portfolios did not affect German commercial banks before the government debt crisis, possibly in part because of the widespread absence of marking to market at the onset of the crisis and the preferential treatment of government debt in central bank operations and capital regulation.The risk of cooperative and savings banks, in contrast, is not affected by high-risk government bond holdings, possibly due to their low holdings of these bonds (Figure 1.2).

Second, holdings of low-risk government bonds are associated with lower bank risk, i.e. a higher *z-score*, for savings and coopaertive banks in the entire sample period (Panel A of Table 1.9). This finding is consistent with the notion that safe government bonds serve as a liquidity buffer. It reflects the investment of German regional banks in German and other safe government bonds.

The results (not reported) remain robust against an alternative aggregation method for the government bond holdings by taking the mean instead of the end-of-year values of a bank's government bond holdings in each year and against winsorizing all covariates.

1.4.4 Market- and credit-based measures of risk

Our baseline measure for bank risk, the *z-score*, reflects only realized risks since it is accounting based. To address this concern, we change the measures of risk entirely and show the results in Table 1.10.

First, we show in Panel A of Table 1.10 results of Probit regressions explaining the likelihood that a bank has non-performing loans in the highest decile in a given year. For the entire sample period, the effect of predicted government debt shares is qualitatively identical to those reported before. Low risk government bonds reduces bank risk whereas high-risk government bond holdings increases bank risk as measured by NPL ratios.

Second, we show in Panel B of Table 1.10 parsimonious regressions that explain the log of bank CDS spreads.[9] This sample is smaller because CDS are available for only 24 German banks. The effect of predicted government bond holdings is reinforced. Over the entire sample period, larger predicted shares of low-risk government bonds reduced CDS spreads of banks whereas larger predicted shares of high-risk government bonds increased those spreads. The coefficient on high-risk government bonds is around 70 times larger compared to the coefficient on low-risk government bonds. Results show that market participants considered higher bank risk associated with larger shares of risky government bonds already before the outbreak of the government debt crisis.

In sum, we confirm our main results that larger shares of risky government debt increase bank risk and larger shares of low risk government debt decrease bank risk for both, CDS as a market-based, forward looking measure of risk as well as the NPL indicator as a measure of relative credit risk.

1.5 Conclusion

The European sovereign debt crisis highlights the need to understand the determinants of banks' government bond holdings and the impact of these exposures on bank risk. This chapter complements prior studies, which are mostly confined to a subset of large European banks and the period since the outbreak of the European sovereign debt crisis. Our granular data allow studying the government bond holdings for all German banks during the pre-crisis, the financial crisis, and the European government debt crisis periods. The German case is of interest because it allows analyzing the investment behavior of banks outside the countries hit by the European government debt crisis.

Our empirical approach takes the self-selection of banks whether, which, and how much government debt to hold explicitly into account. We then estimate the effects of predicted government bond holdings on German banks' risks. Three main findings emerge.

First, only about two thirds of all German banks invest in government bonds. The volume of bonds and the degree of diversification of government bond portfolios differ across banking groups. Larger, weakly capitalized (and in this sense riskier) banks, and banks that are more active on capital markets hold more government bonds. Bank-level determinants of

[9] Data on CDS spreads are available until Q4:2013 and we extend the regression sample period accordingly.

government exposures change over time, especially for German commercial and mortgage banks.

Second, before the financial crisis, banks did not differentiate much between countries based on macroeconomic factors. Afterwards, German banks have restructured their government bond portfolios according to macroeconomic fundamentals. With the outbreak of the government debt crisis in 2010, German banks have decreased bond holdings from countries with high levels of government debt over GDP and high yields.

Third, predicted holdings of government bonds affected the risk of German banks. We use three measures of risk, the *z-score*, CDS spreads, and non-performing loans, and find that larger holdings of low risk government bonds decrease risk of cooperative and savings banks during the entire sample period. Larger exposures to risky government debt however increase the riskiness of German commercial banks after the outbreak of the government debt crisis.

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Appendix to Chapter 1

1.A Data

Data definitions and sources

Government bond portfolios

Exposure to government bonds EXP: this is a dummy variable which is equal to one if the bank *i* holds government bonds of country *j* in quarter *t* and zero otherwise. The information is based on the *Securities Holdings Statistics* of the Deutsche Bundesbank.

Predicted volume of risk government bonds: this variable is used as a regressor in the equations explaining bank risk (Tables 1.10, 1.11, 1.14). It is the predicted value of banks' investment in government bonds from the model for the intensive margin in Table 1.3. The data are aggregated at the bank level and measured relative to total assets. Government bond holdings are categorized into low, intermediate, and high-risk bonds according to the country classifications in Table 1.6. The risk measure is based on the average of the ratings by Moody's, Fitch and Standard and Poor's. Low risk is defined as AAA, intermediate risk is defined as AA and A, and high risk as BBB or worse.

Government bond Holdings SOV: market value of a bank's government bond holdings of country *j* in quarter *t*. Data are obtained from the *Securities Holdings Statistics* of the Deutsche Bundesbank. Individual security data are aggregated to the issuer country level by summing up over all ISINs per country, bank and quarter. Issuers at all levels of the government - central, federal and municipal - are included. Only government bonds held on banks' own accounts are included, covering both the banking book and the trading book.

Bank-level variables

Cash & overnight / total assets: ratio of cash and overnight interbank loans to total assets obtained from the annual financial statements submitted by banks to the Deutsche Bundesbank. This variable gauges the liquid assets of a bank, excluding government bonds.

CDS spread: average quarterly quoted CDS spread on a bond with five-year maturity for senior unsecured debt with the complete restructuring clause and denominated in euro. The data are obtained from the data provider MarkIT.

Core capital ratio: ratio of equity capital minus deficit to total assets obtained from the annual financial statements submitted by banks to the Deutsche Bundesbank. This variable reflects the risk-bearing capacity of banks.

Cost-to-income ratio: ratio of total operating costs to total operating revenue obtained from the annual profit and loss statements of banks submitted to the Deutsche Bundesbank.

Customer loans / total loans: ratio of claims on customers to the sum of claims on customers and on banks obtained from the annual financial statements submitted by banks to the Deutsche Bundesbank. This variable reflects the degree of retail orientation of a bank.

Fee income / interest income: ratio of net fee income over net interest income. Net interest income equals the difference between the interest income and expenses obtained from the annual profit and loss statements of banks submitted to the Deutsche Bundesbank.

NPL ratio: the NPL ratio is an indicator equal to one if the bank belongs to the highest decile of non performing loans to total loans in a given year. Using such a relative measure avoids

contamination by statistical breaks in prudential definitions of NPL over time and are obtained from the annual financial statements submitted to the Deutsche Bundesbank.

Retail deposits / total assets: ratio of overnight deposits from household and non-financial firms to total assets obtained from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank.

Return on equity: ratio of total revenue to equity capital obtained from the annual financial reports and the annual profit and loss statements of the Deutsche Bundesbank.

Securitized liabilities / total assets: ratio of securitized liabilities to total assets. Securitized liabilities include covered bonds, money market papers, and other securitized liabilities. Information is taken from the annual financial statements submitted by banks to the Deutsche Bundesbank.

Security portfolio / total assets: ratio of bonds and stocks portfolio to total assets obtained from the annual financial statements submitted by banks to the Deutsche Bundesbank. This variable reflects the importance of securities trading in the business model of banks.

Total assets: log of total assets of the bank. Data are taken from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank. It is a measure for bank size.

Z-score: z-score, defined as (return on assets plus capital over assets) divided by the volatility of return on assets. In order to obtain a bank-time specific measure for volatility of *RoA*, we regress *RoA* on bank and time fixed effects. The residuals of this regression give the volatility of *RoA* of bank *i* in year t that cannot be explained by bank or time common effects. The residuals are winsorized and taken in absolute terms as measure for σ_{RoA}. The *z-score* is a measure of the distance to insolvency of a bank and thus an inverse measure for bank risk. A higher *z-score* indicates less risk. The *z-score* is winsorized at the 0.1% and 99.9% level to account for outliers. The data are obtained from the annual financial reports and the annual profit and loss statements that banks submitted to the Deutsche Bundesbank.

Country-level variables

CPI inflation: inflation is measured through the consumer price index (CPI). All items are included in the consumer price index and the change against the same quarter of the previous year is calculated in %. The quarterly time series is obtained from the OECD database.

Euro Area bond: dummy variable which is equal to one if the country is a member of the Euro Area in the respective quarter and zero otherwise. This variable might capture preferential regulatory treatment of Euro Area government bonds as well as the absence of exchange rate risk.

GDP: log of a country's GDP. Data are in constant prices as of the year 2005 and are seasonally adjusted. The quarterly time series has been extracted from the OECD database.

IMF measures: these data are obtained from the homepage of the IMF and include Extended Fund Facilities, Extended Arrangements, and Stand-by-Arrangements. We include a dummy variable which is equal to one from the time an IMF program has been started, i.e. for Greece (from Q2:2010), Hungary (from Q2:2008), Ireland (Q4:2010), Mexico (Q2:2008), Poland (Q1:2013) and Portugal (Q2:2011).

Government bond yield: we take the average yield on 10-year government bonds (in %) obtained from MarkIT.

Government debt ratio: percentage ratio of central government debt to GDP. The ratio is drawn from the OECD database and in quarterly frequency.

List of 29 included issuer countries

Australia (AU), Austria (AT), Belgium (BE), Canada (CA), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE),Greece (GR), Hungary (HU), Iceland (IS), Ireland (IE), Italy (IT), Japan (JP), Luxembourg (LU), Mexico (MX), Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Slovak Republic (SK), Slovenia (SI), Spain (ES), Sweden (SE), Switzerland (CH),United Kingdom (UK), United States (US).

1.B Figures and Tables

Figure 1.1: Participation rates in the government bond markets by banking groups

This Figure shows the percentage share of banks (within each banking group) which hold a government bond portfolio on their own accounts in the respective quarter. After the collapse of Lehman Brothers, the decreasing trend for cooperative and savings banks reverses. With the outbreak of the European sovereign crisis in 2010, the share of commercial banks engaged in government bond markets rises as well. Source: *Securities Holdings Statistics* of the Deutsche Bundesbank; own calculations.

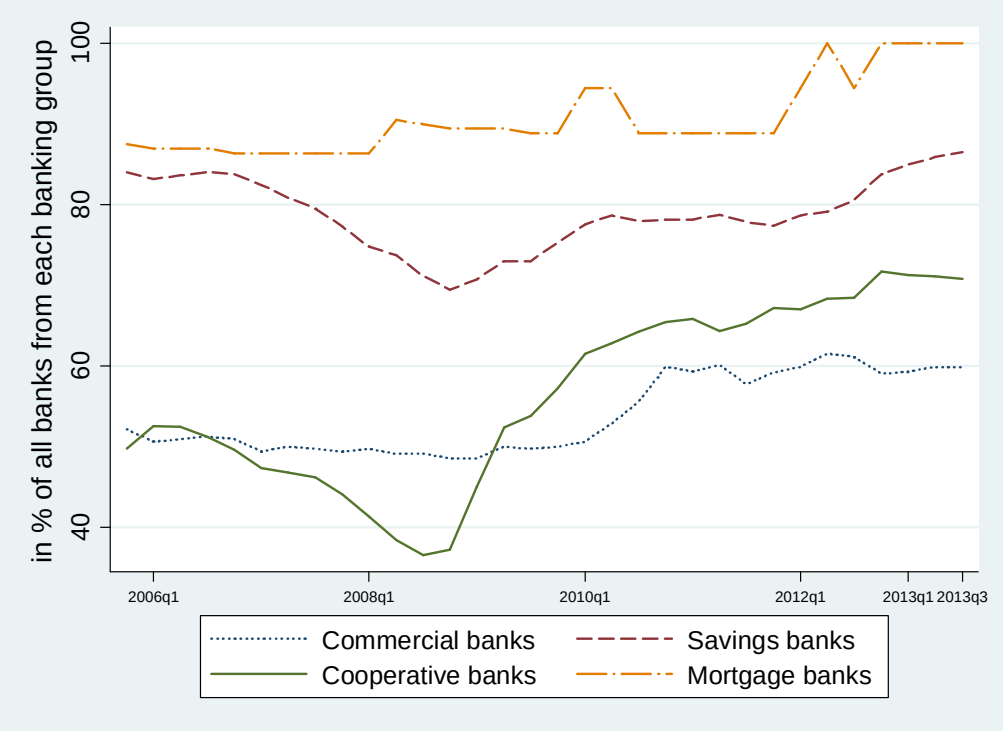

Figure 1.2: Share of government bonds in balance sheets of banks

This Figure gives the average share of government bond holdings in total assets (in %) for each banking group. Government bond holdings are decomposed by issuer, i.e. German government bonds, government bonds issued by Euro Area periphery countries (GR, IT, IE, PT, ES), the remaining Euro Area and the rest of the world. Source: *Securities Holdings Statistics* of the Deutsche Bundesbank; own calculations.

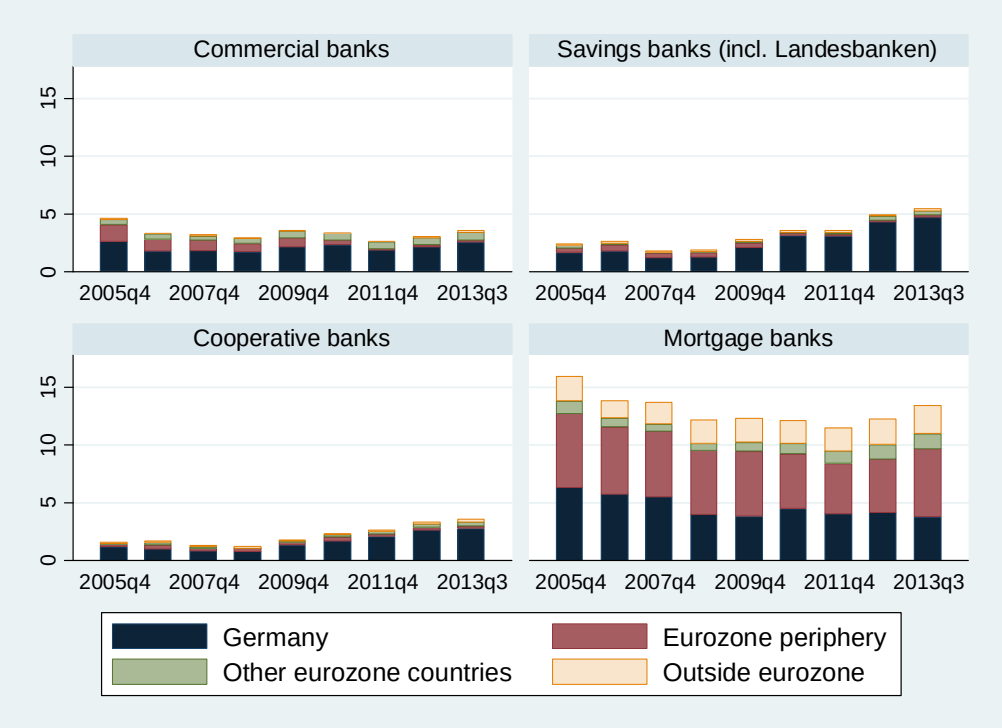

Figure 1.3: Government bond holdings of all German banks 2005-2013

This Figure plots data aggregated over all banks located in Germany. The scale of the vertical axis varies to highlight changes in sovereign risk exposures. The first vertical line marks the insolveny of Lehman Brothers in 2008 Q3, the second line the Greek rescue packages in 2010 Q2. Source: *Securities Holdings Statistics* of the Deutsche Bundesbank; own calculations.

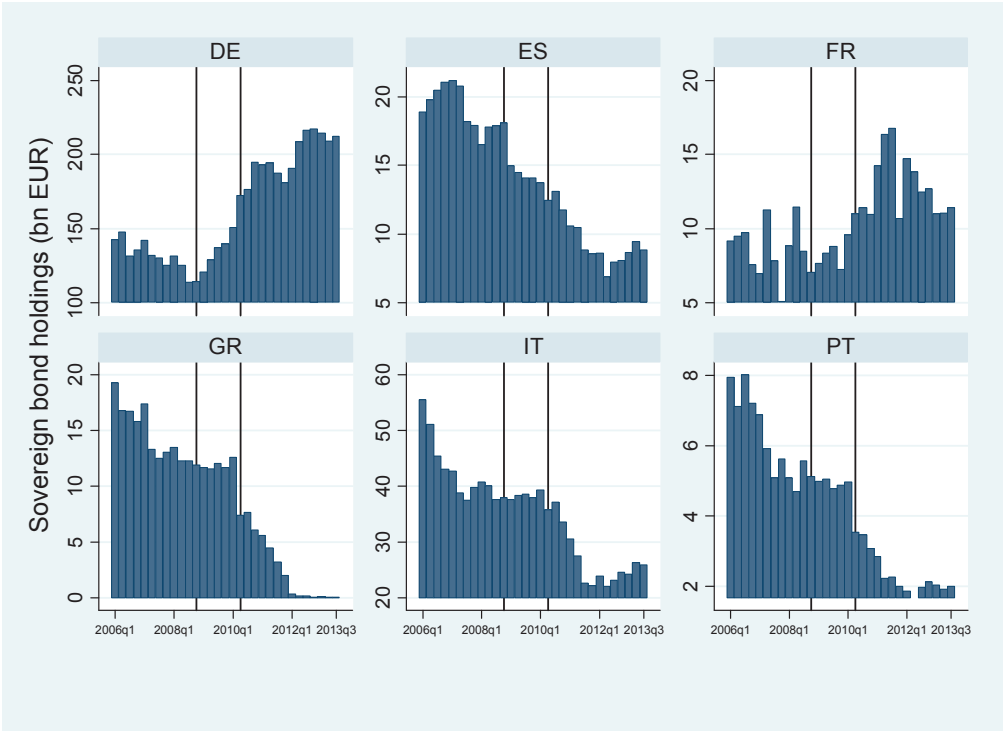

Table 1.1: Importance of the security portfolio in the balance sheet of German banks

This Table shows in column 1 the number of banks in each banking group. Column 2 displays the mean total assets of each bank. Column 3 displays aggregate assets per banking group. Column 4 displays aggregate securities (including shares, bonds, etc). Column 5 shows aggregate government bonds held in the banking or in the market book. Column 6 shows the percentage share of the overall securities portfolio (weighted average) and column 6 the share of all government bonds in total assets (weighted average). The banking group savings banks comprises savings banks and Landesbanken. The banking group cooperative banks include cooperative banks and their head institutions. The row "all banks" comprises the aggregate German banking system. Data are for the third quarter of 2013.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Number of banks	Average size	Aggregate total assets	Securities	Government bonds	Securities	Government bonds
		(billion €)	(billion €)	(billion €)	(billion €)	(% of total assets)	(% of total assets)
Commercial banks	167	15.97	2667.79	289.95	92.78	10.87	3.48
Savings Banks	431	5.27	2270.88	486.43	116.89	21.42	5.15
Cooperative banks	1093	0.95	1034.22	244.64	36.61	23.65	3.54
Mortgage banks	18	26.18	471.29	129.34	60.74	27.44	12.89
All banks	1709	3.77	6444.18	1150.36	307.03	17.85	4.76

Table 1.2: Descriptive statistics for Heckman model estimations

This Table shows in Panel A descriptive statistics for complete observations of macro variables in the selection and the outcome equations. Panel B shows the descriptive statistics for bank variables. All variables are defined in the data appendix 1.A to this chapter. The sample covers the period from Q4:2005 to Q3:2013, 1,970 banks, and 29 destination countries. We include the 25th and 75th percentile of variables for the outcome equation in order to better assess the magnitude of the estimated coefficients in the outcome equation.

	Selection equation		Outcome equation			
	1,632,540		83,698			
	Mean	Stdv	Mean	Stdv	p25	p75
Panel A: Country-specific variables						
Holding government bonds (0/1)	0.051	0.221				
Volume of government bonds (€ bn)			0.1	0.65	0.002	0.02
Ln GDP	0.56	1.92	0.31	1.76	-1.05	1.12
Government debt ratio	0.59	0.36	0.62	0.27	0.41	0.71
CPI inflation	0.03	0.02	0.02	0.02	0.02	0.03
Government bond yield	0.04	0.02	0.04	0.02	0.03	0.05
IMF measures (0/1)	0.07	0.25	0.08	0.27		
Euro Area bond (0/1)	0.47	0.5	0.77	0.42		
Panel B: Bank-specific variables						
Ln total assets	13.09	1.55	14.33	2.23	12.78	15.21
Cash & overnight / total assets	0.07	0.07	0.05	0.05	0.03	0.06
Customer loans / total loans	0.8	0.16	0.77	0.17	0.7	0.89
Security portfolio / total assets	0.23	0.12	0.28	0.12	0.19	0.35
Core capital ratio	0.06	0.05	0.05	0.03	0.04	0.06
Retail deposits / total assets	0.24	0.48	0.22	0.56	0.14	0.29
Securitized liabilities / total assets	0.03	0.06	0.07	0.13	0	0.07
Return on equity	0.04	0.09	0.03	0.14	0.02	0.05
Cost-to-income ratio	0.97	0.18	0.84	0.19	0.78	0.88
Fee income / interest income	0.47	4.64	0.36	2.88	0.2	0.32

Table 1.3: Heckman model for extensive and intensive margin

This Table shows regression results for estimating the determinants of banks' investments in government bonds using a Heckman model. The log of bank *i*'s government bond holdings of country *j* is the dependent variable in the outcome equation. An indicator equal to one when observing that bank *i* holds bonds of country *j* is the dependent variable in the selection equation. Fixed effects for banking group, time and country are specified in the selection equation. In the outcome equation, fixed effects for bank, time and country are included. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. The sample covers the period from Q4:2005 to Q3:2013. Marginal effects are calculated for the extensive margin. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1) Intensive margin (Outcome)	(2) Extensive margin (Selection)	(3) Marginal effects (Selection)
Ln GDP	2.046***	0.674***	0.019***
	(0.273)	(0.072)	(0.002)
Government debt ratio	0.736***	0.304***	0.008***
	(0.117)	(0.030)	(0.001)
CPI inflation	4.776***	1.710***	0.045***
	(0.789)	(0.211)	(0.006)
Government bond yield	-11.390***	-0.025	0.001
	(0.612)	(0.162)	(0.004)
IMF measures	-0.350***	-0.166***	-0.004***
	(0.042)	(0.011)	(0.000)
Home bond	1.180**	0.450***	0.011**
	(0.059)	(0.158)	(0.004)
Euro Area bond	1.980***	0.506***	0.014***
	(0.1677)	(0.0602)	(0.001)
Ln total assets	0.787***	0.164***	0.004***
	(0.050)	(0.002)	(0.000)
Cash & overnight / total assets	0.101	0.125**	0.003**
	(0.322)	(0.049)	(0.001)
Customer loans / total loans	0.093	-0.086***	-0.003***
	(0.138)	(0.017)	(0.000)
Security portfolio / total assets	4.968***	1.897***	0.051***
	(0.191)	(0.018)	(0.001)
Core capital / total assets	-2.670***	-1.019***	-0.019***
	(0.646)	(0.079)	(0.002)
Retail deposits / total assets	0.042**	-0.000	0.000***
	(0.019)	(0.006)	(0.000)
Securitized liabilities / total assets	2.900***	1.040***	0.028***
	(0.003)	(0.000)	(0.000)
Return on equity	0.163**	0.035*	0.001**
	(0.074)	(0.020)	(0.001)
Cost-to-income ratio	0.042	-0.001	-0.000
	(0.060)	(0.002)	(0.000)
Fee over interest income	-0.010***	-0.003***	-0.000***
	(0.003)	(0.001)	(0.000)
Number of observations	83,698	1,632,540	1,632,540
Inverse Mills ratio (IMR)	3.106		
Standard deviation of IMR	0.0874		

Table 1.4: Heckman model by time period

This Table shows regression results for estimating the determinants of banks' investments in government bonds using a Heckman model and splitting the sample into the pre-Lehman (Q4:2005 to Q2:2008), the post-Lehman, pre-Sovereign Crisis period (Q3:2008 to Q1:2010) and the since sovereign crisis period (Q2:2010 – Q3:2013). The log of bank *i*'s government bond holdings of country *j* is the dependent variable in the outcome equation. An indicator equal to one when observing that bank *i* holds bonds of country *j* is the dependent variable in the selection equation. Fixed effects for banking group, time and country are specified in the selection equation. In the outcome equation, fixed effects for bank, time and country are included. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self selection. The sample covers the period from Q4:2005 to Q3:2013, 1,970 banks, and 29 destination countries. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1)	(2)	(3)	(4)	(5)	(6)
	Before Lehman		Post Lehman pre sovereign		Since sovereign crisis	
	Intensive margin	Extensive margin	Intensive margin	Extensive margin	Intensive margin	Extensive margin
Ln GDP	1.487**	0.920***	3.191***	1.231***	0.384	-0.066
	(0.725)	(0.276)	(1.160)	(0.350)	(0.854)	(0.209)
Government debt ratio	1.252**	0.271	-0.795	0.001	-2.118***	-0.703***
	(0.573)	(0.219)	(0.527)	(0.160)	(0.294)	(0.072)
CPI inflation	0.876	0.744	-11.721***	-3.253***	14.768***	3.678***
	(1.292)	(0.501)	(1.973)	(0.566)	(1.829)	(0.441)
Government bond yield	-0.222	0.126	5.589	4.224***	-18.181***	-2.384***
	(4.333)	(1.675)	(4.220)	(1.282)	(1.204)	(0.285)
IMF measures			-0.770***	-0.346***	0.353***	0.100***
			(0.135)	(0.038)	(0.070)	(0.018)
Home bond	1.845	0.158	-1.767	-0.811	4.518**	1.806***
	(1.580)	(0.603)	(2.499)	(0.762)	(1.884)	(0.459)
Euro Area bond	0.974***	0.082	0.824***	0.286***	3.642	0.964
	(0.165)	(0.060)	(0.253)	(0.072)	(3.264)	(0.799)

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Ln total assets	0.391***	0.196***	0.682***	0.180***	0.544***	0.148***
	(0.095)	(0.004)	(0.181)	(0.005)	(0.129)	(0.003)
Cash & overnight / total assets	1.459**	0.510***	-1.102	0.295**	-0.520	-0.008
	(0.590)	(0.094)	(1.361)	(0.121)	(0.583)	(0.069)
Customer loans / total loans	0.141	0.187***	-1.430**	-0.149***	-0.368	-0.201***
	(0.312)	(0.036)	(0.658)	(0.040)	(0.331)	(0.024)
Security portfolio / total assets	4.872***	2.040***	4.274***	1.885***	4.690***	1.795***
	(0.420)	(0.035)	(0.871)	(0.043)	(0.422)	(0.024)
Core capital / total assets	-12.452***	-2.147***	-3.476	-2.058***	-0.103	-0.434***
	(1.488)	(0.179)	(3.986)	(0.243)	(1.071)	(0.097)
Retail deposits / total assets	-1.445***	0.013	-1.263	-0.278***	0.020	-0.001
	(0.483)	(0.049)	(0.876)	(0.059)	(0.023)	(0.006)
Securitized liabilities / total assets	0.830	0.854***	2.389	0.750***	3.528***	1.162***
	(0.627)	(0.072)	(1.824)	(0.088)	(0.836)	(0.067)
Return on equity	0.224**	0.077***	0.090	-0.142***	0.309	0.003
	(0.092)	(0.030)	(0.175)	(0.048)	(0.221)	(0.040)
Cost-to-income ratio	-0.961***	-0.266***	-0.713	-0.110*	0.057	-0.001
	(0.291)	(0.057)	(0.677)	(0.063)	(0.080)	(0.001)
Fee over interest income	-0.018*	-0.009***	0.004	-0.004	-0.011***	-0.003***
	(0.010)	(0.003)	(0.046)	(0.003)	(0.004)	(0.001)
Constant	10.046***	-2.236***	6.488*	-1.975***	4.101	-2.508***
	(2.098)	(0.379)	(3.893)	(0.393)	(3.622)	(0.607)
Observations	24,522	601,911	15,794	364,127	43,382	666,502
Inverse Mills ratio (IMR)	2.191		2.797		3.462	
Standard deviation of IMR	0.0961		0.177		0.158	

Table 1.5: Heckman model by time period and banking group

This Table shows regression results for estimating the determinants of banks' investments in government bonds using a Heckman model and splitting the sample into the pre-sovereign crisis period (Q4:2005 to Q1:2010) and the since sovereign crisis period (Q2:2010 – Q3:2013). The log of bank *i*'s government bond holdings of country *j* is the dependent variable in the outcome equation. An indicator equal to one when observing that bank *i* holds bonds of country *j* is the dependent variable in the selection equation. Fixed effects for banking group, time and country are specified in the selection equation. In the outcome equation, fixed effects for bank, time and country are included. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self selection. The sample covers the period from Q4:2005 to Q3:2013, 1,970 banks, and 29 destination countries. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Commercial banks		Savings banks		Cooperative banks		Mortgage banks	
	Before sovereign crisis	Since sovereign crisis	Before sovereign crisis	Since sovereign crisis	Before sovereign crisis	Since sovereign crisis	Before sovereign crisis	Since sovereign crisis
Ln GDP	-1.888	1.862	1.269*	-1.999	1.729**	1.426	1.351	-2.417
	(1.725)	(3.080)	(0.710)	(1.400)	(0.841)	(1.275)	(0.872)	(2.141)
Government debt ratio	-1.163	-1.897*	1.082***	-2.774***	-1.901***	-2.028***	0.206	-0.989
	(0.719)	(1.031)	(0.394)	(0.485)	(0.437)	(0.446)	(0.377)	(0.779)
CPI inflation	-8.990***	15.254**	-4.175***	18.012***	-3.984***	11.704***	-2.708*	15.449***
	(3.133)	(6.462)	(1.374)	(3.000)	(1.496)	(2.750)	(1.584)	(4.687)
Government bond yield	-5.732	-18.529***	8.463**	-20.950***	29.750***	-17.769***	-11.414**	-15.987***
	(9.976)	(4.198)	(3.938)	(2.029)	(4.969)	(1.787)	(5.315)	(2.968)
IMF measures	0.372	0.790***	-0.615***	0.419***	-1.403***	0.261**	0.040	0.298
	(0.324)	(0.281)	(0.112)	(0.117)	(0.177)	(0.102)	(0.172)	(0.185)
Home bond	9.071**	0.897	3.057***	10.020***	1,064	2,305	0.879	9.074*
	(3.796)	(6.769)	(1.549)	(3.110)	(1.734)	(2.788)	(1.908)	(4.728)
Euro Area bond	0.996**	9.598	1.058***	-6.335	1.862***	13.028**	0.226	-9.742
	(0.409)	(11.775)	(0.143)	(5.328)	(0.233)	(5.129)	(0.167)	(8.149)

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Ln total assets	0.655***	0.751***	0.699***	0.613*	0.418**	0.483*	0.430***	0.546*
	(0.151)	(0.228)	(0.143)	(0.321)	(0.162)	(0.254)	(0.139)	(0.304)
Cash & overnight / total assets	2.076**	-1.230	3.321***	10.487***	0.093	2.590**	9.318**	1.246
	(0.920)	(0.853)	(0.874)	(1.658)	(0.830)	(1.319)	(4.460)	(7.901)
Customer loans / total loans	1.116**	1.069	-0.737*	-1.731**	-0.399	-0.578	-1.671**	3.222**
	(0.470)	(0.729)	(0.389)	(0.714)	(0.462)	(0.588)	(0.705)	(1.262)
Security portfolio / total assets	7.475***	5.165***	3.939***	4.372***	5.236***	6.428***	-0.341	4.820***
	(0.698)	(0.930)	(0.549)	(0.840)	(0.641)	(0.870)	(0.930)	(1.763)
Core capital / total assets	-7.256***	3.291**	-19.946***	-26.555***	1.455	-5.999	-22.792***	-20.285
	(1.409)	(1.461)	(7.139)	(10.204)	(4.683)	(6.644)	(7.101)	(13.676)
Retail deposits / total assets	-2.549***	0.077***	-1.209	-1.928	-0.928	-1.588*	0.966	4.897
	(0.607)	(0.024)	(0.880)	(1.287)	(0.617)	(0.813)	(2.962)	(3.103)
Securitized liabilities / total assets	0.976	4.402**	-3.281***	-3.475	-1.255	6.290***	-1.319**	-0.471
	(1.506)	(1.976)	(1.211)	(2.233)	(1.251)	(1.698)	(0.579)	(1.295)
Return on equity	0.374	0.126	-1.072***	1.376	0.068	0.009	0.154**	-0.211
	(0.264)	(0.511)	(0.220)	(0.859)	(0.583)	(1.047)	(0.074)	(0.243)
Cost-to-income ratio	-1.230***	0.069	-3.867***	2.484***	-1.012**	0.022	1.156	0.500
	(0.397)	(0.093)	(0.663)	(0.826)	(0.478)	(0.659)	(1.182)	(0.991)
Fee over interest income	0.006	-0.009**	-0.304	1.226	0.954*	-0.989	-0.850**	-0.360**
	(0.011)	(0.004)	(0.699)	(0.957)	(0.530)	(0.906)	(0.340)	(0.182)
Constant	2.179	-4.869	6.742**	9.066	6.347**	-6.456	13.987***	11.273
	(3.813)	(10.081)	(2.834)	(7.289)	(2.939)	(6.101)	(3.607)	(8.473)
Observations	4.783	4.353	16.211	14.046	15.883	22.84	3.439	2.143
Inverse Mills ratio (IMR)	2.838	3.793	2.494	3.097	2.651	3.805	1.159	1.597
Standard deviation of IMR	0.218	0.371	0.154	0.228	0.272	0.360	0.112	0.221

Table 1.6: List of countries by risk category

This Table shows the included countries per risk category. The risk measure is based on the average of the ratings by Moody's, Fitch and Standard and Poor's. Low risk is defined as AAA, intermediate risk is defined as AA and A, and high risk as BBB or worse. An asterisk (*) indicates that sovereigns migrated from one category to another between 2005 and 2013.

Low-risk sovereigns	**Intermediate-risk sovereigns**	**High-risk sovereigns**
Australia (AU)	Belgium (BE)	Greece (GR)*since Q2:2010
Austria (AT)	Czech Republic (CZ)	Hungary (HU)*since Q4:2008
Canada (CA)	France (FR)*since Q4:2012	Iceland (IS)*since Q1:2009
Denmark (DK)	Hungary (HU)*until Q3:2008	Ireland (I.E.)*since Q3:2011
Finland (FI)	Iceland (IS)*until Q4:2008	Italy (IT)*since Q4:2012
France (FR)*until Q3:2012	Ireland (I.E.)*Q3:2009 until Q2:2011	Mexico (MX)
Germany (DE)	Italy (IT)*until Q3:2012	Portugal (PT)*since Q3:2011
Ireland (I.E.)*until Q2:2009	Greece (GR)*until Q1:2010	Slovenia (SI)*since Q4:2012
Luxembourg (LU)	Japan (JP)	Spain (ES)*since Q2:2012
Netherlands (NL)	Korea (KR)	
Norway (NO)	Poland (PL)	
Spain (ES)*until Q1:2010	Portugal (PT)*until Q2:2011	
Sweden (SE)	Slovenia (SI)*until Q3:2012	
Switzerland (CH)	Spain (ES)* Q2:2010 until Q1:2012	
United Kingdom (UK)*until Q3:2012	Slovak Republic (SK)	
United States (US)	United Kingdom (UK)*since Q4:2012	

Table 1.7: Descriptive statistics for the bank risk regressions

This Table shows descriptive statistics for the regression sample for bank-level covariates in the bank risk equation. The sample is annual and includes 1,612 banks from 2006 until 2012. The *z-score* which is defined as return on assets plus capital over assets divided by the volatility of return on assets. Volatility is measured by the variation (in absolute terms) in RoA that cannot be explained by time and bank fixed effects. The NPL-indicator equals one if a bank is within the 10% worst quantile of the non-performing loans to total loans distribution in a given year. Deciles are defined on the basis of the entire population of banks, i.e. including those without government bond exposures or missing data that precluded certain observations from the estimation sample. CDS spreads are observed quarterly and are available for 24 German banks. We show the average CDS spread per banking group and year averaged over quarters. Total assets and the funding structure are observed quarterly. The remaining variables are available annually. The government bond exposure variables are included as predicted volumes of low, intermediate, and high risk government bond holdings relative to total assets. Only banks that hold government bonds are included.

	Mean	Standard deviation	Observations
Z-score	3.56	1.2	7,708
CDS spread	112.61	138.81	396
NPL ratio	28.17	44.44	7,704
Ln total assets	13.43	1.6	7,708
Cash & overnight / total assets	0.06	0.06	7,708
Customer loans / total loans	0.8	0.16	7,708
Security portfolio / total assets	0.26	0.12	7,708
Retail deposits / total assets	0.23	0.99	7,708
Cost-to-income ratio	0.83	0.3	7,708
Fee over interest income	0.35	0.6	7,708
Securitized liabilities / total assets	0.03	0.07	7,708
Predicted low risk holdings / total assets	0.4	1.91	7,708
Predicted intermediate risk holdings / total assets	0.008	0.07	7,708
Predicted high risk holdings / total assets	0.0006	0.007	7,708

Table 1.8: Average risk measures per banking group and year

This Table shows the average bank risk measures per banking group and year. Panel A shows the *z-score* which is defined as return on assets plus capital over assets divided by the volatility of return on assets. Volatility is measured by the variation (in absolute terms) in RoA that cannot be explained by time and bank fixed effects. Panel B shows the average of the NPL-Indicator which equals one if a bank is within the 10% worst quantile of the non-performing loans to total loans distribution in a given year. Deciles are defined on the basis of the entire population of banks, i.e. including those without government bond exposures or missing data that precluded certain observations from the estimation sample. In this Table we only show observations that are used in the regression though. Panel C shows the average CDS spread per banking group and year (averaged over quarters). See Section 1.4.2 for a detailed description of the construction of the risk measures. *Z-score* and CDS spread are shown in absolute terms here but enter regressions in logs.

Panel A: Z-score

	2006	2007	2008	2009	2010	2011	2012	*Average*
Commercial banks	3.03	2.75	2.89	3,36	3.19	2.40	2.78	2.91
Savings banks	3.61	3.85	3.81	3.76	3.69	2.56	3.38	3.52
Cooperative banks	3.60	4.12	3.87	4.00	3.84	2.92	3.58	3.67
Mortgage banks	2.84	2.11	1.88	2.78	3.53	1.52	3.07	2.54
All	3.55	3.87	3.73	3.86	3.74	2.76	3.46	3.55

Panel B: NPL ratio

	2006	2007	2008	2009	2010	2011	2012	Average
Commercial banks	0.09	0.11	0.10	0.20	0.16	0.15	0.12	0.13
Savings banks	0.14	0.14	0.14	0.07	0.05	0.07	0.07	0.10
Cooperative banks	0.08	0.08	0.07	0.10	0.11	0.10	0.11	0.09
Mortgage banks	0.11	0.11	0.18	0.06	0.13	0.19	0.12	0.13
All	.099	.0996	.099	.099	.099	.099	.099	.09

Panel C: CDS spreads

	2006	2007	2008	2009	2010	2011	2012	*Average*
Commercial banks	14.35	28.00	86.62	103.59	105.49	169.59	225.14	105.80
Savings banks	11.77	27.22	96.30	120.62	129.71	218.44	182.74	100.68
Cooperative banks	19.83	44.16	126.76	161.08	140.71	158.29	173.43	126.83
Mortgage banks	17.88	22.84	239.53	451.93	127.54	160.58	159.07	152.84
All	14.00	28.24	114.19	165.93	124.03	185.74	190.66	112.61

Table 1.9: Regressions explaining bank risk

This Table shows panel regression results to explain bank risk per banking group and different sample periods. The dependent variable is the log of *z-score* per bank. Higher value indicates lower risk. The government bond exposure variables are included as predicted volumes of low, intermediate, and high risk government bond holdings relative to total assets in %. Panel A shows results for the entire sample. Panels B and Panel C show sample split results for the period before the European sovereign crisis (2006-2009) and the period since the outbreak of the sovereign crisis (2010-2012). Bank-specific control variables are included but not reported. See Table 1.14 in the appendix to this chapter for results on control variables. Fixed effects for bank and time are included. Standard errors are clustered at the bank level. ***, ** and * indicate significance at the 1%, 5% and 10% level.

