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Desislava C. Andreeva, Thomas Vlassopoulos

Home bias in bank sovereign bond purchases and the bank-sovereign nexus

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Abstract

We study whether a pre-existing link between bank and sovereign credit risk biased euro area banks' sovereign debt portfolio choices during 2011Q4 and 2012Q1 – a period of exceptional increases in their domestic sovereign bond holdings. We find that banks whose creditworthiness is linked to that of the respective sovereign tended to purchase higher amounts of domestic sovereign bonds relative to their main assets if the CDS spreads on domestic sovereign bonds were higher. Moreover, for elevated sovereign CDS levels, banks whose creditworthiness is ex ante more strongly positively correlated with that of the local sovereign exhibit larger purchases of domestic government bonds. These findings are consistent with 'risk shifting' behaviour, where by investing in domestic government bonds banks earn the full, high risk premium while the risk is largely borne by their creditors as it materialises in states of the world where the banks are likely to be insolvent anyway. As a result, domestic sovereign debt offers ex ante higher returns to bank shareholders than alternative ways to build up precautionary liquidity buffers or indeed to execute carry trades, such as to invest in non-domestic government bonds.

Keywords: bank-sovereign nexus, sovereign default
JEL Classifications: G01, G11, G21, H6

Non-technical Summary

> *"At this point the bankers can tell themselves: officially these assets are safe, and if not, then we will be bankrupt anyway, so why not borrow more and invest more to earn even greater profits in the likely event that all the worriers are wrong.[...] We have seen such a process unfolding [...] for sovereign debt in the euro zone."* Myerson (2014)

During the euro area sovereign debt crisis of 2011/2012, yields on sovereign bonds issued in vulnerable countries rose dramatically. For euro area banks this development offered a potentially profitable investment opportunity: they could obtain low-cost short-term funding from the central bank and acquire high-yielding sovereign bonds issued in vulnerable countries - an investment strategy dubbed the "carry trade in peripheral bonds". While this possibility was in principle open to all euro area banks, in fact only banks in vulnerable countries pursued it. Importantly, these banks acquired bonds issued by their domestic governments.

This paper argues that the "home bias" in sovereign bond purchases during the sovereign debt crisis resulted from the fact that domestic banks priced the credit risk embedded in vulnerable government bonds differently than their non-domestic peers. This differentiated pricing, in turn, originated from the existence of a sovereign-bank nexus, i.e. a close relationship between the creditworthiness of the bank and that of its respective government.

Non-domestic banks tended to regard the higher yields during the crisis on sovereign bonds issued in vulnerable countries as reflecting an increase in the corresponding riskiness of the bonds. In risk-adjusted terms, which is the relevant perspective for portfolio allocation decisions, the return from the carry trade in peripheral bonds was, therefore, very low for them, if positive at all. By contrast, for domestic banks and in the presence of a sovereign-bank nexus, the credit risk on sovereign bonds materialises in states of the world in which they would very likely be insolvent anyway. This can be the case, for instance, because the banks have already lent to the sovereign directly or because they are both heavily exposed to the state of the domestic economy. Moreover, sovereigns serve as the ultimate backstops in a domestic banking crisis, providing deposit insurance and capital injections to contain systemic risk. A sovereign's inability to play this role would most likely lead to an implosion of the domestic banking system.

Regardless of the precise reasons for which a sovereign-bank nexus was present during this episode, its existence resulted in domestic banks not fully pricing in their sovereign's credit risk when making portfolio allocation decisions. This is because as the credit losses arise in a situation where the banks are anyway insolvent, they are effectively partly borne by the banks' creditors. The banks' shareholders, however, earn the full credit premium in all the states of the world where the sovereign does not default. Using a simple theoretical model, therefore, this paper illustrates that incentives to invest in domestic sovereign debt are stronger when, first, the probability of default of the domestic sovereign is higher and, second, the bank-sovereign nexus is stronger. In the first case the credit risk premium that can be earned is larger, while, in the second, a greater portion of credit risk is shifted to bank creditors.

