Discussion Paper

Banks' holdings of risky sovereign bonds in the absence of the nexus – yield seeking with central bank funding or de-risking?

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Non-technical summary

Research question

While during the financial crisis both moral suasion and search for yield have been cited as factors explaining high and even increasing sovereign exposures of banks in euro area countries strongly affected by the crisis, we analyse whether search-for-yield strategies played a role in investments in risky sovereign bonds in the absence of moral suasion. To this end, our study focuses on the investment patterns of German banks. Besides, we address the extent to which their investment depended on central bank funding, government support, capitalisation and securities trading activities.

Contribution

We fill an important gap in the literature, as our analysis for banks in a non-vulnerable country focuses on their holdings of bonds issued by both vulnerable and non-vulnerable foreign sovereigns. Controlling for bank characteristics – such as participation in government bailout programmes and capital adequacy – allows for a clear-cut investigation into bank behaviour with respect to peripheral sovereign bonds. In addition, we examine whether the risk-taking behaviour of German banks was affected by their recourse to central bank refinancing facilities during phases of expansionary monetary policy, their wholesale funding and their trading activities during and before the crisis period.

Results

For the large German banks under review, a key result is that, during the crisis period, publicly supported banks (bailed-out banks) did not engage in risky yield-seeking strategies, but instead divested from risky assets, including sovereign bonds from vulnerable countries in the euro area. This supports our hypothesis of a regulation- and reputation-induced de-risking strategy. In some ways, this behaviour contrasts with the moral suasion motive of publicly supported banks in the vulnerable countries. Moreover, we find that the yield-seeking of German banks (i.e. their purchases of risky sovereign bonds during the crisis period) depends positively on their degree of capitalisation, but not on central bank funding. This result contrasts with existing evidence for euro area countries strongly affected by the crisis, in which domestic risky sovereign bonds were purchased by weakly capitalised banks – possibly in an attempt to gamble for resurrection to strengthen the sovereign-bank nexus or due to a kind of "indirect" moral suasion.

Nichttechnische Zusammenfassung

Fragestellung

Während die hohen und in der Finanzkrise gewachsenen öffentlichen Anleihebestände der Banken in Ländern des Euroraums, die stark von der Krise betroffen waren, in der Literatur mit staatlicher Einflussnahme (‚Moral suasion') und mit der Suche nach Rendite begründet werden, behandelt die vorliegende Studie die Frage, ob das Renditestreben auch in Abwesenheit von ‚Moral suasion' eine Rolle für Investitionen in risikobehaftete Staatsanleihen gespielt hat. Vor diesem Hintergrund steht hier das Anlageverhalten deutscher Banken im Mittelpunkt. Wir untersuchen, inwieweit Portfoliobewegungen deutscher Banken durch Renditestreben erklärt werden können und in welchem Umfang Anlageentscheidungen von staatlicher Unterstützung, Zentralbankfinanzierung und der Eigenkapitalausstattung abhingen.

Beitrag

Staatsschuldverschreibungen von sicheren und unsicheren Emissionsländern in den Büchern von Banken eines Landes, das nicht von einer eigenen Staatsschuldenkrise betroffen war, sind bisher in der Literatur kaum analysiert worden. Wir können eindeutige Ergebnisse in Bezug auf das Renditestreben deutscher Banken herleiten, indem wir für wichtige Bankcharakteristika wie den Rückgriff auf staatliche Unterstützung in der Krise und die Eigenkapitalausstattung kontrollieren. Zusätzlich erhalten wir Hinweise darauf, wie der Rückgriff auf Liquidität aus der expansiven Geldpolitik – direkt gemessen anhand des Umfangs der Refinanzierung der Banken bei Zentralbanken – sowie die Kapitalmarktfinanzierung und die Handelsaktivitäten der deutschen Banken ihre Risikoneigung in und vor der Krise beeinflusst haben.

Ergebnisse

Große deutsche staatlich unterstützte Banken haben während der Krisenjahre kein Renditestreben in Form einer erhöhten Risikoübernahme gezeigt; vielmehr trennten sie sich von riskanten Titeln, darunter Staatsschuldverschreibungen der Krisenländer. Dies stützt unsere Hypothese einer regulierungs- und reputationsgetriebenen Strategie des Risikoabbaus, was im Kontrast zum ‚Moral suasion'-Motiv staatlich gestützter Banken in den Krisenländern gesehen werden kann. Zudem finden wir, dass das Renditestreben deutscher Banken (d.h. der Kauf von Anleihen aus den Krisenländern) positiv vom Kapitalisierungsgrad abhängt und nicht von der Zentralbankfinanzierung. Dieses Ergebnis steht ebenfalls im Gegensatz zu existierenden Untersuchungen für die Krisenländer, laut denen schwach kapitalisierte Banken riskante heimische Staatstitel mit der Folge – oder der Absicht – eines stärkeren Nexus (‚gambling for resurrection') oder auf Grund einer Art indirekter ‚Moral suasion' erworben haben.

Banks' holdings of risky sovereign bonds in the absence of the nexus – yield seeking with central bank funding or de-risking?[1]

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Abstract

For the largest 55 German banks, we detect the presence of countercyclical yield seeking in the form of acquisition of high-yielding periphery bonds in the period from Q1 2008 to Q2 2011. This investment strategy is pursued by banks not subject to a bailout, banks characterised by high capitalisation, banks that rely on short-term wholesale funding, and trading banks. In the subsequent period up to 2014, these banks switched to a procyclical divestment strategy resulting in the sale of risky assets. Following the launch of the public sector purchase programme (PSPP) in 2015, a clear investment pattern can no longer be identified. Unlike existing evidence for banks domiciled in vulnerable countries, we find that the recourse to central bank finance is rather limited and does not affect the risk-taking behaviour of banks in the non-stressed country Germany. Yield-seeking strategies were predominantly pursued by healthy banks in Germany. This contrasts with the increases in domestic sovereign holdings in vulnerable countries which can be primarily regarded as the result of moral suasion or, for weakly capitalised banks, a kind of "indirect" moral suasion or "home-biased" gambling for resurrection.

Keywords: Sovereign-bank nexus, sovereign bond holdings, yield seeking, moral suasion, capital adequacy, expansionary monetary policy, home bias

JEL classification: G11, G21, F34, H81

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1 Introduction

As at the end of March 2008, EMU government debt securities outstanding amounted to 8.0 trillion € and accounted for 48% of total debt securities issued by euro area residents.[2] The supposed creditworthiness and safety attributed to EMU government bonds, especially before the financial and sovereign debt crisis, was just one argument for their popularity amongst investors and credit institutions, in particular.[3] Another reason why banks hold such bonds is their special regulatory status: under the regulatory framework of the Basel II standardised approach, holdings of domestic government bonds denominated in the home currency are exempted from a costly capital backing. This preferential regulatory treatment incentivised banks to build up considerable stocks of foreign and domestic sovereign debt in domestic currency, where the later in turn gave rise to a nexus between governments and banks. In the literature, several studies for EMU countries strongly affected by the crisis[4] find that the domestic sovereign exposure of banks was significantly enlarged by state-owned banks and banks that were bailed out by their government during the financial and sovereign debt crisis. Against this background, we explore at the bank level the extent to which German banks' sovereign bond investment responded to the perturbations during the recent sovereign debt crisis, as mirrored by high variations in yield and risk profiles for vulnerable EMU bonds in particular. Looking at German banks allows us to investigate banks' investment behaviour in a non-stressed country – hence in the absence of moral suasion which we see as the crucial driver in the stressed countries. Within our sample of the largest 55 German bank, foreign EMU bonds – especially from vulnerable countries – amounted to more than half of their equity capital or 1.5 % of their total assets at the end Q1 2008. This shows the relevance of these positions.[5]

The literature distinguishes two types of behaviour that motivate banks to step up their risky government exposure: if, in the vulnerable countries, public banks or banks under the bailout programme increase their holdings of their stressed sovereigns' debt in order to please their governments or due to pressure exerted by their governments, this behaviour is dubbed "moral suasion" (see, for example, Altavilla, Pagano and Simonelli

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[2] Source: BIS debt security statistics (https://www.bis.org/statistics/secstats.htm).
[3] From the perspective of a credit institution, sovereign debt securities fulfil various functions: Besides generating interest income and its role in meeting regulatory liquidity requirements, bonds can be pledged as collateral within the secured interbank money market and in Eurosystem refinancing operations, allowing liquidity to be obtained at conditions set by monetary policy.
[4] In the remainder of this paper, we refer to these countries as "vulnerable countries".
[5] Besides, some banks were already under stress by their exposure to US mortgage-backed securities which showed sharp price falls with the starting of the financial crisis in mid-2007. The banks partially held these stocks via special purpose vehicles.

(2017), Ongena, Popov and van Horen (2016), and Becker and Ivashina (2014)). In contrast to this strategy, "search for yield" refers to a shift towards risky bonds motivated by economic reasons rather than imposed by the domestic sovereign. This behaviour is also dubbed "carry trade" in some parts of the literature.[6] Unlike the moral suasion motive, banks in both vulnerable countries and those not affected by a sovereign debt crisis may purchase risky sovereign bonds for yield-seeking reasons (see, for example, Acharya and Steffen (2015)). Looking primarily at banks' holdings of domestic government bonds in EMU periphery countries, Altavilla et al. (2017) and Horváth, Huizinga and Ioannidou (2015) empirically confirm both the moral-suasion hypothesis and the yield-seeking hypothesis.

While banks in distress may purchase high-yielding risky paper to gamble for resurrection, banks with a sound balance sheet may buy the same assets because they are in a position to bear the associated risks. In the literature, weakly capitalised banks in vulnerable countries are found to engage with risky *domestic* sovereign bonds even when there is no direct sovereign-bank nexus in terms of bailouts or public ownership. These banks may anticipate that their investment in domestic sovereign debt may be appreciated by the government and thus conduct a special form of gambling for resurrection, namely with a focus on domestic sovereign investments. We call this strategy "home-biased gambling for resurrection". Vice versa, the government may exert special pressure on weakly capitalised banks under stress to reinforce the nexus. Since these capital-weak banks are not subject to explicit public intervention, we dub this kind of government interference "indirect" moral suasion (see Table 2 for a differentiation between the various trading strategies).[7]

In addition, weakly capitalised banks draw on the lender of last resort, borrowing through the ECB with its "unlimited funding to banks" (Drechsler, Drechsel, Marques-Ibanez and Schnabl (2016)),[8] which enables them to invest in risky assets, including

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[6] In this literature, the tested carry-trade hypothesis is limited to yield-seeking driven investment in risky sovereign bonds. The financing conditions for the bond purchases are not addressed. However, we know that, in the financial crisis, banks had access to cheap funding through LTROs offered by the ECB. With this in mind, for Altavilla et al. (2017), carry trades are defined as weakly capitalised banks purchasing more high-yield public debt and, in doing so, they pursue a strategy of gambling for resurrection. However, Acharya and Steffen (2015) define carry trades differently: banks increased their investments in GIIPS sovereign bonds and therefore reduced their holdings in secure papers like German sovereign bonds.

[7] Accordingly, Drechsler, Drechsel, Marques-Ibanez and Schnabl (2016) argue that weak banks in distressed countries may face "political economy pressures" to buy domestic sovereign bonds, as they may experience difficulties in obtaining regulatory approval. In the absence of government intervention, Ben-David, Palvia and Stulz (2019) question gambling for resurrection strategies by distressed banks and rather finds them reducing leverage.