	(1)	(2)	(3)	(4)
	All	Commercial	Savings	Cooperatives
Panel A: Entire sample period 2006-2012				
Predicted low risk holdings / total assets	0.003	0.021	0.056**	0.060**
	(0.015)	(0.024)	(0.025)	(0.026)
Predicted ntermediate risk holdings / total assets	0.301	0.884*	1.197	0.004
	(0.333)	(0.515)	(1.003)	(1.63)
Predicted high risk holdings / total assets	0.243	2.139	-4.934	-4.506
	(1.27	(1.708)	(7.761)	(11.462)
Observations	7,708	595	2,431	4,568
R^2	0.16	0.123	0.232	0.172
Number of banks	1,612	130	436	1,027
Panel B: Before sovereign crisis period 2006-2009				
Predicted low risk holdings / total assets	0.032	0.055**	-0.044	0.031
	(0.023)	(0.024)	(0.041)	(0.045)
Predicted intermediate risk holdings / total assets	0.194	1.169*	2.185**	4.463
	(0.838)	(0.654)	(1.004)	(4.316)
Predicted high risk holdings / total assets	2.566	3.853	46.440*	-12.378
	(7.272)	(5.931)	(26.896)	(33.942)
Observations	4,041	308	1,388	2,277
R^2	0.034	0.174	0.024	0.081
Number of banks	1,409	104	419	868
Panel C: Since sovereign crisis period 2010-2012				
Predicted low risk holdings / total assets	0.026**	0.031**	0.024	0.138***
	(0.012)	(0.015)	(0.029)	(0.046)
Predicted intermediate risk holdings / total assets	-0.449	-1.582***	3.345	0.834
	(0.427)	(0.289)	(3.412)	(2.327)
Predicted high risk holdings / total assets	-9.194***	-4.369***	-6.603	-5.501
	(2.959)	(1.253)	(18.125)	(13.638)
Observations	3,667	287	1,043	2,291
R^2	0.229	0.161	0.324	0.225
Number of banks	1,405	115	389	884

Table 1.10: Regressions explaining bank risk using alternative risk measures

This Table shows panel regression results to explain bank risk per time period using alternative measures for bank risk. In Panel A, the dependent variable is an indicator which equals one if the bank belongs to the upper decile in the non-performing loans to total loans ratio. We estimate the equation using Probit estimation and display marginal effects. In Panel B, the dependent variable is the log of the CDS spread of each bank. Bankgroup and time fixed effects, which control for common financial market developments, are included. Robust standard errors are used. The government bond exposure variables are included as predicted volume of low, intermediate and high risk government bond holdings relative to total assets in %. Bank-specific control variables are included in all specifications but not reported. Standard errors are clustered at the bank level and shown in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% level.

	(1)	(2)	(3)
	All	Before sovereign crisis	Since sovereign crisis
Panel A: NPL ratio as risk measure			
Predicted low risk holdings / total assets	-0.014***	0.000	-0.021***
	(0.005)	(0.011)	(0.008)
Predicted intermediate risk holdings / total assets	0.152	-0.094	0.114
	(0.145)	(0.284)	(0.200)
Predicted high risk holdings / total assets	1.320**	-1.690	2.670
	(0.643)	(2.933)	(1.638)
Observations	7,704	4,039	3,665
Panel B: CDS spreads as risk measure			
Predicted low risk holdings / total assets	-0.004**	-0.006	-0.003***
	(0.002)	(0.004)	(0.001)
Predicted intermediate risk holdings / total assets	0.099**	0.114	0.027
	(0.049)	(0.104)	(0.021)
Predicted high risk holdings / total assets	0.301**	1.493***	0.234**
	(0.142)	(0.550)	(0.106)
Observations	397	257	140
R^2 (incl time and bankgroup FE)	0.887	0.873	0.520

Table 1.11: Heckman model with alternative measures for country risk

This Table shows regression results for estimating the determinants of banks' investments in government bonds using a Heckman model with alternative measures for country risk (ratings and CDS spreads). The log of bank *i*'s government bond holdings of country *j* is the dependent variable in the outcome equation. An indicator equal to one when observing that bank *i* holds bonds of country *j* is the dependent variable in the selection equation. Fixed effects for banking group, time and country are specified in the selection equation. In the outcome equation, fixed effects for bank, time and country are included. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. The sample covers the period from Q4:2005 to Q3:2013, 1,970 banks, and 29 destination countries. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1)	(2)	(3)	(4)
	Average rating		CDS spreads	
	Intensive margin (Outcome)	Extensive margin (Selection)	Intensive margin (Outcome)	Extensive margin (Selection)
Ln GDP	0.624**	0.117*	0.539**	0.096
	(0.257)	(0.070)	(0.264)	(0.073)
Government debt ratio	1.325***	0.455***	-0.417***	-0.088***
	(0.126)	(0.033)	(0.117)	(0.031)
CPI inflation	3.481***	1.268***	-0.951	0.014
	(0.769)	(0.211)	(0.824)	(0.232)
Government bond yield	-6.362***	1.246***	-2.855***	1.015***
	(0.708)	(0.189)	(0.890)	(0.249)
Average country rating	-0.402***	-0.135***		
	(0.027)	(0.007)		
CDS spread of government bond			-0.031***	-0.006***
			(0.003)	(0.001)
Eurozone bond	1.956***	0.520***	2.006***	0.522***
	(0.098)	(0.024)	(0.105)	(0.026)
Ln total assets	0.765***	0.163***	0.745***	0.162***
	(0.049)	(0.002)	(0.052)	(0.002)
Cash & overnight / total assets	0.079	0.106**	0.029	0.076
	(0.318)	(0.050)	(0.333)	(0.053)
Customer loans / total loans	0.104	-0.087***	0.139	-0.081***
	(0.135)	(0.017)	(0.141)	(0.018)
Security portfolio / total assets	4.910***	1.912***	4.796***	1.908***
	(0.188)	(0.018)	(0.195)	(0.019)
Core capital / total assets	-2.614***	-1.002***	-2.502***	-0.965***
	(0.633)	(0.079)	(0.665)	(0.082)
Retail deposits / total assets	0.042**	-0.000	0.046**	0.001
	(0.019)	(0.006)	(0.019)	(0.006)
Securitized liabilities / total assets	2.915***	1.068***	2.942***	1.072***
	(0.299)	(0.041)	(0.311)	(0.043)
Return on equity	0.154**	0.030	0.106	0.006
	(0.072)	(0.020)	(0.074)	(0.021)
Cost-to-income ratio	0.038	-0.001	0.022	-0.001
	(0.059)	(0.002)	(0.059)	(0.002)
Fee over interest income	-0.010***	-0.003***	-0.009***	-0.003***
	(0.003)	(0.001)	(0.003)	(0.001)
Constant	-0.656	-3.095***	0.285	-2.872***
	(1.063)	(0.104)	(1.118)	(0.108)
Observations	83,427	1,569,427	76,731	1,344,731
Inverse Mills ratio (IMR)	3.037		3.007	
Standard deviation of IMR	0.0853		0.0894	

Table 1.12: Heckman model excluding German government bonds

This Table shows regression results for estimating the determinants of banks' investments in government bonds using a Heckman model for different periods excluding German bonds. The log of bank *i*'s government bond holdings of country *j* is the dependent variable and we report only the outcome equation. In the outcome equation, fixed effects for bank, time and country are included. Results are given separately for the pre-Lehman (Q4:2005 to Q2:2008), the post-Lehman, the pre-sovereign crisis period (Q3:2008 to Q1:2010) and the period since sovereign crisis (Q2:2010 – Q3:2013). The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. The sample covers the period from Q4:2005 to Q3:2013, 1,970 banks, and 29 destination countries. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1) Whole period	(2) Before Lehman	(3) After Lehman until sovereign crisis	(4) After sovereign crisis
Ln GDP	2.393***	1.445	4.661***	-0.735
	(0.365)	(0.894)	(1.305)	(1.016)
Government debt ratio	0.675***	1.364**	-0.095	-3.665***
	(0.155)	(0.694)	(0.546)	(0.436)
CPI inflation	5.488***	0.711	-12.266***	21.149***
	(1.020)	(1.593)	(2.087)	(2.454)
Government bond yield	-12.632***	0.794	5.920	-20.938***
	(0.800)	(5.424)	(4.543)	(1.557)
IMF measures	-0.391***		-0.651***	0.449***
	(0.058)		(0.155)	(0.085)
Eurozone bond	2.167***	0.835***	0.916***	-0.403
	(0.141)	(0.199)	(0.259)	(3.871)
Ln total assets	0.946***	0.581***	0.675***	0.654***
	(0.078)	(0.154)	(0.194)	(0.167)
Cash & overnight / total assets	-0.347	0.786	-3.314**	-0.827
	(0.464)	(0.936)	(1.456)	(0.741)
Customer loans / total loans	-0.105	-0.564	-1.825**	-0.330
	(0.191)	(0.463)	(0.749)	(0.407)
Security portfolio / total assets	6.100***	5.426***	5.228***	5.840***
	(0.378)	(0.665)	(1.058)	(0.644)
Core capital / total assets	-1.272	-8.917*	-6.201	1.558
	(0.973)	(4.614)	(6.637)	(1.253)
Retail deposits / total assets	-0.286***	-1.286**	-3.817***	-0.097***
	(0.037)	(0.651)	(0.975)	(0.037)
Securitized liabilities / total assets	2.908***	1.484*	2.367	4.024***
	(0.443)	(0.799)	(1.964)	(1.048)
Return on equity	0.142	0.166	0.062	0.316
	(0.097)	(0.119)	(0.179)	(0.265)
Cost-to-income ratio	-0.751***	-2.051***	-0.837	-0.298
	(0.189)	(0.508)	(0.758)	(0.245)
Fee over interest income	-0.008	0.417*	-0.021	-0.034***
	(0.008)	(0.240)	(0.045)	(0.011)
Constant	-1.375	7.281**	8.568**	5.786
	(1.662)	(3.225)	(4.126)	(4.490)
Observations	52918	14479	9865	29057
Inverse Mills ratio (IMR)	3.823	2.625	2.714	3.934
Standard deviation of IMR	0.211	0.239	0.339	0.320

Table 1.13: Heckman model restricted on central government bonds

This Table shows regression results for estimating the determinants of banks' investments in government bonds using a Heckman model for different periods including only central government bonds. The log of bank *i*'s government bond holdings of country *j* is the dependent variable and we report only the outcome equation. In the outcome equation, fixed effects for bank, time and country are included. Results are given separately for the pre-Lehman (Q4:2005 to Q2:2008), the post-Lehman, the pre-sovereign crisis period (Q3:2008 to Q1:2010) and the period since sovereign crisis (Q2:2010 – Q3:2013). The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. The sample covers the period from Q4:2005 to Q3:2013, 1,970 banks, and 29 destination countries. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1)	(2)	(3)	(4)
	Whole period	Before Lehman	After Lehman until sovereign crisis	Since sovereign crisis
Ln GDP	2.629***	2.384***	4.576***	-0.610
	(0.314)	(0.704)	(1.270)	(1.059)
Government debt ratio	0.880***	1.837***	0.194	-3.387***
	(0.134)	(0.604)	(0.548)	(0.423)
CPI inflation	6.181***	0.122	-11.929***	19.713***
	(0.871)	(1.255)	(2.092)	(2.459)
Government bond yield	-11.922***	-17.429***	8.270*	-21.058***
	(0.679)	(4.973)	(4.506)	(1.590)
IMF measures	-0.155***		-0.680***	0.448***
	(0.046)		(0.150)	(0.088)
Eurozone bond	2.023***	0.818***	0.849***	1.674
	(0.115)	(0.154)	(0.257)	(4.047)
Ln total assets	0.853***	0.490***	0.858***	0.628***
	(0.059)	(0.098)	(0.185)	(0.169)
Cash & overnight / total assets	-0.174	0.527	-0.853	-0.747
	(0.358)	(0.684)	(1.401)	(0.732)
Customer loans / total loans	-0.151	-0.633*	-0.860	-0.721*
	(0.157)	(0.324)	(0.710)	(0.414)
Security portfolio / total assets	5.143***	4.144***	3.954***	6.292***
	(0.282)	(0.456)	(0.997)	(0.639)
Core capital / total assets	-0.897	-4.200**	-1.682	-0.498
	(0.699)	(1.848)	(3.896)	(1.273)
Retail deposits / total assets	0.053***	-1.086**	-2.230**	0.025
	(0.020)	(0.540)	(0.929)	(0.028)
Securitized liabilities / total assets	2.422***	0.350	0.843	3.593***
	(0.360)	(0.648)	(2.034)	(1.067)
Return on equity	0.123	-0.023	0.021	0.603**
	(0.084)	(0.089)	(0.185)	(0.288)
Cost-to-income ratio	0.002	-1.282***	-1.076	0.150
	(0.082)	(0.340)	(0.725)	(0.111)
Fee over interest income	-0.009***	-0.003	0.013	-0.012***
	(0.003)	(0.009)	(0.047)	(0.004)
Constant	0.788	11.299***	4.556	4.247
	(1.242)	(2.115)	(3.948)	(4.640)
Observations	58456	17135	10754	30725
Inverse Mills ratio (IMR)	3.267	1.653	2.754	4.130
Standard deviation of IMR	0.154	0.121	0.302	0.316

Table 1.14: Baseline regressions explaining bank risk

This Table shows panel regression results to explain bank risk. The dependent variable is the log of the *z-score* of each bank where a higher value indicates lower risk. The sample is split into the before European sovereign crisis period (2006-2009) and the period since the outbreak of the sovereign crisis (2010-2012). Fixed effects for bank and time are included. Standard errors are clustered at the bank level and shown in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% level.

	(1) All	(2) Before sovereign crisis	(3) Since sovereign crisis
Ln total assets	-0.038	0.002	-0.049
	(0.031)	(0.051)	(0.092)
Cash & overnight / total assets	-0.296*	-0.619**	-0.185
	(0.152)	(0.300)	(0.214)
Customer loans / total loans	0.014	-0.133	0.045
	(0.083)	(0.127)	(0.184)
Security portfolio / total assets	0.117	0.104	0.037
	(0.111)	(0.191)	(0.212)
Retail deposits / total assets	-0.052	0.292	0.000
	(0.165)	(0.297)	(0.302)
Securitized liabilities / total assets	-0.501**	-0.173	0.464
	(0.224)	(0.425)	(0.570)
Cost-to-income ratio	-0.006	0.146	-0.021*
	(0.016)	(0.137)	(0.012)
Fee over interest income	0.001	0.036	-0.041
	(0.032)	(0.072)	(0.030)
Volume of low risk government bonds (predicted) / total assets (%)	0.003	0.032	0.026**
	(0.015)	(0.023)	(0.012)
Volume of int. risk government bonds (predicted) / total assets (%)	0.301	0.194	-0.449
	(0.333)	(0.838)	(0.427)
Volume of high risk government bonds (predicted) / total assets (%)	0.243	2.566	-9.194***
	(1.270)	(7.272)	(2.959)
Constant	1.727***	1.111	1.915
	(0.436)	(0.717)	(1.280)
Observations	7,708	4,041	3,667
R-squared	0.160	0.034	0.229
Number of banks	1,612	1,409	1,405

Chapter 2: Moral suasion in regional government bond markets[1]

2.1 Introduction

During the European sovereign debt crisis, banks' large holdings of home government debt had detrimental consequences for financial stability, bank lending, and the real economy (Acharya, Eisert, Eufinger, and Hirsch, 2016; Becker and Ivashina, 2017). Policy makers and academics are striving for a better understanding of banks' incentives to hold (home) government debt. One hypothesis is that governments use *moral suasion* to persuade home banks to hold more home government bonds (Ongena, Popov and van Horen, 2016; Weidmann, 2013).

The idea of moral suasion is that governments use explicit or implicit threats or the understanding that favours will be reciprocated in the future to persuade private firms to engage in activities that they would not do otherwise (Romans, 1966).[2] Moral suasion is difficult to observe directly but the theoretical literature suggests that governments have an incentive to use moral suasion on home banks to hold home government debt if fiscal fundamentals are weak and other investors are less willing to lend (Chari, Dovis and Kehoe, 2016). The bank's incentive to act upon moral suasion should be particularly high if the bank is owned by the government and/or politicians are members of its supervisory board.

This chapter tests the moral suasion hypothesis at the *regional* level in Germany, i.e. for German banks' state ("Laender") bond holdings. The institutional setting in Germany lends itself to the study of moral suasion on the regional level since there are close links between state governments and banks, since states have their own budget that they finance (inter alia) by borrowing in bond markets and since detailed data on German banks' state bond holdings are available. My empirical methodolody uses differences in the fiscal strength between states and over time as reported by the German Stability Council[3] to identify differences in the states' incentives to use moral suasion. Specifically, the Stability Council evaluates the fiscal

[1] This Chapter is based on Ohls, J. (2017) Moral suasion in regional government bond markets. Deutsche Bundesbank Discussion Paper Series, 33/2017.

[2] Moral suasion has been used in a wide array of policy areas, including labour policies and monetary policy (Romans, 1966).

[3] The German Stability Council assesses the risk of an impending budgetary emergency of states and publishes its results annually (for detailed information on the Stability Council, see Section 2.2)

condition of German states along four stability criteria and I construct an indicator capturing the number of criteria that are breached by a state (i.e. "breaches of stability criteria").[4] In addition, I make use of differences in bank location and bank ownership to identify the incentives of banks for collusion.

This chapter applies a Heckman (1979) selection model to account for the impact of moral suasion on a bank's decision whether to hold any state bonds (selection equation), in addition to the impact on the volume of a bank's state bond holdings (outcome equation). It is important to control for the self-selection of banks into holding state bonds as moral suasion might trigger a bank to invest in home state bonds at all. In addition, I study the impact of moral suasion on a *bank's share in outstanding state bonds* by implementing a fractional logit model as proposed by Papke and Wooldridge (1996) and fixed effects regressions.

Overall, my results are in line with moral suasion by state governments on (state-owned) home banks. Home banks (i.e. banks located in the state that issues the bond) are more likely to hold home state bonds and hold larger volumes of these bonds than "out-of-state" banks (i.e. banks located in another German state). The preference for home state bonds increases significantly when the state is in a *weak* fiscal condition and the bank is *directly owned by the state government* (i.e. Landesbanken and regional development banks). State-owned banks located in weak states hold more home state bonds than state-owned banks located in "sound" states.

The key challenge for identifying the impact of moral suasion is to control for banks' alternative incentives to hold home government debt. The regional setting of my analysis mitigates differences in the institutional and regulatory framework that may confound results in cross-country studies. Also, I explicitly control for alternative hypotheses suggested by the literature, such as risk shifting (Farhi and Tirole, 2016), political endearing (Koetter and Popov, 2017), other lending opportunities (Gennaioli et al. 2014), and information asymmetries (Portes, Rey and Oh, 2001). Finally, I make use of variation in state bond holdings *between* banks and *within* banks across different issuers over time to control for unobserved incentives of banks for holding government debt (identification through heterogeneity). To the best of my knowledge, this is the first study that simultaneously controls for unobserved time-varying heterogeneity at the bank-level and for the time-constant but bank-specific preference for a particular issuer, e.g. for the home state. My findings on

[4] The stability criteria are the following: interest expense to tax income, outstanding state debt, structural net lending/borrowing, and the credit funding ratio. They are evaluated in two dimensions, current and future fiscal planning.

moral suasion remain. State-owned banks increase their home state bond holdings more than other banks if the fiscal condition of the home state worsens (i.e. the number of stability criteria that are breached increases).

The empirical analysis is based on a detailed panel dataset constructed from the *Securities Holdings Statistics* (Bade, Flory and Schönberg, 2016), *Capital Market Statistics*, *Monthly Balance Sheet Statistics*[5] and bank supervisory data of the Deutsche Bundesbank and data provided by the German Stability Council. My dataset includes all state bond holdings (2,078 state bonds) of each German bank (2,024 banks) for the time period Q4:2005 – Q2:2014 and hence covers tranquil times, the financial crisis and the European debt crisis period. The data suggest that German banks are important for the funding conditions of state governments since they hold 64% of the outstanding volume of German state bonds (Q2:2014). At the same time, German state governments own regional development banks and, partly, Landesbanken, thereby controlling 17% of the German banking system's total assets (*Monthly Balance Sheet Statistic* of the Deutsche Bundesbank).[6] This setting may render moral suasion particularly attractive to state governments.

Governments can exert moral suasion on (state-owned) banks through several channels such as conversations, membership of state politicians in bank supervisory boards, explicit mandates or anticipatory obedience of state-owned banks. I find that a bank's preference for home state bonds is larger if the state owns a larger share of the bank's equity, if the bank is owned by only one instead of several states and if the share of politicians on the supervisory board is higher.

The results on moral suasion are robust to controlling for unobserved time-varying heterogeneity at the issuer level, to different measures of a state's fiscal strength and different clustering of standard errors, to constraining the sample to the period after the introduction of the Stability Council (from 2010 onwards), and to excluding special types of states.

This study is related to several streams of literature, most importantly the recent papers on moral suasion in European government bond markets. These empirical studies on large European banks find that home banks (Horváth, Huizinga and Ioannidou, 2015; Ongena et al., 2016), publicly owned banks (Altavilla, Pagano and Simonelli, 2016; Becker and Ivashina, 2017; De Marco and Macchiavelli, 2016; Ongena et al., 2016) and banks headed by

[5] For more information on the *Monthly Balance Sheet Statistics*, see https://www.bundesbank.de/Redaktion/EN/Standardartikel/Service/Reporting_systems/monthly_balance_sheet_statistics.html?https=1

[6] While the relationship between governments and savings banks is close at the municipality level as well, data on bank lending to municipalities is scarce.

politicians (Becker and Ivashina, 2017; De Marco and Macchiavelli, 2016) tend to hold more home sovereign debt, especially in risky countries (Altavilla et al., 2016; Horváth et al., 2015) and at times in which governments have high funding needs (Ongena et al., 2016).

This chapter contributes to the literature by testing for moral suasion on the regional instead of the consolidated government level which mitigates differences in the institutional framework and helps to better identify the direct links between governments and banks. Also, the empirical approach better accounts for alternative incentives of banks to invest in (home) government debt by controlling for unobserved heterogeneity at the bank-time and issuer-bank level. Finally, the sample extends the evidence for moral suasion beyond large banks and countries that are experiencing a sovereign debt crisis.

The empirical literature has identified several other reasons for banks to hold government debt that I control for in my empirical analysis: Risk-shifting by banks (Horváth et al., 2015), discrimination of foreign bond holders (Brutti and Sauré, 2014), hedging of redenomination risk (Battistini, Pagano, and Simonelli, 2014) and political endearing of banks (Koetter and Popov, 2017). Using a similar dataset as this chapter, Koetter and Popov (2017) study the impact of political elections on the political endearing of savings banks. They find that savings banks owned by municipalities that are politically *misaligned* with the state government (i.e. governed by a different political party) have a *higher* exposure to the home state (relative to their assets). While the study by Koetter and Popov (2017) focuses on municipal-owned savings banks, I focus on state-owned Landesbanken and regional development banks that are politically aligned through direct state ownership. Furthermore, I use the variation between home and out-of-state banks and "sound" and "weak" German states.

This study also relates to the research on the determinants of prices in the German state government bond market. Heppke-Falk and Wolff (2008) and Lemmen (1999) find that yields increase, and thus prices decrease, with higher indebtedness of the state, although only to a limited extent. My findings suggest that it is worthwhile to account for the differences in investors' incentives for holding state bonds when studying the impact of fiscal fundamentals on market prices. Schulz and Wolff (2008) document differences in funding strategies between German states for the time period 1992 – 2007 and a common liquidity event in state bond spreads in 2007. My empirical approach takes that into account by controlling for unobserved heterogeneity at the issuer-time level and, in a robustness check, at the bank-issuer level.

A good understanding of banks' incentives to hold government debt is important since banks' exposures towards risky government bonds have adverse consequences for bank stability (Acharya, Drechsler, and Schnabl, 2014; Buch, Koetter, and Ohls, 2016), bank lending to the private sector (Becker and Ivashina, 2017; Popov and van Horen, 2015) and the real economy (Acharya et al., 2016). Also, a larger home bias in banks' government bond portfolios is associated with higher government debt levels and lower government borrowing costs (Asonuma, Bakhache, and Hesse, 2015). Asonuma et al. (2015) conclude that banks' home bias may give governments more time for consolidation but at the same time pose the risk of delaying necessary reforms.

The remaining part of this chapter proceeds as follows. Section 2.2 derives the hypothesis on moral suasion from the existing theoretical literature and discusses the institutional background in Germany. Section 2.3 explains the construction of the dataset and shows descriptive evidence on the state bond holdings of German banks. Section 2.4 discusses the empirical methodology and presents the results. Section 2.5 concludes.

2.2 Theoretical hypotheses and institutional background

2.2.1 Theoretical hypotheses

The theoretical literature offers several hypotheses on why banks invest more in home than in foreign government debt. These include risk-shifting by risky banks (Ari, 2016; Farhi and Tirole, 2016), information asymmetries (Portes et al., 2001), discrimination of foreign borrowers (Broner, Erce, Martin and Venture, 2014), and moral suasion (Chari et al., 2016) which is the focus of this chapter. This Section briefly describes the theoretical model and its implications, while the following Section 2.2.2 discusses how the hypothesis relates to the institutional setting in Germany. The alternative hypotheses are discussed and tested in Section 4.3.2.

Chari et al. (2016) augment a standard neoclassical model with banks in the spirit of Gertler and Kiyotaki (2010) to study the government's incentives for pressuring banks into holding home government debt. Chari et al. (2016) assume a benevolent government that funds expenditures by levying taxes and borrowing in debt markets subject to a borrowing constraint. Banks face a collateral constraint limiting bank borrowing and thus lending by bank's net worth. As a result, higher holdings of home government debt come at the cost of lower private lending (crowding out). Benefits from requiring banks to hold home government debt arise in the model from alleviating the government's borrowing constraint,

smoothing taxes and thus consumption.[7] The government's borrowing constraint is relaxed because default is assumed to be strategic and higher government bond holdings of *home* banks serve as a commitment device for the government to repay its debt in order to avoid domestic output costs (Chari et al., 2016).[8]

The model predicts that the government requires home banks to hold home government debt (by means of a regulatory constraint), when the government faces funding needs exceeding its borrowing constraint. This situation may occur when the government is in a weak fiscal situation and therefore non-home investors are less willing to lend (Chari et al., 2016).

Moral suasion hypothesis part (I): *The government requires home banks to hold home government bonds if it has weak fiscal fundamentals because banks from other states are less willing to hold government bonds in these situations.*

I test this hypothesis using differences in fiscal strength between German states as reported by the Stability Council and by comparing state bond holdings of home versus out-of-state banks.

While Chari et al. (2016) model the government's ability to impact home banks' investment decisions as a binding regulatory constraint, European banking regulation favours government bonds issued in domestic currency but does not differentiate between government issuers on the regional level. Instead, state governments might impact the investment decisions of home banks through moral suasion (Romans, 1966). Moral suasion should be particularly effective on state-owned banks due to the government's close relationship with these firms. The political view of state-owned firms (Shleifer and Vishny, 1994) suggests that governments might use its control over state-owned firms to pursue private goals. In fact, banks have been shown to engage in politically motivated private lending (see, among others, Dinc, 2005; Khwaja and Mian, 2005; Sapienza, 2004). The second part of my hypothesis on moral suasion therefore refers to the special role of state-owned banks.

Moral suasion hypothesis part (II): *Moral suasion by governments is particularly effective for banks that are directly owned by the state or that have state politicians on the supervisory board as these banks have higher incentives to concede to moral suasion.*

[7] While governments in Chari et al. (2016) smooth taxation, German states are generally not able to increase tax rates because these fall into the authority of the German central or municipal governments. However, German states may engage in smoothing government expenditures.

[8] The reason is that a default on home banks would reduce bank lending, and thus domestic investment and growth. Basu (2009), Broner et al. (2014) and Gennaioli et al. (2014) build models with a similar mechanism but study the probability of a sovereign default and not the implications for moral suasion.

I test this hypothesis using an indicator for state ownership of a bank, using data on the degree of state ownership and on supervisory board members of large banks.

2.2.2 Institutional background

Germany is a federal republic consisting of 16 states ("Laender"), each of them having their own budget.[9] State debt accounts for 30% of consolidated German government debt (Q2:2014, Deutsche Bundesbank) and the funding structure of German states has shifted from bank loans to bonds in recent years (Figure 2.1). Due to limited data availability on banks' lending to German states, this analysis focuses on the bond market for which detailed information is available (see Section 2.3.1).[10]

The fiscal situation varies considerably between states and over time as illustrated, for example, by the distribution of the interest expenses to tax income (in %) and the state government debt (per capita in thsd euro) in the upper panel of Figure 2.2. The analysis makes use of these differences in states' fiscal situation to identify fiscally weak states that may have a larger incentive to sway home banks into holding home state bonds (see moral suasion hypothesis part (I)).

The German Stability Council

The German Stability Council helps with identifying these fiscally weak states as it increases market transparency on the fiscal situation of states through detailed annual reports. The council was established on April 28, 2010 to strengthen the framework for fiscal sustainability in Germany and is a joint body of the German states and the German federation. It is led by the respective finance ministers and advised by an independent scientific committee. The Stability Council assesses the risk of a budgetary emergency in the German states along four criteria and publishes the results on its website in the fourth quarter of each year. The criteria include structural net lending/borrowing, credit funding ratio (i.e. the degree to which the current budget is financed by net borrowing), interest expense to tax income ratio and outstanding debt. They are evaluated in two dimensions: the current budgetary situation (covering the current and last two years) and future fiscal planning (covering the next four years). For each of these criteria, the Stability Council reports a threshold that is derived from

[9] In order to finance higher expenditures, German states are generally not able to increase tax rates because these are set by the German central and municipal governments. Instead, German states may finance fiscal deficits by borrowing directly from banks as well as in the bond market. Differences in the tax income between states generally reflect differences in economic strength and are largely rebalanced through horizontal and vertical fiscal equalization schemes.

[10] While the credit register in Germany now includes data on bank loans to states, government borrowers were excluded from the reporting requirements until 2014 and a reporting threshold of 1.5mn euro applies.

the average value of all states plus an allowance. A state is marked as "noticeable" (in a negative sense) with respect to a criterion if the state breaches the threshold.[11]

My baseline measure for the fiscal situation of a state is the number of stability criteria that a state breaches. The indicator "breaches of stability criteria" is ordinal and can take values from zero breaches to eight breaches (i.e. four criteria times two dimensions). The advantages of this indicator are that it combines the information from all stability criteria and focuses on observations where the case for moral suasion might be particularly strong since the state has been marked as having a relatively weak fiscal condition. Table 2.1 shows the cross-sectional variation (i.e. between states) and the time variation (i.e. within states) of the indicator. In a robustness check, I use the underlying *continuous* indicators (i.e. structural net lending/borrowing, credit funding ratio, interest expense to tax income and outstanding debt) to capture the fiscal situation of states.

One concern is whether investors take the differences in states' fiscal situation into account given high credit ratings (varying between AAA and AA for the 11 out of 16 states that are rated) and bailout expectations (Heppke-Falk and Wolff, 2008). However, the German federal government and the states are in principle not liable for the debt burden of each other. Instead, German Basic Constitutional Law guarantees the sole fiscal responsibility of states for their debt (Article 109 Para 1 Basic Constitutional Law). Under certain conditions though, the Constitutional Court may decide on transfers from the German federal government to a state. Even if positive, these court decisions may lead to a delay in the redemption of state bonds. Heppke-Falk and Wolff (2008) and Lemmen (1999) show that state bond spreads reflect differences in state debt ratios, at least to some extent. This means that latent credit risks are highest for states that are in a relatively weak fiscal condition.

Also, while benefits from moral suasion might be lower for German states than for high credit risk countries, costs in terms of crowding out (Chari et al., 2016) might be lower as well due to the eligibility of German state bonds as collateral in interbank and Eurosystem refinancing operations.[12] The net effect is hence unclear. My findings suggest that banks located in other states reduce their bond holdings of states that have a deteriorating fiscal

[11] If a state breaches more than two criteria, the Stability Council evaluates whether the state is at risk of a budgetary emergency. If so, the state enters a consolidation program. As of 2011 five states (Berlin, Bremen, Saarland, Saxony-Anhalt and Schleswig Holstein) entered a consolidation programme. These state governments have to submit a consolidation plan that is evaluated by a committee and have to ensure the reduction of net borrowing within the next five years. Consolidation members have to report on their progress to the Stability Council on a semi-annual basis.

[12] Roughly 72% of German state bonds have been eligible as collateral in Eurosystem refinancing operations (see Section 3.2).

condition (i.e. a larger number of stability criteria that are breached). This supports the case for moral suasion on the German regional government bond market.

Ownership structure of the German banking system

Another institutional feature used in this analysis is the heterogeneity in the ownership structure of German banks. For a general description of the German banking system, see Section 1.2.1 of this thesis and Koetter (2013). Regarding bank ownership, I distinguish four groups: (i) privately-owned banks (such as commercial banks and specialized banks, e.g. mortgage banks); (ii) mutually-owned cooperative banks; (iii) savings banks which are owned by the municipality; and (iv) state-owned banks, i.e. Landesbanken and regional development banks.

Moral suasion is expected to be particularly effective for the latter group of state-owned banks and for banks with state politicians on their supervisory board (hypothesis part II). I use the term "moral suasion" in a broad sense to summarize various means of government influence, including conversations, membership of state politicians in bank supervisory boards, explicit mandates or anticipatory obedience of state-owned banks. The different channels are difficult to disentangle as they are likely to be used complementarily. Table 2.2 summarizes detailed data on the degree of government control and on supervisory board members that allows me to test for some of these channels.

In total, 20 banks, which account for 17% of the German banking system's total assets, are directly owned by state governments in Q2:2014. During the entire sample period from 2005 to 2014 there are 23 state-owned banks (for more details on these banks, see 2.A in the appendix to this chapter). On average, state governments own 83% of these banks' capital, savings associations own 11%, other public banks own 3% and the remaining share is held by other investors (Table 2.2). The so-called "regional development banks" are fully state-owned and their debt is guaranteed by the states.[13] One fifth of state-owned banks are owned by more than one state government. I test whether multiple state owners limit the ability of a state to impact the bank's investment decisions. Table 2.2 further shows that on average 44% of supervisory board members of state-owned banks are state politicians but there is a large heterogeneity between banks that I will exploit in the empirical analysis.

[13] There are two development banks that are fully guaranteed by the German central government and are therefore not included in the group of state-owned banks, the Kreditanstalt für Wiederaufbau (KFW) and the Landwirtschaftliche Rentenbank. While the KFW is partly owned by the states (20% of equity), it's liabilities are fully guaranteed by the central government and therefore assigned to the group "Other MFI". Results are robust against treating the KFW as a (partly) state-owned bank.

My main approach uses the extensive margin of state ownership, i.e. the variation between state-owned and other banks to test for moral suasion. State ownership is a structural characteristic of the German banking system that has persisted for a long time. This addresses the concern that the degree of state ownership might be endogenous to banks' state bond holdings (for a detailed discussion on endogeneity issues, see Section 2.4.2.2). In further tests, I use differences in the intensity of state control as reflected in the (time-varying) state ownership share and the share of state politicians in the supervisory board of banks.

2.3 Data and descriptive statistics

2.3.1 Data sources

This Section introduces the datasets and discusses data preparation. A detailed description of the constructed variables can be found in 2.A in the appendix to this chapter.

Securities Holdings Statistics of the Deutsche Bundesbank (Bade et al., 2016)

The German state bond market has a size of 315 bn euro of which 81% (254 bn euro) are included in the *Securities Holdings Statistics* of the Deutsche Bundesbank (Q2:2014). My analysis focuses on state bond holdings by German banks which are available for all German banks on a security-by-security and bank-by-bank level. German banks hold 64% (162 bn euro) of the outstanding volume of state bonds in the *Securities Holdings Statistics* (Q2:2014). The time period runs from Q4:2005 to Q2:2014 and thus covers pre-crisis times, the financial crisis and the European sovereign debt crisis.

The dataset covers the entire German banking system and thus complements earlier studies on moral suasion that focus on large banks only (Horváth et al, 2015; Ongena et al, 2016). Similar to Chapter 1, I exclude branches of foreign-owned banks, as their investment behavior typically depends on the business model of the parent banks, which I do not have information on. However, special-purpose banks are included to cover regional development banks. This gives 2,024 banks (unbalanced sample due to mergers, entries and exits). The number of banks per quarter decreases from 1,982 in Q4:2005 to 1,732 in Q2:2014.

I follow the bank supervisory classification of the Deutsche Bundesbank in sampling existing banks. In case of mergers, this implies that the bank that is taking over remains in the sample and reports state bond holdings for both entities together. The asset growth of the absorbing bank is controlled for by including a dummy variable in the estimations. Most mergers have taken place within the groups of small savings or cooperative banks, but there have been three events within the group of state-owned banks, that are given in the data

appendix 2.A.[14] Therefore, Section 2.4.3.1 checks the robustness of the results to excluding the period before 2010 which encompasses the merger and recapitalization events stemming from losses during the financial crisis (Puri, Rocholl, and Steffen, 2011).

I include only banks' bond holdings on their own account and not those on behalf of bank customers since banks cannot actively manage the latter. Furthermore, I use notional values of bond holdings to focus on quantity and not price effects.

Information on the issuer of the bond is obtained from Bloomberg and merged to the securities holdings data using the ISIN of each security. I include bonds issued by German states only. Specifically, I exclude banks' holdings of bonds issued by bad banks, such as "Erste Abwicklungsanstalt", because the state is liable only for part of the bonds. Also, I exclude 41 bonds issued jointly by several German states ("Gemeinsame Laender Anleihe")[15] because I am not able to identify the share and participation of individual states in these bonds (German banks' holdings equal 8 bn euro). Finally, I exclude one security issued jointly by German states and the central government. As a result, my dataset includes 2,078 securities with aggregate holdings by German banks worth 162 bn euro.

For the estimations, I aggregate security holdings of bank *i* in quarter *t* to the issuer (i.e. state) level. To account for the right-skewed distribution of the dependent variable, I take natural logarithms of state bonds holdings.[16] The inflated dataset that includes all bank-issuer-time combinations has 1,031,203 observations and 89,171 non-zero observations. This allows me to study the impact of bank and issuer characteristics on the extensive and intensive margin of banks' state bond holdings.

Capital Market Statistics of the Deutsche Bundesbank

Data on security characteristics such as amount outstanding, amount issued, issue and redemption date are taken from the *Capital Market Statistics* of the Deutsche Bundesbank. These variables are used to clean the data suc as reported holdings prior to the placement of the security or after redemption (111 observations are dropped).

[14] While WestLB AG exited in 2012, Portigon AG became its legal successor and thus the identifier of the bank did not change, following banking supervisory classifications. The size of the bank did only decrease slightly. Furthermore, there has been a merger between two regional banks in the same state in 2011. While the owner did not change, the merger had a scale effect on the absorbing bank that is controlled for through a dummy.

[15] Federal states that regularly participate in these joint issuances are Bremen, Hamburg, Mecklenburg-West Pomerania, Rhineland-Palatinate, Saarland, Schleswig-Holstein and Thuringia.

[16] Due to technical reasons, mainly, 4% of observations on the security level are negative positions, but the majority cancels out on the issuer level. Merely 0.3% of observations need to be dropped in order to take logs.

Data on the initial price, coupon type and rate are in principle also available, but around half of the state bonds are floating coupon bonds with no further details on the coupon rate.

Bank supervisory and statistical data of the Deutsche Bundesbank

Bank control variables including size (i.e. log total assets), capitalization, deposit ratio and commitment ratio are constructed from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank (for a definition of variables, see 2.A).[17] These variables are available at a quarterly frequency; the information on banks' non-performing loans (NPL) obtained from the annual financial statements submitted to the Deutsche Bundesbank is available at an annual frequency. To account for the statistical breaks in the prudential definitions of NPL, I use a relative NPL indicator that is equal to one for banks in the highest quartile of the NPL distribution of the respective year (the indicator remains unchanged within one year). These control variables account for differences in the size and business models between banks that may affect the banks' demand for government bonds (for a detailed discussion, see Section 1.2.4 of this thesis).

Information on bank type, state ownership and the location of the banks' headquarters is taken from bank supervisory data of the Deutsche Bundesbank. I construct an indicator "state-owned" that is equal to one for banks that are directly owned by the state government.

Public (financial) reports and supervisory data on the 23 state-owned banks and 16 other large German banks have been used to identify time-varying ownership shares of state governments and other owners (such as the federal government or banking associations) and to collect information on the supervisory board members of these banks. These data have been gathered for the largest German banks due to data availaibility.

State variables

Macroeconomic data on German states (including state debt and population) is collected from the German Federal Statistical Office. I use annual core state debt per capita as measure for the state debt burden and interpolate it to quarterly frequency. Further information on the fiscal situation of the state is taken from the online publications of the German Stability Council.[18] I construct the composite, ordinal indicator "breaches of stability criteria" as defined in Section 2.2.2. The assessments of the Stability Council are available since Q4:2010 and updated in the fourth quarter of each year (remaining constant throughout the year).