[8] Drechsler et al. (2016) refer to the ECB's offer to banks of borrowing an unlimited amount at a given interest rate against the provision of sufficient collateral. They make reference to a further easing for

distressed sovereign debt. This leads to a shift in the holding structure of risky assets from strongly to weakly capitalised banks. According to Acharya and Steffen (2015), Italian and Spanish banks in particular markedly increased their sovereign bond holdings in the first half of 2012 (see Figure 1), mainly by purchasing bonds with maturities of three years or less – alongside the ECB's provision of funding to euro area banks via longer-term refinancing operations (LTROs).[9] For the non-vulnerable country Germany, Buch, Koetter and Ohls (2015) find that, with the outbreak of the crisis, banks reallocated their portfolios towards low-yielding and low-risk sovereign bonds, while they do not detect search-for-yield behaviour. Besides, Bonner (2016) shows that reinforced with an increase of the preferential treatment of government bonds Dutch banks with low liquidity and a low capital ratio tend to buy government bonds rather than private sector bonds. Finally, Abassi, Iyer, Peydró and Tous (2016) add that banks with intense trading activities engage especially in securities with large price drops, and this effect strengthens with rising capitalisation.

We add substantially to the existing literature in several ways. First, by looking at Germany as a non-vulnerable, safe haven country, we explore banks' sovereign bond portfolio decisions in the absence of moral suasion considerations.[10] Furthermore, our data allows us to compare investment behaviour in risky sovereign bonds – e.g. those issued by vulnerable countries – with the allocation of positions in government bonds regarded as riskless. We investigate the extent to which government interference[11] in combination with banking supervision requirements or reputational risks due to their reliance on public support affects their portfolio decisions and here if German bailed-out banks withdraw from risky positions in the crisis. We dub such a withdrawal of bailed-out banks "regulation- and reputation-imposed de-risking" or, briefly, "regulation-imposed de-risking" which in some ways mirrors the surge in risky domestic sovereign assets in the vulnerable countries – known as "moral suasion". We also investigate whether or not weakly capitalised German banks increase their risky sovereign holdings

banks to obtain funding, with the ECB offering haircuts below private-market haircuts on risky securities, such as asset-backed securities, mortgage-backed securities, covered bonds, and distressed-sovereign debt after September 2008.

[9] In contrast, the outcome for Italy from Peydró et al. (2017) shows – surprisingly – that the more capitalised banks are, the more intensely they reach for yield – a result which is inconsistent with the gambling-for-resurrection hypothesis. However, softer monetary policy is found to prompt more weakly capitalised banks to prefer purchases of securities over expanding credit supply.

[10] We fill an important gap, as our analysis for banks in a non-vulnerable country focuses on their holdings of bonds issued by foreign sovereigns that are either vulnerable or non-vulnerable. As the data used in Altavilla, Pagano and Simonelli's (2016) analysis do not cover banks' foreign government exposures by country, their study disregards substitution effects within the complete sovereign debt portfolio – an important caveat which they concede.

[11] In our sample, several fragile banks received government support. They took recourse to government guarantees, capital, or other rescue programmes.

and thus gamble for resurrection (see Altavilla et al. (2017) for banks in vulnerable countries). If we find that this is not the case, it would be questionable that weakly capitalised banks in vulnerable countries concentrating on domestic sovereign bonds pursue a "standard" gambling-for-resurrection strategy. Instead, we would infer that the latter is rather a special, "home-biased" gambling-for-resurrection strategy with the intention of reinforcing the sovereign-bank nexus. Moreover, we add further characteristics to the analysis which turn out to be highly relevant. These are the recourse to central bank funding, short-term wholesale funding, the tier 1 capital adequacy ratio, as well as proxies for securities trading activities.[12] Thereby in contrast to most other studies in this field, we exactly know how much each bank in our sample relies on central bank funding at each point in time.[13] Furthermore, our results are significantly enriched by the separate analysis of time subsamples – in particular, before and after the launch of the LTROs by the ECB (see also Acharya and Steffen (2015) for the banks' recourse to the LTROs[14]) – and an additional decomposition of bond transactions into purchases and sales.[15] The additional consideration of the period before the start of the sovereign debt crisis allows for an analysis of banks' pre-crisis portfolio strategies. Finally, by extending our sample up to the end of 2016, our data set includes the period in which the Eurosystem's quantitative easing (PSPP) already took place.

As a result in our first subsample from Q1 2008 to mid-2011, the 55 largest German banks exhibited countercyclical yield seeking strategies and acquired high-yielding periphery bonds. This includes the investment behaviour of bailed-out banks. In addition, this behaviour was more common among banks with higher ratios of tier 1 capital to risk-weighted assets (RWA). In contrast to the literature on banks in vulnerable countries, recourse to central bank finance does not have any implications for the risk-taking behaviour of banks in a "safe" country such as Germany. However, a more intense recourse to short-term wholesale funding is linked to yield seeking. As well, banks that are more active in securities trading are more engaged in yield-seeking investments. Subsequently, up to 2014 this strategy was replaced by a procyclical

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[12] For German banks, Frey (2016) shows that different bank characteristics can be used to assess the health of an institute in the crisis.

[13] Some German banks also took recourse to the US Federal Reserve's Term Auction Facility (see Buch, Koch and Koetter (2018)). However, we see this dollar funding with respect to German banks' holdings of EMU sovereign bonds less relevant.

[14] Acharya and Steffen (2015) also construct shorter subsamples within the crisis period. In a different approach, they rely on banks' daily stock returns as the dependent variable – instead of sovereign bond holdings as in our setting – and with the daily return on ten-year government bonds as the most important exogenous variable.

[15] In the literature, different approaches are applied: while, for example, Altavilla et al. (2017) look at purchases and sales of sovereign bonds together, Abassi, Iyer, Peydro and Tous (2016) limit their analysis to purchases.

strategy that was driven primarily by their selling activities. We dub this de-risking strategy found among German banks a "regulation-imposed" divestment. It contrasts with the moral suasion-driven build-up of sovereign domestic bond holdings found in the literature among banks in vulnerable countries over the same period. Finally, for the holdings of bonds from non-vulnerable countries, we see only positive investments through procyclical behaviour and no countercyclical yield-seeking strategies. After 2014, with the launch of the public sector purchase programme (PSPP), a clear investment pattern can no longer be identified.

The paper is organized as follows: Section 2 introduces our data, and section 3 describes our approach. In section 4 the estimation output is presented, and section 5 concludes.

2   Data

We work with micro data on bank balance sheet items collected by the Deutsche Bundesbank. As we focus on banks' foreign sovereign bonds, we gain highly valuable information from the banks' external position statistics. For the German parent banks, this data source offers book values for sovereign holdings in the issue currency from 2002 onwards.[16] In our innovative approach we address the quarterly changes in these book values what provides us with very good approximations of the transaction-induced variations in the sovereign bond positions of banks.[17] As banks concentrate their securities holdings at the parent, we still obtain reliable data for the whole banking group, too.[18] We enrich our bank micro data with banking supervision data to capture banks' fragility with the tier 1-to-RWA ratio. Furthermore, bank characteristic data stem mainly from the monthly balance sheet statistics. Here, we look at the consolidated data of bank parents with their branches that form a legal entity and thus offer a more complete picture with respect to bank characteristics. Finally, to measure banks' securities trading activity, we focus on their international securities transactions recorded as gross values in the balance of payments statistics. As these statistics also record multiple sales and purchases of the same security – commonly identified by ISINs – by an economic agent, this is also an excellent proxy for securities trading

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[16] Like Altavilla (2017), our data does not allow to distinguish hold-to-maturity versus available for sale portfolios. However in internal studies we could see for more recent data that the available for sale portfolio is quite small and that there is no general trend to shift stocks from one portfolio to the other.
[17] Taking recourse to changes in the book value, we can be sure that we identify transactions. However, we do not know the realised payments as we have no knowledge of the market values. As we focus on the growth rates of bond stocks in our estimations, we can expect that our measure is still accurate. In general, write offs play a negligible role.
[18] This holds especially true for bonds issued by euro area countries.

activity that has not been applied in the literature before.[19] With respect to our bank characteristics, our correlation matrix depicts some results that we would expect: first, there is a negative correlation between short-term wholesale funding and net financing at the central bank. We may also expect that it is the banks with a high tier 1-to-RWA ratio that that rely more heavily on wholesale funding – as they have better financing conditions on the financial markets – and less on funding from the central bank. However, this holds true only for our first subsample from Q1 2008 to Q2 2011. In our second sample, wholesale funding is attributed more to the banks with a lower tier 1 ratio. One reason for this could be that their ranking changed as banks that initially had low capital adequacy increased their equity capital over the course of the crisis (see the complete correlation matrix in Table 1).

Table 1: Correlation matrix for bank characteristics

	Tier 1/rwa	St_fund_noBbk	Net_fin_cb	Total_trade	St_total_trade
Period: 2008Q1 bis 2011Q2					
Tier 1/rwa	100%				
St_fund_noBbk	32%	100%			
Net_fin_cb	-29%	-30%	100%		
Total_trade	15%	18%	-9%	100%	
St_total_trade	14%	26%	-10%	97%	100%
Period: 2011Q3 to 2014Q4					
Tier 1/rwa	100%				
St_fund_noBbk	-15%	100%			
Net_fin_cb	-33%	-17%	100%		
Total_trade	-2%	25%	-13%	100%	
St_total_trade	-1%	31%	-19%	96%	100%

With respect to macro data, we use ten-year sovereign bond yield data to calculate price movements of the bonds and we use premia of sovereign credit default swaps (CDS) to classify the riskiness of sovereign bonds. Finally, we utilise exchange rate. All these macro data are provided by Thomson Reuters and Bloomberg.

We focus on the 100 largest German banks measured by total assets at end of 2009 – as, among the small banks, foreign sovereign bond stocks are frequently null or negligible. When we exclude foreign-owned and promotional banks with their narrow business orientation, and additionally control for mergers within the remaining group, the number of banks falls to 67. This sample is reduced by a further 12 banks when we exclude the banks that do not have stocks in foreign euro area sovereign bonds at any –

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[19] The banks report data that comprise both their own securities transactions and those of their customers. This indicator stems from a joint analysis of Rainer Frey and Stefan Goldbach (also Deutsche Bundesbank).

or virtually any – point of observation during our main period from 2008 to 2014.[20] This results in a final sample of 55 banks, of which 10 participated in a state bailout programme from 2008 or 2009 onwards. Our approach of restricting the sample to a smaller number of banks that exhibit significant activity in the sovereign bond market is supported by the literature: Buch, Koetter and Ohls (2016) look at the relevance of German banks' sovereign bonds holdings in the period from Q3 2005 to Q3 2013. They find that 15% of banks never held sovereign bonds in the entire sample period. By contrast, 25% of all German banks always held some sovereign debt, with German sovereign bonds generally playing an important role.[21] However, domestic sovereign bonds played a minor role in comparison to banking systems in other European countries – both in relative and absolute terms (see Figure 1).

Figure 1: Banking sector – security holdings of domestic general government (in billion euro)
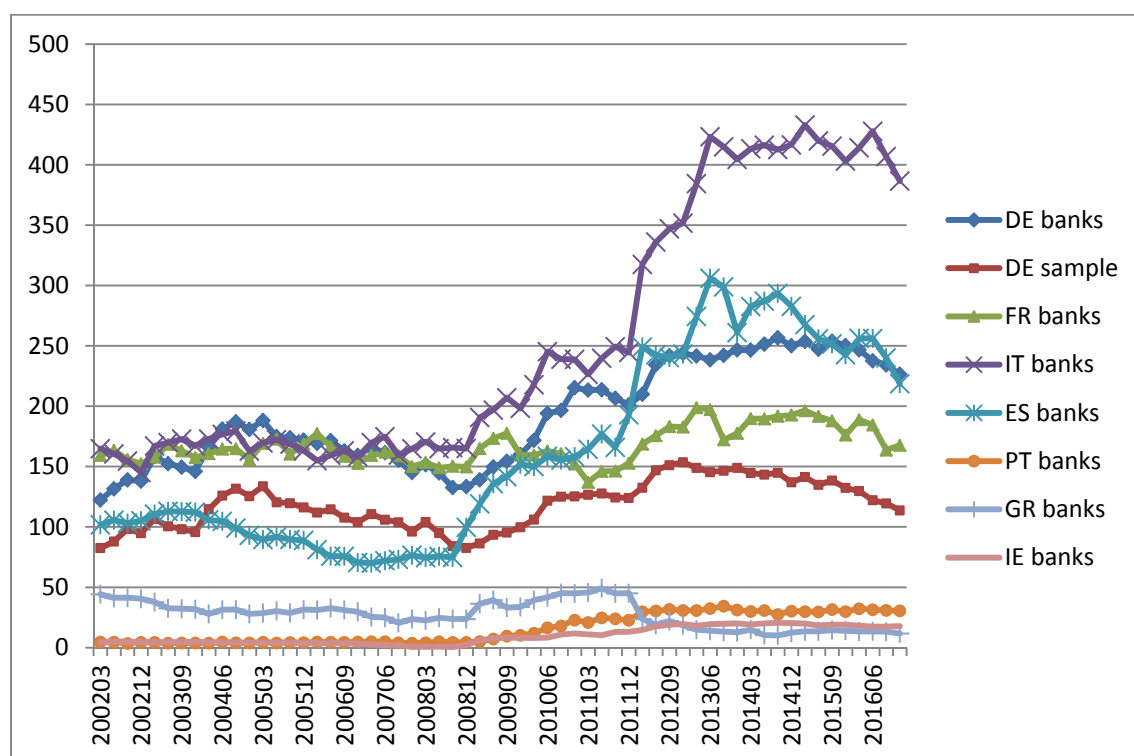
Source: ECB, MFI balance sheet statistics; for micro data for "DE sample": Deutsche Bundesbank's Research Data and Service Centre (RDSC): Monthly balance sheet data from Deutsche Bundesbank.

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[20] This restriction is motivated by our focus on banks "trading" in sovereign bonds. Banks that have nearly no foreign sovereigns obviously do not engage in such yield seeking strategies – at least with sovereign bonds– that are in our focus. Nevertheless, an inclusion of these 12 banks does not change our general conclusions.

[21] Additionally, investment activities in sovereign bond markets vary considerably across banking groups. For example, Buch et al. (2016) find that savings and cooperative banks do not have any significant exposure to euro area peripheral debt.

The crisis period from Q1 2008 to Q4 2014 is at the core of our study of German banking groups. This means that our sample includes the pronounced balance sheet shrinkage of the German banking system starting in Q3 2008.[22] This period corresponds with that of Altavilla, Pagano and Simonelli (2017) and largely overlaps with many of those in other seminal articles in this field, which enables us to introduce new aspects into the ongoing discussions. In comparison, we find that the time spans up to 2007 (from Q1 2002) and after 2014 (to 2016) do not yield evidence comparable to the asset allocation patterns found during the crisis period. We therefore concentrate on banks' investment behaviour displayed during the crisis. Specifically, the ECB's announcement of the Eurosystem's public sector purchase programme (PSPP) in early 2015 heralded a new regime, which apparently affected the management of German banks' sovereign bond portfolios. As a consequence, the relationships prevailing beforehand broke up after 2014. At the same time, the implementation of the banks' crisis-driven sovereign-bond strategies came to an end. Similarly to Acharya and Steffen (2015), we divide our sample period into subsamples and differentiate between country groups of sovereign bond issuers classified by their riskiness. However, while Acharya and Steffen work with four sub-periods, we consider two subsamples appropriate for German banks, namely Q1 2008 to Q2 2011 and Q3 2011 to Q4 2014. We thus split our sample period right in the middle. By doing this, the second peak in the sovereign debt crisis – i.e. the Greek debt relief in Q1 2012 and the preceding negotiations – is at the beginning of our second subsample. Moreover, the second subsample is characterised by an increasingly expansionary stance in monetary policy. In this period, the ECB introduced several refinancing facilities that eased the funding pressure of banks: in October 2011, the first twelve-month tender of LTROs was launched. This was followed by two LTROs with a maturity of three years in December 2011 and February 2012.[23] Moreover, the financial crisis led to various new regulations, and banks were partially forced to change business models either through direct regulation or as certain strategies became inefficient due to higher costs. In our sample, we argue that these adjustments are represented by the regulation- and reputation-imposed de-risking in the case of bailed-out banks, but played a minor role in the sovereign bond investment of non-bailed-out banks in Germany.[24]

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[22] Following the collapse of Lehman Brothers, there has been a broad contraction in the aggregate balance sheet of the German banking system – especially with respect to foreign assets (see Frey, 2015).

[23] In different stages of the crisis, banks may have behaved differently. Drechsler et al. (2016) find that weak bank capitalisation has an impact on central bank borrowing, but not in the first half of their financial crisis sample (October 2008 to May 2010).

[24] The influence of regulation on foreign activities – including securities holdings – may be a priori unclear. Ongena, Popov, and Udell (2013) see tighter home-country regulation and higher home-country minimum capital requirements as being accompanied by lower lending standards abroad.

To further hone our analysis, we also restrict the portfolio of sovereign bond holdings to issuer countries of relevance for German banks. By the end of 2006 – i.e. before the outbreak of the financial crisis – the sovereign bond holdings of the German banking system were concentrated on foreign paper from the euro area Member States (120 billion euro out of a total of 170 billion euro). Besides the EMU portfolio, another 20 billion euro was comprised by investments in the United Kingdom, the United States, Canada, Japan, Poland and Hungary.[25] For our analysis, we divide the euro area sovereign bonds into groups of vulnerable and non-vulnerable issuing countries. With a CDS premium higher than 300 basis points as at the end of 2011,[26] we classify the countries CY, ES, GR, IE, IT, LV, LT, PT and SI as vulnerable.[27] AT, BE, FI, FR, NL, SK, EE, LU and MT are categorised as non-vulnerable, with EE, LU and MT having no relevance for German banks' bond holdings. This country allocation is similar to that applied by Altavilla et al. (2017) and leads to the same outcome.[28] As these country groups are still heterogeneous with respect to size, liquidity, and behaviour of national banks, we also construct further subgroups in our analysis. As the criterion, we use the relevance of the holdings within the German banks' total exposure to foreign sovereign bonds and build subsamples with the three most relevant vulnerable and non-vulnerable issuer countries.[29]As we use CDS prices to gauge the default risk for non-EMU

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[25] Until mid-2016, foreign sovereign euro area holdings decreased to 107 billion euro while the sovereign bond holdings of the six non-euro area countries increased to 56 billion euro (to a new total of 180 billion euro).

[26] This point in time is chosen as it lies just before the Greek debt relief, which is one of the events with high relevance for the yields in the vulnerable countries and lies nearly in the middle of our main sample period from 2008 to 2014.

To cross-check the grouping into vulnerable and non-vulnerable countries in the euro area we also consider the average sovereign CDS spreads between 2008 and 2014. Here, the discrimination between vulnerable and non-vulnerable countries is fully identical with our classification - albeit at a lower CDS threshold level: non-vulnerable countries exhibit average CDS spreads up to 100 bp, while the corresponding values for vulnerable countries exceed 150 bp. As an alternative measure, we looked at average ratings of S&P and Moody's between 2008 and 2014. With the exception of Slovakia, the resulting rating hierarchies are consistent with our classification of countries into vulnerable and non-vulnerable countries. Of course, these static approaches have the disadvantage that they do not consider different economic evolutions of the countries in the aftermath of the crisis. As our main sample already ends in 2014, it may still be appropriate. Besides, as we address both a large group and a small group of vulnerable countries, we have a kind of a further robustness check.

[27] These countries have been at the focus of interest during the financial crisis partially owing to, for example, problems with sovereign debt that they, to a large extent, had already accumulated before the outbreak of the crisis, the role of their banking sectors and/or bursting real estate bubbles with severe implications for their debt burden in this period.

[28] Altavilla et al. (2017) reached the same outcome with a similar approach. They define as "vulnerable" – i.e. subject to high sovereign stress – countries whose ten-year sovereign yield exceeded 6% (or, equivalently, 4 percentage points above the German yield) for at least one quarter between 2008 and 2014.

[29] Acharya and Steffen (2015) identify a yield-seeking strategy for the largest peripheral countries (i.e. Italy and Spain). At the beginning of the sovereign debt crisis, Portuguese and Irish banks were already prominent investors in bonds of their own sovereigns. By contrast, Italian and Spanish banks markedly increased their domestic sovereign bond holdings in the first half of 2012 and thus significantly later.

countries, CA, GB, US, JP and PL are found to belong to the non-vulnerable countries, while HU is assigned to the group of vulnerable countries. Both the relevance of the euro area and reference to the literature suggest a focus on EMU sovereign bond issues in our main analyses. For the purpose of comparison, we also consider US and CA sovereign bonds, which behave similarly.

The regional breakdown of sovereign bond holdings shows considerable differences over time. While bonds from vulnerable countries within the euro area played by far the most important role in banks' sovereign bond portfolios (see Figure 2) around the turn of the year 2005/2006,[30] we see a decline in such holdings with a dip in mid-2007 corresponding to the start of the sub-prime crisis in the United States, which marks the first emergence of the financial crisis under review.[31] After a short period of stabilisation, the pressure on banking sectors intensified from Q1 2008 onwards and culminated in a worldwide meltdown of asset values after the Lehman collapse, entailing unprecedented public interventions and bank rescue measures on a global scale. Two years later, the balance sheets of European banks came under additional pressure by the emergence of the sovereign debt crisis in the wake of the looming Greek default between spring 2010 and the end of 2011. Conversely, the holdings of the sovereign bonds issued by non-vulnerable euro area countries increased from Q1 2008 onwards, although starting from a much lower level and growing at a lower rate. Regarding French government bonds, we observe periods in which these are treated as assets of a non-vulnerable issuer, but also find movements in parallel to the vulnerable countries.[32] Moreover, banks increasingly built up their holdings of sovereign bonds issued by non-euro area countries – largely dominated by the United States – up to the end of our sample starting in 2014.

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[30] This was shortly after the end of the government guarantees ("Gewährträgerhaftung") in mid-2005, which made it especially attractive for saving banks and Landesbanken to issue new debt at conditions very close to those of the public sector and to reinvest them in foreign sovereign bonds with higher yields, for example.

[31] In Figure A1 in the Appendix, the series for the groups of bailed-out and non-bailed-out banks are shown separately.

[32] This observed ambiguity is also reflected in our estimation results, in which including French bonds in the group of non-vulnerable and vulnerable countries respectively dilutes our results to some extent in both cases. It may reflect the fact that the stability of the sustainability of French sovereign debt was at least discussed during the course of the crisis. However, it was never severely questioned and French governments bonds were not the target of significant speculation on the financial markets during the crisis.