[17] For more information on the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank, see https://www.bundesbank.de/Redaktion/EN/Standardartikel/Service/Reporting_systems/monthly_balance_sheet_statistics.html?https=1

[18] For more information on the Stability Council, see http://www.stabilitaetsrat.de/EN/Home/home_node.html

2.3.2 Descriptive statistics

The structure of the German state bond market

The following descriptive statistics and regressions are based on 2,078 state bonds included in the *Securities Holdings Statistics* (without joint state bonds) with an aggregate volume of 254 bn euro of which 64% (162 bn euro) are held by German banks (Q2:2014).

Between Q4:2005 and Q2:2014, German states have placed 1,456 new state bonds (excluding joint state bonds). State bonds are often privately placed (Koetter and Popov, 2017) and have a much smaller bond size (260 mn euro on average) than central government bonds (6,960 mn euro on average) that are publically auctioned to a group of eligible financial institutions. With respect to other bond characteristics, the state bond market consists mainly of coupon bonds (57%) and floaters (42%), while the central government bond market is dominated by zero coupon bonds (57%), followed by coupon bonds (42%) and only a few floaters (1%). The average maturity of a state bond in my sample is 6.2 years and thus below the maturity of central government bonds which is 8.3 years on average. Foreign currency denomination plays a minor role in the state bond market (2.5% of state bonds). Schulz and Wolff (2008) document differences in the volume and frequency of bond placements between German states. My empirical approach accounts for these differences in funding strategies between states through issuer-time and bank-issuer fixed effects.

Given private placements, my results are not likely to be driven by the potential role of dealer banks that redistribute state bonds in the secondary market. In fact, the data shows that changes in the investor base of a particular security are not more frequent in the quarters immediately after a bond's placements than later during the bond's life. Overall, the average state bond is traded at least 9 times within my sample period (Q4:2005 – Q2:2014; based on quarter-on-quarter changes).[19]

The holder structure on the security level is rather concentrated in the German state bond market. One-third of all bonds are held by one bank only. These bonds tend to have a 50% smaller volume than other state bonds but a similar maturity and Eurosystem eligibility. The average state bond is held by 7 German banks simultaneously, while 10% of German state bonds are held by more than 21 banks in the average quarter. Section 2.4.2.2 studies the share of a bank in outstanding state bonds at the issuer level in greater detail.

[19] I can only approximate the trading pattern by quarter-on-quarter changes in the ownership of a particular bond since flow data are not available.

The role of German banks in the state bond market

German banks are the most important investors in the state bond market. They hold on aggregate 64% of the outstanding volume of these bonds (Q2:2014). By comparison, German banks hold only 1.1% of the outstanding volume of German central government bonds (i.e. "bunds"). Instead, foreign investors (incl. foreign central banks) are primarily active in the bund market due to the larger bond sizes and the availability of ratings. Public information on credit risk is less easily available in the state bond market. Only 11 out of 16 states have a rating from a major rating agency, which might constrain some types of investors. As a result, German banks focus on the regional rather than the central government bond market and invest on average 41% of their total government bond portfolio in German state bonds and only 3% in "bunds" (Table 2.3).

Within the German banking system, state-owned banks are the largest creditors in the state bond market. While the average German bank holds only 0.09 bn euro in state bonds, an average state-owned bank holds state bonds worth 2.06 bn euro (Table 2.3). The picture remains similar after controlling for bank size. State-owned banks invest more than 3% of their assets in state bonds, while commercial banks invest a mere 1% and savings and cooperative banks 2% of their assets (Q2:2014). Consequently, the group of state-owned banks hold 16% of the outstanding volume of German state bonds which is a larger market share compared to the other banking groups, despite the relatively small number of state-owned banks. Investment decisions by state-owned banks are thus particularly relevant for the funding conditions of states, which may increase the governments' incentives for using moral suasion.

Despite the general importance of state bonds for German banks, about 26% of them do not hold any state bonds at all during my sample period. Many banks enter and exit the state bond market frequently such that only about 45% of German banks hold some state bonds in the average quarter. Results from Probit estimations on the banks' likelihood of holding some state bonds in Table 2.4 show that these banks tend to be larger, have a larger deposit ratio and a lower capital ratio (relative to unweighted assets). These banks might be more in need for zero risk weighted assets, such as state bonds, to support their regulatory capital ratio. This self-selection of banks into holding state bonds needs to be taken into account in the empirical approach, which I do by applying a Heckman model.

The degree of "home bias" in German banks' state bond portfolios

In order to derive a descriptive measure for a banks' preference of home state bonds which takes into account the size of the home state, I follow Coeurdacier and Rey (2013). Based on the standard Capital Asset Pricing Model (CAPM), they measure home bias as the deviation of an investor's share of home assets in the portfolio from the share of home assets in the market portfolio. Transferring this idea to the subnational level, the "home bias" in the state bond portfolio of a bank *i* in quarter *t* can then be calculated as follows:

$$HomeBias_{it} = 1 - \frac{Share\ of\ "non\ home"\ state\ bonds\ in\ portfolio_{it}}{Share\ of\ "non\ home"\ \ bonds\ in\ German\ state\ bond\ markets_{t}}$$

A value of the $HomeBias_{it}$ equal to one reflects complete home bias while a value of zero indicates perfect diversification according to the CAPM. A negative value is associated with an underrepresentation of home assets in the portfolio.

Table 2.5 shows the $HomeBias_{it}$ in the state bond portfolios of banks that hold some investment in state bonds (by banking group for 2014Q2, excluding banks with zero holdings). On average, state-owned banks exhibit the largest home bias with a value of 0.19. Savings and cooperative banks have a home bias in state bond portfolios of 0.07 and 0.08 respectively. Mortgage banks are fully diversified, arguably reflecting their sophisticated investment strategies in government bond markets. However, the variation within banking groups is large which renders the home bias insignificant at conventional levels (Table 2.5). One reason for this may be the impact of the states' fiscal situation on the banks' home bias. The empirical approach tests this hypothesis, among others, and controls for unobserved differences between states and / or between banks that may drive the descriptive figures.

2.4 Empirical methodology and results

2.4.1 Empirical methodology

To test for moral suasion, I employ heterogeneity between banks with respect to state ownership, within banks with respect to bond holdings from home versus other state issuers and between states over time with respect to the Stability Council indicators. I extend the methodology of existing studies by De Marco and Macchiavelli (2016), Horváth et al. (2015), Koetter and Popov (2017), and Ongena et al. (2016) in two dimensions.

First, I analyse the impact of moral suasion on the bank's decision whether or not to hold any bonds from a specific state (extensive margin), in addition to analysing the volume of the bank's state bond holdings. To this end I apply a Heckman (1979) model and fractional logit model as proposed by Papke and Wooldridge (1996). While previous studies on moral suasion have analysed the intensive margin only (due to their focus on large banks), governments may also use moral suasion to persuade banks to hold asset classes that they would not hold otherwise and therefore affect the extensive margin of banks' state bond holdings.

Second, I use not only banks' bond holdings of the home state but also that of other states on an issuer level. This allows me to control for unobserved heterogeneity between states over time through issuer-time dummies in the baseline specification, and to additionally control for alternative investment incentives of banks by bank-time and bank-issuer fixed effects in the augmented regressions (using high-dimensional fixed effects regressions). Existing studies do not use heterogeneity within banks, but only between banks and states over time (De Marco and Macchiavelli, 2016; Horváth et al., 2015; Koetter and Popov, 2017; Ongena et al., 2016).

Similar to De Marco and Macchiavelli (2016), Horváth et al. (2015), and Koetter and Popov (2017), I study banks' *holdings* of state bonds instead of purchases of state bonds. This allows me to use the *cross-sectional* variation between the states' fiscal condition in addition to the variation within states over time. Also, the dataset does not allow a clear identification of flows (unlike the dataset on large European Banks by Ongena et al., 2016). In an augmented fixed effects regression, I check that my results on moral suasion are not only driven by the cross-sectional variation by including bank-issuer fixed effects (along with bank-time and issuer-time fixed effects, Table 2.9). Results from this estimation are driven by the variation over time and the findings remain in line with moral suasion.

Heckman model

My baseline empirical approach applies a Heckman (1979) model to account for the self-selection of banks into holding state bonds. Buch et al. (2016) apply a similar approach to studying German banks' holdings of OECD government bonds. The model proceeds in two steps. First, it analyses the bank's decision whether to hold bonds from state *j* in quarter *q* using a probit model (selection equation, i.e. extensive margin). And second, if yes, it analyses the bank's decision on how much to hold (outcome equation, i.e. intensive margin). The inverse Mills ratio (*IMR*) calculated from the predicted likelihood of observing an exposure of bank *i* in state *j* at quarter *q* in the first stage corrects for self-selection of banks. In this set-up, the selection equation (1) and outcome equation (2) are specified as follows:

$$(1)\ \Pr\left(EXP_{ijq}=1\right)=\Phi(\alpha_1+\alpha_{1j}+\alpha_{1q}+\beta_{11}X'_{iq-1}+\beta_{12}X'_{jq}$$
$$+\beta_{1h}home_{ij}+\beta_{1h}home_{ij}*Interaction_{ijq})$$

$$(2)\ Sov_{ijq}=\alpha_2+\alpha_{2jq}+\beta_{21}X'_{iq-1}$$
$$+\beta_{2h}home_{ij}+\beta_{2h}home_{ij}*Interaction_{ijq}+\eta IMR+\varepsilon_{ijq}$$

Where EXP_{ijq} is an indicator variable equal to one if bank *i* (2,024 German banks) holds government bonds issued by a specific state *j* (16 states) at the end of quarter *q* (35 quarters from Q4:2005 to Q2:2014) and zero otherwise. Sov_{ijq} gives the corresponding log amount of banks *i*'s bond holdings of state *j* at quarter *q*. Φ(.) is the standard normal distribution function.

The variable $home_{ij}$ is an indicator variable that is equal to one if the issuer state is the state where the bank's headquarters is located. If a bank has more than one headquarters (in the case of a few Landesbanken), I treat all headquarters locations as home states.

The main variable of interest is the interaction effect of the home indicator with bank variables and/or issuer specific variables $home_{ij}*Interaction_{ijq}$. These interactions give bank-issuer-time specific variables that allow testing for the moral suasion hypothesis. In the baseline specification in Table 2.7, the "home" indicator is interacted with an issuer-specific variable, the number of Stability Council criteria that a state breaches ("breaches of stability criteria") to test for the moral suasion hypothesis part (I).[20] In Section 2.4.2.2, the term is

[20] As assessments by the Stability Council are available only from 2010Q4 onwards, all specifications include an indicator equal to one from 2010Q4 onwards (and interaction effects with this indicator are included where appropriate). While this is necessary to correctly interpret the interaction effects with the variable "Breaches of stability criteria", it is generally not reported for the sake of brevity. In a robustness test, I exclude the period before the establishment of the Stability Council in 2010Q4.

additionally interacted with the bank specific variable on state ownership ("state-owned") to test for the second part of the moral suasion hypothesis. All underlying (two-way) interaction effects are included for correct interpretation but usually not reported for the sake of brevity.

Since in principle all banks are able to hold home state debt and moral suasion may affect the extensive as well as the intensive margin, there is no obvious exclusion restriction for the Heckman model. Instead, it is identified based on functional form and on differences in the set of included dummies. The coefficient η on the IMR is significant in all specifications, confirming that it is important to control for self-selection of banks into holding state debt. Differences between state issuers over time, such as differences in placement activity or economic conditions, are controlled for by issuer-time fixed effects α_{2jq} in the outcome equation; only the differential effect between home and out-of-state banks can thus be identified.[21] The selection equation includes one-way issuer and time dummies only in order to avoid the incidental parameters problem in probit estimations.

At the same time, I control for the impact of bank-time specific variables that capture different business models of banks and variations in banks' demand for state bonds over time. These bank-specific control variables X_{iq-1} are lagged by one quarter and include total assets, capitalization, deposit ratio, commitment ratio and a non-performing loan indicator. I control for mergers between banks using an indicator that is equal to 1 for the surviving bank in the quarter of the merger. The indicator is significantly positive in most specifications, reflecting a size effect for the surviving bank, and is not reported. For more information on the bank mergers and exits, see Section 2.3.1. Summary statistics of the variables are given in Table 2.6.

Fractional logit and fixed effects regressions

The Heckman specification studies the impact of moral suasion on banks' state bond holdings *in absolute terms*. Moral suasion behavior might also be reflected in large bond holdings of home state-owned banks *relative to the outstanding state bonds.* This approach focuses on the state's creditor structure and captures diversification in a state's investor base (Asonuma et al., 2015).

In an alternative specification I therefore use the bank's state bond holdings relative to the outstanding amount on an issuer level as the dependent variable. Since it is a proportion and

[21] The baseline impact of issuer-time variables could not be identified even in the absence of issuer-time fixed effect since, by construction, an increase in holdings of one bank has to result from a decrease in holdings from other banks (controlling for the amount outstanding and abstracting from non-bank or foreign investors which are of minor relevance in this market).

does include a corner solution (i.e. the value zero), I use the pooled fractional logit model as proposed by Papke and Wooldridge (1996). The advantage of the fractional logit which uses the logistic link function is that it is fairly robust against misspecification (Papke and Wooldrige, 1996). The explanatory variables are specified as in Equation (1). Due to the incidental parameters problem in non-linear models, I do not include issuer-time dummies in these specifications. In a robustness check, I introduce one-way issuer and time dummies, which are less problematic as there are many banks per issuer and time (Papke and Wooldridge, 2008). Standard errors are clustered on the issuer-time level to account for the fact that the shares of banks in outstanding state bonds are negatively correlated.

I cross-check the results of the fractional logit model with ordinary least squares (OLS) regressions that do not account for the bounded nature of the dependent variable but can provide a good approximation (Papke and Wooldridge, 2008). Also, OLS regressions allow for the inclusion of high dimensional fixed effects and offer a straightforward interpretation of parameters as marginal effects (Papke and Wooldridge, 2008). Specifically, I use issuer-time, bank-time and bank-issuer fixed effects to control for unobserved heterogeneity between and within banks and the structural preference of a bank for a specific state (identification through heterogeneity following Khwaja and Mian, 2005). The dependent and independent variables are the same as in the fractional logit case except that the dependent variable is multiplied by 100 (i.e. given in %) to transform the scale of the estimated coefficients. This specification allows me to identify the bank-issuer-time specific moral suasion effect.

2.4.2 Main Results

2.4.2.1 Differences between home and out-of-state banks

Results of the baseline Heckman model are shown in Table 2.7; for both specifications the first column gives the outcome equation and the second column the selection equation of the Heckman model. Column 3 includes two-way fixed effects at the issuer-time level that captures the heterogeneity at the state level such as differences in funding strategies of states and in economic conditions as well as events that are common to all states such as changes in the bund yield. Column 4 of Table 2.7 gives marginal effects for the selection equation to ease the economic interpretation of the coefficients.

The main results are threefold. First, home banks hold significantly more bonds issued by the state than out-of-state banks. Quantitatively, the volume of bond holdings is by about 49% larger if the bank is located in the issuer state (column 3).

Second, and in support of the moral suasion hypothesis, the state's fiscal condition has an opposite effect on the state bond holdings of home versus out-of-state banks. The latter hold fewer bonds issued by states that breach criteria of the Stability Council (see negatively significant parameter on "Breaches of stability criteria" in column 1). Home banks however hold more bonds if the home state breaches criteria of the Stability Council (see positively significant parameter on the interaction effect of "Home * Breaches of stability criteria" in columns 1 and 3). In fact, banks increase their home state bond holdings by 16% for each stability criterion that the home state breaches (column 3). Similarly, home banks are more likely to hold bonds when the state breaches stability criteria (column 4), while out-of-state banks tend to avoid exposure in these situations (column 2). This is in line with an effect of moral suasion on the extensive margin of banks' state bond holdings.

Third, Table 2.7 shows that bank characteristics matter in explaining banks' state bond holdings. Not surprisingly, there is a scale effect, as larger banks tend to hold more state bonds (in line with Buch et al., 2016, and Acharya and Steffen, 2015). Better capitalized banks, measured as balance sheet equity over unweighted assets, hold fewer state bonds. An increase in capitalization by one percentage point decreases the volume of bonds held by 5% (column 3). This might reflect lower incentives for well-capitalized banks (measured in unweighted terms) to load up on zero risk-weighted assets to support their regulatory capital ratio and is in line with findings by Acharya and Steffen (2015) for European banks. Contrary to the intuition that banks with a large deposit base rely less on state bonds as collateral for wholesale funding (Buch et al., 2016), I find that high deposit ratios are associated with higher state bond holdings of banks. One explanation could be that deposit-funded banks are more risk-averse and therefore favour comparatively safe assets such as German state bonds. This matches the result that riskier banks in terms of having a comparatively high non-performing loans ratio (upper quartile) hold fewer state bonds. The parameters on bank control variables remain very similar in all regressions and are therefore no longer reported in the following tables.

2.4.2.2 The impact of state ownership

This Section gives results on the impact of state ownership on banks' state bond holdings using a Heckman model in Table 2.8 and a fractional logit model as well as a high-dimensional fixed effects model in Table 2.9. All specifications include a set of bank control variables as specified in Table 2.7 (not reported) and control for unobserved heterogeneity at

the issuer-time level (Table 2.8), at the issuer and time level (column 2 of Table 2.9) and at the issuer-time, bank-time and bank-issuer level (column 3 of Table 2.9).

The results from Table 2.8 and 2.9 support the moral suasion hypotheses (part I and II) developed in Section 2.2.1. Home banks that are directly owned by the state are significantly more invested in their home state than other home banks. Column 1 of Table 2.8 shows that state bond holdings of state-owned home banks are about 89% higher than those of other home banks. Also, *state-owned* home banks hold a higher share of outstanding bonds compared to other home banks (columns 1 and 2 of Table 2.9).

In line with moral suasion, state-owned home banks hold even more home state bonds when the state breaches some criteria of the Stability Council (see positively significant parameter on "Home * State-owned * Breaches of stability criteria" in Tables 2.8 and 2.9). In economic terms, state-owned banks hold a 14% larger amount of home state bonds than other home banks and than state-owned banks from other states per breach of stability criteria (column 3 of Table 2.8). Relative to the outstanding amount of home state bonds, the share of state-owned banks in states that breach a stability criterion is 29 percentage points higher than the share of other home banks or state-owned banks from other states (column 3 of Table 2.9). Also, state-owned banks are more likely to hold home state bonds in these situations (column 4 of Table 2.8).

The underlying two-way interaction effect ("State-owned * Breaches of stability criteria" in column 3 of Table 2.8) shows that state-owned banks generally hold more bonds from states that breach stability criteria, not only from the home state. In terms of magnitude though, the effect is only one-third of the incremental *home* effect for state-owned banks (5% compared to 14%) and it is insignificant on the extensive margin. These findings suggest that moral suasion plays an important role in the decision of state-owned banks to hold any home state bonds when fiscal conditions are weak.

After controlling for the special role of state-ownership, home and out-of-state banks differ less in their holdings of bonds issued by weak states which is consistent with the hypothesis that moral suasion is more effective on state-owned banks (part II of the moral suasion hypothesis). In fact, the difference between home and out-of-state banks that are not state-owned becomes insignificant on the extensive margin of state bond holdings (column 4 of Table 2.8) and in the fractional logit model (columns 1 and 2 of Table 2.9).

Hence, home banks have larger holdings of home state bonds if the bank is directly owned by the state government and the state is breaching criteria of the Stability Council. Column 3

of Table 2.9 shows that this finding remains significant after controlling for unobserved heterogeneity at the bank-time level (e.g. time-varying demand of a bank for state bonds), at the issuer-time level (e.g. time-varying differences in issuing strategies or economic and fiscal conditions between states) and at the bank-issuer level (e.g. bank-specific preferences for the home state or for a particular issuer). I find that home state-owned banks increase their state bond holdings more than other home banks or state-owned banks located in other states when the fiscal condition of the home state deteriorates (in terms of the number of stability criteria that are breached). Overall, the results are in line with moral suasion of home state-owned banks by state governments.

Discussion of endogeneity concerns

One potential concern is that state ownership might be endogenous to banks' holdings of state bonds if ownership by states is conditional on the importance of a bank for state funding. Several arguments mitigate this concern in this case. First, my baseline approach uses only the extensive margin of state ownership, i.e. an indicator whether a bank is owned by the state or not. State ownership of regional development banks and Landesbanken is a structural characteristic of the German banking system that persisted for a long time (De Marco and Macchiavelli, 2016). In contrast, banks adjust their state bond holdings frequently. It is thus unlikely that state ownership is a function of banks' state bond holdings.

Second, regional development banks are fully state-owned and their debt is guaranteed by the state such that further increases in the intensity of state ownership conditional on state bond holdings are not possible.

Third, I test for moral suasion using a restricted sample period from 2010 onwards (see Section 2.4.3.1). This smaller sample excludes the financial crisis, during which some Landesbanken have suffered large losses to their wholesale activities and have had to be recapitalized by their owners, i.e. the states and the savings banks associations (Puri et al., 2011). Excluding the financial crisis eliminates all changes in the state ownership indicator making it pre-determined for the subsequent sample. Results on moral suasion remain robust.

Finally, to further corroborate this argument, I test whether weakly capitalized state-owned banks hold more home state bonds presumably to increase bailout probability (see Section 2.4.3.2 and column 1 of Table 2.14). I find that capitalization has no significant effect on home state bond holdings of state-owned banks. In fact, *highly* capitalized state-owned banks generally hold more state bonds, irrespective of the issuer.

The intensity of state control

Based on these arguments, I extend the analysis beyond the binary state ownership indicator and account for differences in the intensity of government control within the group of state-owned banks (for descriptive statistics, see Table 2.2). Table 2.10 gives the results from a Heckman model using a sample of state-owned banks only in columns 1 to 3 and on 39 large banks (including the 23 state-owned banks) in column 4 for which data on supervisory board members could be gathered. Bank control variables (as specified in Table 2.7) and issuer-time dummies are included.

State-owned banks hold more bonds issued by the home than by other states (column 1 of Table 2.10) but this preference for home bonds is smaller for banks that are owned by more than one state (column 2 of Table 2.10). The latter result is in line with a stronger influence of political agents that are homogenous. Column 3 of Table 2.10 shows that the *degree* of state ownership matters. Banks hold more home state bonds if a larger share of bank equity is owned by the home state. Finally, banks with a larger share of state politicians in their supervisory boards also hold more home state bonds. To sum up, the preference for home state bonds increases with the degree of state control over a bank.

2.4.3 Additional results

2.4.3.1 Robustness tests

My main findings remain robust to different measures for a state's fiscal situation, different computation methods of standard errors, to constraining the sample to the period after the introduction of the Stability Council, and to excluding city states.

Table 2.11 shows results from the intensive margin of a Heckman model using alternative measures for a state's fiscal condition. Columns 1 to 4 of Table 2.11 use the structural net lending / borrowing, the credit funding ratio, the interest expense to tax income ratio and the outstanding state debt respectively. In contrast to the composite, baseline measure "breaches of stability criteria", these indicators measure the fiscal strength of each state on a continuous scale and thus address the concern that the findings rely on relatively few breaches only. All four fiscal measures confirm the findings on moral suasion from the baseline results: state-owned banks hold more home bonds than other home banks or state-owned banks located in other states, if the home state is in a weak fiscal condition (columns 1 to 4 of Table 2.11). Furthermore, the information whether a state breaches the stability criteria has explanatory power for banks' state bond holdings even after controlling for the state debt burden (column 5 of Table 2.11). This supports the use of my baseline fiscal measure.

In the baseline estimations, I use heteroscedasticity-robust standard errors. The idea behind this is that banks decide whether they want to invest in a particular state bond or not without having a binding portfolio constraint. The portfolio constraint is alleviated since German state bonds can be used as collateral with the Eurosystem or in the interbank market to obtain additional funding. If, however, banks target a fixed size of their total state bond portfolio, the decision to invest in a particular bond depends on all other state bonds. As a result, a bank's bond holdings might be correlated between states. In a robustness test I allow for this by clustering on the bank-time level and results remain robust (column 1 of Table 2.12). Furthermore, if banks hold state bonds until maturity, there is persistence in state bond holdings over time. In column 2 of Table 2.12, I therefore cluster on the bank-issuer level and find that parameter estimates remain similar but standard errors increase and thus effects become insignificant.[22]

Next, assessments of stability criteria are only available after the introduction of the Stability Council. In my baseline specifications, I account for this through interaction effects with an indicator that is equal to one from the establishment of the Stability Council onwards. Results are also robust against excluding the period before the Stability Council (column 3 of Table 2.12).

Finally, I test whether my results are driven by state-owned banks located in the so-called "city states" (i.e. Berlin, Bremen and Hamburg). These states are special since they consist of cities only. If their fiscal situation is structurally weaker due to larger expenditures per capita and if, at the same time, state-owned banks in these states are large relative to the outstanding volume of state bonds, banks located in city states might be driving my results. However, columns 4 and 5 of Table 2.12 show that the findings on moral suasion remain nearly unchanged when I exclude banks located in city states or restrict the sample to banks from city states respectively. More generally, my findings cannot be explained by large banks that happen to be located in weak states, since my results hold after controlling for bank-issuer unobserved heterogeneity in Table 2.9.

[22] Due to lower degrees of freedom, I do not include any fixed effects in this specification but follow the baseline specification from column 1 of Table 2.7.

2.4.3.2 Alternative hypotheses

Besides moral suasion, the theoretical literature suggests further incentives for banks to invest in home government debt which I address below.

First, banks might hold more home government bonds in order to shift risks from bank owners to debtors (Ari, 2016) or taxpayers (Farhi and Tirole, 2016). In the model of Farhi and Tirole (2016), weak banks load up on risky home sovereign debt in order to maximize the value of the "bailout put", i.e. the taxpayers' money that banks can extract in a bailout. While asset classes other than German state bonds seem more apt to engage in risk taking, the bailout probability of a bank may increase with home government bond holdings as long as the bailout capacity of the government is sufficient (Farhi and Tirole, 2016). In fact, Koetter and Popov (2017) show that German savings banks are more likely to receive a bailout when they have higher holdings of home state bonds. Therefore, Table 2.13 tests whether weakly capitalized banks or "high credit risk" banks have higher holdings of home government bonds, especially in fiscally weak states. Bank capitalization is measured as capital over unweighted assets to ensure that it is not affected by the zero risk weights of state bonds. "High credit risk" banks are banks in the upper quartile of the non-performing loan ratio distribution in the respective year.

I do not find evidence for the hypothesis on increasing bailout probability, since bank capitalization and credit risk does not significantly affect the bank's home state bond holdings (columns 1 and 3 of Table 2.13 respectively). Furthermore, *well capitalized* banks - not weakly capitalized banks - have larger bond holdings when the state breaches stability criteria, irrespective of whether it is the home or another state (see significantly positive coefficient on "Capitalization (%) * Breaches of stability criteria" and insignificant coefficient on "Home * Capitalization (%) * Breaches of stability criteria" in column 2 of Table 2.13). This result is in line with findings by Ongena et al. (2016) on large European banks from countries experiencing a sovereign debt crisis. Focusing on home government debt only, they show that well capitalized banks – not weakly capitalized banks – lend more when the government is faced with a high funding need.

Overall, after controlling for bank riskiness, my results remain in line with moral suasion as reflected in the positively significant parameter on the interaction effect "Home * State-owned * Breaches of stability criteria" in columns 2 and 4 of Table 2.13.

Second, I test whether state-owned banks hold more home state bonds when their capitalization (measured as bank equity over unweighted assets) is low. The idea behind this

is that lowly-capitalized banks could engage in political endearing by financing the home state and thereby increase the likelihood of being bailed out. As discussed in Section 2.4.2.2 and due to direct state ownership or full-fledged state guarantees (for development banks), the incentives for state-owned banks to engage in such behavior should be lower than for savings banks that may need to bridge a political gap (Koetter and Popov, 2017). Still, I check whether weakly capitalized state-owned banks drive my results and find that the level of a state-owned bank's capitalization does not significantly affect its home state bond holdings (see insignificant coefficient on "Home * State-owned * Capitalization (%)" in column 1 of Table 2.14). Generally, *highly* capitalized state-owned banks hold more (home and other) state bonds (see positive coefficient on "State-owned * Capitalization (%)"). In this respect, state-owned banks do not differ from the average German bank that shows no sign of risk-shifting through state bonds (Table 2.13).

Third, the lack of good private lending opportunities rather than moral suasion could be behind banks' large home state bond holdings in times of weak fiscal conditions (for a theoretical model, see Gennaioli et al., 2014). Since the home economy is likely to be in a bad state when fiscal fundamentals are weak, home government bonds may be used to store liquidity for future profitable lending opportunities (Gennaioli et al., 2014). In column 2 of Table 2.14, I test whether German banks hold more home state bonds when their lending to the private sector is low (i.e. their claims on banks and non-banks relative to total assets are low). Contrary to the lending opportunity hypothesis though, banks with a *higher* loan ratio hold more home than other state bonds.

One explanation for this finding might be that state-owned banks expand their private lending activities in weak fiscal situations in order to fulfil their mandate to promote the economic and social development within their home state. At the same time, these banks may also increase their holdings of home government bonds in weak fiscal situations to support the state government that is in need of funding.

Furthermore, a preference for home over foreign assets has often been explained by information asymmetries (Portes et al., 2001). Information costs for the regional government bond market are likely to be higher than for the federal government level given the absence of a rating for 5 out of 16 German states (Q4:2013) and the lower availability of macroeconomic and fiscal data. When testing for the impact of information asymmetries between home and out-of-state banks, I make use of the establishment of the Stability Council in 2010. Column 3 of Table 2.14 shows that an increase in public information through the establishment of the

Stability Council reduced the home preference only in "sound" states. In "weak" states the home effects gets larger when negative information is available through the publications of the Stability Council (the positive significant parameter on "Home * Breaches of stability criteria" is larger than the negative parameter on "Home * Stability Council"). Out-of-state banks have lower state bond holdings in these situations. Hence, while potential information advantages of home banks are reduced through the publications of the Stability Council, home banks in weak states hold *more* state bonds than out-of-state banks.

Finally, since my analysis is on the regional instead of the national level, I can exclude two other hypotheses that have been suggested in the literature: banking supervision (Farhi and Tirole, 2016) and redenomination risk (Battistini et al., 2014). German state governments do not have any bank supervisory powers that they could use to increase home bias. And while the perceived risk of a break-up of the euro area might have driven the home bias at the national level in European sovereign debt markets (Battistini et al., 2014), this would not have introduced redenomination risk in the German subnational state government bond market.

All in all, after testing for alternative hypotheses, evidence remains in line with moral suasion by state governments on home state-owned banks.

2.5 Conclusion

This study tests the hypothesis that governments use moral suasion on home (state-owned) banks to hold home government debt in the context of the German regional government bond market. Thereby, it makes use of differences in the states' fiscal condition as measured by the stability criteria of the German Stability Council as well as differences in bank location and ownership. This chapter is complementary to recent cross-country studies on moral suasion and mitigates differences in the institutional and regulatory framework by focusing on the regional level. The empirical methodology controls for self-selection of banks into holding state bonds and uses the variation in state bond holdings between banks and within banks across different issuers over time to control for alternative incentives of banks to hold (home) state bonds.

The main findings are the following. Home banks are more likely to hold home state bonds and hold a significantly larger volume of these bonds if the home state breaches criteria of the Stability Council. In contrast, banks located in other states (out-of-state banks) hold fewer state bonds in this situation. Banks directly owned by the state government (i.e. Landesbanken and regional development banks) have larger home state bond holdings than other home banks and state-owned banks located in other states. Within the group of state-owned banks,

the preference for home state bonds is larger if the state owns a larger share of the bank's equity and if there are more state politicians on the supervisory board. Finally, state-owned banks that are located in states that breach criteria of the Stability Council hold more home state bonds than their counterparts in fiscally sound states. These results are in line with moral suasion by state governments on home state-owned banks.

The findings remain after controlling for bank characteristics such as size, capitalization, deposit ratio and credit risk, for unobserved time-varying heterogeneity at the issuer level, and for several alternative hypotheses such as risk-shifting by banks (Farhi and Tirole, 2016), information asymmetries (Portes et al., 2001) or alternative lending opportunities (Gennaioli et al., 2014). The results are robust to using different empirical models, different measures of fiscal strength and controlling for unobserved time-varying heterogeneity at the issuer and at the bank level and time-constant heterogeneity at the bank-issuer level.

My findings have implications for risk-sharing between German states. I find that state-owned banks hold more bonds issued by (home and other) states that breach the criteria of the Stability Council. While the effect is largest for home state bonds, it is significantly positive for other states as well. As a result, exposures of state-owned banks may introduce another channel of contagion between German states beyond the institutional channels such as the fiscal equalization scheme. For the European context, Kirschenmann, Korte and Steffen (2016) show that banks' cross-border exposures increase correlation between default risks of sovereigns.

Finally, soft borrowing constraints for regional governments are a major issue in federal unions, including Germany (Baskaran, 2012). The publications of the German Stability Council can reinforce fiscal discipline if bond market participants take differences in the states' fiscal strength into account. Indeed, I find that out-of-state banks that are not state-owned hold fewer bonds from states that breach criteria of the Stability Council. However, home (state-owned) banks hold more state bonds in these situations and thereby potentially mitigate market discipline. The research on the role of market discipline in federal systems (Heppke-Falk and Wolff 2008; Lemmen, 1999) could benefit from taking the heterogeneity in the investment incentives of market participants into account.

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Appendix to Chapter 2

2.A Data

List of state-owned banks

This list gives the names of German banks that are directly owned by a state government (fully or only a fraction of bank equity) and are included in my analysis as "state-owned".

Bayerische Landesbank
Bremer Aufbau-Bank
Bremer Landesbank
Hamburgische Investitions- und Foerderbank (prev: Hamburgische Wohnungsbaukreditanstalt)
HSH Nordbank
Investitions- und Strukturbank Rheinland-Pfalz (ISB)
Investitionsbank Berlin
Investitionsbank des Landes Brandenburg
Investitionsbank Schleswig-Holstein
Landesbank Baden-Wuerttemberg
Landesbank Berlin (until 2007; then owned by savings association)
Landesbank Hessen-Thueringen
Landesbank Saar
Landesbank Sachsen (until 2008, then susidiary of LBBW)
Landeskreditbank Baden-Wuerttemberg
LfA Foederbank Bayern
Norddeutsche Landesbank
NRW.Bank
Saarlaendische Investitionskreditbank
Saechsische Aufbaubank
Thueringer Aufbaubank
WestLB (until mid 2012; then Portigon as legal sucessor)
Landestreuhandbank Rheinland-Pfalz (until end 2011; then merged with ISB Rheinland-Pfalz)

Definitions of variables and data sources

Sovereign bond portfolios

Exposure to issuer state EXP: a dummy variable which is equal to one if the bank *i* holds bonds issued by state *j* in quarter *t* and zero otherwise. The information is based on the *Securities Holdings Statistics* of the Deutsche Bundesbank.

State Bond Holdings SOV: notional value of a bank's state bond holdings of state *j* in quarter *t*. Data are obtained from the *Securities Holdings Statistics* of the Deutsche Bundesbank. Individual security data are aggregated to the issuer state level by summing up overall ISINs per state, bank and quarter. Only state bonds held on banks' own accounts are included, covering both the banking book and the trading book.

Political economy variables

Home: a dummy variable which is equal to one if the bank's headquarters is located in the issuer state. If a bank has more than one headquarters (in the case of a few Landesbanken), I treat all headquarters locations as home states. But results are robust to defining just one headquarters following the bank supervisory database. The information is based on bank supervisory data of the Deutsche Bundesbank and Bloomberg.

State-owned: a dummy variable which is equal to one if the bank is directly owned by a state. These include some Landesbanken and state development banks. For a complete list of state-owned banks see Appendix A1. Information is taken from supervisory data on bank ownership and from public homepages of banks.

State-level variables

State debt: state debt per capita (in thd euro). All debt instruments including bonds and loans are included. Only debt associated with the core budget ("Kernhaushalt") is considered. Additional budgets ("Extrahaushalt") contain spending related to bad banks and public enterprises that would distort my analysis. The information is collected from the German Federal Statistical Office and in annual frequency.

State bonds outstanding: volume of outstanding state bonds per issuer (in mn eur). The information is collected from the German Ministery of Finance and in annual frequency.

Stability Council: a dummy variable which is equal to one after the introduction of the German Stability Council in the first quarter of 2010.

Breaches of stability criteria: the number of stability criteria that are breached according to the German Stability Council. This ordinal variable ranges from zero to eight. The Stability Council assesses four criteria in the following two dimensions: current budgetary situation (covering the current and last two years) and future fiscal planning (covering the next four years). Criteria include structural net lending/borrowing (per capita), credit funding ratio (i.e. net borrowing to fiscal budget) (%), interest expense to tax income ratio (%) and outstanding debt (per capita). The information is collected from the annual online publications (in German) of the German Stability Council. For more information on the Stability Council, see http://www.stabilitaetsrat.de/EN/Home/home_node.html.

Bank-level variables

Balance sheet total: log of total assets (in thsd euro) of the bank. Data are taken from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank. It is a measure for bank size.

Capitalization: ratio of equity capital (= subscribed capital + reserves - published losses) to total assets (in %), obtained from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank. This variable reflects the risk-bearing capacity of banks.

Commitments ratio: ratio of commitments (= contingent liabilities + placing and underwriting commitments + irrevocable lending commitments) to total assets plus commitments (in %) obtained from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank.

Deposit ratio: ratio of overnight deposits from household and non-financial firms to total assets (in %) obtained from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank.

Loan ratio: ratio of claims on banks and non-banks (= loans + advances, including received bills) to total assets (in %) obtained from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank.

NPL (4th quartile): an indicator equal to one if bank is in the 4th quartile of the ratio of non-performing loans to total loans (in %) in the respective year as obtained from the annual financial statements submitted to the Deutsche Bundesbank. To account for the statistical breaks in prudential definitions of NPL, I use this relative NPL indicator instead of comparing NPL ratios over time.

2.B Tables and Figures

Figure 2.1: Funding structure of German states

This Figure shows the decomposition of the aggregate outstanding debt of German states by debt type (i.e. bonds, loans from banks and other debt) over time. Data are taken from Deutsche Bundesbank.

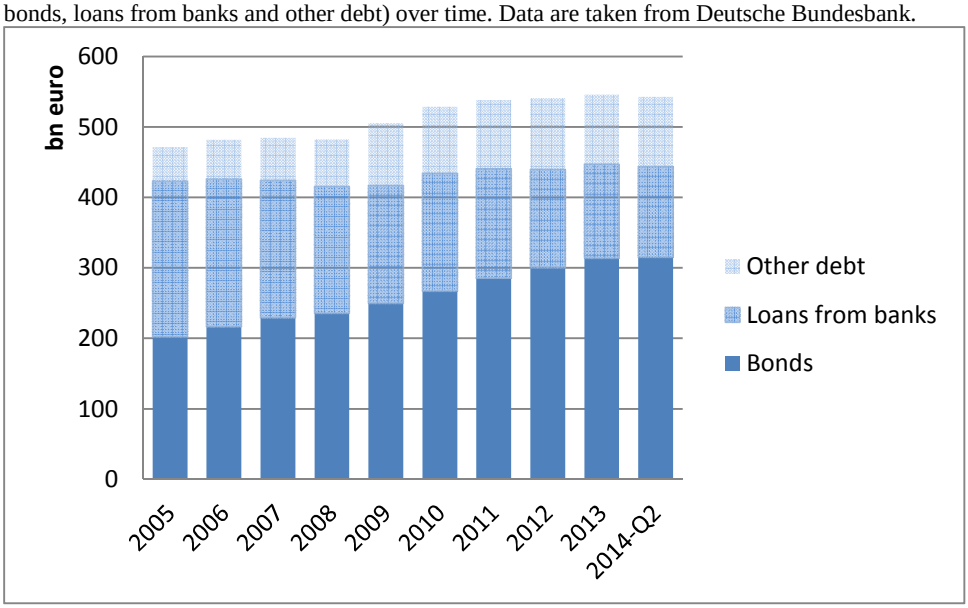

Figure 2.2: Heterogeneity between states in the fiscal indicators

This Figure shows the distribution of four fiscal indicators over time using boxplots. The upper (lower) hinge of the box shows the 75th (25th) percentile of the distribution. The median is indicated by the horizontal line within a box and the lines give the upper and lower adjacent values respectively. Outside values are not shown. The upper left panel shows the interest expense to tax income (in %), the upper right panel the state debt level Per Capita (in thsd euro), the lower left panel the credit funding ratio (i.e. net borrowing to fiscal budget, in %) and the lower right panel the structural net borrowing Per Capita (in thsd euro). Data are collected from the public reports by the Stability Council that can be accessed at http://www.stabilitaetsrat.de/EN/Home/home_node.html.

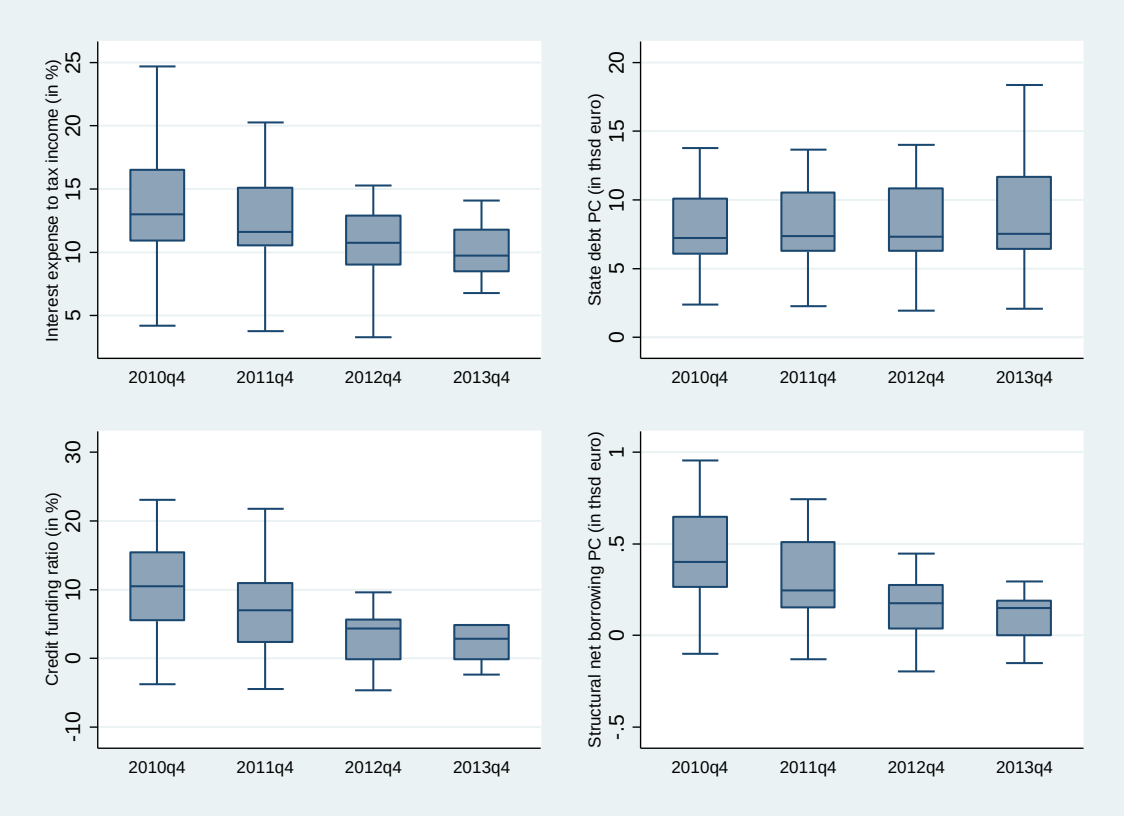

Table 2.1: Assessments by the German Stability Council

This Table shows the variation in assessments of the German Stability Council between states, i.e. the variation in the variables "breaches of stability criteria". Columns give the number of stability criteria that are breached by the issuer state. The variable ranges from zero to eight, i.e. four criteria in two dimensions each (current fiscal situation and future budgetary planning). Criteria include structural net lending/borrowing (per capita), credit funding ratio (%), interest expense to tax income ratio (%) and outstanding debt (per capita). Each observation in the Table gives the assessment of one year. For each state there are four observations, i.e. annual assessments of the Stability Council from 2010-2013.

	Number of stability criteria that are breached								
Issuer	0	1	2	3	4	5	6	7	8
Baden-Wuerttemberg	4	0	0	0	0	0	0	0	0
Bavaria	4	0	0	0	0	0	0	0	0
Berlin	0	0	2	0	1	1	0	0	0
Bremen	0	0	0	0	0	0	0	1	3
Hamburg	2	2	0	0	0	0	0	0	0
Hesse	1	3	0	0	0	0	0	0	0
Lower Saxony	4	0	0	0	0	0	0	0	0
Northrhine-Westphalia	3	1	0	0	0	0	0	0	0
Rhineland Palatinate	1	3	0	0	0	0	0	0	0
Saarland	0	0	0	0	0	0	0	1	3
Schleswig Holstein	0	0	1	1	1	1	0	0	0
Mecklenburg Western Pomerania	4	0	0	0	0	0	0	0	0
Brandenburg	4	0	0	0	0	0	0	0	0
Saxony-Anhalt	0	2	2	0	0	0	0	0	0
Thuringia	4	0	0	0	0	0	0	0	0
Saxony	4	0	0	0	0	0	0	0	0
Total (=64)	35	11	5	1	2	2	0	2	6

Table 2.2: Intensity of state government control over state-owned banks

This Table shows descriptive statistics for the intensity of state government control over state-owned banks. The first row shows the share of bank capital owned by the state (in %). The subgroup of regional development banks are fully state-owned, which is shown in italics in the second row. The following rows report the owners of state-owned banks other than the state governments. Other proxies for the intensity of state control are an indicator variable on whether the bank is owned by more than one state and the share of state politicians on the supervisory board (in %). Column 3 gives the share of the respective banks in the total assets of the German banking system (in %). For instance, banks that are owned by several states account for 9.12% of the banking system's assets. The Table shows unweighted averages for the 20 state-owned banks at the second quarter of 2014.

	(1)	(2)	(3)
	Mean	Std	Size of banks in % of banking system assets
Share owned by state (in %)	83.17	25.88	16.96
Other owners of state-owned banks			
Savings association (in %)	10.68	20.58	
Other public banks (in %)	2.84	12.24	
Other (in %)	3.31	7.82	
Owned by several states (1/0)	0.20	0.41	9.12
State politicians on supervisory board (in %)	44.00	25.00	

Table 2.3 German banks' government bond portfolios

This Table shows the importance of state bonds in the government bond portfolios of German banks. Unweighted averages within each banking group are reported. The group of cooperative banks include the head institutions. Column 1 shows total assets in bn euro, Columns 2 and 3 the overall government bond portfolio and Columns 4 and 5 holdings of German central government bonds. Columns 6 and 7 give the state bonds holdings per banking group. Column 8 shows the number of banks per banking group. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, own calculations, 1,732 banks as of Q2:2014. Data are for the second quarter of 2014.

	Total assets (TA)	Government bond portfolio (Gov PF)		German central government bond holdings		German state bond holdings		No of banks
	bn euro	bn euro	*in % of TA*	bn euro	*in % of Gov PF*	bn euro	*in % of Gov PF*	No
Commercial banks	15.69	0.54	*3%*	0.02	*5%*	0.25	*46%*	167
State-owned banks	63.54	5.13	*8%*	0.17	*3%*	2.06	*40%*	20
Savings banks	2.65	0.11	*4%*	0.00	*3%*	0.06	*57%*	417
Cooperative banks	0.97	0.04	*4%*	0.00	*1%*	0.01	*33%*	1,076
Mortgage banks	24.67	3.26	*13%*	0.01	*0%*	0.66	*20%*	17
Other MFI	29.39	1.03	*3%*	0.00	*0%*	0.42	*41%*	35
All banks	4.33	0.21	*3%*	0.01	*3%*	0.09	*41%*	1,732

Table 2.4: Banks' likelihood of holding state bonds

This Table shows results for estimating the determinants of the banks' likelihood of holding some state bonds using Probit estimations. An indicator equal to one when observing that bank i holds some state bonds in quarter t is the dependent variable. For a definition of all variables, see data appendix. Fixed effects are included as specified in the lower part of the Table. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Securities Holdings Statistics and Monthly Balance Sheet Statistics, Q4:2005 – Q2:2014, own calculations. Marginal effects for the Prbit estimations are reported in Column 2. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are shown in brackets.

	(1)	(2)
	Probit results	Marginal Effects
Balance sheet total (ln)	0.309***	0.122***
	(0.004)	(0.002)
Capitalization (%)	-0.021***	-0.008***
	(0.002)	(0.001)
Deposit ratio (%)	0.012***	0.005***
	(0.000)	(0.000)
Commitment ratio (%)	-0.011***	-0.004***
	(0.002)	(0.001)
NPL (4th quartile)	-0.017	-0.007
	(0.012)	(0.005)
State-owned bank	0.318***	0.126***
	(0.064)	(0.025)
Constant	-4.526***	
	(0.070)	
Observations	64,463	64,463
FE	Time	Time

Table 2.5 Home bias in banks' state bond portfolios

This Table shows descriptive statistics on the home bias in banks' state bond portfolios measured as HomeBias_it=1-(The group of cooperative banks include the head institutions. Share of foreign state bonds in portfolio_it)/(Share of foreign bonds in German state bond markets_t). Column 1 gives the mean of the home bias measure in the respective banking group, Column 2 the standard deviation and Column 3 the number of banks in each banking group. Banks that do not have any state bond holdings in 2014 Q2 are exlcuded because the home bias is not defined in these cases. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, own calculations, 933 banks. Data are for the second quarter of 2014.

	(1)	(2)	(3)
Bank type	Home bias		No of banks
	mean	sd	
Commercial banks	0.02	0.22	72
State-owned banks	0.19	0.29	19
Savings banks	0.07	0.30	319
Cooperative banks	0.08	0.33	486
Mortgage banks	0.00	0.18	16
Other MFI	0.14	0.28	21
All banks	0.08	0.31	933

Table 2.6: Descriptive statistics for Heckman model estimations

This Table shows in Panel A descriptive statistics for the dependent variables in selection and outcome equation and in Panel B the complete observations of issuer-specific variables in the selection and the outcome equations. Panel C shows the descriptive statistics for bank variables. The variables are defined in the Appendix A2. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations, 2,024 banks (unbalanced), and 16 issuer states. I include the 25th and 75th percentile of variables for the outcome equation in order to better assess the magnitude of the estimated coefficients in the outcome equation.

	Selection equation		Outcome equation			
	1,031,203		89,171			
	Mean	Stdv	Mean	Stdv	p25	p75
Panel A: Dependent variables						
Holding bonds issued by state *j* (dummy)	0.09	0.28				
Volume held of bonds issued by state *j* (ln)			15.97	1.74	14.73	16.99
Volume held of bonds issued by state *j* (euro bn)			0.05	0.22	0.00	0.02
Panel B: State-specific variables						
State bonds outstanding	13.81	16.35	27.14	22.15	9.16	34.75
State debt (thd euro PC)	8.61	7.43	9.45	9.66	6.08	9.00
Stability Council	0.41	0.49	0.55	0.50		
Breaches of stability criteria	0.68	1.86	0.65	1.51		
Home	0.06	0.24	0.12	0.33		
Panel C: Bank-specific variables						
Balance sheet total (ln)	13.18	1.59	14.62	2.04	13.25	15.52
Capitalization (%)	6.37	5.78	5.13	2.62	4.07	5.92
Deposit ratio (%)	26.53	12.94	23.64	15.19	12.50	34.60
Commitment ratio (%)	5.21	3.62	5.64	4.05	3.12	6.99
NPL (4th quartile)	0.25	0.43	0.21	0.41		

Table 2.6: Differences between home and out-of-state banks

This Table shows regression results for estimating the determinants of banks' investments in state bonds using a Heckman model. The log of bank i's sovereign bond holdings of state j is the dependent variable in the outcome equation. An indicator equal to one when observing that bank i holds bonds of state j is the dependent variable in the selection equation. An indicator that is equal to one from the introduction of the Stability Council onwards is included (stand-alone and interacted with home indicator) but not reported. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Fixed effects are included as specified in the lower part of the Table. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations. Marginal effects for the extensive margin are reported in Column 4. ***, ** and * indicate significance at the 1%, 5% and 10% level. Robust standard errors are shown in brackets.

	(1)	(2)	(3)	(4)
	Intensive margin	Extensive margin	Intensive margin	Extensive margin (Marginal Effects)
Home	0.317***	0.323***	0.485***	0.025***
	(0.025)	(0.010)	(0.029)	(0.001)
State bonds outstanding	0.032***	0.022***		
	(0.001)	(0.000)		
Breaches of stability criteria	-0.008***	-0.015***		
	(0.003)	(0.001)		
Home * Breaches of stability criteria	0.152***	0.013	0.155***	0.002**
	(0.016)	(0.008)	(0.019)	(0.001)
Balance sheet total (ln)	1.022***	0.322***	1.195***	0.027***
	(0.017)	(0.001)	(0.021)	(0.000)
Capitalization (%)	-0.033***	-0.025***	-0.049***	-0.002***
	(0.002)	(0.001)	(0.003)	(0.000)
Deposit ratio (%)	0.007***	0.007***	0.010***	0.001***
	(0.001)	(0.000)	(0.001)	(0.000)
Commitment ratio (%)	-0.037***	-0.007***	-0.040***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.000)
NPL (4th quartile)	-0.116***	-0.049***	-0.140***	-0.004***
	(0.010)	(0.005)	(0.011)	(0.000)
Constant	-1.724***	-6.276***	-4.844***	
	(0.392)	(0.025)	(0.458)	
Observations	89,171	1,031,203	89,171	1,031,203
FE	No	No	Issuer-Time	Issuer, Time
Inverse Mills ratio (IMR)	1.379		1.994	
Standard deviation of IMR	0.0698		0.0810	

Table 2.8: Differences between state-owned and other banks

This Table shows regression results for estimating the determinants of banks' investments in state bonds using a Heckman model and distinguishing between state-owned and other banks. The log of bank i's sovereign bond holdings of state j is the dependent variable in the outcome equation. An indicator equal to one when observing that bank i holds bonds of state j is the dependent variable in the selection equation. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Fixed effects and bank control variables are included as specified in the lower part of the Table. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations. ***, ** and * indicate significance at the 1%, 5% and 10% level. Robust standard errors are shown in brackets.

	(1)	(2)	(3)	(4)	(5)
	Baseline		Split by Stability Council assessment		
	Intensive margin	Extensive margin	Intensive margin	Extensive margin	Extensive margin (Marginal Effects)
Home	0.452***	0.296***	0.444***	0.295***	0.024***
	(0.029)	(0.010)	(0.029)	(0.010)	(0.001)
State-owned bank	-0.269***	0.074***	-0.378***	0.072***	0.006***
	(0.031)	(0.016)	(0.041)	(0.021)	(0.002)
Home * State-owned bank	0.886***	0.386***	0.852***	0.455***	0.037***
	(0.095)	(0.060)	(0.120)	(0.073)	(0.006)
Home * Breaches of stability criteria			0.092***	-0.004	-0.000
			(0.021)	(0.010)	(0.001)
State-owned * Breaches of stability criteria			0.047***	0.013	0.001
			(0.017)	(0.009)	(0.001)
Home * State-owned * Breaches of stability criteria			0.135**	0.115***	0.009***
			(0.053)	(0.030)	(0.002)
Constant	-4.983***	-6.189***	-4.699***	-6.191***	
	(0.464)	(0.030)	(0.457)	(0.030)	
Observations	89,171	1,031,203	89,171	1,031,203	1,031,203
Bank control variables	Y	Y	Y	Y	Y
FE	Issuer-Time	Issuer, Time	Issuer-Time	Issuer, Time	Issuer, Time
Inverse Mills ratio (IMR)	2.002		1.950		
Standard deviation of IMR	0.0821		0.0808		

Table 2.9: Alternative empirical approaches

This Table shows regression results for estimating the determinants of banks' investments in state bonds relative to outstanding state bonds using fractional data response models and fixed effects regressions. The proportion of state bond holdings relative to the outstanding state bonds is the dependent variable in Columns 1 and 2 and multiplied by 100% in Columns 3. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Fixed effects, underlying interaction effects and bank control variables are included as specified in the lower part of the Table. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors clustered at the issuer-time level are shown in brackets.

	(1) Fractional logit	(2) Fractional logit	(3) OLS regression
	Proportion including zeros	Proportion including zeros	Proportion (in %) including zeros
Home	0.299***	0.509***	
	(0.082)	(0.088)	
Home * State-owned bank	0.744***	0.661***	
	(0.116)	(0.121)	
Home * Breaches of stability criteria	0.010	0.003	0.006***
	(0.049)	(0.042)	(0.001)
State-owned * Breaches of stability criteria	0.081***	0.087***	0.046***
	(0.013)	(0.014)	(0.013)
Home * State-owned * Breaches of stability criteria	0.120**	0.109***	0.285***
	(0.049)	(0.042)	(0.029)
Constant	-21.496***	-21.721***	
	(0.144)	(0.163)	
Observations	1,029,507	1,029,507	1,036,067
Bank control variables	Y	Y	Y
FE	No	Issuer, Time	Issuer-Time; Bank-Time; Bank-Issuer
Interactions effects	Y	Y	Y
R-squared			0.366

Table 2.10: Intensity of government control on state-owned banks

This Table shows regression results for estimating the impact of state control on banks' state bond holdings using a Heckman model. The log of bank i's sovereign bond holdings of state j is the dependent variable in the outcome equation. An indicator equal to one when observing that bank i holds bonds of state j is the dependent variable in the selection equation. For the sake of brevity, only the results from the intensive margin are reported. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Fixed effects and bank control variables are included as specified in the lower part of the Table. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Only state-owned banks are included in columns 1 to 3; column 4 additionally includes 39 large banks for which supervisory board information was collected for the years 2013 and 2014. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations, except for Column 4 which covers Q1:2013 to Q2: 2014. ***, ** and * indicate significance at the 1%, 5% and 10% level. Robust standard errors are shown in brackets.

	(1)	(2)	(3)	(4)
	Baseline	Multiple state owners	Intensity of state ownership	Supervisory board membership
	Intensive margin	Intensive margin	Intensive margin	Intensive margin
Home	1.157***	1.776***	0.625***	0.653***
	(0.085)	(0.120)	(0.125)	(0.187)
Owned by several states		1.073***		
		(0.075)		
Home * Owned by several states		-1.026***		
		(0.159)		
Intensity of state ownership			-0.246***	
			(0.093)	
Home * Intensity of state ownership			0.959***	
			(0.190)	
State politicians in supervisory board (%)				-2.010***
				(0.338)
Home * State politicians in supervisory board (%)				2.690***
				(0.584)
Constant	-1.857	-2.858**	0.912	12.752***
	(1.345)	(1.258)	(1.214)	(1.012)
Observations	3,965	3,965	3,965	1,561
Bank control variables	Y	Y	Y	Y
FE	Issuer-Time	Issuer-Time	Issuer-Time	Issuer-Time
Inverse Mills ratio (IMR)	0.984	1.500	0.668	1.522
Standard deviation of IMR	0.139	0.133	0.128	0.269

Table 2.11: Robustness tests using different measures for the states' fiscal situation

This Table shows robustness results from a Heckman model using different measures for the fiscal situation of states. The log of bank i's sovereign bond holdings of state j is the dependent variable in the outcome equation. An indicator equal to one when observing that bank i holds bonds of state j is the dependent variable in the selection equation. For the sake of brevity, only the results from the intensive margin are reported. Columns 1-4 give the results for the structural net lending / borrowing, the credit funding ratio, the interest expense to tax income ratio and the outstanding state debt respectively as fiscal variables on the issuing state. Data for these variables are taken from the publications of the Stability Council and thus are available for 2010Q4 - 2014Q2 only. Column 5 uses outstanding state debt as provided by statistical offices and is thus available for the entire sample period. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Issuer-time fixed effects, bank control variables and all necessary two-way interaction effects are included. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations, in Columns 4-5 and the period from Q4:2010 to Q2:2014 in Columns 1-3 due to data availability. ***, ** and * indicate significance at the 1%, 5% and 10% level. Robust standard errors are shown in brackets.

	(1)	(2)	(3)	(4)	(5)
Fiscal variables	Structural net lending/borrowing	Credit funding ratio	Interest expense to tax income ratio	Outstanding state debt (thd eur PC)	Outstanding state debt (thd eur PC)
	Intensive margin	Intensive margin	Intensive margin	Intensive margin	Intensive margin
Home	0.612***	0.611***	0.410***	0.364***	0.361***
	(0.042)	(0.037)	(0.064)	(0.029)	(0.031)
Home * State-owned bank	0.630***	0.575***	0.153	0.879***	0.797***
	(0.146)	(0.148)	(0.291)	(0.127)	(0.147)
Home * Fiscal variable	-0.001***	-0.040***	0.003	0.011***	0.009***
	(0.000)	(0.005)	(0.006)	(0.003)	(0.003)
State-owned bank * Fiscal variable	0.000***	0.022***	0.025***	0.027***	0.026***
	(0.000)	(0.006)	(0.008)	(0.003)	(0.003)
Home * State-owned bank * Fiscal variable	0.003***	0.133***	0.101***	0.023**	0.006
	(0.000)	(0.018)	(0.024)	(0.011)	(0.012)
Home * Breaches of stability criteria					0.081***
					(0.021)
Home * State-owned * Breaches of stability criteria					0.121**
					(0.053)
Constant	-3.177***	-3.113***	-2.954***	-3.889***	-4.020***
	(0.496)	(0.493)	(0.492)	(0.435)	(0.443)
Observations	48,803	48,803	48,803	89,171	89,171
Bank control variables	Y	Y	Y	Y	Y
Interaction effects	Y	Y	Y	Y	Y
FE	Issuer-Time	Issuer-Time	Issuer-Time	Issuer-Time	Issuer-Time
Inverse Mills ratio (IMR)	1.627	1.613	1.585	1.803	1.827
Standard deviation of IMR	0.0899	0.0893	0.0890	0.0770	0.0784

Table 2.12: Robustness tests

This Table shows robustness results for estimating the determinants of banks' investments in state bonds using a Heckman model. The log of bank i's bond holdings of state j is the dependent variable in the outcome equation. An indicator equal to one when observing that bank i holds bonds of state j is the dependent variable in the selection equation. For the sake of brevity, only the results from the outcome equation are reported. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Fixed effects, bank control variables and all necessary interaction effects are included as specified in the lower part of the Table. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations, except for in Column 3 where it covers Q1:2010 to Q2:2014. ***, ** and * indicate significance at the 1%, 5% and 10% level. Standard errors are clustered at the bank-time level in Column 1 and at the bank-issuer level in Column 2 using a bootstrap technique. In Column 3 robust standard errors are shown in brackets.

	(1)	(2)	(3)	(4)	(5)
	Std errors clustered at bank-time level	Std errors clustered at bank-issuer level	Since Stability Council	Excluding city states	Only city states
	Intensive margin	Intensive margin	Intensive margin	Intensive margin	Intensive margin
Home	0.437***	0.274***	0.404***	0.480***	0.121
	(0.026)	(0.088)	(0.030)	(0.031)	(0.141)
Home * State-owned bank	0.833***	0.762	0.808***	0.612***	0.371
	(0.120)	(0.545)	(0.119)	(0.146)	(0.256)
Home * Breaches of stability criteria	0.092***	0.112*	0.073***	0.012	-0.133**
	(0.019)	(0.060)	(0.019)	(0.026)	(0.061)
Home * State-owned * Breaches of stability criteria	0.140***	0.024	0.156***	0.137*	0.281***
	(0.041)	(0.171)	(0.044)	(0.072)	(0.091)
Constant	-4.617***	-1.615	-2.587***	-5.955***	3.761***
	(0.587)	(1.255)	(0.487)	(0.519)	(1.157)
Observations	89,171	89,171	48,803	83,456	5,715
Bank control variables	Y	Y	Y	Y	Y
Interaction effects	Y	Y	Y	Y	Y
FE	Issuer-Time	No	Issuer-Time	Issuer-Time	Issuer-Time
Inverse Mills ratio (IMR)	1.932	1.341	1.532	2.088	0.909
Standard deviation of IMR	0.0804	0.0693	0.0882	0.0906	0.210

Table 2.13: Testing the risk-shifting hypothesis

This Table shows regression results from a Heckman model for testing whether banks' investments in state bonds can be explained by the risk shifting hypothesis. The log of bank i's sovereign bond holdings of state j is the dependent variable in the outcome equation. For the sake of brevity, only the results from the outcome equation are reported. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Column 1 and 2 analyse the impact of banks' capital ratio and Column 3 and 4 the impact of a banks' non performing loans ratio on its state bond holdings decisions. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Issuer-time fixed effects, bank control variables and all necessary two-way interaction effects are included. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations. ***, ** and * indicate significance at the 1%, 5% and 10% level. Robust standard errors are shown in brackets.

	(1)	(2)	(3)	(4)
	Capitalization		NPL Ratio	
	Intensive margin	Intensive margin	Intensive margin	Intensive margin
Home	0.428***	0.394***	0.541***	0.457***
	(0.046)	(0.045)	(0.025)	(0.031)
Home * Capitalization (%)	0.005	0.003		
	(0.005)	(0.007)		
Capitalization (%) * Breaches of stability criteria		0.015***		
		(0.001)		
Home * Capitalization (%) * Breaches of stability criteria		-0.005		
		(0.010)		
Home * Breaches of stability criteria		0.104*		0.087***
		(0.058)		(0.024)
Home * State-owned * Breaches of stability criteria		0.159***		0.136***
		(0.053)		(0.053)
Home * NPL (%)			-0.052	-0.080*
			(0.034)	(0.047)
NPL (%) * Breaches of stability criteria				0.032***
				(0.008)
Home * NPL (%) * Breaches of stability criteria				0.008
				(0.041)
Constant	-4.400***	-4.874***	-4.832***	-4.493***
	(0.451)	(0.460)	(0.456)	(0.451)
Observations	89,171	89,171	89,171	89,171
Bank control variables	Y	Y	Y	Y
Interaction effects	Y	Y	Y	Y
FE	Issuer-Time	Issuer-Time	Issuer-Time	Issuer-Time
Inverse Mills ratio (IMR)	1.889	1.997	1.996	1.916
Standard deviation of IMR	0.0797	0.0815	0.0809	0.0800

Table 2.14: Testing for alternative explanations

This Table shows regression results for testing alternative hypotheses on banks' investments in state bonds using a Heckman model. The log of bank *i*'s sovereign bond holdings of state *j* is the dependent variable in the outcome equation. An indicator equal to one when observing that bank *i* holds bonds of state *j* is the dependent variable in the selection equation. For the sake of brevity, only the results from the outcome equation are reported. Column 1 tests whether banks' capitalization (i.e. equity over unweighted assets) affects the holdings of state-owned banks. Column 2 tests the hypothesis that banks hold home state bonds to store liquidity for future lending opportunities. The loan ratio is defuned as claims on banks and non-banks relative to total assets. Column 3 tests for information asymmetries where Stability Council is an indicator equal to one from 2010 onwards. The variable "breaches of stability criteria" captures the number of stability criteria (0-8) that a state breaches in the respective year as reported by the German Stability Council. For a definition of all variables, see data appendix. Fixed effects, bank control variables and underlying interaction effects are included as specified in the lower part of the Table. The inverse Mills ratio (IMR) is obtained from the extensive margin and corrects for self-selection. Data sources: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, *Securities Holdings Statistics* and *Monthly Balance Sheet Statistics*, Q4:2005 – Q2:2014, own calculations. ***, ** and * indicate significance at the 1%, 5% and 10% level. Robust standard errors are shown in brackets.

	(1)	(2)	(3)
	Capitalization of state-owned banks	Other lending opportunities	Information asymmetries
	Intensive margin	Intensive margin	Intensive margin
Home	0.436***	0.157**	0.317***
	(0.036)	(0.062)	(0.025)
Home * State-owned	1.150***		
	(0.170)		
State-owned * Capitalization (%)	0.151***		
	(0.010)		
Home * State-owned * Capitalization (%)	-0.000		
	(0.030)		
Loan ratio		-0.033***	
		(0.001)	
Home * Loan ratio		0.003***	
		(0.001)	
Home * Breaches of stability criteria		0.165***	0.152***
		(0.015)	(0.016)
Breaches of stability criteria			-0.008***
			(0.003)
Home * Stability Council			-0.061**
			(0.028)
Stability Council			0.213***
			(0.016)
Constant	-4.900***	1.534***	-1.724***
	(0.458)	(0.269)	(0.392)
Observations	89,171	89,171	89,171
Bank control variables	Y	Y	Y
Interaction effects	Y	Y	Y
FE	Issuer-Time	Issuer-Time	No
Inverse Mills ratio (IMR)	2.012	1.230	1.379
Standard deviation of IMR	0.0815	0.0558	0.0698

Chapter 3: The transmission of sovereign risk to insurance companies[1]

3.1 Introduction

Since the onset of the European sovereign debt crisis, sovereign risk has been one of the main threats to financial stability. Many recent research papers investigate the link between sovereign risk and the banking system. By contrast, however, research on the effects of sovereign risk on insurance companies is very rare. This is surprising, given the importance of insurance companies as large institutional investors in sovereign bond markets. Insurers hold roughly 12% of all global financial assets (IAIS, 2011) and they invest about 20% of those assets in sovereign bonds (J.P. Morgan Cazenove, 2014). To the best of our knowledge, our study is the first to analyse empirically the channels of risk transmission from sovereigns to insurers.

In our empirical methodology, we control for reverse causality using an Instrumental Variable approach, identify a portfolio channel and a transmission channel to systemically important insurers, and test for differences sovereign risk transmission to insurers, banks and non-financial firms.

Our analysis is based on a novel panel dataset that covers sovereigns, insurance companies, banks and non-financial firms from nine countries (Belgium, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States) over the time period from 1 January 2008 to 1 May 2013. We analyse the market's expectations of default risk by using CDS spreads as our baseline risk measure. We control for risk transmission from the domestic banking sector and for the macroeconomic environment.

We find that there is a strong and robust transmission of default risk from sovereigns to insurers. This risk spillover is not significantly different from the spillover of sovereign risk onto banks but it is stronger than for non-financial firms. We take a closer look at the channels of risk transmission and find that insurers which later have been classified as global

[1] Chapter 3 is based on the published article Duell, R., Koenig, F., and Ohls J. (2017) On the exposure of insurance companies to sovereign risk - Portfolio investments and market forces. Journal of Financial Stability, 31, pp. 93–106. The copyright of the original article is with Journal of Financial Stability, Elsevier B.V.

systemically important insurer (G-SII) by the Financial Stability Board (FSB) were more susceptible to domestic sovereign risk during our sample period.

We also test for the impact of insurers' sovereign bond holdings on insurer default risk using portfolio data for 16 large European insurers as provided by J.P. Morgan Cazenove (2014). These data are based on the financial reports published by insurance companies and are available quarterly from Q4 2009 through to Q1 2013 (see Appendix for a list of insurers). We show that sovereign risk spills across borders through insurers' holdings of foreign sovereign bonds. Domestic sovereign bond holdings are not a significant driver of insurer default risk in our sample, probably because data are available predominantly for insurers from relatively safe countries. These insurers are affected by their exposure to foreign, risky sovereigns. We document that diversification in sovereign bond portfolios is low and has been declining in recent years.

Furthermore, we find that sovereign risk transmission to domestic insurers increases with the level of sovereign risk and has been stronger in the euro area than elsewhere. Over time, however, the transmission of sovereign risk to domestic insurers is rather stable. Finally, risk in the domestic banking sector also significantly raises insurance companies' default risk.

Our findings are important for policymakers, regulators and the industry alike. The portfolio channel identified has important implications for supervisory monitoring and designing regulation. At present, domestic sovereign bond investments are generally exempt from capital charges under insurance regulation. Under the new European insurance regulation, Solvency II, which came into effect at the beginning of 2016, EU sovereign bonds are exempt from the credit and concentration risk modules when calculating solvency capital requirements under Pillar 1. The regulation thus deems domestic and EU sovereign bonds to be risk free for European insurance companies. We show, however, that markets take risks in sovereign bond portfolios into account when assessing insurer default risk.

Insurer stability is of interest from a macroprudential perspective as insurance companies pool and allocate risks in the economy, thereby contributing to financial stability. Moreover, distress in the insurance sector can destabilize the financial system (International Monetary Fund, 2016) given its importance as a large institutional investor.

Taking into account these issues, it is surprising that research on insurers' vulnerability to sovereign risk is so rare. The only paper known to us that includes insurance companies as part of the nexus between sovereigns and the financial system is Billio, Getmansky, Gray, Lo, Merton, and Pelizzon (2013). Based on Granger causality and network analysis, this chapter

finds that the system of banks, insurance companies, and sovereigns is highly dynamically connected. It does not, however, discuss the channels of risk transmission, which is what we do in this chapter.

The literature on risk spillovers between sovereigns and the private sector focuses almost exclusively on (i) banks (see, for example, Acharya, Drechsler, and Schnabl, 2014; Altera and Schüler, 2012; Battistini, Pagano, and Simonelli, 2014)[2] or (ii) (non-financial) firms (see, for example, Ciocchini, 2002; Durbin and Ng, 2005). We contribute to this strand of the literature by providing insights into the effects of sovereign risk on a third important sector: insurance.

Before turning to the empirical approach, we first look at the mere correlation of sovereign risk and insurer risk. While both sectors tend to move together, the extent of the comovement varies between countries (see Figure 3.1). The blue (red) line reports the average 5-year CDS spread of the insurance sector (the sovereign) as published by the data provider, Markit. While Figure 3.1 gives a first hint at a relationship between sovereign and insurer risk, this finding might be driven by different factors that affect both sovereign and insurer risk simultaneously. We will address these concerns in our empirical strategy.

First, we estimate a reduced form equation of insurer risk on sovereign risk, controlling for a number of confounding factors (following the methodology in Acharya et al., 2014, for an application to the banking sector). We perform additional checks to address whether sovereign risk transmission has a causal and insurer-specific effect. We compare the magnitude of transmission across sectors (as in Bühler and Prokopczuk, 2010) and control for reverse causality through instrumental variable (IV) regressions (as in Bedendo and Colla, 2013).

The chapter is structured as follows. In Section 3.2 we discuss our hypotheses of the transmission channels through which sovereign risk spills over onto insurer risk. Section 3.3 presents the dataset and our empirical strategy. In Section 3.4 we present the results. Section 3.5 concludes and offers insights into policy implications.

[2] For the sake of completeness, it should be mentioned that several studies analyse contagion from banks to the sovereign, e.g. through bank bail-outs (Alter und Beyer, 2014; Gerlach, Schulz and Wolff, 2010; International Monetary Fund, 2012).

3.2 Hypotheses of risk transmission channels

To the best of our knowledge, there is no theoretical model to guide our hypotheses of the relationship between sovereigns and insurance companies. We, therefore, build on the findings of the related literature on banks and non-financial firms mentioned above and adapt them to suit the insurance-specific case. In our empirical setup, we consider several transmission channels through which sovereign risk can spill over onto insurer risk.

1. Various studies have shown that banks are vulnerable to sovereign risk due to their sovereign bond portfolios (see, for example, Buch, Kötter and Ohls, 2016; De Bruyckere, Gerhardt, Schepens and Vander Vennet, 2013). This may stem from the risk of incurring direct losses on bond holdings as well as from the importance of sovereign bonds as collateral to obtain funding (CGFS, 2011). Similarly, sovereign risk may affect insurers through a **portfolio channel.** We will study this channel by including company-level information on insurers' sovereign bond holdings.

Insurers are highly exposed to sovereigns through their bond holdings. Our data suggest that insurers hold a larger share of their assets in sovereign bonds than banks do (in Europe, the portions are roughly 20% and 11%, respectively).[3] Life insurance companies, in particular, often have long-term nominal liabilities. In respect of duration matching, these are best matched with long-term low-risk bonds with a fixed nominal return. This – together with preferential regulatory treatment – has led many insurance companies to invest heavily in government bonds (Wilson, 2013). Moreover, anecdotal evidence suggests that insurers' domestic sovereign bond investments are particularly large and growing in countries experiencing sovereign stress. Italian insurers, for instance, increased their exposure to Italian public debt from 33% of their total asset portfolio in 2008 to 50% of their portfolio by the end of 2012.[4]

Credit risk from sovereign bond holdings may impact insurer default risks in several ways. Direct losses in the market value of their sovereign portfolio are likely to pose the greatest risk (see also Bank of England, 2014; Ellul, Jotikasthira, Lundblad and Wang, 2014). According to Ernst & Young, the majority of insurers' sovereign bonds (over 60%) are classified as "available for sale" (Ernst & Young, 2011).[5] This is because they are held as a liquidity buffer with the option of selling them before maturity. Given current accounting

[3] For insurers, see J.P. Morgan Cazenove (2014); for European banks, see EBA (2011).
[4] See speech by Aldo Minucci, the Head of Italy's insurance association, ANIA (Bloomberg news, 2.7.2013).
[5] This view is supported by Impavido and Tower (2014), p. 18.

rules (i.e. IAS 39 - Financial Instruments), this implies that movements in the price of sovereign bonds will affect the insurers' capital position directly.

Also, insurance companies may need collateral for hedging operations such as interest rate swaps. In contrast to banks, though, insurers rely less on sovereign bonds as collateral for funding. They are prefunded as they receive regular payments from insurance customers. Insurers typically impose costs on their customers for lapsing an insurance policy and are hence less prone to liquidity runs than banks. Large-scale policy lapses cannot be ruled out completely, however (Feodoria and Förstemann, 2015; Foley-Fisher, Narajabad, and Verani, 2015).

Finally, there is a trade-off between the risks and the returns connected with the purchases of new sovereign bonds. If higher returns are compensation for higher risks, then the impact of new sovereign bond purchases on insurer default risk is ambivalent. Life insurers have, in some jurisdictions, issued fixed nominal interest rate guarantees which they are struggling to fulfil in the current low interest rate environment (Kablau and Weiss, 2014). As we base our analysis on the market's expectations of insurer default risk, the trade-off between risks and returns should already be priced in, meaning that the estimated coefficients should give the net effect of the risk and return effects.

Insurance regulation treats sovereign bond holdings as risk free. The Solvency I framework, which applied in Europe during our sample period, does not involve capital requirements for holding financial assets, including government bonds.[6] Some countries within our sample have introduced additional requirements, thus augmenting the Solvency I rules (the Netherlands and the United Kingdom), while other countries have introduced risk-based capital requirements (Switzerland, Japan, and the United States). However, even in the latter countries, sovereign bonds are generally also excluded from both capital requirements and diversification requirements.[7]

A new regulatory framework, Solvency II, was introduced in Europe in 2016. Under Solvency II, all assets held by insurance companies, including any holdings of sovereign bonds, have to be marked to market. Thus, a Solvency II balance sheet reflects the expected value of an insurer's assets and liabilities. In addition, insurers have to hold capital to cover

[6] Capital requirements were generally based on the volume of premiums, technical provisions or claims incurred.
[7] At least those issued by OECD countries and especially those issued by the domestic sovereign. In Switzerland, claims against AAA-rated sovereigns are exempt from diversification requirements.

unexpected losses under different risk categories (e.g. spread and concentration risks).[8] However, sovereign bonds issued by an EU member state are exempt from the pillar 1 capital requirements for spread and concentration risks.[9] Thibeault and Wambeke (2014) show that an investment in long-term EU sovereign bonds could even result in a marginal decrease in capital requirements if this investment reduces the overall interest rate risk from a duration mismatch between assets and liabilities. As a result, insurers' incentives to invest in sovereign bonds could even be higher under Solvency II than during our sample period and therefore increase insurers' exposure to sovereign risk.

2. **Risk transmission from the banking system** to insurance companies may also play a role. Our portfolio data from J.P. Morgan Cazenove (2014) suggests that insurers' exposure to bank debt is of a similar size to their exposure to sovereigns. A number of earlier studies document that insurers are affected by bank risk (Bernoth and Pick, 2011; Chen, Cummins, Viswanathan and Weiss, 2014; Hammoudeh, Nandha, and Yuan, 2013). We control for the banking channel by including a measure of domestic banking system risk. There is some indication that risk spillovers can also occur from insurers to banks (Podlich and Wedow, 2013). We take this potential endogeneity into account by using instrumental variables regression as a robustness check (see Section 3.4). The banking channel may capture part of the (indirect) transmission of sovereign risk to insurers, as banks are also highly exposed to the sovereigns themselves.