Figure 2: German banks' sovereign holdings in book values – breakdown by vulnerable and non-vulnerable euro area countries, as well as countries outside the euro area (in billion euros)
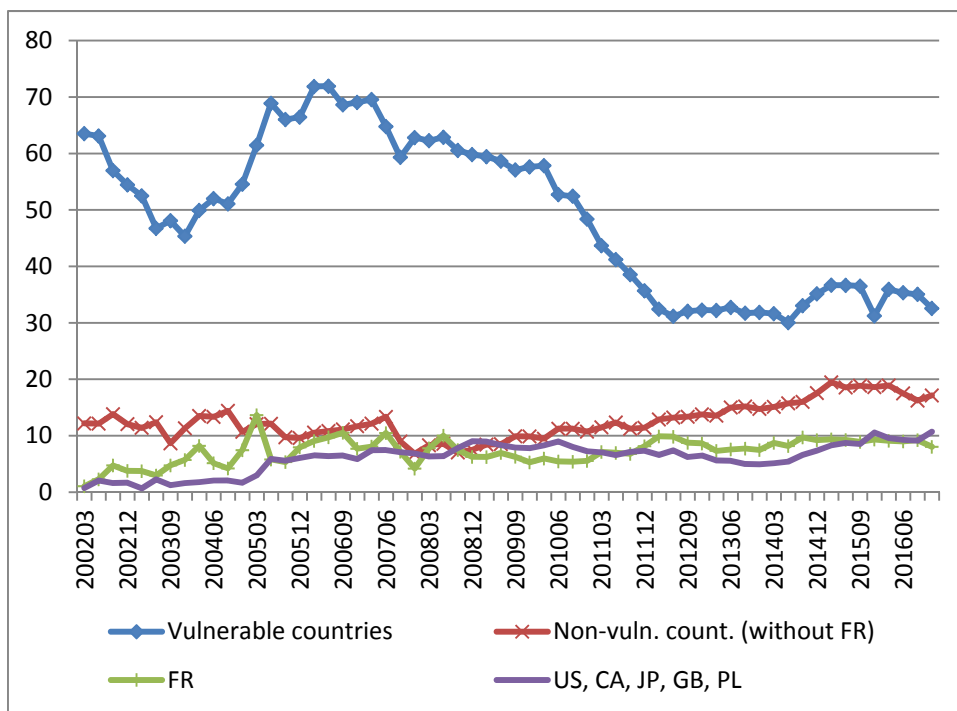
Source: Micro data from Deutsche Bundesbank's Research Data and Service Centre (RDSC): External position of banks; own calculations.

With respect to the individual euro area countries under review, the outstanding position of German banks' holdings of Italian bonds is noteworthy (see Figure 3). However, they were drastically cut back over time – more than halved – and ultimately reached the level of the Spanish issuance activity, which has grown strongly since mid-2014. The increasing investment in Spanish bonds indicates that market participants perceived Spain to be on its way to leaving the group of vulnerable countries. By contrast, the bonds issued by the third major player among the vulnerable countries in the German banks' sovereign portfolios in Q1 2008 – Greek government bonds – were cut back almost completely to zero – partially caused by a debt relief – at the beginning of 2012.

Figure 3: German banks' sovereign holdings in the most relevant vulnerable and non-vulnerable euro area countries (in billion euros)
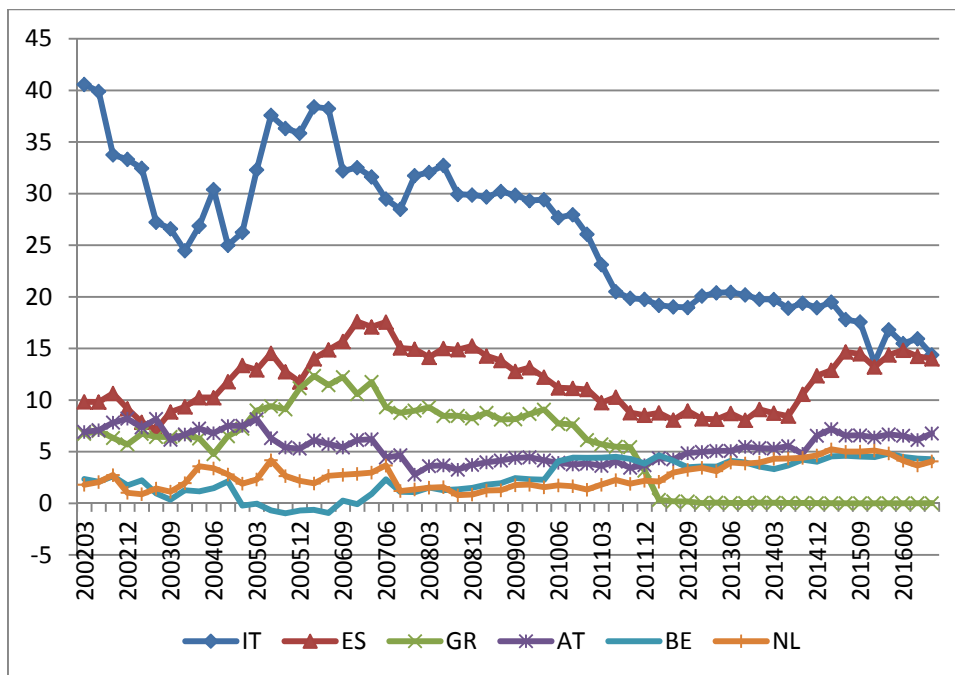
On the side of the most relevant non-vulnerable euro area countries, holdings of Austrian, Belgian and Dutch bonds in particular were stepped up after Q1 2008.

All data are calculated on a quarterly basis (for more on the data construction, see Section 4.1; and, for descriptive statistics, see Table 3 in the Appendix).

3 Methodology

Specifically, the project investigates the extent to which heightened risk perception on the market (rating downgrades, wider CDS spreads) altered portfolio structure and holdings of government bonds issued by non-domestic euro area governments, especially between 2008 and 2014. For instance, banks' propensity to hold risky foreign paper may decline with higher (expected) probabilities of default for the issuers of securities (i.e. with higher risk premia). For euro area government bonds, risk considerations were largely neglected prior to the financial and sovereign debt crisis; they were de facto considered safe and benefited from preferential regulatory treatment compared to private bonds.[33] Both risk and yield considerations may, therefore, have a

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[33] By contrast, the costs associated with higher regulatory capital requirements mean that there will per se be an incentive for greater reticence to include private issues in the portfolio; assuming the "same level of

role to play. Nonetheless, banks' portfolio decisions reflect the perceived riskiness of the exposure in relation to earning expectations: if banks expect a sovereign's probability of default to rise, coupled with a (further) increase in risk premia and a price decline in these government bonds, they are – in the absence of moral suasion and transaction costs – likely to sell. Banks' investment behaviour therefore also indirectly reflects their expectations regarding future market developments.

Thus, in our approach, we look at how individual banks' government bond holdings respond to price changes in these bonds. This allows us to detect the presence of procyclical versus countercyclical trading strategies. In doing so, we stick to the approach of Altavilla, Pagano and Simonelli (2017) to determine banks' portfolio investment behaviour. For both the moral-suasion hypothesis – limited to banks in vulnerable countries buying their domestic sovereign bonds – and the countercyclical yield-seeking hypothesis, banks are expected to invest in high-yielding and high-risk-bearing sovereign bonds in periods when their prices fall. This behaviour is consistent with a search for yield: if risk premia reflected in yield spreads are already high, like in the case of the periphery euro area bonds during the crisis (i.e. they exhibited an increase), the expectation of no further increase could induce banks to buy such bonds even in uncertain times. In doing so, they may try to benefit from a yield differential when they possibly finance their investment through "cheaper" short-term wholesale funding, central bank funding, or by selling safer, lower-yielding paper.

Altavilla et al. (2017) trace the yield-seeking strategy of domestic sovereign bond purchases back to the group of more weakly capitalised banks in vulnerable countries. They dub this behaviour "gambling for resurrection", which can be regarded as a special form of yield-seeking in distress. Nonetheless, it is not entirely clear why more weakly capitalised (and thus higher-risk) banks are more engaged in yield-seeking than well capitalised banks. On the one side, gambling for resurrection suggests that market participants with a high-risk profile are more prone to speculative behaviour. On the other side, well capitalised banks are in a better position to bear risks and to take advantage of risky but profitable investment opportunities. While both forms can be regarded as yield seeking, the results of Altavilla et al. (2017) point to its negative dependence on the degree of capitalisation. This warrants a closer look at whether or not the same linkage holds true for German banks.

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risk", the yield required (in the market or by banks) is therefore likely to be higher than for privileged debtors. Due to the different regulatory treatment, public and private bonds are not perfect substitutes. This leads us to limit our analysis to sovereign bonds, which is common in the literature.

Table 2: Trading strategies in risky sovereign bonds during the financial crisis

Investment in sovereign bonds issued by vulnerable countries		Strategy	
		Procyclical strategy:	**Countercyclical strategy:**
Notions		Procyclical shift towards risk versus procyclical de-risking	Yield seeking, risk-taking, risk-shifting; Gambling for resurrection: *in case of stressed banks with low capital endowment*
In addition to Banks in Vulnerable countries			Moral suasion (traditional): *bailed-out banks or publicly owned banks with strong investment in domestic sovereign bonds* "Indirect" moral suasion**: *stressed banks with low capital endowment and strong investment in domestic sovereign bonds; government interference to make banks increase domestic sovereign exposure* "Home-biased" gambling for resurrection**: *stressed banks with low capital endowment and with strong investment in domestic sovereign bonds; the banks intention is to strengthen the sovereign-bank nexus*
Banks in non-vulnerable countries		"Regulation- and reputation-imposed" divestment from risky sovereign bonds**: *Bailed-out banks with strong divestment in risky sovereign bonds*	
Reaction of banks' exposure in risky assets to price changes	Increase	Purchase if prices* are rising	Trading activity in bonds (purchase if prices are falling, or sale if prices are rising)
	Decrease	Sale if prices* are falling (de-risking)	
Macroeconomic implication		"Destabilising"	"Stabilising"

*) Prices of sovereign bonds.
**) Notions introduced by the authors.

In contrast to the yield-seeking strategies, we define the trading behaviour of banks to be procyclical if investors divest when prices fall, and vice versa (Table 2). With respect to the sovereign bond portfolio of German banks, our research question is how stressed bond holdings respond to price changes. More precisely, we address which types of banks invest or divest in a procyclical manner, and which types of banks tend to search for yield in a countercyclical manner. According to the IMF (2013), the banking sector is especially prone to procyclicality, as high leverage – in combination with rigid market-based risk management systems and capital requirements – triggers a tightening of credit standards in an economic downturn (Gerlach and Gruenwald, 2006; Brunnermeier, 2009; Fernandez de Lis and García-Herrero, 2010). In the same vein, Rochet (2008) argues that regulatory systems may themselves generate procyclicality in financial systems. However, the present paper shows that, even without capital requirements,[34] part of the German banking sector acts procyclically by offloading risky sovereign bond positions as prices go down. In this context, we speak of "regulation- and reputation-imposed de-risking" or, briefly, "regulation-imposed de-risking" [35] – mirroring the shift of risky sovereign bond positions from German banks to (certain) banks in vulnerable EMU countries, where the risk-taking of the latter is likely to be driven by moral suasion or "home-biased" gambling for resurrection.

Within this framework, we can empirically test theories currently being debated in the literature about buying and selling behaviour in terms of domestic versus foreign government bonds before and during the crisis. To this end, we carry out panel regressions at the sovereign bond stocks' country-quarter level for each bank. The inclusion of specific bank characteristics – for example, with respect to the funding structure – enables us further to assess the heterogeneity of bank responses.