3. A large number of studies have found that the **expectation of government bail-outs** creates a robust link between the credit risk of key financial institutions and the domestic sovereign (e.g. Acharya et al., 2014; Correa, Lee, Sapriza, and Suarez, 2014; Noss and Sowerbutts, 2012). While these studies focus on banks, government guarantees for insurance companies or insurance guarantee funds[10] may also lead to sovereign risk spillovers onto insurers. If a government guarantees that it will rescue an insurance company (or is expected to do so), then the perceived risk for insurers grows if the risk of sovereign default increases, i.e. if bail-out capacity decreases. We will test whether insurers which the FSB has classified as G-SIIs in June 2013 are more closely connected to the default risk of the domestic sovereign. We are unable, though, to provide a direct test for government guarantees. Such a

[8] The solvency capital requirement is calibrated in such a way that it reflects the value-at-risk at the 99.5% quantile.
[9] Under Pillar 2 of Solvency II, however, insurance companies still have to assess their overall solvency needs in relation to their specific risk profile (Own Risk and Solvency Assessment (ORSA)).
[10] Insurance guarantee funds step in to honour the covered claims of an insolvent insurer's policyholders, similar to a deposit insurance system.

test would require data on the market's expectations regarding bail-outs – which are unavailable to us – and is therefore left to future research.

4. Insurer risk and sovereign risk are also linked through the **macroeconomic environment**. Heightened sovereign risk often goes hand in hand with an economic downturn and reduced domestic demand which, in turn, impairs private firms' earning opportunities and increases their probability of default (see, for example, Ciocchini, 2002; Durbin and Ng, 2005). Moreover, Acharya et al. (2014) argue that sovereign default risk increases the expected tax burden, consequently reducing firms' profitability and investment. Based on these findings, our analysis includes the national stock index as a proxy for the macroeconomic environment. Also, by explicitly comparing the vulnerability of insurance companies with that of other private sector firms, we control for the transmission effect common to all firms.

3.3 Dataset and empirical strategy

We construct a panel dataset with information on the credit default risk of firms in different industries around the world. It covers insurance companies, banks, and non-financial firms from nine countries (Belgium, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom, and the United States) over the time period from 1 January 2008 to 1 May 2013. The countries were selected on the basis of data availability on CDS spreads of insurance companies from these countries.

Our dataset includes all types of insurers (life, reinsurance, health, property, etc.) except insurers that provide financial guarantees (e.g. AIG or MBIA). The latter have a very special business model which focuses on so-called "non-traditional insurance activities", such as bond insurance. Sovereign risk is, therefore, likely to be transmitted differently in the case of these firms which is not covered by our analysis. Our exclusion of financial guarantee insurers reduces the sample size from 46,712 to 39,673. Also, we exclude three financial conglomerates whose business includes not only insurance but also banking activities to a non-negligible extent (above 10% of their group balance sheet).[11] This reduces our sample to 35,090 observations. To make sure that only quotes for frequently traded CDS are used in the analysis, we exclude any company reporting CDS values for less than three years over our

[11] Furthermore, we exclude the initial observations of two companies that conducted banking activities exceeding 10% of their group balance sheet total until the financial crisis (Allianz until selling Dresdner Bank to Commerzbank on 12 January 2009 and Ageas being part of a financial conglomerate (Fortis group) until October 2008).

sample period (750 trading days).[12] This reduces our sample further to 32,592 observations. Owing to missing control variables, our final sample comprises 30,555 observations. The resulting sample covers 26 insurance companies and 1,379 trading days (unbalanced sample). We also collect CDS data for banks and non-financial firms from the aforementioned countries. We include all firms with non-missing CDS pricing data for 750 trading days. This extended sample has 461,138 observations and covers 393 private sector firms from ten industry sectors over 1,379 trading days (unbalanced sample).[13] The sample is composed of 7% insurance companies, 20% banks and 73% non-financial firms.

Table 3.1 contains summary statistics of the variables in the different estimation samples. All in all, our estimation sample is rather similar to the overall sample.

Empirical approach

As a baseline, we regress insurer risk on home sovereign risk. This yields Equation (I)

$$\Delta \ln(risk_{i,t}) = \beta_0 + \beta_1 \Delta \ln(risk_{j,t}^{home}) + \beta_2 \Delta lnX_{jt} + \varepsilon_{i,t} \quad \text{(I)}$$

where $risk_{i,t}$ is a measure of insurer performance at time t, $risk_{j,t}^{home}$ is domestic sovereign risk, and X_{jt} is a matrix of country-specific control variables. We control for growth (expectations), risk aversion in financial markets, counterparty risk in the CDS market and risks in the national banking system. All variables are measured daily and in changes of their logs $\Delta \ln(.)$. A similar approach has been used by Acharya et al. (2014) for studying the effects of sovereign risk on banks. The log transformation allows us to interpret the coefficients as elasticity, a measure of sensitivity that is independent of the scale of our risk measure. That is to say, the coefficient captures the percentage increase in insurer risk for a 1% increase in the independent variable.

The current low interest rate environment poses a challenge for (life) insurer solvency, especially if the insurer has promised fixed nominal interest rates to its policyholders (International Monetary Fund, 2015; Kablau and Weiss, 2014). Typically, insurance companies' vulnerability depends on the level of interest rates as well as on the business model. Therefore, we control for any structural differences between insurers in e.g. asset liability management, by estimating all of the specifications in log changes. Also, we include

[12] We also collect data on the trading volume of each insurer CDS used. This confirms that our risk measure is based on a highly liquid market.

[13] We distinguish between the following sectors as classified by the data provider, Markit: insurance, banks, basic materials, consumer goods, consumer services, energy (including oil and gas), healthcare, industrials, technology and telecommunications.

time fixed effects that capture the common decrease in interest rates across advanced economies during our time period. In an augmented specification, we include country-time fixed effects, which also capture the time-varying differences in insurers' business models from country to country.[14]

A potential concern with Equation (I) is reverse causality. A detailed discussion of endogeneity issues and the results of instrumental variable regression can be found in Section 3.4.1.

Since our data contain a substantial time series component, we check for stationarity and find no evidence of unit roots in first differences.[15] We also check for autocorrelation in our standard errors, but find little evidence of this.[16] Our baseline regression does not control for autocorrelation. However, the results are unaffected if we do so.[17] Apart from a correlation of shocks over time, there may be concerns about a correlation of shocks between firms during the same time period. To take this into account, we allow shocks to be correlated contemporaneously by clustering standard errors on the time dimension.

Dependent variables

We use three alternative measures for $risk_{i,t}$: CDS spreads with a five-year maturity published by Markit, stock returns published by Bloomberg and expected default frequencies (EDFs) by Moodys KMV. CDS spreads measure default risk and are the standard metric in recent literature (Longstaff, Pan, Pedersen, and Singleton, 2011; Acharya et al., 2014).[18] These papers discuss the two main reasons for choosing CDS spreads in lieu of bond spreads: first, they better reflect risk, as CDS are designed to insure against default risk and serve no other purpose that might affect their price; second, the CDS market is more liquid than most

[14] For example, the duration gap between assets and liabilities varies substantially between insurers in different European countries. On average, German insurers have the largest duration gap, while the assets and liabilities of UK insurers are matched quite well (EIOPA, 2014).
[15] We perform the Fisher unit root test for heterogeneous mixed panel data. This assumes that there is no cross-sectional dependence within the dataset. Our analysis has no independent cross sections as several insurance companies are from the same country, which means that they are related and exposed to common shocks. In order to mitigate this problem, we demean our time series as suggested by Levin, Lin, and Chu (2002).
[16] Autocorrelation in the errors is below 0.2 and insignificant from the second lag onwards in all time series.
[17] As a robustness check, we allow for autocorrelated errors of up to one month (i.e. 20 trading days) (see Driscoll and Kraay (1998)). The results (available upon request) remain practically unchanged.
[18] We selected USD-denominated CDS quotes published by the Markit group with a five-year maturity for senior unsecured debt, with the modified-modified restructuring clause for financial and non-financial firms and the cumulative restructuring clause for sovereigns. These represent the conventional and most liquid terms for CDS contracts on European reference entities, which will be the focus of our analysis. See also Bedendo and Colla (2013).

bond markets. Liquidity is key, as our analysis seeks to uncover risk transmission at a relatively high frequency (daily and weekly data).

As a robustness check, we use other measures of insurer performance, namely stock returns and expected default probabilities. Stock returns reflect a broad set of developments, including default risk and insurer profitability. The advantage of stock returns is that they are more widely available and thus allow us to check whether our results hold more broadly. However, they include additional information that is unrelated to default risk.

One great advantage of our market-based performance measures over balance sheet data are that they capture ex ante anticipated risk exposures and are available at a high frequency. Balance sheet measures would reflect only ex post realized risk. Our measures capture only risks that are correctly priced by the market, however. We, thus, do not seek to uncover hidden risks, but rather to highlight how risk passes from the sovereign sector to insurers based on the market's expectations.

Independent variables

Our main variable is $risk_{j,t}^{home}$, which is measured on the basis of domestic sovereign CDS with a five-year maturity (drawn from Markit).

We include country-specific measures of economic performance, market confidence and banking risk as control variables. The national stock market index (drawn from Bloomberg) is a proxy for economic activity and growth. Both insurers (through loss events and premium income) and sovereigns (through tax income and social expenditure) are influenced by real economic activity. It is, therefore, important to control for growth in order to avoid an omitted variable bias. Market sentiment and risk aversion are measured by implied volatility on the national stock indexes over 30 days, e.g. VDAX-NEW for Germany and VIX for the United States (drawn from Bloomberg).[19]

To control for risks emanating from the banking sector, we take the weighted average of the CDS of domestic banks, where we weight each bank by its relative size in the country.[20]

Testing for transmission channels

In order to analyse the transmission channels, we introduce additional variables to Equation (I). The portfolio channel captures exposure to (domestic and foreign) sovereign risk

[19] We were unable to obtain a national volatility index for Belgium, which is why we take VSTOXX in this case.
[20] Size is measured by total assets. National currency-denominated CDS spreads with a five-year maturity were taken from Markit.

through insurers' sovereign bond holdings. We construct a measure of a sovereign portfolio's riskiness by weighing each sovereign CDS with its relevant sovereign share in an insurer's portfolio, i.e.

$$risk_{i,t}^{portfolio} = \sum_{all\ sovereigns\ j}\left(\frac{sovbonds_{ijt}}{totalassets_{it}} * \Delta \ln\left(risk_{j,t}\right)\right).$$

where $sovbonds_{ijt}$ refers to insurer i's holdings of bonds issued by sovereign j (in USD) and $risk_{j,t}$ refers to the CDS quote for the same sovereign j. We divide the sovereign bond holding by total assets instead of the insurer's overall sovereign bond portfolio in order to differentiate between insurers with a large or small overall sovereign bond portfolio relative to their total assets.

This yields Equation (II):

$$\Delta \ln\left(risk_{i,t}\right) = \beta_0 + \beta_1 \Delta \ln\left(risk_{j,t}^{home}\right) + \beta_2 \Delta lnX_{j,t} + \beta_4 risk_{i,t}^{portfolio} + \varepsilon_{i,t} \quad \text{(II)}$$

where all variables and econometric specifications are equivalent to those in Equation (I). The measure of portfolio risk is company-specific. This allows us to control for country-specific time effects in a robustness check.

As we are analyzing market behavior, we use the market estimate of an insurer's exposure as provided by J.P. Morgan (J.P. Morgan Cazenove, 2014) rather than administrative data. J.P. Morgan regularly publishes estimates of the sovereign bond holdings of 16 large European insurers (see Appendix for a list of insurers). These data are based on the insurance companies' own financial reports and are available quarterly from Q4 2009 through Q1 2013.

In order to test for international versus domestic transmission of sovereign risk, we separate the overall sovereign portfolio into its domestic and foreign parts, constructing the riskiness of both parts of the portfolio separately. In this specification, the riskiness of the home sovereign portfolio is simply the home sovereign bonds' share of total assets multiplied by the CDS of the home sovereign. The riskiness of the foreign sovereign portfolio is constructed in a similar way to the riskiness of the overall sovereign portfolio, but excludes the domestic sovereign.

Finally, we create a G-SII dummy that differentiates between insurers which the FSB (2013) classifies as systemically important and those which it does not. We will test whether the transmission of sovereign risk is the same for both groups.

3.4 Estimation and results

3.4.1 Does sovereign risk transmit to risk in insurance?

Table 3.2 reports the results of estimating Equation (I). Column 1 includes only the variable of interest and the coefficient thus reflects the correlation between insurance risk and the domestic sovereign. We find a highly significant positive elasticity. A 10% rise in sovereign risk leads to a 1.8% rise in domestic insurer risk. Column 2 controls for the national volatility index and stock market movements. The coefficients on the volatility index (stock market index) show the expected positive (negative) sign and reduce the effect of sovereign risk on insurer risk.

In column 3, we control for risks in the banking sector. Including controls for the banking sector has two effects. First, as discussed above, the banking sector could be an omitted variable, which needs to be introduced for correct estimation. At the same time, however, the proxies for the domestic banking system may also capture an indirect transmission channel from sovereigns to insurers. Banks themselves are typically also highly exposed to the sovereign. Therefore, the estimated direct impact of home sovereign CDS on insurer CDS (=0.06) in column 3 can be interpreted as a lower bound of the total impact. Bank bonds are roughly as important in insurers' balance sheets as sovereign bonds are (J.P. Morgan Cazenove, 2014). Indeed, we find that the stability of the domestic banking system is important for insurer stability. A 10% increase in banking risk increases a domestic insurer's default risk by 4.4%. This finding is in line with previous studies, which found a significant transmission of banking risk to the insurance sector (Bernoth and Pick, 2011; Chen et al., 2014; Hammoudeh et al., 2013). We will control for the potential endogeneity between insurer CDS and banking system CDS by using instrumental variables.

In column 4, we use time fixed effects to absorb factors that are common to all insurers. What remains is a conservative estimate of risk contagion from the sovereign to the domestic insurer, as the average transmission at a given date will be absorbed by the time fixed effects. As expected, the elasticity decreases further in economic terms. However, even at this lower bound, the elasticity remains significant at the 1% confidence level.

These findings prove robust to a number of different specifications. We perform the above regression in level changes rather than log changes and using weekly data instead of daily quotes (not reported). These results are in line with what we report above. Furthermore, we estimate Equation (I) with two alternative dependent variables: the log change in an insurer's

stock price and in an insurer's expected default frequency (EDF).[21] The results are reported in Table 3.3 and confirm our findings based on CDS spreads. An increase in domestic sovereign risk is associated with a decrease in the insurer stock price and an increase in the EDF.[22] Finally, we extend our time period to include data from 1 January 2006 onwards so as not to focus exclusively on the crisis period.[23] The coefficient on home sovereign CDS becomes slightly smaller when pre-crisis data are included, but remains positively significant at the 1% level (not reported). We test for differences in risk transmission over time in Section 3.4.4.

IV Estimation

An econometric concern may arise in the presence of reverse causality. Equation (I) is a reduced form regression, which yields the "true" causal effect of sovereigns on insurers only if there is no reverse causality, i.e. no effect of insurance companies on both sovereign risk and banking system risk. There are a number of a priori reasons why reverse causality would not be expected to be a concern in this specific context.

First, traditional insurance companies have not featured prominently in the debate on government solvency. The insolvency of Equitable Life (UK) in 2000, for instance, is seen as an example of how policyholders can incur considerable losses without a subsequent need for state intervention. Empirically, Billio et al. (2013) provide evidence on the Granger causality relations between sovereigns, banks and insurers, suggesting that the predictive power of insurer risk for sovereign risk is far weaker than the opposite relation from sovereigns to insurers.

Second, our dependent variable is measured at the micro level. We consider individual insurance companies which are less likely to impact the macro level, such as the overall banking system and the sovereign.

Finally, we perform instrumental variables regressions to test the robustness of our results. Following Bedendo and Colla (2013), we use average foreign sovereign risk as the instrument for domestic sovereign risk and, similarly, foreign banking system risk as the instrument for domestic banking system risk. This eliminates the concern that our observed link between insurers and sovereigns is due to implicit guarantees by their home governments. Our

[21] We use Moody's KMV EDF over a one-year horizon as a measure of the probability that a company will default within the next year.
[22] In this regression, we exclude the domestic stock index as an explanatory variable, as it often bundles the respective insurer stock prices into a single element.
[23] Owing to liquidity concerns regarding the CDS market prior to 2008, we use the extended time series as a robustness check only.

instrument is the average risk in the largest sovereign bond markets and banking systems.[24] This instrument is relevant since foreign risks are correlated with domestic risks through contagion effects on the sovereign and banking CDS markets. F-statistics in the first stage regressions are highly significant and weak identification tests, as proposed by Angrist and Pischke (2010), confirm the relevance of our instruments above the conventional threshold.

Our instrument would be invalid if there was reverse causality running from insurers to foreign sovereigns, most notably through their foreign sovereign bond holdings. However, reverse causality is unlikely to bias our results in this case, since individual insurers hold only a small share of outstanding foreign sovereign bonds. AXA holds the largest market share, it has 4% of Irish sovereign bonds in one quarter. Insurers are hence not expected to cause fluctuations in the *foreign* sovereign bond market. We perform overidentification tests to corroborate the argument. We include the interbank lending rate to satisfy the overidentification restriction.[25] The overidentification test is not rejected at the 5% significance level. We can, thus, be more confident that our IV estimates identify the transmission effect.

Another concern is that our instrumental variable approach will give a combined "reduced form" effect of the portfolio channel and the risk transmission channel. This is because insurers are affected directly by foreign sovereign risk through their bond holdings. As an additional robustness test, we use alternative instruments. First, we use a weighted measure of foreign sovereign risk that downweights the sovereigns to which an insurer is exposed directly. Second, we use a measure of political uncertainty as reflected in Google searches for the term "*country* government".[26] Both instruments plausibly do not affect insurer risk directly. Owing to data availability (e.g. portfolio data), we have to run these additional tests on a reduced sample and thus standard errors increase. Point estimates for home sovereign risk in the second stage remain very similar, albeit not always significant. A final concern is omitted variable bias. General market risk sentiment or shocks to global economic output may impact foreign sovereign risk and insurer risk simultaneously. Therefore, we explicitly control

[24] For sovereign bonds, these are US, JP, DE, IT, FR, UK, ES, CA, NL KR. In terms of banking systems, we take those of the largest non-developing countries, namely US, CA, BE, CH, DE, FR, UK, IT, NL, ES, JP and AU.

[25] Since short-term liquidity is less of a concern for insurers, movements in this rate should not affect the solvability of insurers directly. It does, however, have considerable effects on banks' funding costs and, thus, on bank default risk.

[26] To measure political uncertainty we collate Google searches for the term "country government" using Google Stats. During periods of high political uncertainty, the number of search queries rises. This allows us to construct a country-specific high frequency dataset of political risks. The search data are available at weekly frequency. We thus run the regressions at the weekly level.

for stock index volatility and stock index developments in order to capture these common factors.

Table 3.4 reports the results of the instrumental variables regression. As in the OLS regressions, we find that domestic sovereign risk has a strong and significant effect on insurers. This also holds true if we introduce the interbank rate as an additional instrument (column 4).

One interesting finding is that the coefficient of interest on domestic sovereign risk increases in IV estimation relative to our OLS estimates: it is twice as large as in the baseline column 3 of Table 3.2. At the same time, the effect emanating from the banking system also increases, while the effect assigned to wider market developments decreases substantially.

The changes in coefficients relative to the OLS setting are in line with a negative effect of insurers on sovereigns and banks in the structural equation. This implies that our reduced form regression above *underestimates* the effect which sovereign risk has on insurers. One interpretation is that insurers absorb risks by providing stable liquidity in times of market stress (see Bank of England, 2014, for an illustration of this point).

Overall, our robustness tests confirm that home sovereign risk plays an important role in insurance industry risk.

3.4.2 Are insurers different to banks and non-financial firms?

Sovereign default risk can create problems for any private sector firm, not just insurance companies. We would, therefore, like to know whether insurers are special when it comes to sovereign risk.

We re-estimate specification (I) for insurers, banks and non-financial firms from the same nine countries (Belgium, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States) and over the same time period between 1 January 2008 and 1 May 2013. As we include bank risk as a dependent variable, we no longer control for average banking system CDS on the right-hand side in order to avoid correlation by construction. All other variable definitions remain the same as described in Section 3.3.

Table 3.5 reports the results of these regressions. In the pooled regression (column 1), the sovereign risk estimate is about 0.08 and highly statistically significant. We, thus, conclude that there is risk transmission from the domestic sovereign to private firms in general. This average effect disguises substantial differences across industries, however. In column 2, we

use insurance companies as a baseline category and introduce interaction effects between domestic sovereign risk and an identifier for banks and non-financial firms, respectively. Column 2 of Table 3.5 shows that risk transmission to non-financial firms is significantly lower than transmission to the insurance sector. This finding is not driven by specific non-financial sectors. In column 3, we use a more detailed breakdown by sector and find that insurers are more affected than any non-financial sector. In terms of economic magnitude, domestic sovereign risk has an impact on insurers which is about twice as large (coefficient = 0.130) as that on non-financial firms (coefficient = 0.130 [baseline effect] - 0.066 [interaction effect] = 0.064; see column 2 of Table 3.5).

In a comparison between banks and insurers, we do not find a significant difference in these financial institutions' vulnerability to sovereign risk (see insignificant coefficient of 0.011 in column 2 of Table 3.5). Given the importance of sovereign bonds for bank funding (see, for example, Correa et al., 2014; International Monetary Fund, 2012) and the value of implicit state guarantees for banks, one might have expected banks to be more vulnerable than insurers. However, insurers also rely on sovereign bonds as collateral for swaps and they hold a larger share of their assets in sovereign bonds than banks do.

In column 4, we add time fixed effects to account for common developments across firms and the results still hold.

Overall, we find that banks and insurers are affected to a similar degree by domestic sovereign risk, while non-financial firms are significantly less affected. In what follows, we analyse the additional transmission channels that explain this gap between insurers and non-financial firms.

3.4.3 Taking a closer look at risk transmission channels

In this section, we test for the transmission channels from sovereign risk to the insurance sector which were discussed in Section 3.2 and which may explain the greater vulnerability of insurers compared with non-financial firms. We start with a description of insurers' sovereign bond portfolios. We then formally test the importance of the portfolio channel using the sovereign bond portfolio figures published by J.P. Morgan. These are available only from Q4 2009 to Q1 2013, and for 16 European insurers. We, therefore, perform the subsequent analysis with this reduced sample.

Descriptive facts concerning insurers' sovereign portfolios

Overall, sovereign bond investments play a sizeable and increasing role in the balance sheets of European insurance companies, amounting to around 22% of total assets in Q1 2013 (see Figure 3.2), which is significantly more than in the balance sheets of European banks (approximately 11% of total assets, source: EBA 2011).

Interestingly, the heterogeneity between countries is high. At the country level, the average importance of sovereign bonds is lowest for Dutch and UK insurers at 10% of total assets and highest for Italian and Belgian insurers at 35% of total assets. There is also within-country heterogeneity between insurers. We make use of this in the regressions.

The importance of **home** sovereign bonds in insurers' balance sheets stands out when considering their sovereign bond portfolios (see Figure 3.2): domestic sovereign bonds are the most important item, with an average share of 33%. If there were no home bias in sovereign bond portfolios, we would expect the *average* share of domestic sovereign bonds to equal 1/number of sovereigns j = 1/11, i.e. 9%. Taking unweighted averages across all countries should mitigate the size effects of different countries, which could impact their weight in the sovereign portfolio.

We take a closer look at diversification in insurers' sovereign bond portfolios given the strong home bias. To measure portfolio concentration, we use the Herfindahl-Hirschman-Index (HHI). The HHI is calculated as the sum of the squared shares of sovereign j in the total sovereign portfolio. In our case, the index can, in theory, range from 0.09 (perfectly diversified) to 1 (completely concentrated).[27] The average concentration index increased continuously, from 0.3 in Q4 2009 to 0.4 in Q1 2013. Moreover, heterogeneity is high as the HHI ranges from 0.2 (10% quantile) to 0.9 (90% quantile) in Q1 2013.

One remarkable event within our sample period is the restructuring of Greek debt in early 2012. This induced losses on the part of private investors, including insurance companies. US insurance companies, for instance, realized losses amounting to $859.5 million due to the Greek bond exchange (NAIC, 2013). Before turning to the econometric analysis of the portfolio channel, we take a first descriptive look at whether the market differentiated between insurers with and insurers without exposure to the Greek sovereign. Figure 3.3 shows that the market charged higher CDS premiums for those insurers that had a high exposure to

[27] We have exposure information for 11 sovereigns; the HHI may lie between 0.09 (equal shares for all sovereigns) and 1 (full concentration on only one sovereign)

the Greek sovereign at the time of the restructuring event. The CDS price for the highly exposed insurers increased markedly from mid-2011 onwards and became more volatile than that of the other insurers. However, in the period of the restructuring announcement, the highly exposed insurers' risk decreased. This descriptive analysis does not take into account any determinants of insurer risk other than Greek debt exposures. We next turn to the empirical analysis of the portfolio channel's impact on changes in insurer risk.

Testing the portfolio channel

To test the portfolio channel of sovereign risk transmission, we estimate Equation (II). In Table 3.6, column 1 shows that an insurer's default risk increases significantly with growing riskiness in the sovereign bond portfolio. In column 2, we include country-time fixed effects to check the robustness of this finding. These two-way fixed effects capture the unconditional effect of domestic sovereign risk and all other macro variables on insurers, but the impact of sovereign portfolio risk can still be estimated since it is insurer-specific. Importantly, the portfolio channel remains significant.

Overall, the results confirm that the market takes account of the investment risk in an insurer's balance sheet or, more specifically, the credit risk involved in sovereign bond holdings. The major insurance regulations, such as Solvency I in Europe, have not acknowledged these connections. The traditional regulatory view is that insurance risk is driven by insurance policy-related risk on the liability side and not asset-related risk (Schinasi, 2005, page 266). The introduction of Solvency II in 2016 changed the regulatory treatment of investment risk in Europe. Our results underline the importance of taking asset risk into account. Our findings highlight the fact that sovereign bonds cannot be considered to be risk free. However, sovereign bonds issued by EU countries remain largely exempt from capital requirements under Solvency II.

In column 3, we split the overall sovereign bond portfolio into its domestic and foreign parts. The domestic part is measured as the home sovereign bond holding share of total assets multiplied by the home sovereign CDS; its coefficient is positive but insignificant. The finding that larger home sovereign bond holdings do not significantly increase an insurer's default risk is surprising at first. However, it may simply reflect the fact that the sample covers mainly insurers from stable countries where domestic sovereign risk does not vary very much. Ideally, we would have included a greater number of insurers from countries that experienced a sovereign debt crisis, such as Greece, Ireland or Portugal, but no CDS and/or portfolio data were available for insurers from those countries. Thus, Italy is the only stressed

country included in this regression and relatively stable countries, such as Germany, the UK and Switzerland, dominate the sample. In line with this explanation, we find that foreign sovereign bond holdings, which include bonds from stable countries as well as from countries in crisis, are an important driver of insurer default risk. Increases in the riskiness of the foreign sovereign bond portfolio significantly amplify an insurer's default risk. Sovereign risk thus spills over internationally through insurers' cross-border sovereign bond holdings.

Implicit government guarantees

In Table 3.5, we show that, on average, insurers are more susceptible to domestic sovereign risk than non-financial firms are. In the previous section, we rejected the hypothesis that insurers' holdings of domestic sovereign bonds are an explanation for why insurers are more vulnerable to domestic sovereign risk. Next, we test whether the nexus between the insurance sector and sovereign risk is stronger for certain types of insurers. In column 4 of Table 3.6, we differentiate between insurers that have been classified as systemically important by the Financial Stability Board in July 2013 (FSB, 2013) and those who have not. The FSB based its decision regarding the systemic importance of insurers on five criteria (size, global activity, interconnectedness, non-traditional and non-insurance activities and substitutability; see IAIS, 2013). It should be noted that the FSB's decision was taken after the end of our sample period. We, thus, do not test for the effect of the announcement. Instead, we analyse whether the systemically important insurance companies' CDS spreads reacted more sensitively to sovereign risk than those of others before the FSB decision was made public. Indeed, the elasticity of insurer risk to sovereign risk is 0.15 percentage points higher for systemically important insurers. This is a substantial difference given the baseline effect of 0.035 (column 4 of Table 3.6). The difference between insurers classified as G-SII and other insurers is not driven by variations in their sovereign bond exposures, however, as we simultaneously control for the riskiness of their sovereign bond portfolios. As we allow for greater sensitivity to sovereign risk on the part of systemically important insurers, the baseline effect which domestic sovereign risk has on insurer risk (i.e. 0.035, column 4 of Table 3.6) and becomes similar in magnitude to the effect which sovereign risk has on non-financial firms (see column 2 of Table 3.5).

All in all, after controlling for sovereign bond exposure, we find that systemically important insurers are more closely linked to their home sovereign than other insurers are. This is not direct evidence for the existence of implicit guarantees but provides a clue that should be explored further in future research.

3.4.4 Heterogeneity across countries and over time

Our panel dataset, which covers various countries, allows us to test for heterogeneity in the transmission of sovereign risk between countries and over time. The euro area is a special case during our sample period from 2008 until May 2013, since several countries experienced a severe sovereign debt crisis in that time. Therefore, in Table 3.7, we look at the transmission of sovereign risk within the euro area in more detail. Column 1 shows that insurers located in a euro area country were more sensitive to sovereign risk than insurers located in other countries. Next, we study whether the level of sovereign risk plays a role in risk transmission to domestic insurers. We do so by including an interaction effect between the log changes of home sovereign risk and the level of home sovereign risk. The results are presented in column 2 and confirm that the elasticity of insurer risk is higher in the crisis countries than in the relatively safe countries. Thus, the transmission of sovereign risk to insurers is heterogeneous across countries.

Next, we investigate changes in the sovereign-insurer relationship over time. We closely follow Acharya et al. (2014) who study sovereign-banking spillovers during the pre-bailout, bailout and post-bailout periods of the recent financial crisis. We regress insurer risk on domestic sovereign CDS, domestic stock index volatility and domestic banking system CDS, including time fixed effects and standard errors clustered at the company level (specification from Table 3.3 in Acharya et al., 2014). An augmented specification additionally controls for insurer fixed effects and the effects of insurer-specific parameters on domestic stock index volatility and domestic banking system CDS (as in Acharya et al., 2014).

Columns 1 and 2 of Table 3.8 give the results for the pre-bailout period (1 January 2007 to 15 September 2008). Insurer risk is not significantly affected by domestic sovereign risk during this period, which is in line with the findings of Acharya et al. (2014) regarding banks. The bailout period starts on 16 September 2008, when the US government decided to bail out AIG, and runs until 21 October 2008 (following Acharya et al., 2014). In contrast to bank risk (Acharya et al., 2014, Table 3.3, columns 3 and 4), however, insurer risk is not significantly reduced by sovereign risk during the bailout period, but remains insignificant. This arguably shows that the traditional insurers on which we focus did not receive a bailout from their domestic governments. These insurers, thus, did not transfer part of their risk to domestic sovereigns like banks did (Acharya et al., 2014). Finally, the post-bailout period runs from 21 October 2008 to 30 April 2011, for consistency with Acharya et al. (2014); the estimation results are given in columns 5 and 6 of Table 3.8.

In addition to the financial crisis, the European sovereign debt crisis may have affected the relationship between sovereign risk and insurer risk. Bijlsma and Vermeulen (2016) find that Dutch insurers showed a marked flight to quality behavior in their sovereign bond portfolios during the height of the sovereign debt crisis. The flight to quality behavior disappeared, however, after ECB President Mario Draghi's speech in mid-2012, in which he announced that the ECB would do "whatever it takes" to protect the euro within the limits of its mandate. We, thus, look at the post-bailout period in greater detail and focus exclusively on euro area insurers. We distinguish between the post-bailout but pre-sovereign debt crisis period (October 2008 to 2010), the height of the sovereign debt crisis (2010 to mid-2012) and the period following Mario Draghi's speech in London, and the subsequent announcement of outright monetary transactions (OMT) (from 26 July 2012 to May 2013). Column 3 of Table 3.7 shows that the transmission of home sovereign risk to insurer risk in the euro area did not change significantly between these time periods.

Thus, while the market did not price domestic sovereign risk into insurer default risk prior to the financial crisis, sovereign risk has increased insurer CDS since the bailout period and these transmission effects have remained fairly stable since then.

3.5 Conclusion

This chapter finds a strong and highly significant link between sovereign default risk and risks in the insurance sector. Such transmission has been found for a number of different sectors. We document, however, that there are major differences in the various sectors' vulnerability to sovereign risk. Insurers are affected by domestic sovereign risk to a similar extent as banks, but significantly more than non-financial firms.

We investigate why such differences arise and find that sovereign risk has a greater impact on insurance companies which have subsequently been classified as global systemically important insurers by the FSB. This finding suggests that government guarantees may play a bigger role for some insurers.

We also find that the riskiness of the sovereign bond portfolio is an important determinant of an insurer's default risk, even after controlling for country-time fixed effects. As data are available mainly for insurers from relatively stable countries, we find holdings of *foreign* sovereign bonds (which include bonds from crisis countries) to be more important than holdings of domestic sovereign bonds. Thus, sovereign risk spills over internationally through insurers' cross-border bond holdings. We descriptively document a high concentration in

insurers' sovereign bond portfolios as measured by the Herfindahl-Hirschman-Index. The concentration (along with the share of domestic bonds) has increased substantially since the beginning of 2010. Also, heterogeneity between insurers is high, with Italian insurers being particularly exposed to the home sovereign. The incentives behind this home bias may be an interesting avenue for future research.

Finally, we take a more detailed look at heterogeneity across countries and over time. We find that risk transmission to insurers is more prolific in high-risk countries. Similarly, the link between the sovereign and domestic insurers is stronger in the euro area than in other regions. While the market did not price domestic sovereign risk into insurer default risk prior to the financial crisis, it recognized the risk of spillovers after the bailout period; the transmission effects from sovereign to insurers have remained fairly stable since then. Overall, our results underline the fact that sovereign bonds should not be regarded as a risk-free investment. We provide a detailed analysis of how sovereign risk is transmitted to insurer default risk and find the asset portfolio channel to be important. Hence, the market generally takes sovereign bond portfolio risk into account when assessing insurer default risk. Against this backdrop, our results challenge the regulatory treatment of sovereign bonds in most jurisdictions, including the Solvency II regulations in Europe, which exempt EU sovereign bonds from the credit risk and concentration risk modules when calculating the solvency capital requirement. Future research is needed to better understand the investment incentives induced by insurance regulation and their general equilibrium effects.

3.6 References

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Appendix to Chapter 3

3.A Data

List of insurers

ACE Ltd
*Aegon N.V.
*Ageas N.V.
*Allianz AG
Allstate Corp
Aon Corp
*Assicurazioni Generali S p A
*Aviva plc
*AXA
Genworth Financial Inc
Groupe des Assurances Mutuelles Agricoles
*Hannover Re AG
*Legal & Gen Gp plc
Liberty Mutual Group Inc
MetLife Inc
*Munich Re
Old Mutual plc
Prudential Financial Inc
*Prudential PLC
*Royal & Sun Alliance Insurance Group plc
*SCOR
Sompo Japan Insurance Inc
*Standard Life Assurance Co
*Swiss Life Insurance & Pension Co
*Swiss Re Co
*Zurich Insurance Co Ltd

* Relevant information on sovereign bond portfolios is available in the J.P. Morgan Cazenove (2014) dataset

3.B Figures and Tables

Figure 3.1: CDS spreads of insurers and sovereigns
This Figures gives the CDS spread movements of the insurance sector (blue solid line) and the sovereign (red dashed line) in Germany, Italy, the UK, and the USA in the time period from 1 January 2008 to 1 May 2013 in basis points (Source: Markit).

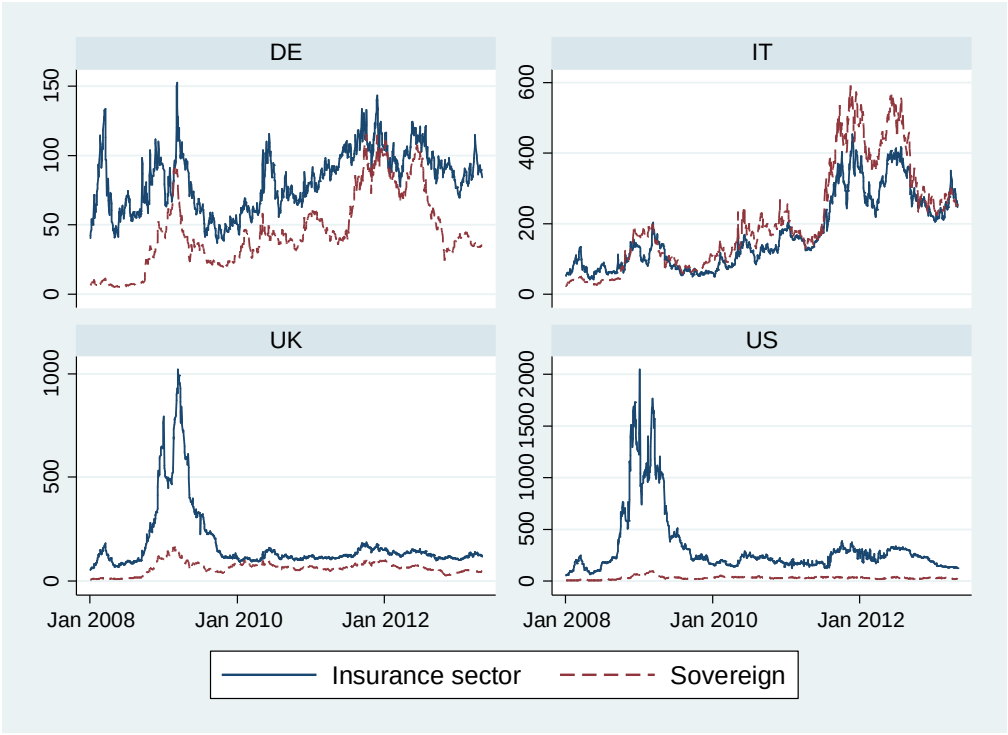

Figure 3.2: Importance of sovereign bond portfolio

This Figure shows goves the share of sovereign bonds to total assets (blue solid line) and domestic sovereign bonds to total assets (red dashed line) of the 16 insurance companies in our sample (unweighted averages) in the time period from 1 October 2009 to 1 May 2013 (Source: J.P. Morgan Cazenove, own calculations).

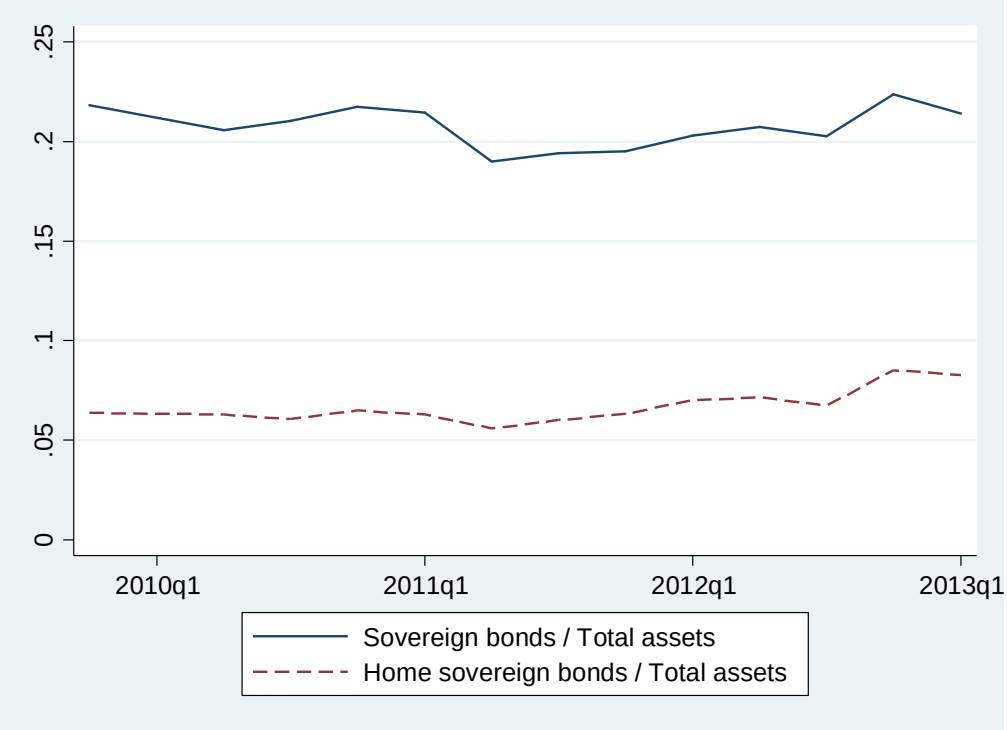

Figure 3.3: CDS spreads of insurers by size of exposure to the Greek sovereign bond restructuring

This Figure gives the CDS spreads of the group of insurers with low exposure to the Greek sovereign (lowest quartile of Greek sovereign exposure to total assets as of Q1 2012) relative to group of insurers with high exposure to the Greek sovereign (highest quartile of Greek sovereign exposure to total assets as of Q1 2012), in basis points. The total sample consists of 16 insurance companies with available portfolio data from J.P. Morgan Cazenove. The red vertical line indicates the Greek bond exchange (Source: Markit).