Our approach closely resembles that of Altavilla et al. (2017): we look at the banks' decisions with respect to their sovereign bonds portfolios when, in the event of a sovereign debt crisis, prices fall.[36] However, while they only take into account the percentage price change in interaction with other variables, we also include it as a stand-

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[34] Under the current regulatory regime, banks that choose an internal risk-based approach (IRBA) have the option of exempting euro-denominated sovereign debt positions from capital requirements (partial use).

[35] In non-vulnerable countries, bailed-out banks may withdraw from risky sovereign bond positions in the crisis as a result of government interference and banking supervision requirements. Furthermore, defamatory pressure in the public due to their reliance on state aid may lead to a cutback in risky activities, such as government bonds with high CDS premia.

[36] For the regressions below, as in Altavilla et al (2017), we also let the movements of transactions and prices act simultaneously. This may be technically justified as we look at variations across quarters and we thus get a stronger link between the movements. Besides, as we focus on foreign sovereign holdings, the German banks have rather a small fraction of the overall outstanding bonds. This should further limit endogeneity issues.

alone exogenous variable, which allows us to calculate overall effects for the estimated coefficients.[37] In our basic econometric equation, we divide our sample running from Q1 2008 to Q4 2014 into two subsamples with the split at mid-2011, which does not only lie right in the middle of our sample, but can also be justified for economic reasons: the break is just before the peak in the Greek debt crisis and before the launch of the LTROs by the ECB. In our first specification, we investigate whether the investment strategies of bailed-out banks differ from those of the other banks across the two subsamples – for all transactions, but also for purchases and sales separately[38] and for different country groupings:

$$\frac{\Delta H_{ijt}}{H_{ijt-1}} = \alpha_i + \beta_j + \gamma_t + \vartheta Bailout_i + \delta_1 \frac{\Delta P_{jt}}{P_{jt-1}} + \delta_2 Bailout_i * \frac{\Delta P_{jt}}{P_{jt-1}} + \theta_1 \frac{\Delta P_{jt}}{P_{jt-1}} * Post +$$

$$\theta_2 Bailout_i * \frac{\Delta P_{jt}}{P_{jt-1}} * Post + \rho X_{it-1} + \varepsilon_{ijt} \tag{1}$$

where the dependent variable $\frac{\Delta H_{ijt}}{H_{ijt-1}}$ is the quarterly percentage change in bank i's sovereign holding issued in country j, and held in quarter t. $\frac{\Delta P_{jt}}{P_{jt-1}}$ is the percentage change in the price of the bonds of country j, as in Altavilla et al. (2017), calculated as the product of the quarter-on-quarter change in the relevant ten-year yield by the corresponding duration, as in De Marco (2018).[39] The indicator variable *Bailout$_i$* takes a value of one for the complete period[40] if bank i benefits from government support in the form of recapitalisation or a guarantee at any time in the period from Q1 2008 to Q4 2014, or zero otherwise. *Post* represents a time dummy, taking a value one from Q3 2011 onwards and zero before. As in Altavilla et al. (2017), we include the lagged deposit-liability ratio X_{t-1} as a bank-level control. In addition, we include a bank fixed effect α_i for the unobserved heterogeneity at the bank level. To control for differences across countries and over time, we include a country fixed effect β_j and a time fixed effect γ_t. In addition, errors are clustered at the bank-country level to allow for serial correlation of residuals at this level.

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[37] However, we leave out foreign subsidiaries, as these are generally not relevant investors in securities. Thus, with respect to the moral-suasion hypothesis in Altavilla et al. (2017) and our proposed "regulation-imposed" de-risking hypothesis, we concentrate on the bailout variable, especially in its interaction with the percentage price change, but also as a stand-alone variable.

[38] In the literature, different approaches are applied: while, for example, Altavilla et al. (2017) look at purchases and sales of bonds together, Abassi, Iyer, Peydro and Tous (2016) limit their analysis to purchases.

[39] The quarterly growth rates of sovereign holdings are trimmed at ±100% to remove outliers.

[40] Most of our bailed-out banks received state aid, which may be in form of financial support or guarantees towards the end of 2008 and the beginning of 2009 respectively (according to an online request to the European Commission state aid database in 2017). Our assumption of setting the dummy across the whole period is therefore not very strong. Furthermore, it is expected that these banks would have already behaved differently in the months just before the bailouts were officially announced.

In a slight modification, we consider this relationship in the period before our main sample, with a time span from Q1 2002 to Q4 2007. Again, we introduce a sample split in order to define a pre-crisis period immediately preceding our crisis period:

$$\frac{\Delta H_{ijt}}{H_{ijt-1}} = \alpha_i + \beta_j + \gamma_t + \vartheta Bailout_i + \delta_1 \frac{\Delta P_{jt}}{P_{jt-1}} + \delta_2 Bailout_i * \frac{\Delta P_{jt}}{P_{jt-1}} + \theta_1 \frac{\Delta P_{jt}}{P_{jt-1}} * Pre +$$

$$\theta_2 Bailout_i * \frac{\Delta P_{jt}}{P_{jt-1}} * Pre + \rho X_{it-1} + \varepsilon_{ijt} \quad\quad\quad (1B)$$

where *Pre* represents a time dummy, taking a value of one from Q1 2005 to Q4 2007 and zero before. Here, $Bailout_i$ again refers to the banks that requested state aid in the subsequent period, which allows us to investigate whether they had already exhibited different investment patterns previously.

We then open up our approach for other bank characteristics to allow us to investigate some other questions currently discussed in the literature:

$$\frac{\Delta H_{ijt}}{H_{ijt-1}} = \alpha_i + \beta_j + \gamma_t + \vartheta Characteristic\_H_{it} + \delta_1 \frac{\Delta P_{jt}}{P_{jt-1}} + \delta_2 Characteristic\_H_{it} *$$

$$\frac{\Delta P_{jt}}{P_{jt-1}} + \theta_1 \frac{\Delta P_{jt}}{P_{jt-1}} * Post + \theta_2 Characteristic\_H_{it} * \frac{\Delta P_{jt}}{P_{jt-1}} * Post + \rho X_{it-1} + \varepsilon_{ijt} \quad (2)$$

where the dummy $Characteristic\_H_{it}$ takes a value of one for half of the bank sample marked by a value equal to or greater than the median of that specific bank characteristic and zero otherwise.[41] We look at the following characteristics: net funding at the central bank, short-term wholesale funding, capital adequacy in form of the tier 1-to-RWA ratio,[42] and securities trading at period *t*.

In our analysis, we use interaction terms to capture the incremental response to price changes for group of banks or periods of time. The sum of the original (non-interacted) response to a price change and the incremental response (the interaction term referring to a specific subgroup of banks or to a restricted period) is dubbed "overall effect" in our study. Referring to the notation of the coefficient of the resulting linear combination, we use the suffix of a quotation mark ("′") in our output tables.

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[41] As capital adequacy is rather a strategic target variable for the bank, we find it more suitable to address the median for the banks' mean of the first subsample, rather than to reclassify the banks at every point of time. In the second subsample, banking supervision may already have affected the value.

[42] This is an essential component of testing gambling for resurrection according to the definition of Altavilla et al. (2017).

4 Outcome

4.1 Bailed-out and non-bailed-out banks' sovereign bond holdings of vulnerable and non-vulnerable issuer countries

As German banks are not resident in a vulnerable country where the moral-suasion argument may arise, our focus is on the contercyclical yield-seeking hypothesis and the regulation-imposed de-risking strategy. For German bailed-out banks, we expect the latter, as these are "officially" in bad health and thus may behave differently than other banks. Furthermore, in exchange for government support, they may also have had to abide by official instructions. This, and a likely interest in improving their tarnished reputation, may lead them to reduce risky sovereign holdings, which we subsume under regulation-imposed de-risking. In the figures (see Figure A1 in the Appendix), we can already see that the bailed-out banks' exposure vis-à-vis the vulnerable countries sharply decreases from Q1 2010 onwards, while one of the non-bailed-out banks sees a steep decline following Q4 2010. We therefore start our analysis by differentiating between the groups of bailed-out and non-bailed-out banks (see Equation (1)).

In Table 4, columns (1)-(3), we address the banks' holdings of sovereign bonds issued by vulnerable countries over the two subsamples of Q1 2008 to Q2 2011 and Q3 2011 to Q4 2014. First, when we focus on *all* transactions (column (1)) – including purchases and sales – yield-seeking, risk-taking strategies are pursued solely by non-bailed-out banks in the first subsample. This is shown by a significantly negative coefficient of the price change variable (δ_1). However, we cannot detect a clear investment strategy for the bailed-out banks in the first subsample. The coefficient $\delta_2{}'$ denotes the combined effect (i.e. referring to the sum of the coefficient of the price change and the coefficient of the interaction between the price change and the bailout dummy).[43] In the second subsample, starting from Q3 2011 and characterised by large decreases in the stocks of sovereign bonds from the periphery, we find a procyclical strategy for both non-bailed-out and bailed-out banks (significantly positive coefficients θ_1' and $\theta_2{}'$). For the latter, this divestment strategy corresponds to our definition of imposed de-risking. Second, differentiating transactions by bond purchases and bond sales yields additional valuable insights: first, banks subject to a bailout buy per se less and sell per se more in the period Q1 2008 to Q4 2014 (coefficient ϑ in column (2) for purchases – and with stronger price reactions for the most relevant vulnerable countries IT, ES and GR in column (5) – and in column (3) for sales). However, with respect to their reaction to

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[43] In the following, all coefficients followed by a notation mark (′) indicate that we consider sensitivities for combined effects – here, the pure price effect in combination with the price effect interacted with a dummy.

price changes, our estimation results for bond purchases suggest a countercyclical investment strategy both for the non-bailed-out *and* the bailed-out banks in the first subsample (coefficients δ_1 and $\delta_2{}'$). However, on the sales side, bailed-out banks pursue a procyclical regulation-imposed de-risking strategy in both subsamples (coefficients $\delta_2{}'$ and $\theta_2{}'$) – they sell bonds in times of decreasing prices. Column (4) reports the resulting coefficients for the estimation over the entire estimation period of Q1 2008 to Q4 2014 with respect to changes in sovereign bond holdings, referring to our large sample of bond holdings issued by vulnerable countries. For this period, the only evidence we find is the regulation-imposed de-risking strategy of bailed-out banks, as indicated by a positive sensitivity for the interaction term of bailout and price change ($\delta_2{}'$).

In line with the developments of the sovereign bond holdings depicted in Figure (2), the banks' investment strategies are not the same with respect to bonds issued by vulnerable and non-vulnerable sovereigns.

Table 4 also reports the estimation results for all transactions in bonds issued by non-vulnerable EMU countries. In column (6), we see only procyclical behaviour but no countercyclical yield-seeking strategy. However, this behaviour is detected only for the second sub-period under review (from Q3 2011 onwards). Here, we find significantly positive sensitivities for both bailed-out as well as non-bailed-out banks (see the coefficients $\theta_1{}'$ and $\theta_2{}'$, which capture the interactions with price change). As reported in columns (7) and (8), procyclicality turns out to be significant in their purchase behaviour only. Moreover, we obtain a better fit in terms of higher coefficients and a higher R squared when we restrict the sample to the most relevant holdings of Austrian, Belgian and Dutch sovereign bonds – for purchases, see column (9). As can be seen in a comparison of columns (9) and (10), adding French sovereign bonds to the estimation sample reduces the coefficients of interest to some extent. This indicates that banks were temporarily uncertain about the stability of French finances during the course of the crisis. Apparently, banks reassessed the role of French sovereign bonds more often than those of other safe government bonds.[44] With the inclusion of German sovereign bonds (column 11), the impact of price changes on bond holdings is still highly significant, but strongly reduced. This finding points to the fact that Bund positions, in particular, fulfil a number of different functions for German banks, including their role as a liquidity management tool. After all, search-for-yield considerations do not prompt German banks to hold domestic sovereign bonds. Finally, we compare these results to

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[44] Adding French sovereign bonds reduces the coefficients in both the estimations for the group of non-vulnerable countries and the group of vulnerable countries, which we tested in several regressions. For this reason, we ignore the bonds of this country in our estimations.

the sensitivities found for major holdings in non-euro area sovereign bonds. These are mainly bonds issued by the United States and Canada[45] (see column (12)). The estimation results are similar to those of the complete group of non-vulnerable EMU countries (column (6)). Here, we also find a procyclical investment strategy in the period from Q3 2011 to Q4 2014 – both for bailed-out and non-bailed-out banks (see significantly positive sensitivities θ_1' and θ_2').

4.2 The effects of central bank versus wholesale funding, capital adequacy and security trading on banks sovereign investments

Next, we take into account the fact that banks are heterogeneous and consider various characteristics that we conjecture to determine the banks' decision to buy or sell a risky sovereign bond.[46] To this end, we split the sample into two subgroups at the median value of a specific bank characteristic at each point of time. The dummy *Characteristic_H* takes a value of one for the upper half of the banks and zero for the lower half of the banks (see Table 5). With respect to the banks' funding, our estimations are carried out against the background that banks in vulnerable countries were found to increase their stocks in domestic sovereign bonds in response to expansionary monetary policies (see, for example, Acharya et al. (2015)). We address this question quite directly by considering, on a net basis, the use of central bank refinancing facilities including LTROs (see Table 5, columns (1) and (2)). At least for exposures to the most relevant vulnerable countries IT, ES and GR (see column 2), we find a negative sensitivity to price changes (δ_1). Accordingly, banks with moderate central bank funding (i.e. below the cross-section median) pursue a countercyclical yield-seeking strategy in the first subsample from Q1 2008 to Q2 2011. Conversely, banks with relatively great recourse to central bank funding are not sensitive to price changes (δ_2') in their sovereign bond exposures (for both the large and the small group of vulnerable countries). However in the second stage from Q3 2011 to Q4 2014, both groups of banks pursue a – possibly regulation-imposed – de-risking strategy (see coefficients θ_1' and θ_2'). Thus, higher reliance on central bank funding does not coincide with greater risk-taking among German banks. A reason might be that central bank funding is more the outcome of the necessities of all business fields of a bank and there is thus no direct link to risky sovereign investments. This contrasts with the literature that finds, for banks in vulnerable countries, that central bank funding has supported risk-taking strategies. Instead, German banks rely more on short-term wholesale funding when they pursue countercyclical yield-seeking strategies, as

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[45] The evolution of stocks of Canadian bonds in German banks' bond holdings resembles that of the much more relevant US bonds.
[46] Here, risky sovereign bonds refer to debt securities issued by vulnerable countries.

suggested in our first subsample (see coefficients $\delta_2{'}$ for sensitivities with significantly negative signs in columns (3) and (4)). In the second period, however, they switch to a de-risking strategy (see coefficients $\theta_2{'}$ with significantly positive signs).

In the next step, we focus on differences in the investment behaviour by splitting our sample into weakly capitalised and well capitalised banks. We define banks to be weakly (or well) capitalised if the average tier 1-to-RWA ratio in the period from Q1 2008 to Q2 2011 is below (or above) the sample median (see columns (5) and (6)). This allows us to distinguish between two forms of yield seeking: on the one side, well capitalised banks are likely to be able to bear associated risks. On the other side, the motive for gambling for resurrection is more likely to play a role among weakly capitalised banks. With regard to well capitalised banks, the coefficients of percentage price changes ($\delta_2{'}$) turn out to be significantly negative in columns (5) and (6) – for all vulnerable countries at the 10% significance level, and for IT, ES and GR at the 5% level. The coefficient for the weakly capitalised banks (δ_1) is only found to be negative for IT, ES and GR, and only at a significance level of 10% and lower (in absolute terms). Thus, in our study, the better capitalised banks are more engaged in countercyclical yield-seeking strategies.[47] This pattern contradicts the findings in the literature for vulnerable countries, stating that weakly capitalised banks act as risk-takers in the sense of a gambling for resurrection (see, for example, Acharya and Steffen (2015)). This fits with our aforementioned estimation result that short-term wholesale funding, rather than central bank funding, is a more important vehicle for financing the implementation of search-for-yield strategies. Thus, financial market conditions seem to have been less favourable for the more weakly capitalised banks. Again, in our later subsample starting from Q3 2011, we find de-risking behaviour for both groups defined in terms capital adequacy (see significantly positive coefficients $\theta_1{'}$ and $\theta_2{'}$) in columns (5) and (6).

Finally, we look at trading banks in terms of banks with high gross values of cross-border securities transactions, both in total and in the short term, with a limitation of transactions involving the same security within one month (see columns (6) to (10)). In accordance with expectations, the trading banks – both in total figures and in the short-term differentiation – are the banks engaged in yield seeking in the first subsample until Q2 2011 (significantly negative sensitivity coefficient $\delta_2{'}$). This supports the results of Abbassi et al. (2016), who find that, in the period from 2005 to 2012, German trading

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[47] This outcome holds when we run our regressions without the group of bailed-out banks. However, we find that the discrepancies in the results between the higher and lower capitalised banks are less accentuated than in the complete sample.

banks[48] increased their investments primarily in securities with a large price drop. In our second subsample, we see a reversal in trading banks' behaviour towards de-risking (see sensitivity $\theta_2{}'$ with significantly positive signs).

4.3 Banks' investment in the sovereign bonds of vulnerable countries before and after the crisis

In the preceding sections, we addressed banks' portfolio strategies during the financial and sovereign debt crisis, where extraordinary changes in yield, risk perception and bank portfolios occurred, and some banks were confronted with a worsening of their financial health. Now we ask whether banks pursue similar investment strategies in "normal" times with less volatile markets. To this end, we look back at the time span from Q1 2002 to Q4 2007, which we split into two sub-periods at Q4 2004.[49] With the second sub-period from Q1 2005 to Q4 2007, we analyse the run-up period to the financial crisis. Again, our focus is on the vulnerable countries as defined above. Even before the start of the crisis, bonds in these jurisdictions traded at a wider yield spread than bonds from Germany to compensate for higher risks – though at much lower levels.[50] Still, holdings of sovereign bonds from vulnerable countries were relatively high up to the start of the crisis. In our estimations, we explore whether banks subject to a bailout during the crisis had already been taking different portfolio decisions before the start of the crisis. To address this issue, we estimate equation (1B). According to columns (1) to (5) in Table 6, the coefficients of the percentage price change variable and its interaction terms become almost completely insignificant. The sole exception is column (4), where we limit the transactions to the purchases in the three most important vulnerable countries: IT, ES and GR. Here, non-bailed-out banks, as well as banks subject to a bailout in the subsequent crisis period, exhibit significantly negative sensitivities to the percentage change in prices during the run-up to the crisis between Q1 2005 and Q4 2007 (see coefficients $\theta_1{}'$ and $\theta_2{}'$). Thus, we already see a kind of yield-seeking behaviour according to our definition here. However, only the behaviour for the bailed-out banks is significant at the 5% level – for the non-bailed-out ones only at the 10% level – and the sensitivity coefficient for the latterly supported banks corresponds to nearly twice that of the non-bailed-out banks. This outcome gives us some indication that banks that were later in difficulties neglected the risks in the run-up

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[48] Their proxy of trading banks is direct membership in the fixed-income trading platform Eurex Exchange.

[49] Frey (2015) shows that, for German banks in time span from 2005 to mid-2008 – and thus relatively close to the outbreak of the crisis – extraordinary risk-taking was taking place.

[50] Notwithstanding the subdued perception of sovereign default risk at that time, Gerlach, Schulz and Wolff (2010) find that countries with large banking sectors tended to exhibit greater widening of yield spreads when aggregate risk increased.

to the crisis. Rather astonishing is the outcome that a bailout per se reduces investment in the vulnerable countries (significantly negative coefficient ϑ).

While our core analysis covers the period up to 2014, we also report our estimation results for an extended period up to 2016 (see columns (6)-(8) in Table 6). The period after 2014 is characterised by the launch of the public sector purchase programme (PSPP) in 2015, through which the ECB entered the euro area sovereign markets as a dominant investor. We test whether this modified environment affected the relationships found beforehand or whether banks' crisis strategies have been replaced by changed investment behaviour. Indeed, with this two-year extension, we find that the de-risking strategy of banks is no longer significant in the estimation period from Q3 2011 onwards – though in column (6), $\theta_2{'}$ is significantly positive but, with a coefficient of 0.006, at a rather negligible level. Thus, for this period, we do not find any evidence for a clear investment strategy at all (see the coefficients $\theta_1{'}$ and θ_2'). Likewise, the banks do no longer follow unique strategies. This suggests that some of the banks under review are likely to be still engaged in divestment strategies, while other banks may have re-entered the trading business. Moreover, as the crisis regime is being phased out, a breakdown of the banking sector into bailed-out and non-bailed-out banks is likely to have become less relevant, in explaining differences in bond-holding strategies.

5 Conclusions

For the large German banks, a key result is that, in general, bailed-out banks did not engage in countercyclical yield seeking but pursued a strategy of divestment from sovereign periphery bonds. This supports our hypothesis of a regulation- and reputation-induced de-risking strategy, which, in some ways, mirrors the moral suasion-driven purchases of banks in the vulnerable countries. In the period from Q1 2008 to Q2 2011, a yield-seeking strategy with respect to investments in sovereign bonds issued by vulnerable, peripheral EMU countries was indeed observable for German banks, but was limited to banks that had not been bailed out, banks with high short-term wholesale funding, and banks with a high level of engagement in securities trading. Furthermore, we obtain no evidence for the yield-seeking hypothesis in the sense of gambling for resurrection among weakly capitalised German banks, defined by an average tier 1-to-RWA ratio below the median. Instead, the first sample period provides evidence for search-for-yield activities among well capitalised banks, implying an increased sovereign exposure in peripheral countries. This result contrasts with the findings of Altavilla et al. (2017) for vulnerable countries, where, accordingly, domestic sovereign bond purchases have been used to gamble for resurrection. With reference to our output,

their focus on domestic high yielding bonds – thus neglecting high-yielding assets from foreign sovereigns – may instead prompt a "indirect" moral suasion. This is supported by Drechsler et al. (2016), who argue that weak banks in distressed countries may face "political economy pressures" to buy domestic sovereign bonds – while in the absence of government intervention, the distressed banks would reduce leverage (see Ben-David et al. (2019)). Moreover, these banks may have their own motivations for intensifying the sovereign-bank nexus and pursue a home-biased gambling-for-resurrection strategy.