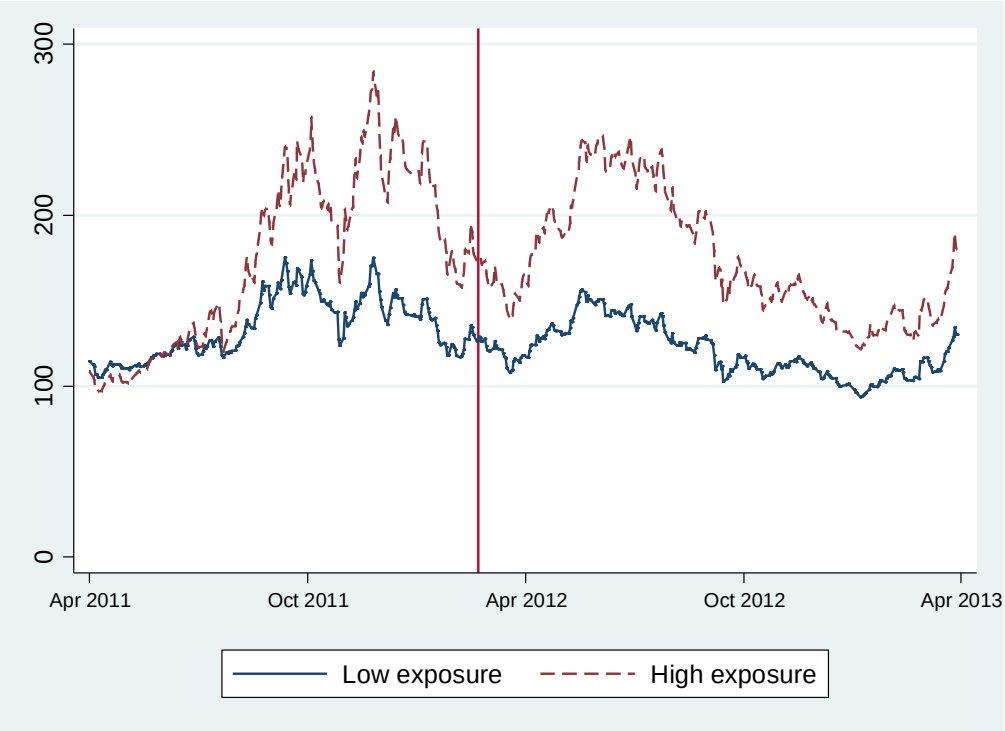

Table 3.1: Summary statistics of variables

Table 3.1 gives descriptive statistics of the estimation sample (left hand side) and the full sample (right hand side) of insurer and country specific variables. Note that variables are not yet transformed into log differences in this Table (like in the regressions) in order to facilitate interpretation of magnitudes. The full sample contains all insurers with traditional business model (excl. financial guarantee insurers and bancassurance companies). Panel a shows the sample of the regressions of insurer risk in Tables 3.2 -3.4 and 3.6-3.7. Panel b shows the sample of regressions on risk of insurers, banks and non-financial firms in Table 3.5. The sample covers the period from 01/01/2008 to 01/05/2013 for panel a and b.

a. Estimations of insurer risk

	Estimation sample			Full sample		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Insurer CDS	30,555	186.07	258.66	35,090	186.27	250.70
Sovereign CDS	30,555	64.48	59.34	34,186	62.90	57.66
Stock index volatility	30,555	24.76	10.23	34,365	25.43	10.65
Stock index	30,555	5591.25	6078.19	34,237	5484.81	6092.39
Banking system CDS	30,555	153.87	70.49	35,090	152.18	70.56
Systemically important dummy	30,555	0.29	0.45	35,090	0.26	0.44
Home sovereign bonds / total assets	10,815	0.06	0.05	11,622	0.06	0.06
Home sovereign bonds (mn EUR)	12,150	20506.73	22160.81	13,224	20055.87	21631.97

b. Are insurers different?

	Estimation sample			Full sample		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
CDS	461,138	223.78	401.73	594,409	264.51	4543.97
of which						
Insurer CDS	*30,588*	*186.13*	*258.58*	*37,163*	*186.19*	*251.72*
Bank CDS	*91,063*	*221.85*	*386.94*	*107,771*	*219.80*	*395.32*
Non-financial firm CDS	*339,487*	*227.69*	*415.80*	*449,475*	*281.88*	*5223.29*
Sovereign CDS	461,138	62.56	60.47	589,222	57.83	56.19
Stock index volatility	461,138	25.35	10.39	581,379	25.89	10.68
Stock index	461,138	5367.12	6417.91	580,106	4843.77	6093.65
Insurer dummy	461,138	0.07		594,409	0.06	
Banks dummy	461,138	0.20		594,409	0.18	
Basic material dummy	461,138	0.09		594,409	0.08	
Consumer goods dummy	461,138	0.16		594,409	0.17	
Consumer services dummy	461,138	0.21		594,409	0.20	
Energy, Oil & gas dummy	461,138	0.03		594,409	0.04	
Health care dummy	461,138	0.04		594,409	0.05	
Industrials dummy	461,138	0.13		594,409	0.14	
Technology dummy	461,138	0.03		594,409	0.03	
Telecommun. Dummy	461,138	0.05		594,409	0.05	

Table 3.2: Baseline regressions explaining changes in insurance risk

Table 3.2 gives regression results for an estimation of the determinants of insurer risk. The log change in insurer *i*'s CDS spread is the dependent variable. All explanatory variables are measured as log changes. Column 4 includes time fixed effects. The sample covers the period from 1 January 2008 to 1 May 2013. Cluster-robust standard errors (clustered at time t) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1)	(2)	(3)	(4)
Home sovereign CDS	0.181***	0.121***	0.063***	0.019***
	(0.015)	(0.012)	(0.007)	(0.006)
Home stock index volatility		0.057***	0.018*	-0.011
		(0.011)	(0.010)	(0.013)
Home stock index		-0.662***	-0.284***	-0.171***
		(0.061)	(0.047)	(0.053)
Home banking system CDS			0.446***	0.164***
			(0.023)	(0.019)
Constant	0.000	0.000	0.000	-0.005***
	(0.001)	(0.001)	(0.000)	(0.001)
Observations	30,555	30,555	30,555	30,555
Number of insurers	26	26	26	26
Time FE	N	N	N	Y
R-squared	0.052	0.141	0.257	0.403

Table 3.3: Regressions with alternative dependent variables

Table 3.3 gives regression results for an estimation of the determinants of insurer performance and risk using alternative dependent variables. The dependent variable is the log change in insurer *i*'s stock price in columns 1 and 2 and the log change in insurer *i*'s expected default frequency (EDF) over a one-year horizon as provided by Moody's KMV. All explanatory variables are measured as log changes. Columns 2 and 4 include time fixed effects. The sample covers the period from 1 January 2008 to 1 May 2013. Cluster-robust standard errors (clustered at time t) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1) Stock price	(2) Stock price	(3) EDF	(4) EDF
Home sovereign CDS	-0.021***	-0.017***	0.020***	0.007*
	(0.005)	(0.004)	(0.004)	(0.004)
Home stock index volatility	-0.178***	-0.132***	0.047***	0.053***
	(0.007)	(0.008)	(0.006)	(0.006)
Home stock index			-0.699***	-0.520***
			(0.028)	(0.037)
Home banking system CDS	-0.149***	-0.083***	0.053***	0.031***
	(0.015)	(0.016)	(0.009)	(0.012)
Constant	-0.000	0.039***	0.000	0.003***
	(0.000)	(0.001)	(0.000)	(0.001)
Observations	39,070	39,070	24,744	24,744
Number of insurers	30	30	23	23
Time FE	N	Y	N	Y
R-squared	0.216	0.394	0.316	0.475

Table 3.4: Instrumental variables regression explaining changes in insurance risk

Table 3.4 gives instrumented variables regression results for estimating the determinants of insurer risk. The log change of insurer *i*'s CDS spread is the dependent variable in the second stage (Column 1 and 4). Home sovereign CDS and home banking CDS are both instrumented by average foreign sovereign and banking system CDS in Column 2 and 3. In Column 4 we additionally include the interbank rate as instrument and report only the second stage results for the sake of brevity. All explanatory variables are measured in log changes. The sample covers the period from 01/01/2008 to 01/05/2013. Cluster robust standard errors (clustered at time t) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1) Second Stage	(2) First Stage	(3) First Stage	(4) Second stage, overidentified
	Insurer CDS	Home sovereign CDS	Home banking system CDS	Insurer CDS
Home sovereign CDS	0.153***			0.223***
	(0.055)			(0.077)
Home banking system CDS	0.721***			0.678***
	(0.050)			(0.063)
Average of foreign sovereign CDS		0.041***	0.002	
		(0.015)	(0.002)	
Average of foreign bank CDS		0.498***	0.868***	
		(0.042)	(0.021)	
Stock index volatility	-0.013	0.011	0.030***	-0.012
	(0.011)	(0.015)	(0.010)	(0.011)
Home stock index	0.022	-0.279***	-0.278***	0.029
	(0.052)	(0.063)	(0.046)	(0.051)
Constant	-0.000	0.001	-0.000	-0.000
	(0.000)	(0.001)	(0.000)	(0.000)
Observations	30,455	30,455	30,455	30,315
Number of insurers	26	26	26	26
R-squared	0.209	0.123	0.561	0.190

Table 3.5: Are insurers different?

Table 3.5 gives regression results for an estimation of sovereign risk transmission to insurers, banks and non-financial firms. The log change in company *i*'s CDS spread is the dependent variable. All explanatory variables are measured as log changes. Column 1 gives the pooled effect of domestic sovereign risk. In columns 2 to 4, the insurance sector is the omitted category and reflected in the baseline effect of sovereign risk. The sample covers the period from1 January 2008 to 1 May 2013. Column 3 gives a detailed breakdown into non-financial sectors. Column 4 includes day fixed effects. Cluster-robust standard errors (clustered at time t) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1) Aggregate view	(2) Sectoral breakdown	(3) Disaggregate breakdown	(4) Disaggregate breakdown
Home sovereign CDS	0.082***	0.130***	0.130***	0.056***
	(0.008)	(0.012)	(0.012)	(0.007)
Home stock index volatility	0.053***	0.054***	0.054***	0.015**
	(0.007)	(0.007)	(0.007)	(0.007)
Home stock index	-0.544***	-0.539***	-0.538***	-0.217***
	(0.039)	(0.038)	(0.038)	(0.027)
Banks *home sov CDS		0.011	0.011	0.007
		(0.009)	(0.009)	(0.008)
Real sector *home sov CDS		-0.066***		
		(0.008)		
Basic materials *home sov CDS			-0.051***	-0.051***
			(0.008)	(0.008)
Consumer goods *home sov CDS			-0.063***	-0.063***
			(0.008)	(0.008)
Consumer services *home sov CDS			-0.074***	-0.065***
			(0.008)	(0.007)
Energy, oil & gas *home sov CDS			-0.083***	-0.062***
			(0.008)	(0.007)
Health care *home sov CDS			-0.092***	-0.065***
			(0.009)	(0.008)
Industrials *home sov CDS			-0.048***	-0.051***
			(0.007)	(0.007)
Technology *home sov CDS			-0.086***	-0.069***
			(0.010)	(0.009)
Telecom. *home sov CDS			-0.054***	-0.050***
			(0.008)	(0.008)
Constant	0.000	0.000	0.000	-0.017***
	(0.000)	(0.001)	(0.001)	(0.000)
Observations	461,138	461,138	461,138	461,138
Time FE	N	N	N	Y
Number of firms	393	393	393	393
R-squared	0.123	0.125	0.125	0.286

Table 3.6: Regressions explaining transmission channels

Table 3.6 gives regression results for an estimation of the transmission channels from sovereign risk to insurer risk. The log change in insurer *i*'s CDS spread is the dependent variable. All explanatory variables are measured as log changes. The exposure and portfolio variables are measured as shares relative to total assets and are drawn from J.P. Morgan publications. An insurer is a G-SII if the FSB has classified it as being systemically important. The sample covers the period from 1 October 2009 to 1 May 2013 and includes 16 large European insurers. Country-time fixed effects are introduced in column 2. Cluster-robust standard errors (clustered at time t) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1)	(2)	(3)	(4)
	Overall sovereign portfolio	Country-time FE	Home and foreign sovereign exposure	Systemic relevance
Home sovereign CDS	0.081***		0.101***	0.035**
	(0.018)		(0.023)	(0.015)
Stock index volatility	0.015		0.013	0.020*
	(0.012)		(0.012)	(0.011)
Home stock index	-0.382***		-0.389***	-0.365***
	(0.045)		(0.045)	(0.044)
Home banking system CDS	0.426***		0.424***	0.412***
	(0.033)		(0.033)	(0.031)
Riskiness of overall sovereign portfolio	0.488***	0.261***		0.458***
	(0.076)	(0.093)		(0.074)
Exposure to home sovereign * CDS			0.121	
			(0.200)	
Riskiness of foreign sovereign portfolio			0.533***	
			(0.090)	
G-SII insurer * home sovereign CDS				0.151***
				(0.019)
Constant	0.000	0.001***	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)
Observations	10,814	10,814	10,814	10,814
Number of insurers	16	16	16	16
R-squared	0.437	0.862	0.437	0.442

Table 3.7: Heterogeneity across countries and over time

Table 3.7 gives regression results for an estimation of the transmission channels from sovereign risk to insurer risk across countries and over time. The log change in insurer *i*'s CDS spread is the dependent variable. All explanatory variables are measured as log changes. The period "prior to debt crisis" runs from 1 January 2008 to 1 January 2010. The period "height of sovereign debt crisis" is defined as starting on 1 January 2010 and ending with Mario Draghi's speech on 26 July 2012, in which he first announced the OMT and stated that the ECB would "do whatever it takes" (the period thereafter is defined as "post-Draghi speech"). Cluster-robust standard errors (clustered at time t) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1) All countries: euro area effects	(2) All countries: country risk effects	(3) Euro area: time period split
Home sovereign CDS	0.036***	0.047***	0.168***
	(0.007)	(0.009)	(0.029)
Stock index volatility	0.023**	0.020*	0.010
	(0.010)	(0.010)	(0.013)
Home stock index	-0.237***	-0.269***	-0.211***
	(0.047)	(0.049)	(0.045)
Home banking system CDS	0.437***	0.443***	0.507***
	(0.023)	(0.023)	(0.036)
Home sovereign CDS*euro area	0.138***		
	(0.018)		
Home sovereign CDS*level of sovereign CDS		0.038***	
		(0.014)	
Home sovereign CDS * height of sovereign debt crisis			-0.025
			(0.036)
Home sovereign CDS * post- Draghi speech			-0.033
			(0.038)
Constant	0.000	0.000	-0.001
	(0.000)	(0.000)	(0.001)
Observations	30,555	30,555	11,158
Number of insurers	26	26	9
R-squared	0.262	0.258	0.292

Table 3.8: Regressions explaining change in insurance risk following Acharya et al (2014)

Table gives regression results for estimating the determinants of insurer risk following the specification in Table 3.3 of Acharya et al (2014). The log change of insurer i's CDS spread is the dependent variable. All explanatory variables are measured in log changes. Columns (1) to (2) cover the pre-bailout period (1/1/2007 to 9/15/2008), columns (3) to (4) cover the bailout period (9/16/2008 to 10/21/2008), and columns (5) to (6) cover the post-bailout period (10/22/2008 to 04/30/2011). All columns include day fixed effects. Following Acharya et al (2014), Columns (2), (4), and (6) include insurer fixed effects as well as insurer specific parameters for the change in the domestic banking system CDS and the change in the domestic stock market volatility indices (not reported). Cluster robust standard errors (clustered at insurer level) are shown in brackets. ***, **, * = significant at the 1%, 5%, 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Pre-Bailout		AIG-Bailout		Post-Bailout	
Home sovereign CDS	0.013	0.003	0.102	0.112	0.048**	0.040**
	(0.013)	(0.009)	(0.103)	(0.092)	(0.018)	(0.015)
Home stock index volatility	0.003		0.084		-0.018	
	(0.031)		(0.080)		(0.022)	
Home banking system CDS	0.246***		0.184**		0.199***	
	(0.065)		(0.080)		(0.057)	
Constant	0.181	0.189	0.136***	0.105***	0.069**	0.066**
	(0.178)	(0.179)	(0.021)	(0.019)	(0.027)	(0.025)
Observations	7,684	7,684	439	439	14,813	14,813
Number of insurers	23	23	18	18	26	26
Time FE	Y	Y	Y	Y	Y	Y
Insurer FE and interactions	N	Y	N	Y	N	Y
R-squared	0.402	0.437	0.474	0.571	0.344	0.382

Chapter 4: Cross-border spillovers of regulation[1]

4.1 Introduction

In response to the recent financial crisis, numerous and substantial changes have been made to the architecture of the financial system. One key objective is to maintain financial stability by widening the focus of regulation from individual banks to the stability of the financial system as a whole. Prudential instruments can help in achieving this objective. The effectiveness of these instruments for financial stability hinges however on the absence of unintended leakages and spillovers. In integrated financial markets, such as in the German case, this might be a challenge given that banks can circumvent prudential regulation by adapting their global activities.

In this chapter, we analyse how prudential policies implemented in domestic and foreign markets affect German banks' local and global lending behavior. Our study relates to the current policy debate on cross-border effects of regulatory policies and reciprocation. For instance, the European Systemic Risk Board (ESRB), which is the European macroprudential institution, has recently issued recommendations which call for an annual assessment of cross-border effects of national macroprudential measures (ESRB, 2015). We use detailed micro-level data on German banks to study regulatory spillovers across borders in three different dimensions; inward transmission of foreign regulation into Germany due to international activities of German banks, inward transmission through foreign-owned affiliates located in Germany, and outward transmission to foreign countries through foreign lending of German banks and their affiliates.

This analysis is part of the International Banking Research Network (IBRN) project on cross-border regulatory spillovers and follows the methodology described in Buch and Goldberg (2017). The IBRN is a network of several national central banks (NCBs), the Bank for International Settlements (BIS), the European Central Bank (ECB) and the International

[1] Chapter 4 is based on Ohls, J., Pramor, M., and Tonzer, L. (2016) International Banking and Cross-Border Effects of Regulation: Lessons from Germany. Deutsche Bundesbank Discussion Paper Series, 27/2016. The paper has been published in a shorter version as Ohls, J., Pramor, M., and Tonzer, L. (2017) International Banking and Cross-Border Effects of Regulation: Lessons from Germany. *International Journal of Central Banking*, 13 s1, pp.129-162. The copyright of the original article is with the Association of the International Journal of Central Banking.

Monetary Fund (IMF) which seeks to analyse questions regarding global banks' activities.[2] The key advantage of the IBRN is the access to NCBs' high-quality micro-level data combined with the use of up-to date empirical methods and the availability of expert knowledge on the characteristics of national banking systems.

The IBRN's work thus yields, first, relevant results from single-country studies based on a common methodology and performed by the country teams within the network (for a complete list of country studies on regulatory spillovers, see International Journal of Central Banking, Volume 13, Supplement 1, March 2017). This chapter is based on the country study for Germany.

Second, these country-specific results are compared and analysed in a meta-analysis (Buch and Goldberg, 2017). A previous IBRN project focused on the transmission of liquidity risk through banks' international exposures; a summary of the results can be found in Buch and Goldberg (2015).

We use the *External Position* Report of the Deutsche Bundesbank, which gives us detailed micro-level information on German banks' international lending. Data on changes in prudential policies is obtained from the newly established *IBRN Prudential Instruments Database* which includes information on prudential instruments for more than 60 countries over the 2000-2014 period (Cerutti, Correa, Fiorentino, and Segalla, 2017). Furthermore, given that regulatory changes are likely to interact with economic conditions, we control for the business and financial cycles using data provided by the BIS.

The prudential instruments studied in this chapter include general capital requirements, sector-specific capital requirements, loan-to-value ratio limits, reserve requirements (in local and foreign currency), and concentration limits. Thus, we take a broad approach and include micro- and macroprudential instruments as well as monetary policy instruments (i.e. reserve requirements) to study cross-border spillovers of instruments (Buch and Goldberg, 2017). While some of these instruments do not primarily target financial stability, they may affect financial stability through (desired or undesired) spillover effects on banks' lending decisions. Also, the evaluation of these policies may be informative for the analysis of future macroprudential measures. Buch and Goldberg (2017) discuss the expected effects of the instruments under consideration in greater detail.

The common methodology makes use of the international dimension of the data and of bank-level heterogeneity to address potential endogeneity concerns. For one, foreign

[2] For more information on the IBRN please see https://www.newyorkfed.org/IBRN/index.html.

regulation is unlikely to respond to the lending behavior of an individual (German) bank. Furthermore, the identification strategy is based on the variation between banks' balance sheet conditions and on differences in the banks' exposure to regulatory changes through their international lending activities. This variation allows controlling for unobserved heterogeneity at the time and at the country level. In a robustness check, our analysis further controls for loan demand by including country-time fixed effects in the regressions.

The German setting is well suited for an analysis of regulatory spillovers across borders because of the high degree of international activity of German banks. We analyse international loan growth of German-owned banks to 52 foreign countries. These foreign loans amount to 33% of total loans of German banks. Also, Germany hosts 72 affiliates of foreign banks which hold 9% of all German claims. From a German policy perspective, it is important to understand whether and how these foreign-owned banks transmit regulatory changes from their home country into the German market. Finally, German banks enter foreign markets not only through cross-border lending but also through both, foreign branches and foreign subsidiaries. Our data allow us to test whether foreign branches and subsidiaries behave differently to changes in regulation.

While our results provide evidence for international spillovers of prudential instruments, we document that these spillovers are heterogeneous between types of instruments and types of banks. There are five main findings.

First, analyzing the inward transmission of regulatory changes abroad due to foreign exposures of German banks, we find for the average bank that domestic loan growth increases if foreign regulation tightens. This holds specifically for a tightening in capital requirements and loan to value ratios.

Second, foreign-owned affiliates located in Germany contract their loan growth in Germany in response to a policy tightening in their home country. This finding is surprising as one might expect that foreign-owned banks respond to stricter regulation in their home country by increasing lending activities of their foreign affiliates that are not subject to the regulation. However, regulatory pressure can have indirect effects on foreign affiliates located in Germany if their parent bank draws resources from them in order to fulfill tighter requirements in the home country. While there is a substantial heterogeneity between different types of foreign-owned banks, the impact of bank characteristics depends on the regulatory instrument. Overall, the retrenchment from the German lending market is less pronounced for larger banks that are better capitalized and with a higher ratio of illiquid assets to total assets.

Third, for the outward transmission exercise, we find evidence that international loan growth by German banks is negatively affected by stricter regulation in the destination country. However, for most prudential instruments we only find short-run effects that vanish after one quarter. Only in the case of local reserve requirements, we find that a tightening in this instrument significantly reduces loan growth over a longer time horizon. This suggests that local reserve requirements, which have been used mainly by emerging markets in our sample, have been successful in controlling capital inflows from German banks.

Furthermore, we study whether foreign branches and subsidiaries of German banks differ in their responses to changes in the prudential regulation in their host country. Institution-based regulation in the host country usually applies to foreign subsidiaries, while foreign branches are subject to home country regulation. These differences in the treatment of branches compared to subsidiaries in the host country may facilitate regulatory leakages. Our results suggests that foreign subsidiaries are constrained by host country regulation as they reduce loan growth after a tightening in the host country prudential index (as well as in sector-specific capital buffers, loan-to-value-ratios and foreign reserve requirements). Foreign branches, however, do not change their loan growth significantly after a change in host country regulation (except for a negative effect of concentration ratios and a positive contemporaneous effect of the prudential index). In contrast to foreign subsidiaries, marginal effects of a tightening in prudential instruments are positive in the foreign branch sub-sample, but they lack significance.

Finally, we find that business and financial cycles matter for lending decisions. For example, foreign-owned banks located in Germany increase loan growth when the financial cycle in their home country undergoes an upturn. Similarly, German banks increase loan growth to destination countries which experience an upturn in the financial and business cycles. This procyclicality to destination country cycles, however, cannot be found for loan growth by German banks' foreign affiliates that are hosted in these countries.

Our study adds to research on the pattern of German banks' international activities and cross-border spillovers. Buch, Koch, and Koetter (2014), for example, find that more productive German banks are more likely to maintain cross-border activities. In contrast, the propensity to maintain cross-border loans decreases with risk aversion (Duewel, Frey, and Lipponer, 2011). Besides productivity and risk aversion, bank size matters. While a large percentage of German banks are active abroad, only large banks maintain foreign affiliates

(Buch, Koch, and Koetter, 2011a). We include a set of bank control variables based on this literature.

The recent financial crisis has affected banks' international activities.[3] Banks have withdrawn from international markets, with one reason being changes in funding conditions or government interventions (Buch, Neugebauer, and Schroeder, 2013; Kerl and Koch, 2015). Internal capital markets have been one tool to stabilize foreign affiliates' lending activities after the crisis depending on parent banks' characteristics (Frey and Kerl, 2015). Regarding international spillovers, Buch, Koch, and Koetter (2011b) look at the effect of rescue measures implemented in response to the recent financial crisis in the US and Germany and find evidence of spillover effects through foreign affiliates.

This chapter contributes to these studies by focusing on the effects of changes in prudential regulation on German banks' (international) lending activity. We address this issue by exploiting a novel dataset on regulatory changes obtained from Cerutti et al. (2017b), thereby contributing to a relatively new strand of the literature (e.g. Jiménez, Ongena, Peydro, and Saurina Salas, 2012; Aiyar, Calomiris, and Wieladek, 2014). However, studies that evaluate the use and effectiveness of prudential instruments are mostly based on country-level data (IMF 2011; Claessens, Ghosh, and Mihet, 2013). Cerutti, Claessens, and Laeven (2016) study the outcome of a new survey on prudential instruments conducted by the IMF. They find that these instruments tend to be used more in emerging market economies, that their use is linked to the state of the credit and housing markets, and, importantly, that there is evidence for avoidance of these policies by relying more on cross-border borrowing. Evidence at the micro level is scarce and often limited to domestic markets or single instruments (Jiménez et al., 2012; Aiyar et al., 2014). Overall, we find a withdrawal from foreign markets when regulation in the home or foreign market tightens.

The chapter is structured as follows. The following part describes the data and stylized facts regarding international activities of German banks. The third part presents regression results for the analysis of inward and outward transmission of prudential instruments. In addition to the common methodology, we analyse whether adjustments differ for foreign branches and subsidiaries of German banks. The final part concludes the chapter.

[3] For studies on the transmission of shocks through international banks, see, for example, Cetorelli and Goldberg (2011). Bremus and Fratzscher (2015) look at the factors that caused changes in the structure of cross-border capital flows after the recent crisis.

4.2 Data and stylized facts for Germany

4.2.1 Bank-level data

We use confidential data collected by the Deutsche Bundesbank for the *Monthly Balance Sheet Statistics* of banks (BISTA)[4] and for the *External Position Report* (Fiorentino, Koch,and Rudek, 2010). The sample covers the period from Q1:2002 to Q4:2013. Data are available for (i) all banks located in Germany, including foreign-owned subsidiaries, and (ii) German banks' branches and subsidiaries operating abroad. The analysis is conducted at quarterly frequency in order to match the frequency of the regulatory dataset. To aggregate monthly data to quarterly frequency, we use quarter-end values.

Dependent variables

For the dependent variable, we use the change in log outstanding loans multiplied by 100. In the baseline specification, we use total loans; in robustness tests, we exploit the sectoral breakdown and analyse the effect on loans to banks, non-bank private sector, and the public sector separately.

For the inward transmission exercise, we refer to total domestic loans as provided by the *Monthly Balance Sheet Statistics*. This data are available for domestic (German) banks and foreign affiliates located in Germany. [5] For the latter, we can identify the country of the parent bank.

For the outward transmission exercise, we make use of data from the *External Position Report*. All German banks, including their foreign affiliates (branches and subsidiaries), are required to report foreign asset positions, broken down by destination country and asset class. While foreign subsidiaries of German banks have to report their foreign claims individually, foreign branches are aggregated for each German parent bank and host country.[6] Our analysis includes the 52 largest destination countries (in terms of overall claims of the German banking system) and the 92 largest banks (plus their foreign affiliates) in terms of foreign assets. In this way, we cover more than 90% of the German banking system's total foreign loans as of December 2013.

[4] For more information on the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank, please see https://www.bundesbank.de/Redaktion/EN/Standardartikel/Service/Reporting_systems/monthly_balance_sheet_statistics.html?https=1

[5] Please note that foreign affiliates located in Germany are not included in the outward transmission exercise due to data restrictions. In the inward transmission exercise, these banks are only included when specifically analyzing inward transmission through foreign banks located in Germany. We can not differentiate between branches and subsidiaries due to data limitations.

[6] For a comprehensive description of the External Position Report, see Fiorentino, Koch, and Rudek (2010).

We focus on the traditional banking activities such as loans and advances and exclude tradeable claims such as equity and bonds for consistency with the common methodology in the IBRN. Furthermore, loans and advances account for roughly two thirds of German banks' international claims comprised in the External Position Report (Fiorentino et al., 2010) and are more likely to be affected by bank regulation than tradeable assets. Our analysis focuses on the intensive margin, i.e. on loan growth, not on adjustments along the extensive margin. In order to reduce the cases of entries into and exits out of foreign markets in our dataset, we exclude small banks and less relevant destination countries. As a result, 84% of all bank-destination country combinations exist in at least 75% of all quarters.

Regarding the level of consolidation, we proceed as follows. When studying the lending responses of German-owned banks, we use consolidated (parent bank plus foreign branch) data if a German bank owns foreign affiliates but include also banks that lend directly cross-border without having a foreign affiliate. This consolidation choice accounts for the fact that parents and their foreign branches are subject to home country regulation, whereas subsidiaries are subject to host country regulation. We approximate consolidated exposures at the parent-foreign branch level by using the unconsolidated positions of the parent and its foreign branches and a proxy for intrabank flows. This proxy has been used in previous studies with this data (Frey and Kerl, 2015). When studying the lending behavior of foreign-owned affiliates located in Germany, we have to use unconsolidated data due to data constraints but control for internal capital market positions.

To account for outliers we drop observations where log changes of lending exceed 100% in absolute terms. We keep only series for which at least two consecutive observations and at least eight observations in total are available. Qualitatively, our main regression results are not affected by the data cleaning. Summary statistics are provided in Table 4.1.

Balance sheet characteristics

The balance sheet characteristics are taken from the *Monthly Balance Sheet Statistics* (BISTA). To clean the data, we drop observations for which the ratios described below are less than zero or greater than 100%.[7] The balance sheet variables include the illiquid assets ratio, core deposits ratio, capital ratio, net intragroup funding ratio, log of total assets, and international activities ratio. The balance sheet variables are defined as follows, with corresponding summary statistics provided in Table 4.1:

- percentage of a bank's portfolio of assets that is illiquid $\left(IlliquidAssetsRatio_{b,t-1}\right)$
- percentage of a bank's balance sheet financed with core deposits $(CoreDepositsRatio_{b,t-1})$
- percentage of a bank's equity-to-asset ratio $\left(CapitalRatio_{b,t-1}\right)$
- percentage of a bank's net intragroup funding position of headquarters relative to total liabilities $(NetIntragroupFunding_{b,t-1})$
- log of total assets $(LogTotalAssets_{b,t-1})$
- percentage of a bank's foreign assets plus foreign liabilities relative to total assets plus total liabilities $(InternationalRatio_{b,t-1})$

Detailed information on the construction of these variables can be found in Table A1 in the appendix to this chapter.

4.2.2 Data on prudential instruments

To analyse spillovers of regulatory policies, this study draws on the *IBRN Prudential Instruments Database* developed by Cerutti et al. (2017b) which provides quarterly information on changes in prudential instruments plus a composite index for more than 60 countries over the time period 2000-2014.[8] The prudential variables provide information on tightening (coded by 1) and loosening (coded by -1) of a specific instrument in the specific quarter when the change came into effect, and zero otherwise. In this study, we focus on six out of seven instruments to study spillovers of prudential policies: general capital requirements, sector-specific capital requirements, loan-to-value ratio limits, reserve requirements (in local and foreign currency), concentration limits. We exclude interbank

[7] The variable capturing internal capital market positions can be less than zero; we therefore drop values that exceed 100%.
[8] The database is available at https://www.newyorkfed.org/ibrn.

exposures limits from our analysis due to the small number of changes for this instrument in our sample (see Table 4.2).

We use this information in our analysis to control for individual changes in prudential instruments in the home country of foreign banks located in Germany and in the destination country of lending by German banks. We are not analyzing the effects of regulatory changes in Germany on bank lending because we do not observe enough changes in regulatory instruments in Germany over the sample period. Instead, we control for German regulation through time fixed effects. The variables are defined as follows:

Regulation weighted by foreign exposures (= all exposures of the banks *outside* the home country)

$\text{ExpP}_{b,t-l}$ (where $l = 0, 1, 2$) = Foreign exposure-weighted regulation

Home country regulation (home country = country of the foreign parent bank)

$\text{HomeP}_{j,t-l}$ (where $l = 0, 1, 2$) = Home country regulation with 0, 1, and 2 lags

Destination country regulation (destination country = country to which the loan goes)

$\text{DestP}_{j,t-l}$ (where $l = 0, 1, 2$) = Destination country regulation with 0, 1, and 2 lags

See Buch and Goldberg (2017) for more details on the construction of regulatory measures. Table 4.2 provides summary statistics for changes in these instruments. We see that most changes occur for reserve requirements on local and foreign currency deposits followed by capital requirements. A tightening of standards occurred more often than a loosening.

Our sample is rather dominated by advanced economies (60% of the underlying observations in the Inward A and Outward specifications, 90% of the underlying observations in the Inward B specification). However, we observe relatively more regulatory changes in emerging market economies for the regulatory instruments that are significant in the regression analysis. This holds particularly true for foreign and local reserve requirements.

4.2.3 Data on the business and financial cycles

Another part of the dataset focuses on macroeconomic conditions and was provided by the BIS. It allows us to control for the current state of the business (output gap) and financial (credit-to-GDP gap) cycles when assessing regulatory spillovers (BIS 2014; Drehmann, Borio, and Tsatsaronis, 2011). This is important given that changes in regulation often take place in response to economic and financial conditions while their implementation might, in

turn, affect economic outcomes. For example, Cerutti et al. (2017a) analyse a new IMF database on prudential policies for a sample of 119 countries over the 2000-2013 period and establish that the use of these policies is linked to developments in credit and housing markets.

4.2.4 Stylized facts

[Fact 1: The degree of internationalization is heterogeneous across German banks.]

A large percentage of German banks maintain international activities (Buch et al., 2011a). Figure 4.1 shows that German banks have recently increased their foreign loan supply relative to assets (lower left panel), whereas this cannot be observed for domestic lending (upper right panel). On average, German banks are net lenders regarding their intragroup positions (lower right panel). Hence, on average, they distribute liquidity to their foreign subsidiaries rather than absorbing liquidity from them.

The size of international activities of German banks and thus presumably their potential to generate cross-border spillovers of regulation varies with the banks' business models: notably, large German banks conduct a relatively high amount of their business abroad (Fiorentino et al., 2010). Table 4.3 shows correlations of banks' total, domestic, and foreign loan shares with balance sheet characteristics. Besides the relevance of bank size, it can be seen that German banks' capital and core deposits ratios correlate positively with the share of domestic loans to assets, whereas this finding is less pronounced or even reversed for the share of foreign loans to assets. We will therefore test whether banks' balance sheet characteristics affect their responses to regulatory changes abroad and at home (Section 4.3.1).

Heterogeneity in international activities also comes into play if we look at foreign loans by bank group relative to total foreign lending by German banks. For example, in Q3:2013, around 60% of foreign loans granted by German banks can be attributed to the "large commercial banks", around 20% to the "head institutes of savings banks and credit unions", but only 6% to "other commercial banks" and less than 1% to "savings banks and credit unions" (Table 4.4). The average bank size in the latter two banking groups is significantly smaller compared to the former two banking groups, such that the result is consistent with the relevance of bank size for the conduct of international activities (Table 4.5). Furthermore, comparing large commercial banks and head institutes of savings banks and credit unions to banks in the other banking groups reveals that they have, on average, a lower capital ratio and illiquid assets ratio, they are net lenders regarding their intragroup positions and financed to a

lower degree by core deposits. These differences in exposure to foreign activities as well as business models might thus impact the transmission of prudential changes.

[Fact 2: (Inter)national activities of German banks include loans to different sectors.]

Heterogeneity also exists regarding the sectoral breakdown of lending. For example, German banks' domestic loan supply comprises 56 percent of total assets: 14 percent directed to banks, 37 percent to the non-bank private sector (i.e. non-financial firms and households), and 5 percent to the public sector (Table 4.6). If changes in prudential regulation occur, banks' responses might vary depending on the loan type. We analyse this issue further in robustness tests (Section 4.3.1). Also, the sectoral composition of loans differs between types of German banks' foreign affiliates. A relatively high share of local (=foreign) lending by foreign branches is directed toward the non-bank private sector. In contrast, foreign subsidiaries have similar shares of local lending exposures to banks and the non-bank private sector. Both foreign branches and subsidiaries maintain a relatively high share of home country (=domestic) loans to banks, most likely reflecting internal capital market activities.

[Fact 3: Foreign affiliates of German banks include both branches and subsidiaries.]

German banks maintain both foreign subsidiaries and foreign branches in a large number of different counterparty countries. In an extended analysis on the impact of the organizational structure, we cover around 40 destination countries with approximately 170 subsidiaries and 190 aggregates of branches. [9] Foreign subsidiaries are assumed to respond differently to host country regulation than foreign branches. For example, German banks' foreign branches, which are under home country regulation, can expand/reduce their activities compared to domestic banks in the host country if the latter face a tighter/looser regulatory environment. In Section 4.3.2, we thus analyse whether foreign branches respond differently to a tightening or loosening of host country policies compared to foreign subsidiaries of German banks.

[9] Note that, as described in the data section, we do not have data on individual branches but the aggregate of branches per German parent bank and host country. For example, if the German parent bank A has two branches in the US, we have information on the sum of these two branches.

4.3 Empirical methodology and results

This section presents the baseline estimations for inward and outward transmission of prudential instruments (Section 4.3.1). We extend our analysis and ask whether banks adjust their loan growth differently depending on their organizational form in Section 4.3.2.

4.3.1 Baseline analysis of inward and outward transmission of prudential policies

In the following, we provide a description of the baseline empirical model to study inward and outward transmission and comment on the results. The analysis closely follows the approach described in Buch and Goldberg (2017).

In each specification 1 to 3, we include our variable of interest, a prudential policy change, both contemporaneously as well as its two lags. Furthermore, the prudential policy is interacted with banks' balance sheet characteristics showing how banks with different (structural) balance sheet characteristics adjust their loan growth in response to changes in regulation. In regression Tables 4.7 to 4.16, for the sake of brevity, the reported coefficients are the sum of the contemporaneous term and its two lags, with the corresponding p-value of the F-statistics for joint significance in square brackets.

As the prudential instrument enters individually as well as in the interaction effects with bank variables, we calculate a marginal effect (at the average) for both, the contemporaneous changes as well as for the sum of contemporaneous and lagged changes. These marginal effects give the effects of regulation for the average bank and are reported at the bottom of each Table. Baseline regression models include time and bank fixed effects.

Specification 1: **Exposure-weighted inward transmission of regulation** (Table 4.7).

$$\Delta Y_{b,t} = \alpha_0 + (\alpha_1 ExpP_{b,t} + \alpha_2 ExpP_{b,t-1} + \alpha_3 ExpP_{b,t-2}) + a_4 X_{b,t-1} + (\beta_1 ExpP_{b,t} \cdot X_{b,t-1} + \beta_2 ExpP_{b,t-1} \cdot X_{b,t-1} + \beta_3 ExpP_{b,t-2} \cdot X_{b,t-1}) + f_b + f_t + \epsilon_{b,t} \quad (1)$$

where $\Delta Y_{b,t}$ is the log change in the domestic loans of bank b at time t. $X_{b,t-1}$ is a vector of control variables that captures the degree to which a bank is exposed to changes in regulation through ex ante balance sheet composition as described in Section 4.2.1. The prudential policy changes are captured by ExpP, that is an index of exposure-weighted prudential policies outside the home country. We control for time-invariant heterogeneity at the bank level by including bank fixed effects f_b. Time fixed effects f_t capture global developments that affect all banks contemporaneously.

The interaction terms of the prudential instrument with banks' balance sheet characteristics shows how banks with different (structural) balance sheet characteristics adjust their loan growth in response to changes in regulation. As the baseline regression model includes time and bank fixed effects, the coefficient of the interaction term measures how the structure of banks' balance sheets affects the response of bank lending to changes in regulation.

This approach helps with identification in two dimensions. First, we estimate lending responses (i.e. log changes in outstanding loans) at the bank-level with respect to a change in regulatory policies at the country-level. Assuming that an individual bank does not drive adjustments in regulatory policies, this reduces endogeneity concerns. Second, we interact changes in regulatory policies with balance sheet characteristics. Like this, we can account for the fact that banks' reactions to regulatory policy can be heterogeneous depending on their business model. For example, banks' internationalization pattern as well as liquidity and capital buffers might determine to which extent a bank is affected by changes in regulatory instruments.[10]

Results for specification 1 are shown in Table 4.7; we see that the exposure-weighted index of changes in the overall prudential index increases domestic loan growth for the average bank (see marginal effects at the bottom of Table 4.7). While this effect is significant contemporaneously, it becomes insignificant in the medium run, if we add the effects for the first and second lag to a joint effect. One reason for the lack of medium-run effects can be that most of the changes in instruments are clustered in 2012 and 2013. The result on the prudential index is driven by two instruments, capital requirements and loan to value ratios. For the latter, we also see a significant effect for the average bank over current and two lags. In quantitative terms, the current effect of the loan to value ratio is also strongest: Given a tightening of the policy, loan growth rates increase on average by 15.2% which corresponds to an increase of the median loan growth rate (0.27% per quarter) by 0.04 percentage points in that quarter. Loan to value ratios have been used actively by emerging market economies over our sample period and have been both tightened and loosened. This provides a solid ground for the empirical analysis.

Differences in bank characteristics do not seem to consistently affect the response to regulatory changes abroad. The positive effect in case of the prudential index is weakened for banks with higher net intragroup positions; banks' response to a tightening in the instrument is more than four times weaker if the net intragroup funding ratio increases by one standard

[10] For a more detailed discussion about identification issues, see Buch and Goldberg (2016).

deviation. This might be because foreign affiliates have less scope to provide intragroup funding to the German parent bank given tighter regulation.

Specification 2: **Inward transmission of home prudential policy via foreign affiliates** (Table 4.8).

$$\Delta Y_{b,j,t} = \alpha_0 + (\alpha_1 \mathrm{HomeP}_{j,t} + \alpha_2 \mathrm{HomeP}_{j,t-1} + \alpha_3 \mathrm{HomeP}_{j,t-2}) + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 \mathrm{HomeP}_{j,t} \cdot X_{b,t-1} + \beta_2 \mathrm{HomeP}_{j,t-1} \cdot X_{b,t-1} + \beta_3 \mathrm{HomeP}_{j,t-2} \cdot X_{b,t-1}) + f_b + f_t + \epsilon_{b,j,t} \quad (2)$$

where $\Delta Y_{b,t}$ is the log change in the loans to Germany of a foreign affiliate bank b located in Germany with a foreign parent from country j at time t. [11] The vector of bank control variables $X_{b,t-1}$ is the same as above. The prudential policy changes are captured by HomeP, reflecting prudential policy in the home country that is the country of the parent bank of the foreign-owned affiliate located in Germany. $Z_{j,t}$ represents the cycle variables for home country j.

Results on specification (2) are shown in Table 4.8. For the average foreign bank (see marginal effects at the bottom of the Table), home country policy is of importance for sector-specific capital buffers, loan to value ratios and reserve requirements on local currency deposits. The latter two instruments have been used mainly by emerging market countries in our sample. An increase in these instruments reduces the host (i.e. German) loan growth by foreign affiliates located in Germany. The economic magnitude of the current effect is strongest for sector-specific capital buffers: Given a tightening of the policy, on average loan growth rates decrease by 17.4% which corresponds to a decrease in the median loan growth rate (1.43% per quarter) by 0.25 percentage points.

This decrease in loan growth can be caused by foreign parents drawing on resources of their foreign affiliates to fulfill higher reserve or capital requirements and to maintain lending at home. The effect is, for example, less pronounced for illiquid banks which might have less scope to transfer liquidity to their parent bank. Also larger and better-capitalized banks are affected less severely, possibly due to higher buffers which allow them to maintain loan growth. Two conclusions can be drawn from these results. First, especially reductions in loan growth in response to activity based measures like loan to value ratios might be problematic from the perspective of the German regulator in case domestic and foreign financial cycles do

[11] Ideally, we would like to distinguish between foreign-owned affiliates that are subject to German (i.e. host) country regulation and those that are subject to home country regulation. Unfortunately, our data do not allow us to do so. However, regulatory changes in the home country might be important for both types of foreign affiliates due to the internal capital market and the influence of the parent bank.

not coincide. Second, a foreign affiliate located in Germany is not independent from home country regulation, in particular tighter regulation in its parent bank's country does not make it more attractive to increase loan growth in Germany.[12]

Regarding the financial and business cycle, we find that an upswing in the financial cycle of the home country has positive effects on loan growth of foreign affiliates located in Germany. In sum, this suggests that foreign affiliates are not independent of developments in the country in which their parent bank is located. Regulatory changes and macroeconomic developments alike are mirrored in their lending activities within the host country.

Specification 3: Outward transmission of destination country prudential policy (Table 4.9).

$$\Delta Y_{b,j,t} = \alpha_0 + \left(\alpha_1 DestP_{j,t} + \alpha_2 DestP_{j,t-1} + \alpha_3 DestP_{j,t-2}\right) + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + (\beta_1 DestP_{j,t} \cdot X_{b,t-1} + \beta_2 DestP_{j,t-1} \cdot X_{b,t-1} + \beta_3 DestP_{j,t-2} \cdot X_{b,t-1}) + f_j + f_t + f_b + \varepsilon_{b,j,t} \quad (3)$$

where $\Delta Y_{b,j,t}$ is the log change in the loans of a German bank b to a foreign country j at time t. The prudential policy changes are captured by DestP, reflecting prudential changes in the destination country j of the loan by bank b. All other variables are defined in parallel to specifications (2) and (3). Again we interpret the effect of the regulatory index by computing its marginal effect for the average bank.

Results in Table 4.9 reveal that a tightening in the prudential index of the destination country reduces loan growth of the average German bank to this country. Hence, stricter policies in the destination country spill over to German banks even though these are not always directly subject to the change in regulation. The significant result for the prudential index is driven in particular by changes in reserve requirements. For local reserve requirements, banks do not only react in the short-run as can be observed for the prudential index, the concentration ratio or foreign reserve requirements. Also, the cumulated effect over the current and following two quarters is negative and significant. Our results thus suggest that reserve requirements which have been used mostly by emerging market countries, have indeed been successful in dampening lending inflows. An increase in reserve requirements imposes additional costs on funding, which might in turn be passed on to borrowers by

[12] Interestingly, a tightening in concentration ratios in the home market has the opposite effect, namely an increase in loan growth to the host (i.e. German) market. With tighter concentration ratios, banks might seek to increase diversification across regions. However, changes in this instrument go back to only two countries (the Netherlands and France) such that these results should be taken with care.

increasing loan rates and hence dampening credit growth. To simultaneously reduce the country's attractiveness for foreign capital inflows, an increase in reserve requirements can be accompanied by expansive monetary policy, which translates into lower returns for foreign investors.

A tightening of local reserve requirements relates on average to a short-run decline in loan growth rates by 0.41 percentage points. The negative effect is smaller for banks with more liquid assets, possibly because holding the required reserves may be less costly for these banks, but reinforced for banks that obtain higher net intragroup funding.

Finally, macroeconomic developments in the destination country matter for German banks' international loan portfolio. An upturn in the business and financial cycles causes a positive response in loan growth. This suggests that German banks expand across borders during economic and financial upswings in the respective destination country.

Robustness tests

We test the robustness of our results to including country-time fixed effects. They control for unobserved time-varying factors at the destination country level such as demand effects. With destination country-time fixed effects we are no longer able to estimate the unconditional impact of regulatory changes on bank lending, but can still identify the bank-specific effects of regulatory changes based on the interactions effects. The results are robust (Table 4.10).

A second robustness tests exploits the granularity of our data and conducts regressions in which the dependent variable is broken down by loans to banks, to the non-bank private sector, and the public sector. The sector breakdown shows that responses to prudential measures vary across loan sectors and specifications which might explain why we observe only few significant results for total loan growth. For inward transmission through foreign exposures, our results are strongest for loan growth to banks and less pronounced to the non-bank private sector (Tables 4.11-4.12). Loan growth to the public sector in Germany is negatively affected by a tightening in reserve requirements (local and foreign currency) in foreign countries (Table 4.13). For outward transmission, the negative effect of a tightening in local-currency reserve requirements on German banks' total international lending is confirmed contemporaneously and in the medium run for loan growth towards the non-bank private sector, as well as in the short-run towards the bank sector (Tables 4.14-4.15).

Finally, we test the robustness of our results to excluding small exposures of a bank to a foreign country as this might reflect idiosyncratic business outside the scope of our model

(not reported). Results remain robust when we exclude the 1% or 5% smallest destination country-bank positions and when we change the clustering of the standard errors.

4.3.2 Exploration of the banks‘ organizational structure

This Section explores whether foreign affiliates differ in their lending behavior in response to prudential instruments due to their organizational form. We focus on outward transmission distinguish between lending by foreign subsidiaries and by foreign branches of German banks. Foreign branches and subsidiaries might be affected differently by changes in prudential instruments in the home and the host country (Danisewicz, Reinhardt, and Sowerbutts, 2015). For institution-based instruments, such as capital requirements or concentration limits, branches tend to be subject to home country regulation whereas subsidiaries have to comply with host country regulation. We use this variation across bank and instrument types to analyse banks' differential responses.

Our approach is similar to specification (3) but the sample pools across foreign branches and foreign subsidiaries of German banks. This reduces our sample size relative to Table 4.9 as we exclude all banks that do not own foreign affiliates but only lend cross-border. We allow for heterogeneous effects of cycle variables, of regulation and of the interaction of regulation with bank variables by interacting them with an indicator variable that equals one in case of a foreign subsidiary. At the bottom of Table 4.16, we report the marginal effects of the prudential instruments for branches and subsidiaries, where the latter consists of the joint effect of the baseline category (=branch) plus the interaction effect.

We find that the average foreign subsidiary reduces loan growth contemporaneously following a tightening in the prudential index, sector-specific capital buffers and loan to value ratios. A tightening in foreign reserve requirements leads to a reduction in loan growth of foreign subsidiaries in the medium run. While foreign subsidiaries are thus constrained by host country regulation, we only find weaker evidence for foreign branches. A tightening in concentration ratios leads to a reduction in loan growth in the short run, while a tightening in the prudential index leads to an increase in loan growth in the medium run (finding significant at 10% level only). Bank characteristics other than the organizational structure seem to play a less important role in the response of foreign affiliates to regulatory changes. Overall, we find that foreign subsidiaries react more strongly to host country regulation. Foreign branches do not generate regulatory leakages by increasing loan growth after a tightening in host country regulation.

4.4 Conclusion

Global banks may generate cross-border spillovers of the regulatory stance if they adjust their international loan portfolio in response to foreign and domestic regulation. While prudential instruments like reserve requirements or loan to value ratios have mostly been implemented by emerging market countries, in recent times also advanced countries increase their macroprudential toolkit to target financial stability. For countries like Germany with a highly internationalized banking system, concerns about regulatory spillovers are a topic of utmost importance. Therefore policy discussions and coordination are conducted at the European level at the ESRB. This macroprudential body has recently recommended monitoring cross-border effects of macroprudential instruments on an annual basis (ESRB 2015). Our study may inform this current policy debate by analyzing the inward and outward transmission of regulation for German banks.

Overall, while we find evidence for cross-border spillovers of regulation, there is no general conclusion that holds for all types of policy instruments and banks. Instead, heterogeneity between banks, loan types and specification matters.

Foreign regulatory changes spill over to loan growth in Germany through both, foreign-owned banks located in Germany as well as German-owned banks which maintain international activities. Foreign-owned banks located in Germany reduce their local loan growth following a tightening of sector-specific capital buffers, local reserve requirements and loan to value ratios in their parent bank's country. This finding suggests that regulatory pressure can have indirect effects on foreign affiliates located in Germany if their parent bank draws resources from them in order to fulfill tighter requirements in the home country. German-owned banks also transmit changes in foreign countries' regulatory stance to German borrowers. A tightening of foreign regulation leads to an increase in domestic loan growth.

Furthermore, we find that German banks reduce foreign loan growth given a tightening in prudential instruments in the destination country. However, these negative responses abate rather quickly, except for local reserve requirements. Thus, our results suggest that reserve requirements have been effective in dampening lending inflows by German banks into foreign economies.

Finally, transmission occurs not only because of regulatory changes but also because of economic developments. This is reflected by the fact that business and financial cycles matter for lending decisions: foreign subsidiaries located in Germany increase loan growth in the

host country in response to an upturn in the financial cycle of their home country. Also, German banks' international lending behavior is procyclical in the sense that loan growth increases in response to an upturn in the financial and business cycles of the destination country.

4.5 References

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Appendix to Chapter 4

4.A Data

Data Description

To analyse the effect of changes in prudential instruments on banks' international activities, we use three main data sources. First, bank-specific data are obtained from the Deutsche Bundesbank. Second, information on prudential instruments come from the "IBRN Prudential Instruments Database" introduced in Cerutti et al. (2017a). Variables on the business and financial cycle are provided by the Bank for International Settlements (BIS).

External position report

Since 2003, all German banks have been required to report their foreign assets and liabilities (in thousands of euro) on a monthly basis and broken down by sector, destination country, and asset class. Foreign subsidiaries of German banks provide a report on their external positions by entity whereas foreign branches of German banks located in the same host country provide a joint report. A detailed description of the reporting can be found in Fiorentino et al. (2010). Table A1 in the Appendix provides information on the variables used in this chapter.

Macroeconomic variables

Prudential instruments: Data are obtained from Cerutti et al. (2017a) and available for more than 60 countries over the period 2000-2014. The instruments in the database include sector-specific capital requirements (i.e. real state credit, consumer credit, and other), countercyclical capital buffers, interbank exposure limits, concentration limits, loan-to-value ratio limits, general capital requirements, and reserve requirements. A tightening is coded by 1, a loosening by -1, and zero otherwise.

Business cycle: The state of the business cycle is approximated by the output gap (BIS 2014).

Financial cycle: The state of the financial cycle is estimated by the credit-to-GDP gap (BIS 2014).

Construction of Balance Sheet Variables

Independent Variables		
Variable Name	**Description**	**Data Source**
Illiquid Assets Ratio	(Loans and advances to banks plus loans and advances to non-banks, including received bills) / Assets (in %)	Monthly balance sheet statistics (Deutsche Bundesbank)
Core Deposits Ratio	Savings deposits / Assets (in %)	Monthly balance sheet statistics (Deutsche Bundesbank)
Capital Ratio	Equity capital / Assets (in %)	Monthly balance sheet statistics (Deutsche Bundesbank)
Net Intragroup Funding	(Liabilities minus claims of the parent bank vis-à-vis foreign affiliates, summed across all affiliates per parent bank)/Liabilities (in %)	Monthly balance sheet statistics (Deutsche Bundesbank)
Log Total Assets	Log (balance sheet total)	Monthly balance sheet statistics (Deutsche Bundesbank)
International Activity Ratio	(Foreign assets plus foreign liabilities) / (Total assets plus total liabilities) (in %)	Monthly balance sheet statistics (Deutsche Bundesbank)

4.B Figures and Tables

Figure 4.1: Domestic and Foreign Lending Activities of German Banks

This Figure gives the evolution of German banks' loan supply. Data are observed quarterly from Q1:2002-Q4:2013. The figure shows unweighted averages across the sample of German bank holding companies. Descriptive statistics are shown for banks' loan-to-asset ratios (in %), the breakdown into domestic versus foreign loans to assets (in %) as well as the net intragroup funding (net due) variable that measures, from the perspective of a bank's headquarters, total net internal borrowing, that is liabilities minus claims of the parent bank vis-à-vis all foreign affiliates of the parent bank relative to total liabilities (in %) (Source: Deutsche Bundesbank Monthly Balance Sheet Statistic).

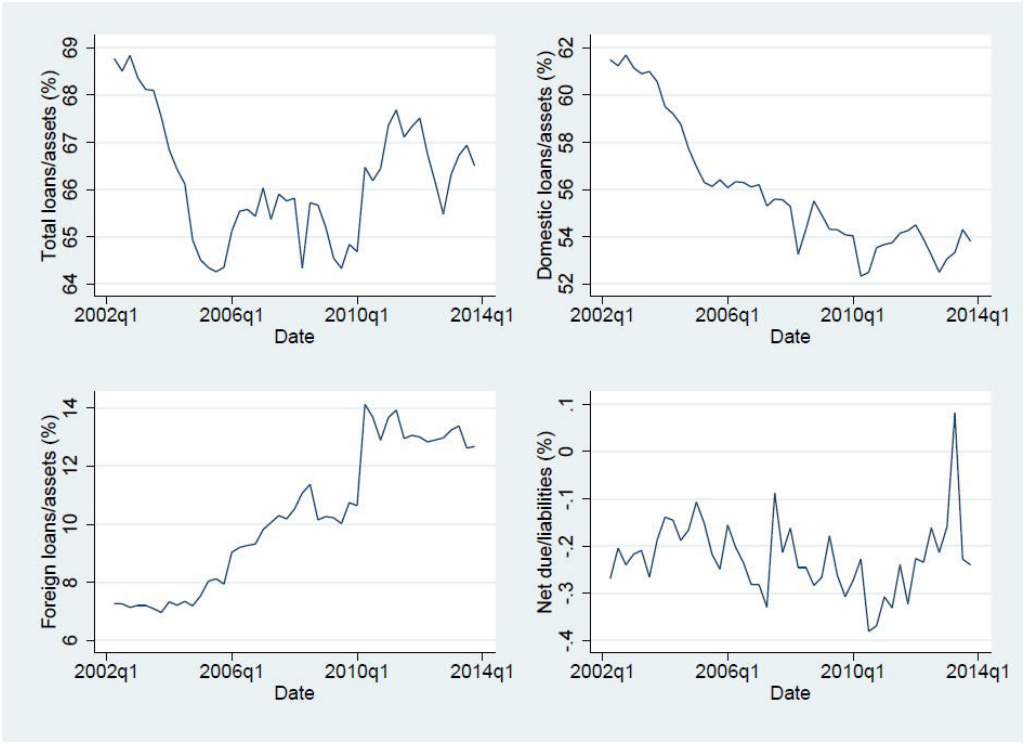

Table 4.1: Summary Statistics on Bank Characteristics and Loan Growth

This Table provides summary statistics for bank balance sheet and lending data for the inward and outward transmission data set. For Inward A and B we report log changes of domestic loans, i.e. to Germany, on an aggregate basis as well as split by counterparty sector. For Outward transmission, we report log changes of loans in each destination country, again on an aggregate basis as well as split by counterparty sector. Data are observed quarterly from Q1:2002-Q4:2013. Banking data comes from on the *Monthly Balance Sheet Statistics* and the *External Position Report* of the Deutsche Bundesbank and is reported at the group level (inward A and outward sample) as well as at the level of the individual bank (inward B sample). The net intragroup funding variable measures, from the perspective of a bank's head office, total net internal borrowing vis-à-vis all its related domestic and international offices.

	All Banks (Inward A) (bank-quarter obs=3852)			All Banks (Inward B) (bank-quarter obs=2591)			All Banks (Outward) (bank-quarter-destinationcountry obs=182379)		
Variable	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Balance sheet data									
Dependent Variables									
Δ Domestic Loans	0.18	0.14	10.51	1.25	0.64	26.11			
Δ Destination Country Loans							-0.58	0.00	21.13
Δ Loans to banks	-0.23	-0.13	26.66	-0.51	0.00	38.76	-0.19	0.00	19.12
Δ Loans to non-bank private sector	0.20	0.21	9.74	0.69	0.35	20.93	-0.49	0.00	16.29
Δ Loans to public sector	-0.80	-0.35	20.07	-0.01	-0.01	0.59	0.00	0.00	0.18
Independent Variables									
Log Total Assets	23.49	23.60	1.87	21.99	21.96	1.55	23.44	23.54	1.89
Capital Ratio (%)	4.38	3.90	3.00	6.51	4.97	6.98	4.53	3.86	4.41
Illiquid Assets Ratio (%)	68.85	70.19	15.89	81.52	89.69	20.04	68.39	70.10	16.43
International Activity (%)	6.48	3.30	7.46	na	na	na	6.16	2.98	7.38
Net Intragroup Funding/Liabilities (%)	-0.22	0.00	3.30	0.00	0.00	1.00	-0.24	0.00	3.32
Core Deposits Ratio (%)	23.55	15.11	24.18	19.77	8.48	24.20	24.75	15.15	25.55

Table 4.2: Summary Statistics on Changes in Prudential Instruments

This Table shows summary statistics on changes in prudential instruments for banks located in Germany over the 2002-2013 period. Data on the eight instruments comes from the "Prudential Instruments Database" developed by Cerutti et al. (2017b) and is on the quarter level. The number of changes in prudential instruments is reported on several dimensions, i.e. on the country-time level and on the bank-time level. The last column of each Table shows the ratio of prudential changes to total observations (i.e. the share of non-zero observations). The column "Exposure weighted observations" is based on the underlying data on prudential changes in foreign countries (columns "base data"). The reported data are based on the regression sample. "na" indicates that no data was available for this instrument. Source: IBRN.

Inward: Specification A

	Base Data (Before Aggregating to Exposure-Weighted Measures)					**Exposure-Weighted Observations**
Instrument	# of Country-Time Changes	# of Country-Time Changes (Tightening)	# of Country-Time Changes (Loosening)	# of Bank-Time Changes	Proportion that is non-zero	Proportion in ExpP_t that is non-zero
Prudential index	441	305	136	3,623	0.166	0.952
General capital requirements	66	66	0	880	0.024	0.209
Sector specific capital buffer	62	47	15	2,299	0.023	0.526
Loan-to-value ratio limits	83	62	21	2,833	0.031	0.657
Reserve requirements: Foreign	121	79	42	3,623	0.046	0.778
Reserve requirements: Local	215	104	111	3,623	0.081	0.871
Interbank exposure limit	18	17	1	838	0.007	0.193
Concentration ratio	28	26	2	1,623	0.011	0.368

Inwards: Specification B

	Policy Changes in Home Country				
Instrument	# of Country-Time Changes	# of Country-Time Changes (Tightening)	# of Country-Time Changes (Loosening)	# of Bank-Time Changes	Proportion that is non-zero
Prudential index	131	102	29	304	0.120
General capital requirements	24	24	0	69	0.027
Sector specific capital buffer	17	16	1	24	0.009
Loan-to-value ratio limits	28	22	6	68	0.027
Reserve requirements: Foreign	32	25	7	48	0.019
Reserve requirements: Local	73	39	34	144	0.057
Interbank exposure limit	9	9	0	18	0.007
Concentration ratio	10	10	0	42	0.017

Table 4.2 continued

Outward Transmission of Policy to Destination Country

	Policy Changes in Destination Country				
Instrument	# of Country-Time Changes	# of Country-Time Changes (Tightening)	# of Country-Time Changes (Loosening)	# of Bank-Country-Time Changes	Proportion that is non-zero
Prudential index	390	267	123	29,347	0.161
General capital requirements	61	61	0	4,393	0.024
Sector specific capital buffer	58	43	15	4,331	0.024
Loan-to-value ratio limits	80	60	20	5,898	0.032
Reserve requirements: Foreign	99	62	37	7,615	0.042
Reserve requirements: Local	185	82	103	14,136	0.078
Interbank exposure limit	17	16	1	1,264	0.007
Concentration ratio	26	23	3	1,959	0.011

Table 4.3: Correlations Between Loan Shares and Balance Sheet Characteristics

This Table shows correlations between banks' loan-to-asset ratios and balance sheet data. Data are observed quarterly from Q1:2002-Q4:2013. Banking data comes from on the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank and is reported at the (consolidated) group level. Descriptive statistics are shown for banks' loan-to-asset ratios (in %) and the breakdown into domestic versus foreign loans to assets (in %). Balance sheet characteristics are as defined in Table 4.1 in the Appendix.

	All Banks (Inward A) (n=3852)		
Variable	Loans/Assets (%)	Domestic Loans/Assets (%)	Foreign Loans/Assets (%)
Correlation with balance sheet variable (for each bank b and quarter t)			
Independent Variables			
Total Assets (thd Euro)	-0.24	-0.38	0.31
Capital Ratio (%)	0.20	0.16	-0.01
Illiquid Assets Ratio (%)	0.93	0.68	0.06
International Activity (%)	-0.02	-0.59	0.94
Net Intragroup Funding/Liabilities (%)	-0.09	0.12	-0.31
Core Deposits Ratio (%)	-0.10	0.14	-0.35

Table 4.4: Shares of Banking Groups in Lending

This Table provides summary statistics for lending data by banking group. Data are shown for the period Q4:2013. Banking data comes from on the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank. Column (1) shows the banking group's total loans relative to total loans of all banks in the sample (in %). Column (2) shows the ratio of the banking group's domestic loans in total domestic loans of all banks in the sample (in %). Column (3) shows the ratio of the banking group's foreign loans in total foreign loans of all banks in the sample (in %). The last column shows the percentage share of observations attributed to each banking group.

	All Banks (Inward A) by banking group in 2013Q4			
Variable	Total loans	Domestic loans	Foreign loans	Observations
	Loans by banking group to total loans, by loan type (%)			% of total
Share of Each Banking group				
Large commercial banks	37.37	22.78	60.95	5.71
Other commercial banks	7.82	8.77	6.30	32.86
Head institutes of savings banks and credit unions	29.01	33.23	22.20	15.71
Savings banks	2.22	3.47	0.19	10.00
Credit unions	1.69	2.69	0.07	17.14
Mortgage banks	8.98	10.18	7.05	12.86
Building societies	3.43	5.26	0.48	5.71
All banking groups	100%	100%	100%	100%

Table 4.5: Bank Characteristics by Banking Group

This Table provides summary statistics by banking group. Data are shown for the period Q4:2013. Banking data comes from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank and is reported at the level of the individual bank. We depict the mean for various variables as specified in the column head across all banks in a banking group.

	All Banks (Inward A)							
	mean, by banking group in 2013Q4							
Variable	Assets (billion Euro)	Foreign loan share	Domestic loan share	Capital Ratio (%)	Illiquid Assets Ratio (%)	International Activity (%)	Net Intragroup Funding/Liabilities (%)	Core Deposits Ratio (%)
Banking group								
Large commercial banks	611.00	21.58	30.19	3.33	51.94	14.95	-1.93	29.66
Other commercial banks	11.40	16.39	50.26	11.18	66.65	11.87	-0.31	36.33
Head institutes of savings banks and credit unions	128.00	17.61	44.97	4.12	62.60	11.19	-0.39	9.40
Savings banks	13.40	1.81	66.73	4.95	68.56	0.92	0.01	62.56
Credit unions	6.07	2.59	63.70	5.07	66.29	1.49	0.17	63.74

Table 4.6: Domestic and Foreign Loan Shares and Sectoral Breakdown

This Table provides summary statistics for lending data. Data are observed quarterly from Q1:2002- Q4:2013. Banking data comes from the *Monthly Balance Sheet Statistics* of the Deutsche Bundesbank and is reported at the (consolidated) group level (inward A sample). For German banks' foreign branches, data are not reported by individual branch but aggregated by destination country and parent bank. For foreign subsidiaries, data are reported at the level of the individual subsidiary. Descriptive statistics are shown for banks' loan-to-asset ratios (in %) and the breakdown into domestic versus foreign loans to assets (in %) as well as the sectoral split differentiating between loans to banks, to non-bank private sector and to the public sector.

	All Banks (Inward A)			Foreign Branches			Foreign Subsidiaries		
	(n=3852)			(n=9615)			(n=6263)		
Variable	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Balance sheet data									
Dependent Variables									
Total Loans/Assets (%)	66.19	66.25	16.60	65.87	75.05	31.40	66.05	74.04	29.19
Domestic Loans/Assets (%)	56.00	56.83	21.59	20.31	6.80	28.10	16.07	4.01	24.22
Foreign Loans/Assets (%)	10.19	4.71	13.26	45.56	40.92	35.19	49.98	50.03	32.98
Domestic Loans/Assets (%) by sector									
to banks	14.03	10.21	13.72	20.37	6.20	28.06	12.33	1.83	22.01
to non-bank private sector	36.66	34.47	24.10	1.77	0.00	7.69	3.84	0.02	10.27
to public sector	5.10	2.24	6.93	0.23	0.00	1.83	0.15	0.00	1.04
Foreign Loans/Assets (%) by sector									
to banks	2.29	0.28	5.09	6.90	0.00	17.93	23.70	13.69	26.17
to non-bank private sector	7.40	1.96	11.17	41.82	34.22	34.02	26.89	13.24	28.99
to public sector	0.51	0.00	1.73	1.18	0.00	6.71	1.15	0.00	4.23

Table 4.7: Inward Transmission of Policy Through Domestic Banks' International Exposures

This Table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. The data are observed quarterly from Q1:2002- Q4:2013 for a panel of domestic bank holding companies whereas we use consolidated data. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are the total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by bank. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) ExpP= Prudential IndexC	(2) ExpP= Capital Requirements	(3) ExpP= Sector-Specific Capital Buffer	(4) ExpP= Loan To Value Ratio	(5) ExpP= Reserve Requirement Foreign	(6) ExpP= Reserve Requirement Local	(7) ExpP= Concentration Ratios
Foreign-Exposure-Weighted Regulation (ExpP)	-4.417	73.107	-145.850	132.524	-260.478	-64.081	62.442
	[0.909]	[0.258]	[0.170]	[0.139]	[0.431]	[0.272]	[0.423]
Log Total Assets_t-1	-5.922***	-5.634***	-5.632***	-5.637***	-5.466***	-5.634***	-5.803***
	[0.001]	[0.003]	[0.001]	[0.002]	[0.003]	[0.002]	[0.002]
Capital Ratio_t-1	-0.591**	-0.475*	-0.488*	-0.473*	-0.409*	-0.472*	-0.595**
	[0.035]	[0.086]	[0.073]	[0.097]	[0.097]	[0.085]	[0.034]
Illiquid Assets Ratio_t-1	-0.189***	-0.182***	-0.192***	-0.193***	-0.187***	-0.172***	-0.190***
	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]
International Activity_t-1	0.142*	0.121	0.179**	0.114	0.131*	0.124*	0.143*
	[0.056]	[0.139]	[0.017]	[0.170]	[0.053]	[0.088]	[0.050]
Net Intragroup Funding_t-1	-0.311	-0.398**	-0.386	-0.365	-0.419*	-0.380*	-0.327
	[0.158]	[0.047]	[0.115]	[0.108]	[0.064]	[0.080]	[0.125]
Core Deposits Ratio_t-1	-0.032	-0.026	-0.029	-0.005	-0.017	-0.023	-0.024
	[0.510]	[0.588]	[0.529]	[0.901]	[0.716]	[0.616]	[0.614]
Log Total Assets * ExpP	0.133	-2.111	4.534	-2.528	12.148	0.616	-1.900
	[0.919]	[0.390]	[0.267]	[0.376]	[0.396]	[0.778]	[0.534]
Capital Ratio * ExpP	3.105	-0.719	2.091	-3.811	17.859*	4.391	4.602**
	[0.155]	[0.772]	[0.484]	[0.203]	[0.051]	[0.175]	[0.011]
Illiquid Assets Ratio * ExpP	-0.170	-0.313	0.478	-0.641	-2.032	0.383*	-0.531
	[0.357]	[0.248]	[0.355]	[0.223]	[0.115]	[0.077]	[0.108]
International Activity* ExpP	-0.260	0.268	-2.095***	0.662	0.675	-0.396	-0.350
	[0.468]	[0.685]	[0.005]	[0.428]	[0.767]	[0.207]	[0.455]
Net Intragroup Funding * ExpP	-1.383***	-0.402	3.542	-1.034	22.045*	0.919	-5.552***
	[0.005]	[0.721]	[0.220]	[0.355]	[0.054]	[0.573]	[0.000]
Core Deposits Ratio * ExpP	0.053	0.090	0.166	-0.089	-0.264	-0.034	-0.263
	[0.594]	[0.467]	[0.345]	[0.708]	[0.756]	[0.814]	[0.211]
Observations	3,757	3,757	3,757	3,757	3,757	3,757	3,757
R-squared	0.062	0.070	0.057	0.064	0.086	0.063	0.054
Adjusted R-squared	0.043	0.052	0.038	0.045	0.068	0.045	0.035
Number of Banks	96	96	96	96	96	96	96
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of ExpP (Contemporaneous and Lagged Indicator)	0.405	2.722	-7.636	14.785**	-44.407	-7.674	-5.984
	[0.874]	[0.446]	[0.217]	[0.012]	[0.141]	[0.206]	[0.364]
Contemporaneous Marginal Effect of ExpP	3.754**	5.523***	-5.078	15.173***	-21.458	1.745	-0.163
	[0.014]	[0.002]	[0.232]	[0.001]	[0.244]	[0.604]	[0.966]

Table 4.8: Inward Transmission of Policy via Foreign-Owned Affiliates

This Table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in total loans. The data are quarterly from Q1:2002- Q4:2013 for a panel for foreign-owned affiliates located in Germany. HomeP refers to changes in regulation in the home (i.e. parent bank) country of foreign affiliates located in Germany. For the marginal effect of HomeP as well as HomeP interaction effects the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by home country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) HomeP= Prudential IndexC	(2) HomeP= Capital Requirements	(3) HomeP= Sector-Specific Capital Buffer	(4) HomeP= Loan To Value Ratio	(5) HomeP= Reserve Requirement Foreign	(6) HomeP= Reserve Requirement Local	(7) HomeP= Concentration Ratios
Home Country Regulation HomeP_t	-41.624	22.788	-286.785**	-64.058	193.626	-10.774	-11.312
	[0.563]	[0.579]	[0.012]	[0.293]	[0.294]	[0.810]	[0.938]
Home Country Regulation HomeP_t-1	-48.934**	-14.234	129.751	93.210*	-253.897***	-121.710***	-11.289
	[0.028]	[0.771]	[0.481]	[0.072]	[0.004]	[0.006]	[0.869]
Home Country Regulation HomeP_t-2	-11.523	-3.113	-116.128	-83.172***	-56.095	37.359	3.800
	[0.675]	[0.932]	[0.366]	[0.006]	[0.267]	[0.346]	[0.871]
Log Total Assets_t-1	-5.309***	-4.731***	-5.057***	-5.064***	-4.768***	-4.939***	-4.665***
	[0.002]	[0.002]	[0.001]	[0.001]	[0.002]	[0.002]	[0.001]
Capital Ratio_t-1	0.143	0.224**	0.207**	0.184*	0.206*	0.186*	0.207**
	[0.233]	[0.041]	[0.047]	[0.098]	[0.067]	[0.094]	[0.046]
Illiquid Assets Ratio_t-1	-0.126*	-0.083	-0.103*	-0.095	-0.105*	-0.111**	-0.094*
	[0.055]	[0.163]	[0.079]	[0.119]	[0.061]	[0.042]	[0.088]
Net Intragroup Funding_t-1	-0.143	-0.131	-0.189	-0.266	-0.294	-0.266	-0.271
	[0.663]	[0.684]	[0.532]	[0.359]	[0.253]	[0.332]	[0.312]
Core Deposits Ratio_t-1	0.020	0.034	0.035	0.022	0.039	0.028	0.035
	[0.808]	[0.663]	[0.655]	[0.773]	[0.609]	[0.714]	[0.656]
BIS Financial Cycle (Home country)	0.094**	0.098**	0.093*	0.094**	0.081*	0.086*	0.090**
	[0.046]	[0.032]	[0.056]	[0.020]	[0.088]	[0.053]	[0.044]
BIS Business Cycle (Home country)	0.650	0.582	0.713	0.780	0.451	0.523	0.561
	[0.302]	[0.343]	[0.230]	[0.227]	[0.462]	[0.410]	[0.358]
Log Total Assets * HomeP	3.593***	0.853***	5.225***	0.730***	2.212***	2.452***	2.797***
	[0.234]	[0.732]	[0.258]	[0.777]	[0.611]	[0.033]	[0.396]
Capital Ratio * HomeP	0.783***	-0.599***	1.709***	1.156***	-0.128***	0.904***	-1.049***
	[0.115]	[0.542]	[0.375]	[0.454]	[0.922]	[0.034]	[0.158]
Illiquid Assets Ratio * HomeP	0.117***	-0.264***	1.648***	0.058***	0.843***	0.373***	-0.481***
	[0.542]	[0.187]	[0.052]	[0.867]	[0.110]	[0.016]	[0.145]
Net Intragroup Funding * HomeP	-4.497***	-7.707***	11.750***	-5.000***	-19.778***	7.533***	4.072***
	[0.015]	[0.099]	[0.524]	[0.098]	[0.686]	[0.267]	[0.243]
Core Deposits Ratio * HomeP	0.160***	0.188***	-1.439***	0.638***	0.340***	-0.129***	0.129***
	[0.170]	[0.238]	[0.001]	[0.061]	[0.586]	[0.472]	[0.022]
Observations	2,466	2,466	2,466	2,466	2,466	2,466	2,466
R-squared	0.091	0.081	0.084	0.094	0.084	0.094	0.080
Adjusted R-squared	0.035	0.025	0.029	0.039	0.029	0.039	0.024
Number of Banks	72	72	72	72	72	72	72
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of HomeP (Contemporaneous and Lagged Indicator)	-5.334*	2.510	-41.154***	-13.187*	6.892	-7.485	-0.814
	[0.069]	[0.746]	[0.000]	[0.075]	[0.442]	[0.145]	[0.837]
Contemporaneous Marginal Effect of HomeP	-3.886	0.469	-17.384**	-9.863	-9.303	-8.850*	5.191***
	[0.233]	[0.901]	[0.011]	[0.101]	[0.523]	[0.083]	[0.004]