While central bank refinancing facilities such as LTROs apparently played a key role for banks in vulnerable countries investing in risky sovereign bonds (see, for example, Acharya et al. (2015)), central bank funding did not incentivise German banks to invest more in risky foreign sovereign assets. In the later period from Q3 2011 to Q4 2014, the German banks under review broadly pursued a de-risking strategy in terms of divestment from periphery sovereign bonds. This was largely independent of their capitalisation, central bank funding, and other distinctive bank characteristics. Consistent with investment behaviour characterised by prudence, they stepped up their holdings of sovereign bonds from non-vulnerable countries – including Germany. Such a strategy strengthens the banks and thus prevents them from curtailing their lending activities to the private sector due to stress – with potentially adverse implications for the real economy.[51] Again, this stands in contrast to the considerable domestic positions in risky domestic sovereign debt held by banks in the vulnerable countries – which actually even significantly increased in the later stage of crisis; these shifts in risky holdings were facilitated by the preferential regulatory treatment of sovereign exposures.[52]

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[51] Becker and Ivashina (2018) show that, in countries affected by the crisis, banks' increased holdings of domestic sovereign bonds cause corporate lending to be crowded out. In addition, the ESRB (2015), in its special report on sovereign exposures, sees the danger of high risk in banks' books stemming from their holdings of sovereigns. The reasons why the governments of the vulnerable countries in particular argue that the preferential regulatory treatment of sovereign bonds is indispensable for maintaining the domestic banking sector as a powerful shock absorber in periods of distress must therefore be scrutinised (see Visco (2016) and Gros (2017)).

[52] See Basel Committee on Banking Supervision (2017). Besides, Rochet (2008) argues that capital requirements lead to procyclical behaviour. However we see procyclicality in the financial system in the absence of such a regulatory approach as well. This raises doubts regarding the buffering function of this sector in times of distress when investment is not led by moral-suasion strategies.

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6 Appendix

Figure A1: Development of German bailed-out and non-bailed-out banks' sovereign holdings from vulnerable euro area countries (in billion euro)
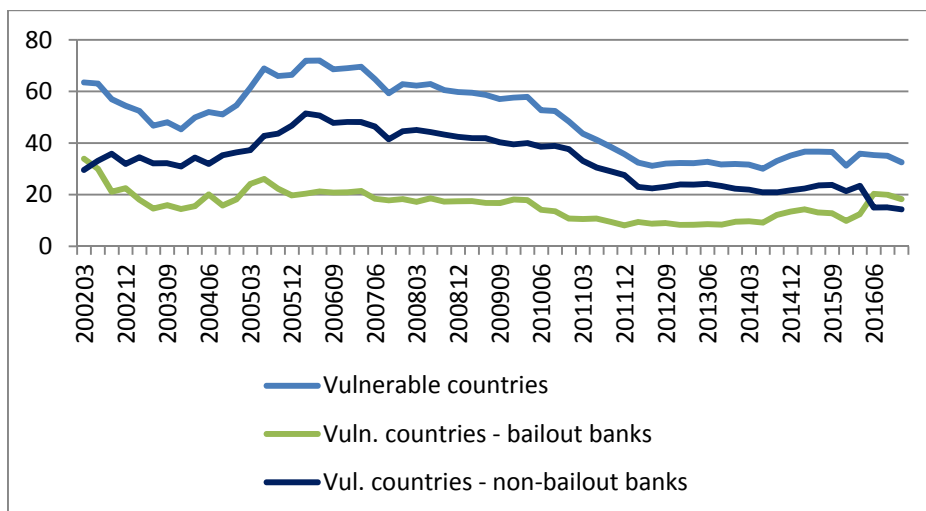
Source: Micro data from Deutsche Bundesbank's Research Data and Service Centre (RDSC): External position of banks; own calculations.

Table 3: Descriptive statistics

In its upper panel, this table presents the mean, median, and standard deviation of banks' quarterly sovereign exposures and its quarter-on-quarter growth rates for different samples of countries. The following countries are categorised as EMU vulnerable: CY, ES, GR, IE, IT, LV, LT, PT and SI (labelled 'vulnerable large'). AT, BE, FI, FR, NL, and SK are categorised as EMU non-vulnerable (labelled 'non-vulnerable large'). Separate regressions are carried out for the subgroups a) ES, IT and GR (labelled 'vulnerable small'), b) AT, BE and NL (labelled 'non-vulnerable small') – partially with FR and DE in addition – and c) US and CA as non-vulnerable countries outside EMU. With respect to the bank characteristics in the second panel of the table, net funding at the central bank, short-term wholesale funding, the tier 1-to-RWA ratio, total trading activity, short-term trading activity, as well as deposits are defined – with the exception of the tier 1-to-RWA ratio – as a percentage of total bank assets. The indicator variable bailout takes a value of one for banks that took recourse to government support in the financial crisis, and zero otherwise.

Panel: Sovereign bond exposures vis-a-vis different country groups						
Time: 2008Q1 to 2014Q4						
	Sample without Germany			*Germany*		
	Mean	Median	SD	Mean	Median	SD
Sovereign exposure	72212,6	0,0	391139,8	2250379,9	571841,5	3641812,6
Sovereign holdings growth	0,007	0,000	0,277	0,050	0,000	0,271
	Vul large			*Non-vul large*		
	Mean	Median	SD	Mean	Median	SD
Sovereign exposure	89099,3	0,0	493659,7	43318,4	0,0	152465,7
Sovereign holdings growth	-0,004	0,000	0,249	0,022	0,000	0,320
	Vul small			*Non-vul small*		
Sovereign exposure	237374,0	0,0	829610,7	61814,1	0,0	190584,7
Sovereign holdings growth	-0,008	0,000	0,262	0,028	0,000	0,330
Time: 2008Q1 to 2011Q2						
	Vul large			*Non-vul large*		
Sovereign exposure	111759,6	0,0	551692,3	34995,9	0,0	135377,8
Sovereign holdings growth	-0,001	0,000	0,254	0,020	0,000	0,331
	Vul small			*Non-vul small*		
Sovereign exposure	297435,3	1004,0	920163,9	49345,0	0,0	168342,2
Sovereign holdings growth	-0,006	0,000	0,257	0,028	0,000	0,342
Time: 2011Q3 to 2014Q4						
	Vul large			*Non-vul large*		
Sovereign exposure	66439,0	0,0	426665,6	51640,8	0,0	167427,3
Sovereign holdings growth	-0,007	0,000	0,244	0,025	0,000	0,308
	Vul small			*Non-vul small*		
Sovereign exposure	177312,7	0,0	723109,0	74283,2	0,0	209787,0
Sovereign holdings growth	-0,009	0,000	0,267	0,029	0,000	0,316

Panel: Bank characteristics (for 2008Q1 to 2014Q4):			
	Mean	Median	SD
Total assets	83896486	27829172	151283308
Own_deposits_cb	0,012	0,007	0,017
Net_fin_cb	0,007	-0,001	0,044
St_fund_noBbk	0,357	0,367	0,170
Tier 1/rwa	18,307	15,585	17,892
Total_trade	101,541	18,919	204,294
St_total_trade	48,970	0,319	134,798
Deposits	0,465	0,387	0,410
Bailout	0,182	0,000	0,386

Table 4: Results: Banks' investment strategies with respect to sovereign bonds from vulnerable and non-vulnerable countries

This table presents the results of regression equation (1) – a non-dynamic panel with bank, country and time fixed effects – based on quarterly data for the crisis period (Q3 2008 to Q4 2014), where the dummy post takes a value of one from Q3 2011 onwards, and zero otherwise. The (non-)vulnerable issuer countries are CY, ES, GR, IE, IT, LV, LT, PT and SI (inside EMU: AT, BE, FI, FR, NL, and SK – with FR and DE in noted separate regressions; outside EMU: US and CA). The dependent variable is the growth rate of banks' domestic sovereign holdings in quarter t. It is calculated as the percentage change between the end-of-period values in quarter t and quarter $t + 1$. With respect to the exogenous variables, the percentage change in the price of the bond of country j is calculated as the product of the quarter-on-quarter change in a country's ten-year sovereign bond yield by the corresponding duration. The bank-level (lagged) deposit–liability ratio is also added as a control variable. The indicator variable *Bailout* takes a value of one for banks that took recourse to government support in the financial crisis, and zero otherwise. Standard errors are clustered at the bank-country level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Countries	Vulnerable countries: All				IT ES GR	Non-vulnerable countries: All			AT BE NL	AT BE NL FR	AT BE NL DE	US CA
Type of transaction	Total	Purchase	Sale	Total	Purchase	Total	Purchase	Sale	Purchase	Purchase	Purchase	Total
Bailout	0.0305	-0.555***	0.505***	0.0291	-0.507***	0.0540	-0.702***	0.698***	-0.696***	-0.537***	-0.524***	-0.0505
(ϑ)	(0.0234)	(0.0661)	(0.0525)	(0.0233)	(0.129)	(0.0561)	(0.0344)	(0.0399)	(0.0419)	(0.103)	(0.154)	(0.0515)
ΔPrice	-0.387***	-0.238***	-0.101	0.0466	-0.709**	-0.483	-0.170	0.0169	-1.300*	-1.013	-0.323	0.187
(δ1)	(0.149)	(0.0882)	(0.0907)	(0.0769)	(0.303)	(0.378)	(0.221)	(0.177)	(0.769)	(0.638)	(0.493)	(0.439)
Bailout_X_Δprice	0.694*	-0.500	0.731**	0.462**	-0.746	-0.253	-0.0307	-0.0819	0.382	0.192	0.324	0.000925
(δ2)	(0.378)	(0.362)	(0.303)	(0.235)	(0.779)	(0.400)	(0.228)	(0.269)	(0.375)	(0.363)	(0.348)	(0.476)
ΔPrice_X_post	0.639***	0.399***	0.139		1.382***	0.796*	0.467*	0.0242	2.126***	1.792***	0.797	1.226**
(θ1)	(0.173)	(0.110)	(0.112)		(0.367)	(0.413)	(0.243)	(0.177)	(0.775)	(0.648)	(0.506)	(0.559)
Bailout_X_Δprice_X_post	-0.308	0.483	-0.446		0.998	0.328	0.117	0.121	-0.168	-0.112	-0.250	0.0277
(θ2)	(0.542)	(0.422)	(0.314)		(1.088)	(0.402)	(0.250)	(0.293)	(0.417)	(0.408)	(0.387)	(0.476)
Deposits	0.0623	0.0176	0.00277	0.0626	-0.0815	0.0649	0.0949	-0.0402	0.112	0.142	0.114	0.0317
	(0.0445)	(0.0430)	(0.0317)	(0.0444)	(0.0859)	(0.0697)	(0.0735)	(0.0510)	(0.113)	(0.105)	(0.107)	(0.0707)
Sensitivities for combined effects:												
Bailout_X_Δprice':	0.3074	-0.7384**	0.6295**	0.5084**	-1.4548*	-0.736	-0.2009	-0.065	-0.9187	-0.8211	0.0011	0.188
δ2'=δ1+δ2	(0.3446)	(0.345)	(0.2987)	(0.2331)	(0.7737)	(0.5024)	(0.2907)	(0.2791)	(0.9223)	(0.7822)	(0.5955)	(0.7485)
ΔPrice_X_post':	0.252***	0.1609**	0.0383		0.673***	0.3129**	0.297***	0.0411	0.8253***	0.7785***	0.4739***	1.4128***
θ1'=δ1+ θ1	(0.0896)	(0.0765)	(0.0601)		(0.2215)	(0.1242)	(0.0816)	(0.0482)	(0.1661)	(0.1571)	(0.1111)	(0.4736)
Bailout_X_Δprice_X_post':	0.6388**	0.1441	0.3225***		0.9254	0.3878**	0.3836**	0.0806	1.0389***	0.8585***	0.5484***	1.4414***
θ2'=δ1+δ2+ θ2	(0.31579)	(0.225313)	(0.121439)		(0.633364)	(0.16643)	(0.153755)	(0.085596)	(0.227908)	(0.225587)	(0.184439)	(0.457147)
Constant	-0.0616***	0.591***	-0.554***	-0.0618***	0.546***	-0.139*	0.835***	-0.753***	0.690***	0.634***	0.579***	-0.0761
Observations	13.860	11.984	12.583	13.860	3.613	7.700	6.623	6.614	3.932	5.171	4.835	3.080
Number of bc	495	494	495	495	164	275	275	275	165	220	220	110
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R2 within	0.00770	0.0106	0.0153	0.00694	0.0212	0.00820	0.0137	0.00526	0.0309	0.0225	0.0274	0.0151
R2 overall	0.0162	0.295	0.264	0.0155	0.258	0.0167	0.313	0.361	0.297	0.272	0.201	0.0250

Standard errors in parenthesis.

*** significant 1% level, ** significant 5% level, * significant 10% level

Table 5: Results: Banks' investment strategies affected by bank characteristics

This table presents the outcome of regression equation (2) – a non-dynamic panel with bank, country and time fixed effects – based on quarterly data for the crisis period (Q1 2008 to Q4 2014) where the indicator variable post takes a value of one from Q3 2011 onwards, and zero otherwise. The complete sample of vulnerable issuer countries includes CY, ES, GR, IE, IT, LV, LT, PT and SI. The dependent variable – growth rate of banks' domestic sovereign holdings in quarter t – is defined as the percentage difference between the end-of-period values in quarter t and quarter $t + 1$. With respect to the exogenous variables, the percentage change in the price of the bond of country j is calculated as the product of the quarter-on-quarter change in the relevant ten-year yield by the corresponding duration. Bank characteristics are net funding at the central bank, short-term wholesale funding, the tier 1-to-RWA ratio, total trading activity, and short-term trading activity. These are defined – with the exception of the tier 1-to-RWA ratio – as a percentage of total bank assets. These variables enter the regressions via dummies that take a value of one for the half of the bank sample with values above the median and otherwise zero for all characteristics at any point of time within the sample. The bank-level (lagged) deposit–liability ratio is also added as a control variable. Standard errors are clustered at the bank-country level.

Characteristic	(1) All Net fin at cb	(2) IT ES GR Net fin at cb	(3) All Sht. funding	(4) IT ES GR Sht. funding	(5) All Tier1 to rwa	(6) IT ES GR Tier1 to rwa	(7) All Total trade	(8) IT ES GR Total trade	(9) All Sht. total trade	(10) IT ES GR Sht. total trade
ΔPrice	-0.263	-1.251***	-0.0735	-0.707*	-0,1396	-0.7413*	-0.0305	-0.707*	-0.0264	-0.708*
(δ1)	(0.209)	(0.483)	(0.157)	(0.399)	(0,143)	(0,4227)	(0.143)	(0.400)	(0.143)	(0.389)
ΔPrice_X_post	0.541**	1.639***	0.196	1.056**	0.3379**	1.2258**	0.170	0.819*	0.200	0.754*
(θ1)	(0.242)	(0.564)	(0.199)	(0.468)	(-0,1704)	(-0,4916)	(0.169)	(0.452)	(0.170)	(0.426)
Deposits	0.0533	-0.0310	0.0602	-0.0111	0,0751	0,0016	0.0739	0.0126	0.0571	-0.0291
	(0.0460)	(0.0925)	(0.0447)	(0.0872)	(-0,0466)	(-0,0912)	(0.0455)	(0.0893)	(0.0443)	(0.0859)
Characteristic_H_X_Δprice	0.00567	0.630	-0.381	-0.480	-0,2667	-0,4821	-0.448*	-0.455	-0.455*	-0.453
(δ2)	(0.252)	(0.497)	(0.265)	(0.480)	(-0,2776)	(-0,5014)	(0.262)	(0.483)	(0.260)	(0.480)
Characteristic_H_X_Δprice_X_post	0.0846	-0.241	0.789**	0.946	0,5444	0,7182	0.801**	1.350**	0.742**	1.476**
(θ2)	(0.277)	(0.627)	(0.324)	(0.692)	(-0,3357)	(-0,719)	(0.315)	(0.676)	(0.312)	(0.666)
Characteristic_H	-0.00801	-0.0164	-0.00353	-0.000226	-0,0616**	-0,021	0.00359	0.00641	0.00298	0.00319
(ϑ)	(0.00537)	(0.0101)	(0.00698)	(0.0136)	(-0,0303)	(-0,0616)	(0.00560)	(0.0115)	(0.00557)	(0.0130)
Sensitivities for combined effects:										
Characteristic_H_X_Δprice':	-0.2578	-0.6217	-0.4547**	-1.1866**	-0.4064*	-1.2234**	-0.478**	-1.1621**	-0.4819**	-1.161**
δ2'=δ1+δ2	(0.1595)	(0.4328)	(0.2193)	(0.5034)	(0.2447)	(0.5191)	(0.2242)	(0.4982)	(0.2237)	(0.5056)
ΔPrice_X_post':	0.278**	0.3878	0.1221	0.3495	0.1983**	0.4845*	0.1393*	0.1122	0.1738*	0.0455
θ1'=δ1+ θ1	(0.1413)	(0.2493)	(0.1167)	(0.263)	(0.0966)	(0.2829)	(0.0827)	(0.2196)	(0.0908)	(0.193)
Characteristic_H_X_Δprice_X_post':	0.3683***	0.7763**	0.53***	0.816**	0.4759***	0.7207**	0.4924***	1.0074***	0.4603***	1.0687***
θ2'=δ1+δ2+ θ2	(0.109891)	(0.317924)	(0.136317)	(0.3177)	(0.1615)	(0.3208)	(0.156388)	(0.339257)	(0.153394)	(0.347268)
Constant	-0.0611***	-0.0443	-0.0612**	-0.0486	-0.0233	0.0402	-0.0682***	-0.0616*	-0.0669***	-0.0540
Observations	13.860	Apr 62	13.860	4.620	13356	4.452	13.860	4.620	13.860	4.620
Number of bc	495	165	495	165	477	159	495	165	495	165
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R2 within	0.00726	0.0258	0.00791	0.0255	0,008	0.026	0.00785	0.0273	0.00768	0.0279
R2 overall	0.0157	0.0402	0.0163	0.0396	0.016	0.040	0.0163	0.0413	0.0161	0.0418

Standard errors in parenthesis.
*** significant 1% level, ** significant 5% level, * significant 10% level

Table 6: Results: Banks' investment strategies before the crisis and up to 2016

Columns (1) to (5) present the outcome of regression equation (1B) – a non-dynamic panel with bank, country and time fixed effects – based on quarterly data for the pre-crisis period Q1 2002 to Q4 2007, where the indicator variable *pre* takes a value of one from Q1 2005 to Q4 2007 and zero otherwise. Referring to equation (1) in columns (6)-(8), the crisis time sample is extended and thus comprises Q1 2008 to Q4 2016, where the dummy post takes a value of one from Q3 2011 onwards and zero otherwise. The complete sample of vulnerable issuer countries includes CY, ES, GR, IE, IT, LV, LT, PT and SI. The dependent variable – growth rate of banks' domestic sovereign holdings in quarter t – is defined as the percentage difference between the end-of-period values in quarter t and quarter $t + 1$. With respect to the exogenous variables, the percentage change in the price of the bond of country j is calculated as the product of the quarter-on-quarter change in a country's ten-year sovereign bond yield by the corresponding duration. The bank-level (lagged) deposit–liability ratio is also added as a control variable. Standard errors are clustered at the bank-country level.

	(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)
Time horizon	PRE	PRE	PRE	PRE	PRE		To 2016	To 2016	To 2016
Countries	All	All	IT ES GR	IT ES GR	IT ES GR		All	All	All
Type of transaction	Total	Total	Total	Purchase	Sale		Total	Purchase	Sale
Bailout	-0.100***	-0.101***	-0.0679**	-0.509***	0.372***	Bailout	0.0178	-0.525***	0.492***
(ϑ)	(0.0280)	(0.0277)	(0.0290)	(0.149)	(0.0690)	(ϑ)	(0.0216)	(0.0621)	(0.0476)
ΔPrice	-0.0382	0.133	0.924	1.795	-0.634	ΔPrice	-0.372**	-0.239***	-0.0860
($\delta 1$)	(0.316)	(0.194)	(2.091)	(1.461)	(1.214)	($\delta 1$)	(0.146)	(0.0909)	(0.0905)
Bailout_X_Δprice	-0.348	-0.140	-1.358	-1.137	-0.455	Bailout_X_Δprice	0.731**	-0.488	0.820***
($\delta 2$)	(0.849)	(0.556)	(1.587)	(1.324)	(0.901)	($\delta 2$)	(0.368)	(0.363)	(0.306)
ΔPrice_X_pre	0.327		-2.801	-3.550**	1.000	ΔPrice_X_post	0.378***	0.239***	0.0880
($\theta 1$)	(0.462)		(2.495)	(1.720)	(1.491)	($\theta 1$)	(0.147)	(0.0909)	(0.0907)
Bailout_X_Δprice_X_pre	0.381		0.907	-0.184	0.105	Bailout_X_Δprice_X_post	-0.725**	0.490	-0.820***
($\theta 2$)	(1.204)		(1.948)	(1.665)	(1.364)	($\theta 2$)	(0.367)	(0.363)	(0.305)
Deposits	-0.0185	-0.0196	0.125	0.0949	0.0274	Deposits	-0.00382	-0.0401	0.0116
	(0.0434)	(0.0435)	(0.0889)	(0.0705)	(0.0762)		(0.0320)	(0.0341)	(0.0275)
Sensitivities for combined effects:						**Sensitivities for combined effects:**			
Bailout_X_Δprice':	-0.2282	-0.0067	-0.434	0.6582	-10.892	Bailout_X_Δprice':	0.3587	-0.7265**	0.7336**
$\delta 2'=\delta 1+\delta 2$	(0.6754)	(0.5537)	(2.7463)	(2.0356)	(1.5394)	$\delta 2'=\delta 1+\delta 2$	(0.3365)	(0.3445)	(0.3015)
ΔPrice_X_pre':	0.1337		-1.877	-1.7543*	0.366	ΔPrice_X_post':	0.006**	-0.0001	0.002
$\theta 1'=\delta 1+\theta 1$	(0.1441)		(1.4244)	(0.9646)	(0.9762)	$\theta 1'=\delta 1+\theta 1$	(0.0029)	(0.0008)	(0.0015)
Bailout_X_Δprice_X_pre':	-0.2452		-23.284	-3.0756**	0.0159	Bailout_X_Δprice_X_post	0.0116	0.0024	0.0016
$\theta 2'=\delta 1+\delta 2+\theta 2$	(0.531486)		(1.880426)	(1.447061)	(1.477066)	$\theta 2'=\delta 1+\delta 2+\theta 2$	(0.010896)	(0.002627)	(0.003914)
Constant	0.101***	0.0967***	-0.0541	0.697***	-0.578***	Constant	-0.0441*	0.557***	-0.530***
Observations	11.376	11.376	3.792	2.936	3.044		17.802	15.496	16.233
Number of bc	495	495	165	165	165		495	494	495
Bank FE	YES	YES	YES	YES	YES		YES	YES	YES
Country FE	YES	YES	YES	YES	YES		YES	YES	YES
Time FE	YES	YES	YES	YES	YES		YES	YES	YES
R2 within	0.00457	0.00447	0.0124	0.0141	0.00858		0.00666	0.00914	0.0138
R2 overall	0.0136	0.0136	0.0250	0.330	0.292		0.0136	0.281	0.254

Standard errors in parenthesis.
*** significant 1% level, ** significant 5% level, * significant 10% level