Table 4.9: Outward Transmission of Policy to Destination Country

This Table reports the effects of changes in destination country regulation and bank characteristics on log changes in total loans by destination country. The data are quarterly from Q1:2002- Q4:2013 for a panel of bank holding companies whereas we use consolidated data. DestP refers to the changes in regulation in the destination country of the loan. For the marginal effect of DestP as well as DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by destination country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	DestP= Prudential IndexC	DestP= Capital Requirements	DestP= Sector-Specific Capital Buffer	DestP= Loan To Value Ratio	DestP= Reserve Requirement Foreign	DestP= Reserve Requirement Local	DestP= Concentration Ratios
Destination Country Regulation DestP_t	6.609***	28.453***	2.199	8.388	2.940	2.842	-2.739
	[0.007]	[0.000]	[0.692]	[0.227]	[0.345]	[0.293]	[0.446]
Destination Country Regulation DestP_t-1	-5.333**	4.961	-3.519	-4.265	-3.742	-5.977*	3.078
	[0.038]	[0.504]	[0.273]	[0.557]	[0.157]	[0.053]	[0.562]
Destination Country Regulation DestP_t-2	-2.903	17.253***	-12.359***	-4.044	-4.829	-1.215	-7.128
	[0.204]	[0.004]	[0.005]	[0.555]	[0.114]	[0.588]	[0.459]
Log Total Assets_t-1	-0.187	-0.171	-0.191	-0.188	-0.187	-0.180	-0.184
	[0.263]	[0.318]	[0.257]	[0.261]	[0.270]	[0.287]	[0.274]
Capital Ratio_t-1	-0.012	-0.013	-0.011	-0.012	-0.010	-0.010	-0.010
	[0.543]	[0.517]	[0.546]	[0.514]	[0.563]	[0.594]	[0.568]
Illiquid Assets Ratio_t-1	-0.004	-0.006	-0.005	-0.004	-0.004	-0.005	-0.004
	[0.557]	[0.408]	[0.496]	[0.561]	[0.552]	[0.477]	[0.542]
International Activity_t-1	-0.043**	-0.034*	-0.040**	-0.038*	-0.039**	-0.037*	-0.038*
	[0.034]	[0.080]	[0.043]	[0.054]	[0.044]	[0.056]	[0.054]
Net Intragroup Funding_t-1	0.072	0.051	0.074	0.066	0.073	0.070	0.074
	[0.120]	[0.255]	[0.111]	[0.156]	[0.116]	[0.131]	[0.114]
Core Deposits Ratio_t-1	0.008	0.007	0.008	0.008	0.008	0.008	0.007
	[0.358]	[0.447]	[0.363]	[0.361]	[0.365]	[0.339]	[0.382]
BIS Financial Cycle (Destination country)	0.012***	0.012***	0.012***	0.012***	0.012***	0.012***	0.012***
	[0.004]	[0.003]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
BIS Business Cycle (Destination country)	0.081**	0.082**	0.082**	0.079**	0.083**	0.082**	0.082**
	[0.024]	[0.022]	[0.024]	[0.026]	[0.023]	[0.020]	[0.022]
Log Total Assets * DestP	0.069	-1.996***	0.460**	0.038	0.277	0.223	0.305
	[0.721]	[0.000]	[0.014]	[0.948]	[0.162]	[0.310]	[0.488]
Capital Ratio * DestP	0.023	-0.151**	0.046	0.027	0.018	0.060	0.091
	[0.575]	[0.028]	[0.472]	[0.805]	[0.593]	[0.260]	[0.748]
Illiquid Assets Ratio * DestP	-0.006	-0.024	0.033	-0.011	-0.026*	-0.027***	-0.026
	[0.468]	[0.549]	[0.290]	[0.611]	[0.077]	[0.001]	[0.659]
International Activity * DestP	0.042	-0.019	0.087*	0.047	0.054	0.048	0.011
	[0.144]	[0.804]	[0.096]	[0.505]	[0.183]	[0.148]	[0.932]
Net Intragroup Funding * DestP	0.014	0.096	0.001	0.334**	-0.004	-0.094**	0.037
	[0.751]	[0.531]	[0.994]	[0.042]	[0.891]	[0.026]	[0.831]
Core Deposits Ratio * DestP	0.004	-0.043	0.012	0.004	0.020**	0.004	0.041
	[0.697]	[0.172]	[0.452]	[0.906]	[0.012]	[0.756]	[0.155]
Observations	177,777	177,777	177,777	177,777	177,777	177,777	177,777
R-squared	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Adjusted R-squared	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Number of Destination Countries	52	52	52	52	52	52	52
Number of Banks	96	96	96	96	96	96	96
Destination Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of DestP	0.060	0.350	0.371	0.628	0.011	-0.293**	0.043
(Contemporaneous and Lagged Indicator)	[0.749]	[0.560]	[0.290]	[0.230]	[0.975]	[0.042]	[0.962]
Contemporaneous Marginal Effect of DestP	-0.269**	0.176	-0.110	0.129	-0.326*	-0.407**	-0.667*
	[0.039]	[0.581]	[0.742]	[0.675]	[0.060]	[0.013]	[0.063]

Table 4.10 : Outward Transmission of Policy to Destination Country Using County-Time Fixed Effects

This Table reports the effects of changes in destination country regulation and bank characteristics on log changes in total loans by destination country. The data are quarterly from Q1:2002- Q4:2013 for a panel of bank holding companies whereas we use consolidated data. DestP refers to the changes in regulation in the destination country of the loan. Due to the inclusion of twoway country-time fixed effects, the destination country policy and the cycle variables are not included on a standalone basis. For the marginal effect of DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by destination country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	DestP= Prudential IndexC	DestP= Capital Requirements	DestP= Sector-Specific Capital Buffer	DestP= Loan To Value Ratio	DestP= Reserve Requirement Foreign	DestP= Reserve Requirement Local	DestP= Concentration Ratios
Log Total Assets_t-1	-0.189	-0.172	-0.194	-0.191	-0.188	-0.183	-0.186
	[0.265]	[0.321]	[0.255]	[0.261]	[0.272]	[0.286]	[0.276]
Capital Ratio_t-1	-0.012	-0.012	-0.011	-0.012	-0.010	-0.009	-0.010
	[0.537]	[0.537]	[0.550]	[0.519]	[0.572]	[0.610]	[0.591]
Illiquid Assets Ratio_t-1	-0.004	-0.006	-0.005	-0.004	-0.004	-0.005	-0.004
	[0.549]	[0.402]	[0.492]	[0.561]	[0.547]	[0.479]	[0.531]
International Activity_t-1	-0.042**	-0.033*	-0.039**	-0.038*	-0.039**	-0.037*	-0.038*
	[0.039]	[0.085]	[0.048]	[0.059]	[0.050]	[0.062]	[0.061]
Net Intragroup Funding_t-1	0.070	0.049	0.073	0.064	0.072	0.068	0.072
	[0.134]	[0.285]	[0.124]	[0.169]	[0.128]	[0.144]	[0.128]
Core Deposits Ratio_t-1	0.008	0.007	0.008	0.008	0.008	0.008	0.008
	[0.343]	[0.432]	[0.352]	[0.350]	[0.353]	[0.329]	[0.366]
Log Total Assets * DestP	0.061	-1.993***	0.504***	0.043	0.266	0.209	0.216
	[0.759]	[0.000]	[0.007]	[0.942]	[0.188]	[0.360]	[0.618]
Tier1 Ratio * DestP	0.029	-0.148**	0.057	0.041	0.028	0.065	0.064
	[0.517]	[0.044]	[0.375]	[0.727]	[0.441]	[0.242]	[0.821]
Illiquid Assets Ratio * DestP	-0.005	-0.022	0.033	-0.015	-0.024*	-0.027***	-0.019
	[0.566]	[0.586]	[0.281]	[0.503]	[0.093]	[0.002]	[0.758]
International Activity * DestP	0.040	-0.012	0.097*	0.049	0.041	0.041	0.017
	[0.205]	[0.873]	[0.097]	[0.489]	[0.301]	[0.254]	[0.900]
Net Intragroup Funding * DestP	0.017	0.111	0.012	0.328*	-0.004	-0.097**	0.065
	[0.717]	[0.469]	[0.940]	[0.052]	[0.879]	[0.019]	[0.705]
Core Deposits Ratio * DestP	0.003	-0.042	0.015	0.006	0.018**	0.002	0.040
	[0.736]	[0.182]	[0.363]	[0.864]	[0.028]	[0.873]	[0.177]
Observations	177,777	177,777	177,777	177,777	177,777	177,777	177,777
R-squared	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Adjusted R-squared	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Number of countries	52	52	52	52	52	52	52
Number of banks	96	96	96	96	96	96	96
Destination country-time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4.11: Inward Transmission of Policy Through Domestic Banks' International Exposures – Loans to Banks

This Table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in loans to banks. The data are quarterly from Q1:2002- Q4:2013 for a panel of domestic bank holding companies whereas we use consolidated data. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are the total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by bank. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) ExpP= Prudential IndexC	(2) ExpP= Capital Requirements	(3) ExpP= Sector-Specific Capital Buffer	(4) ExpP= Loan To Value Ratio	(5) ExpP= Reserve Requirement Foreign	(6) ExpP= Reserve Requirement Local	(7) ExpP= Concentration Ratios
Foreign exposure weighted regulation (ExpP)	-116.369*	-123.038	-183.879	80.562	-319.768	42.987	-667.961**
	[0.065]	[0.235]	[0.639]	[0.738]	[0.471]	[0.711]	[0.035]
Log Total Assets_t-1	-10.484***	-10.606***	-10.363***	-10.346***	-10.462***	-10.387***	-10.709***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Capital Ratio_t-1	-0.728	-0.724*	-0.646	-0.657	-0.636	-0.700	-0.774
	[0.126]	[0.090]	[0.152]	[0.147]	[0.124]	[0.105]	[0.114]
Illiquid Assets Ratio_t-1	-0.376***	-0.345***	-0.358***	-0.363***	-0.367***	-0.344***	-0.369***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
International Activity_t-1	-0.071	-0.066	0.005	-0.022	-0.028	-0.037	-0.071
	[0.602]	[0.641]	[0.973]	[0.878]	[0.843]	[0.811]	[0.638]
Net Intragroup Funding_t-1	-0.649	-0.720*	-0.618	-0.549	-0.550	-0.536	-0.580
	[0.246]	[0.087]	[0.251]	[0.201]	[0.246]	[0.149]	[0.241]
Core Deposits Ratio_t-1	0.094	0.085	0.079	0.105	0.092	0.085	0.074
	[0.275]	[0.347]	[0.376]	[0.207]	[0.291]	[0.351]	[0.392]
Log Total Assets * ExpP	3.584	3.901	6.038	-4.911	6.492	-4.868	22.131**
	[0.171]	[0.315]	[0.703]	[0.620]	[0.687]	[0.282]	[0.043]
Capital Ratio * ExpP	-1.074	-1.142	-4.098	-6.316	9.056	-0.612	7.874*
	[0.706]	[0.769]	[0.561]	[0.546]	[0.562]	[0.837]	[0.054]
Illiquid Assets Ratio * ExpP	0.534*	0.274	0.897	1.389	0.809	0.842*	1.423
	[0.096]	[0.558]	[0.351]	[0.184]	[0.716]	[0.056]	[0.321]
International Activity* ExpP	0.984*	1.906**	-1.903	1.979	2.220	0.093	3.295**
	[0.090]	[0.044]	[0.279]	[0.296]	[0.334]	[0.880]	[0.017]
Net Intragroup Funding * ExpP	1.882	3.834**	6.001	3.390	4.933	2.803	2.301
	[0.387]	[0.035]	[0.194]	[0.510]	[0.880]	[0.420]	[0.604]
Core Deposits Ratio * ExpP	0.299	0.384	0.352	-0.309	1.736	0.035	1.157
	[0.135]	[0.204]	[0.507]	[0.578]	[0.245]	[0.894]	[0.127]
Observations	3,525	3,525	3,525	3,525	3,525	3,525	3,525
R-squared	0.039	0.036	0.036	0.045	0.041	0.038	0.036
Adjusted R-squared	0.019	0.016	0.016	0.025	0.021	0.018	0.016
Number of Banks	96	96	96	96	96	96	96
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of ExpP (Contemporaneous and Lagged Indicator)	12.778*	2.898	-1.616	37.808***	-19.701	-15.483	30.699
	[0.062]	[0.786]	[0.906]	[0.004]	[0.598]	[0.202]	[0.225]
Contemporaneous Marginal Effect of ExpP	14.457***	2.781	12.492	39.451***	7.424	12.389	22.135**
	[0.006]	[0.745]	[0.205]	[0.000]	[0.778]	[0.203]	[0.027]

Table 4.12: Inward Transmission of Policy Through Domestic Banks' International Exposures – Loans to Non-bank Private Sector

This Table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in loans to the Non-bank Private Sector. The data are quarterly from Q1:2002- Q4:2013 for a panel of domestic bank holding companies whereas we use consolidated data. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are the total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by bank. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) ExpP= Prudential IndexC	(2) ExpP= Capital Requirements	(3) ExpP= Sector-Specific Capital Buffer	(4) ExpP= Loan To Value Ratio	(5) ExpP= Reserve Requirement Foreign	(6) ExpP= Reserve Requirement Local	(7) ExpP= Concentration Ratios
Foreign exposure weighted regulation (ExpP)	67.950***	104.942***	299.331**	87.659	22.765	40.687	-92.970
	[0.009]	[0.006]	[0.046]	[0.151]	[0.911]	[0.340]	[0.269]
Log Total Assets_t-1	-0.217	-0.369	-0.132	-0.209	0.031	-0.003	-0.048
	[0.863]	[0.767]	[0.926]	[0.873]	[0.982]	[0.998]	[0.972]
Capital Ratio_t-1	0.628	0.487	0.513	0.472	0.513	0.499	0.640
	[0.160]	[0.279]	[0.261]	[0.301]	[0.229]	[0.281]	[0.172]
Illiquid Assets Ratio_t-1	-0.085**	-0.080**	-0.087**	-0.084**	-0.084**	-0.076**	-0.070*
	[0.019]	[0.031]	[0.032]	[0.030]	[0.030]	[0.044]	[0.057]
International Activity_t-1	-0.020	-0.037	-0.045	-0.004	-0.027	-0.025	-0.015
	[0.844]	[0.736]	[0.679]	[0.970]	[0.779]	[0.807]	[0.874]
Net Intragroup Funding_t-1	0.018	-0.100	-0.046	-0.022	-0.072	-0.087	0.013
	[0.912]	[0.569]	[0.813]	[0.903]	[0.688]	[0.627]	[0.937]
Core Deposits Ratio_t-1	-0.011	-0.006	-0.004	-0.005	-0.001	-0.003	-0.005
	[0.760]	[0.870]	[0.907]	[0.902]	[0.977]	[0.934]	[0.883]
Log Total Assets * ExpP	-2.959**	-3.961**	-13.430**	-1.087	-1.117	-2.934	5.306
	[0.014]	[0.015]	[0.040]	[0.634]	[0.897]	[0.108]	[0.173]
Capital Ratio * ExpP	-2.306	-2.699	-5.217	-4.640*	-11.522	1.525	-1.896
	[0.118]	[0.216]	[0.137]	[0.057]	[0.258]	[0.287]	[0.322]
Illiquid Assets Ratio * ExpP	0.155	-0.016	0.698*	-0.405	0.193	0.306***	-0.425
	[0.229]	[0.940]	[0.089]	[0.232]	[0.603]	[0.001]	[0.115]
International Activity* ExpP	-0.079	0.510	1.265	-1.727**	1.890**	0.291	-0.491
	[0.689]	[0.285]	[0.333]	[0.016]	[0.044]	[0.294]	[0.496]
Net Intragroup Funding * ExpP	-0.318	0.748	0.185	-2.503**	25.440**	-0.896	-1.765**
	[0.457]	[0.284]	[0.909]	[0.025]	[0.020]	[0.114]	[0.021]
Core Deposits Ratio * ExpP	0.056	0.074	-0.143	-0.052	0.687	-0.125	0.497*
	[0.516]	[0.519]	[0.517]	[0.759]	[0.301]	[0.300]	[0.082]
Observations	3,742	3,742	3,742	3,742	3,742	3,742	3,742
R-squared	0.042	0.037	0.040	0.050	0.048	0.040	0.042
Adjusted R-squared	0.023	0.019	0.021	0.031	0.029	0.021	0.023
Number of Banks	96	96	96	96	96	96	96
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of ExpP (Contemporaneous and Lagged Indicator)	-0.004	3.905	13.987*	2.273	-17.863	-1.389	3.058
	[0.999]	[0.336]	[0.068]	[0.628]	[0.341]	[0.670]	[0.641]
Contemporaneous Marginal Effect of ExpP	-1.269	4.425*	-1.650	-2.741	-15.135*	-1.803	0.076
	[0.298]	[0.065]	[0.664]	[0.330]	[0.083]	[0.446]	[0.978]

Table 4.13: Inward Transmission of Policy Through Domestic Banks' International Exposures – Loans to Public Sector

This Table reports the effects of changes in regulation and bank characteristics and their interactions on log changes in loans to the Public Sector. The data are quarterly from Q1:2002- Q4:2013 for a panel of domestic bank holding companies whereas we use consolidated data. Foreign-exposure-weighted regulation ExpP is calculated as the weighted average of changes in foreign regulation where the weights are the total assets and liabilities of the bank in the respective foreign country. For ExpP and its interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by bank. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ExpP= Prudential IndexC	ExpP= Capital Requirements	ExpP= Sector-Specific Capital Buffer	ExpP= Loan To Value Ratio	ExpP= Reserve Requirement Foreign	ExpP= Reserve Requirement Local	ExpP= Concentration Ratios
Foreign exposure weighted regulation (ExpP)	-102.544**	-92.489	-443.104*	-186.596	-313.007	25.469	81.569
	[0.041]	[0.184]	[0.080]	[0.196]	[0.433]	[0.708]	[0.656]
Log Total Assets_t-1	-3.253*	-2.833	-3.445*	-2.713	-3.172*	-3.149*	-3.083*
	[0.074]	[0.129]	[0.060]	[0.131]	[0.077]	[0.084]	[0.087]
Capital Ratio_t-1	-0.508	-0.495	-0.606	-0.510	-0.516	-0.501	-0.555
	[0.338]	[0.345]	[0.275]	[0.334]	[0.339]	[0.337]	[0.302]
Illiquid Assets Ratio_t-1	-0.007	0.007	-0.041	-0.001	-0.031	-0.018	-0.007
	[0.923]	[0.923]	[0.560]	[0.992]	[0.656]	[0.810]	[0.924]
International Activity_t-1	-0.156	-0.129	-0.239	-0.200	-0.209	-0.209	-0.210
	[0.273]	[0.381]	[0.116]	[0.169]	[0.149]	[0.160]	[0.147]
Intragroup Funding_t-1	-0.398	-0.488	-0.497*	-0.440	-0.464	-0.554*	-0.449
	[0.179]	[0.136]	[0.093]	[0.144]	[0.123]	[0.074]	[0.136]
Core Deposits Ratio_t-1	-0.048	-0.039	-0.042	-0.010	-0.041	-0.034	-0.042
	[0.782]	[0.826]	[0.807]	[0.958]	[0.814]	[0.845]	[0.810]
Log Total Assets * ExpP	4.769**	6.137**	7.504	6.046	12.576	-1.529	-1.400
	[0.021]	[0.031]	[0.370]	[0.255]	[0.471]	[0.605]	[0.874]
Capital Ratio * ExpP	0.427	0.734	6.990	-5.617	16.822	-1.368	3.148
	[0.834]	[0.776]	[0.197]	[0.388]	[0.442]	[0.431]	[0.322]
Illiquid Assets Ratio * ExpP	-0.098	-0.557*	2.842**	1.051	-3.304	-0.061	-0.891
	[0.672]	[0.089]	[0.018]	[0.197]	[0.114]	[0.817]	[0.330]
International Activity* ExpP	-0.812*	-1.074	1.367	0.897	4.459	-0.435	-0.204
	[0.062]	[0.135]	[0.261]	[0.432]	[0.221]	[0.313]	[0.851]
Intragroup Fundin * ExpP	-0.429	1.352	5.069	4.397	17.059	-2.374	5.720
	[0.661]	[0.535]	[0.193]	[0.481]	[0.771]	[0.183]	[0.404]
Core Deposits Ratio * ExpP	0.233	0.175	1.198**	-0.170	1.308	0.065	0.407
	[0.177]	[0.536]	[0.021]	[0.691]	[0.679]	[0.766]	[0.617]
Observations	3,233	3,233	3,233	3,233	3,233	3,233	3,233
R-squared	0.021	0.020	0.023	0.024	0.031	0.024	0.024
Adjusted R-squared	-0.001	-0.002	0.000	0.002	0.009	0.001	0.002
Number of banks	96	96	96	96	96	96	96
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of ExpP (Contemporaneous and Lagged Indicator)	5.536	14.345*	-5.365	7.670	-119.611***	-21.667**	6.712
	[0.209]	[0.078]	[0.616]	[0.473]	[0.002]	[0.014]	[0.708]
Contemporaneous Marginal Effect of ExpP	1.113	2.079	7.611	13.107*	-25.891	-18.918***	-5.892
	[0.712]	[0.634]	[0.430]	[0.077]	[0.276]	[0.000]	[0.483]

Table 4.14: Outward Transmission of Policy to Destination Country – Loans to Banks

This Table reports the effects of changes in destination country regulation and bank characteristics on log changes in loans to banks by destination country. The data are quarterly from Q1:2002- Q4:2013 for a panel of bank holding companies whereas we use consolidated data. DestP refers to the changes in regulation in the destination country of the loan. For the marginal effect of DestP as well as DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by destination country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) DestP= Prudential IndexC	(2) DestP= Capital Requirements	(3) DestP= Sector-Specific Capital Buffer	(4) DestP= Loan To Value Ratio	(5) DestP= Reserve Requirement Foreign	(6) DestP= Reserve Requirement Local	(7) DestP= Concentration Ratios
Destination Country Regulation DestP_t	2.762	9.205*	7.705**	4.950	0.142	1.569	-9.874
	[0.172]	[0.080]	[0.036]	[0.298]	[0.944]	[0.433]	[0.159]
Destination Country Regulation DestP_t-1	-2.965	0.271	-5.965*	-3.069	-0.437	-5.808**	5.885
	[0.190]	[0.963]	[0.066]	[0.596]	[0.852]	[0.038]	[0.472]
Destination Country Regulation DestP_t-2	-1.708	6.975	-2.735	2.006	-2.526	-1.206	-7.485
	[0.376]	[0.155]	[0.474]	[0.712]	[0.280]	[0.498]	[0.293]
Log Total Assets_t-1	-0.065	-0.050	-0.064	-0.061	-0.065	-0.060	-0.065
	[0.569]	[0.666]	[0.584]	[0.600]	[0.574]	[0.607]	[0.577]
Capital Ratio_t-1	-0.016	-0.017	-0.018*	-0.016	-0.017	-0.018*	-0.018*
	[0.143]	[0.138]	[0.095]	[0.128]	[0.101]	[0.097]	[0.093]
Illiquid Assets Ratio_t-1	0.005	0.003	0.005	0.005	0.005	0.004	0.004
	[0.457]	[0.555]	[0.438]	[0.466]	[0.443]	[0.490]	[0.466]
International Activity_t-1	-0.005	0.005	-0.001	-0.000	0.000	0.003	0.003
	[0.756]	[0.771]	[0.954]	[0.982]	[0.987]	[0.869]	[0.862]
Net Intragroup Funding_t-1	0.133***	0.124**	0.135***	0.131***	0.137***	0.136***	0.138***
	[0.008]	[0.012]	[0.007]	[0.008]	[0.006]	[0.006]	[0.006]
Core Deposits Ratio_t-1	0.005	0.005	0.005	0.005	0.005	0.005	0.005
	[0.371]	[0.413]	[0.376]	[0.337]	[0.340]	[0.330]	[0.364]
BIS Financial Cycle (Destination country)	0.009***	0.009***	0.010***	0.009***	0.010***	0.010***	0.010***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
BIS Business Cycle (Destination country)	0.056*	0.059*	0.059*	0.057*	0.060*	0.059*	0.059*
	[0.078]	[0.062]	[0.059]	[0.069]	[0.060]	[0.060]	[0.060]
Log Total Assets * DestP	0.063	-0.687	-0.004	-0.168	0.142	0.227	0.413
	[0.618]	[0.101]	[0.984]	[0.660]	[0.433]	[0.173]	[0.431]
Capital Ratio * DestP	-0.014	-0.060	-0.009	-0.094	-0.012	0.014	0.146
	[0.555]	[0.226]	[0.779]	[0.248]	[0.637]	[0.595]	[0.248]
Illiquid Assets Ratio * DestP	0.002	0.021	-0.008	0.006	-0.015	-0.008	0.020
	[0.854]	[0.512]	[0.769]	[0.815]	[0.117]	[0.355]	[0.639]
International Activity * DestP	0.063*	0.175	0.123	0.251*	-0.038*	0.012	-0.128
	[0.085]	[0.161]	[0.308]	[0.085]	[0.093]	[0.690]	[0.437]
Net Intragroup Funding * DestP	0.007	-0.013	0.028**	0.000	0.007	0.009	0.014
	[0.145]	[0.402]	[0.036]	[0.995]	[0.369]	[0.163]	[0.603]
Core Deposits Ratio * DestP	0.064***	-0.012	0.157***	0.096	0.074*	0.064**	-0.093
	[0.009]	[0.877]	[0.003]	[0.198]	[0.063]	[0.020]	[0.271]
Observations	171,216	171,216	171,216	171,216	171,216	171,216	171,216
R-squared	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Adjusted R-squared	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Number of Destination Countries	52	52	52	52	52	52	52
Number of Banks	96	96	96	96	96	96	96
Destination Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of DestP	0.148	1.080**	-0.061	0.432	0.065	-0.013	0.029
(Contemporaneous and Lagged Indicator)	[0.341]	[0.016]	[0.883]	[0.277]	[0.789]	[0.927]	[0.964]
Contemporaneous Marginal Effect of DestP	-0.100	0.355	-0.157	0.086	-0.193	-0.222*	-0.597
	[0.381]	[0.230]	[0.556]	[0.709]	[0.131]	[0.058]	[0.114]

Table 4.15: Outward Transmission of Policy– Loans to the Non-bank Private Sector

This Table reports the effects of changes in destination country regulation and bank characteristics on log changes in loans to the Non-bank Sector by destination country. The data are quarterly from Q1:2002- Q4:2013 for a panel of bank holding companies whereas we use consolidated data. DestP refers to the changes in regulation in the destination country of the loan. For the marginal effect of DestP as well as DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Standard errors are clustered by destination country. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) DestP= Prudential IndexC	(2) DestP= Capital Requirements	(3) DestP= Sector-Specific Capital Buffer	(4) DestP= Loan To Value Ratio	(5) DestP= Reserve Requirement Foreign	(6) DestP= Reserve Requirement Local	(7) DestP= Concentration Ratios
Destination Country Regulation DestP_t	3.803*	13.116**	0.660	4.332	2.766	2.669	1.567
	[0.073]	[0.010]	[0.869]	[0.250]	[0.406]	[0.383]	[0.640]
Destination Country Regulation DestP_t-1	-3.647*	3.475	-3.489	-2.011	-5.629**	-4.580*	3.581
	[0.060]	[0.540]	[0.369]	[0.622]	[0.027]	[0.087]	[0.405]
Destination Country Regulation DestP_t-2	-0.778	15.508***	-8.780**	-7.435	-2.388	0.294	-3.633
	[0.713]	[0.005]	[0.010]	[0.132]	[0.331]	[0.893]	[0.656]
Log Total Assets_t-1	-0.203	-0.208	-0.210	-0.206	-0.204	-0.201	-0.201
	[0.139]	[0.142]	[0.131]	[0.135]	[0.141]	[0.149]	[0.149]
Capital Ratio_t-1	-0.013	-0.015	-0.012	-0.013	-0.011	-0.011	-0.012
	[0.387]	[0.341]	[0.426]	[0.377]	[0.437]	[0.474]	[0.435]
Illiquid Assets Ratio_t-1	-0.008	-0.008	-0.009*	-0.008	-0.008*	-0.009*	-0.008
	[0.116]	[0.123]	[0.087]	[0.105]	[0.098]	[0.083]	[0.103]
International Activity_t-1	-0.040**	-0.038**	-0.040**	-0.038**	-0.040**	-0.040**	-0.040**
	[0.023]	[0.022]	[0.018]	[0.026]	[0.018]	[0.018]	[0.020]
Net Intragroup Funding_t-1	-0.014	-0.021	-0.016	-0.021	-0.017	-0.020	-0.017
	[0.613]	[0.433]	[0.556]	[0.461]	[0.528]	[0.463]	[0.543]
Core Deposits Ratio_t-1	0.003	0.001	0.002	0.002	0.002	0.002	0.002
	[0.735]	[0.856]	[0.737]	[0.785]	[0.780]	[0.750]	[0.796]
BIS Financial Cycle (Destination country)	0.010*	0.010*	0.009*	0.009*	0.009*	0.010*	0.010*
	[0.072]	[0.067]	[0.075]	[0.072]	[0.075]	[0.077]	[0.074]
BIS Business Cycle (Destination country)	0.029	0.028	0.027	0.027	0.027	0.028	0.028
	[0.156]	[0.186]	[0.195]	[0.190]	[0.190]	[0.187]	[0.186]
Log Total Assets * DestP	0.048	-1.141***	0.453***	0.225	0.241	0.103	-0.037
	[0.762]	[0.003]	[0.007]	[0.556]	[0.122]	[0.613]	[0.936]
Capital Ratio * DestP	0.037	-0.056	0.042	0.083	0.044	0.067	0.119
	[0.357]	[0.336]	[0.515]	[0.421]	[0.137]	[0.257]	[0.556]
Illiquid Assets Ratio * DestP	-0.010	-0.075**	0.023	-0.004	-0.011	-0.021**	-0.015
	[0.191]	[0.032]	[0.291]	[0.819]	[0.332]	[0.012]	[0.623]
International Activity * DestP	-0.053	-0.189	-0.043	0.162*	-0.027	-0.077**	-0.069
	[0.112]	[0.121]	[0.651]	[0.069]	[0.487]	[0.012]	[0.662]
Net Intragroup Funding * DestP	-0.002	-0.021	-0.013	0.006	0.011*	-0.004	0.017
	[0.837]	[0.396]	[0.454]	[0.821]	[0.063]	[0.736]	[0.691]
Core Deposits Ratio * DestP	-0.012	-0.033	-0.012	-0.043	-0.040*	0.025	-0.069
	[0.650]	[0.511]	[0.826]	[0.390]	[0.067]	[0.416]	[0.559]
Observations	176,099	176,099	176,099	176,099	176,099	176,099	176,099
R-squared	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Adjusted R-squared	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Number of Destination Countries	52	52	52	52	52	52	52
Number of Banks	96	96	96	96	96	96	96
Destination Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of DestP	-0.101	-0.729	0.356	0.110	-0.140	-0.267*	0.160
(Contemporaneous and Lagged Indicator)	[0.522]	[0.110]	[0.197]	[0.813]	[0.628]	[0.091]	[0.778]
Contemporaneous Marginal Effect of DestP	-0.196**	0.000	-0.028	0.001	-0.288	-0.337***	-0.324
	[0.041]	[1.000]	[0.897]	[0.998]	[0.134]	[0.003]	[0.343]

Table 4.16: Outward Transmission of Policy to Destination Country – Foreign Branches vs. Subsidiaries

This Table reports the effects of changes in host country regulation and bank characteristics on log changes in local lending of German banks' foreign branches and subsidiaries. The data are quarterly from Q1:2002- Q4:2013 for a panel of foreign affiliates of German banks. Branch-level data are aggregated across all branches of one parent bank per destination country. Coefficients referring to subsidiaries show the total effect by aggregating the coefficients of the baseline category (Branches) and the subsidiary specific interaction effect and reporting their joint significance. DestP refers to the changes in regulation in the destination country of the loan, which is the host country in this specification. For the marginal effect of DestP as well as DestP interaction effects, the reported coefficient is the sum of the contemporaneous term and two lags, with the corresponding p-value of the F-statistic for joint significance reported below. For more details on the variables see Appendix, Table 4.1. Each column gives the result for the regulatory measure specified in the column headline. All specifications include fixed effects as specified in the lower part of the Table. Bank explanatory variables, cycle variables, prudential instruments are included in the regressions but not reported. Standard errors are clustered at the host country level. P-values are reported in square brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) DestP= Prudential IndexC	(2) DestP= Capital Requirements	(3) DestP= Sector-Specific Capital Buffer	(4) DestP= Loan To Value Ratio	(5) DestP= Reserve Requirement Foreign	(6) DestP= Reserve Requirement Local	(7) DestP= Concentration Ratios
Log Total Assets * DestP (Branches)	-5.848**	-9.772	-2.097	-1.138	5.093	2.902	-15.680*
	[0.042]	[0.230]	[0.827]	[0.836]	[0.583]	[0.404]	[0.062]
Capital Ratio * DestP (Branches)	-1.448**	-1.133	-0.796	-0.117	2.546	-0.446	-2.930***
	[0.043]	[0.555]	[0.737]	[0.910]	[0.110]	[0.596]	[0.003]
Illiquid Assets Ratio * DestP (Branches)	0.229	-0.195	0.410	0.470	-1.995***	0.735**	0.778
	[0.249]	[0.484]	[0.602]	[0.107]	[0.001]	[0.038]	[0.184]
International Activity * DestP (Branches)	-0.097	-0.014	-0.733	-0.163	0.239	-0.096	-1.951
	[0.615]	[0.982]	[0.573]	[0.559]	[0.616]	[0.708]	[0.301]
Net Intragroup Funding * DestP (Branches)	-0.119	-0.287	0.228	-0.073	0.368*	-0.203	0.065
	[0.351]	[0.193]	[0.298]	[0.615]	[0.072]	[0.510]	[0.888]
Core Deposits Ratio * DestP (Branches)	-0.341	-0.348	-0.223	-0.930	-0.974***	-0.054	-2.501***
	[0.281]	[0.562]	[0.844]	[0.171]	[0.008]	[0.898]	[0.000]
Log Total Assets * DestP (Subsidiaries)	0.236	-1.592	-0.181	-1.962	2.053	-1.669	12.099
	[0.895]	[0.774]	[0.927]	[0.761]	[0.504]	[0.558]	[0.243]
Capital Ratio * DestP (Subsidiaries)	0.294	0.117	-0.308	0.809	0.882	0.485	1.969
	[0.367]	[0.838]	[0.756]	[0.515]	[0.290]	[0.474]	[0.112]
Illiquid Assets Ratio * DestP (Subsidiaries)	0.329	-0.786	-0.043	0.794	-0.343	0.850	0.876
	[0.253]	[0.366]	[0.807]	[0.456]	[0.129]	[0.149]	[0.537]
International Activity * DestP (Subsidiaries)	-0.023	1.213	-0.352*	0.029	0.960**	-0.572	1.583
	[0.928]	[0.321]	[0.084]	[0.972]	[0.012]	[0.344]	[0.215]
Net Intragroup Funding * DestP (Subsidiaries)	0.253	0.392	0.298	0.252	0.601**	0.023	0.848
	[0.182]	[0.218]	[0.320]	[0.390]	[0.018]	[0.925]	[0.376]
Core Deposits Ratio * DestP (Subsidiaries)	0.314	0.353	0.250*	-0.111	0.047	0.245	1.200*
	[0.147]	[0.692]	[0.083]	[0.813]	[0.824]	[0.491]	[0.090]
Observations	9,273	9,273	9,273	9,273	9,273	9,273	9,273
R-squared	0.024	0.023	0.021	0.021	0.020	0.021	0.023
Adjusted R-squared	0.014	0.012	0.011	0.011	0.010	0.011	0.013
Number of Host Countries	49	49	49	49	49	49	49
Number of Banks	349	349	349	349	349	349	349
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Marginal Effect of DestP (Contemporaneous and Lagged Indicator) (Branches)	11.209*	12.910	10.439	0.856	14.393	11.649	-2.724
	[0.092]	[0.176]	[0.604]	[0.927]	[0.533]	[0.230]	[0.782]
Contemporaneous Marginal Effect of DestP (Branches)	2.523	6.508	3.360	4.876	21.345	3.151	-19.115***
	[0.468]	[0.112]	[0.660]	[0.335]	[0.150]	[0.490]	[0.000]
Marginal Effect of DestP (Contemporaneous and Lagged Indicator) (Subsidiaries)	-6.495	-27.280	6.958	-13.781	-31.083**	5.997	-74.528
	[0.358]	[0.206]	[0.305]	[0.557]	[0.015]	[0.714]	[0.116]
Contemporaneous Marginal Effect of DestP (Subsidiaries)	-12.384***	-16.168	-11.815***	-27.211**	-19.162	2.026	-7.676
	[0.000]	[0.149]	[0.005]	[0.020]	[0.140]	[0.810]	[0.316]

Conclusion and outlook

During the European sovereign debt crisis, implicit government bailout guarantees for banks and financial institutions' large government debt holdings, among other factors, have spurred negative feedback effects between sovereign risk and risks in the financial system. This so-called "sovereign-bank-nexus" has threatened financial stability in Europe. This thesis contributed to the research on spillovers from sovereign risk to the financial system, on banks' demand for government bonds, and on cross-border spillovers of national prudential measures.

Chapter 1 of the thesis studied the determinants of German banks' government bond holdings and the effects of these holdings on bank risk. One lesson from this paper was that banks select themselves into holding government debt and that about 15% of German banks never participated in government bonds markets (during the period 2005-2013). Another lesson was that macroeconomic and fiscal fundamentals of sovereigns did not play a role in German banks' investment decisions before the global financial crisis, but only afterwards. Also, German commercial banks, in particular, were affected by their cross-border holdings of risky government debt after the outbreak of the European debt crisis.

Chapter 2 tested whether moral suasion by regional ("Länder") governments could explain German banks' preference for home over other state bonds. The Chapter showed that a bank had higher holdings of home state bonds if the home state was in a weaker fiscal situation and the bank was directly owned by the state or was controlled by state politicians as members of its supervisory board. Banks located in other states had lower bond holdings of weak states. The results implied that political linkages such as public ownership of banks or membership of politicians in banks' supervisory boards played a role in banks' investment decisions, even in a relatively fiscally strong country like Germany.

Chapter 3 considered the effects of sovereign risk on different sectors of the economy, with a focus on insurance companies. The results suggested that the vulnerability of insurers to an increase in domestic sovereign risk was not significantly different from the vulnerability of banks but larger than that of non-financial companies. This difference to non-financial companies was attributed to systemically important insurers. Similar to the results on banks in Chapter 1, insurers were also affected by foreign sovereign risk through their cross-border holdings of government bonds.

Chapter 4 analyzed cross-border spillovers of regulation through German banks' local and global lending activities. The findings emphasized that a tightening in foreign regulation may spill to the German lending market through two channels, the presence of foreign-owned affiliate in Germany and the international activities of German-owned global banks. In addition, the banks' organizational structure and the regulatory perimeter mattered for the lending response of German banks' foreign affiliates to host country regulation.

Overall, this thesis has implications for the design and evaluation of regulation, for the political economy of banking and for cross-border spillovers of risks and regulation. An overarching lesson from the thesis is that granular, micro-level data is key to identifying the incentives and vulnerabilities of financial institutions.

The thesis highlights a shortcoming of current banking and insurance regulations which assume that domestic sovereign bonds are risk free. The empirical analysis showed that accounting-based and market-based measures for banks' and insurers' default risk are increased by the riskiness of these institutions' sovereign bond portfolios. However, in European banking regulation, sovereign bonds that are issued by European member states in domestic currency are granted a zero risk weight and are exempted from large exposure limits (Article 114(4) and Article 400 of the Capital Requirements Regulation (CRR)). Also, bank liquidity regulations grant a preferential treatment to EU sovereign bonds. Under European insurance regulation, the Solvency II framework, EEA sovereign bonds are exempted from the credit and concentration risk modules for the calculation of solvency capital requirements (Solvency II, Delegated Regulation (EU) 2015/35). This preferential treatment of sovereign debt relative to private debt may crowd out lending to the private sector (see Bonner, 2015, for a study on the banking case) and leave the financial system unprotected against a rise in sovereign risk. Policy makers are therefore discussing potential changes to the regulatory treatment of sovereign debt (BCBS, 2015; ESRB, 2015).

Another topic of this thesis is that the political setting may impact the investment decisions of private firms beyond explicit regulations. Politics are particularly relevant for financial firms since governments simultaneously borrow from, regulate, and provide financial backstops to domestic financial institutions. Depending on the federal structure of political systems, these connections between governments and banks may be closer at the regional than at the central level. Evidence for moral suasion in Germany may hence be uncovered only at the regional government level, not at the aggregated country level (Ongena, Popov, and van Horen, 2016). The mutual dependence between governments and domestic banks may give

rise to moral hazard on both sides and has been one reason for the establishment of the European Banking Union (Farhi and Tirole, 2016).

The thesis has implications for the evaluation of regulatory reforms. Since the global financial crisis, the banking regulatory framework has been adjusted in numerous ways, including through higher capital and liquidity requirements and the implementation of macroprudential instruments that target systemic risks. The interactions of regulatory changes with other policies such as monetary and fiscal policy as well as the responses by regulated and unregulated entities are complex and evolving over time. Therefore, the effectiveness and costs of (regulatory) policies need to be evaluated in a comprehensive and transparent approach. This thesis contributes to a broad, multi-country research project conducted by the International Banking Research Network (IRBN) that studies the spillovers of regulation across borders. The thesis provides evidence for the German banking system and has implications for the effectiveness of regulations. Another conclusion is that microprudential characteristics such as a bank's capital and liquidity buffer are important for the effects of macroprudential policies.

Overall, the thesis focused on the volume of banks' activities and thereby contributed to the literature on prices in government bond markets. The results highlighted the differences in incentives between types of market participants, for instance home versus other investors. Understanding the incentives of market participants is crucial for understanding market outcomes and how policies interact with them. A common misconception in academic and policy discussions is that "the market" has coherent beliefs or expectations as if it was one person (Shin, 2015). In fact, market prices are being driven by many market participants that may have different incentives and beliefs and jointly determine the effects of policies (Shin, 2015). In terms of research, a next step could be to integrate the volume and the price perspectives and study the price setting behavior at the investor level. There are however constraints to data availability that will need to be addressed.

Another interesting extension of this thesis would be to study cross-sector spillovers of regulation through non-bank financial intermediaries that are outside the bank regulatory perimeter. When regulation for the banking sector tightens, non-banks may benefit from a competitive advantage and take over some of the banking activities. The scope and implications of these cross-sector shifts in financial intermediation are a worthwhile avenue for future research.

More generally, researchers and policymakers so far concentrated on understanding and re-regulating banking activities mainly. Insight into the role of non-bank financial intermediaries for financial stability is more limited at this stage. This thesis makes a first step in addressing this gap by including insurance companies in the analysis of sovereign risk transmission. Going forward, the interaction between banks, non-banks and the real economy needs to be studied further.

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