The main part of this paper tests the empirical validity of this hypothesis using data on individual euro area banks' purchases of domestic sovereign bonds. Our empirical analysis focusses in particular on the last quarter of 2011 and the first quarter of 2012, when two longer-term refinancing operations with a maturity of three years were announced and conducted by the ECB. In this period larger domestic sovereign bond purchases were made by banks whose creditworthiness correlates more strongly with the one of the domestic sovereign (measured by respective CDS spreads) and for sovereign bonds with higher CDS spreads. This finding continues to hold when taking into account an array of other factors that are likely to influence banks' decisions to acquire government bonds. This incentive mechanism is, however, not relevant on average over the entire sample considered (spanning 2008 Q1 to 2015 Q2), as it requires the coexistence of non-trivial levels of sovereign credit risk and a material intensity of the bank-sovereign nexus in order to surface. In the presence of these conditions, domestic sovereign debt offers ex ante higher returns to bank shareholders than alternative ways to build up precautionary liquidity buffers or indeed to execute carry trades, such as to invest in non-domestic government bonds.

According to the analysis presented in this paper, the existence of a sovereign-bank nexus results in an incomplete internalisation of credit risk for domestic sovereigns that, in turn, leads to home bias in sovereign bond purchases. To the extent that this reinforces the sovereign-bank nexus, policy should aim to tilt banks' risk-return calculus so that domestic sovereign bond credit risk is taken into account more fully. By weakening the bank-sovereign nexus, policy initiatives already underway under the Banking Union agenda should contribute in this direction.

1 Introduction

The financial crisis that has beleaguered the world economy since 2008 has had a distinct effect on euro area monetary financial institutions' (MFIs)[1] holdings of government debt. Shortly after the initial shock of the collapse of Lehman Brothers in October 2008, euro area banks started buying sizeable amounts of euro area government debt (see Chart 1). This development was reflecting 'flight to safety' behaviour, as a range of other financial assets had proved to be much riskier than previously perceived. In this initial stage, the discrimination between domestic government bonds and those issued by other euro area governments was not absolute, as banks were acquiring both types of debt.

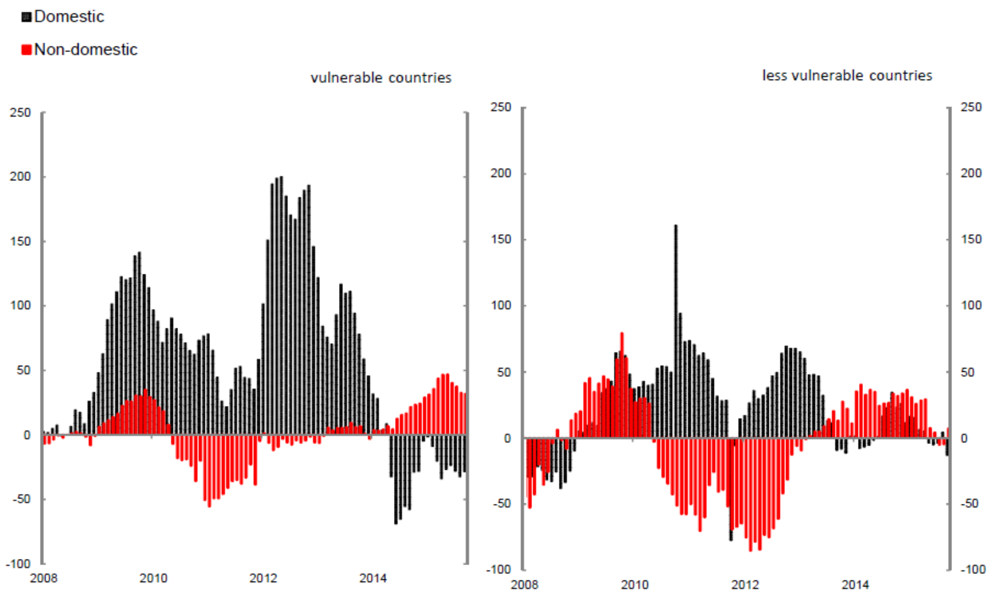

Chart 1: Purchases of euro area government bonds by euro area banks (12-month flows in EUR bn)

With the onset of the euro area sovereign debt crisis, however, this changed in a dramatic way. Banks started to only acquire domestic government bonds, shedding those issued by other euro area sovereigns. Importantly, while banks in both vulnerable[2] and less vulnerable euro

[1] The terms MFIs and banks are used interchangeably in this paper.

[2] Throughout this paper the term 'vulnerable countries' refers to Ireland, Greece, Spain, Italy, Cyprus, Portugal and Slovenia, while the term 'less-vulnerable countries' refers to the remaining euro area countries.

area countries were engaged in this type of activity, the magnitude of purchases by the banks in vulnerable countries was much higher.[3] Indeed, there is a correlation between the expansion of domestic sovereign bond portfolios by banks at the height of the sovereign debt crisis and sovereign credit risk, as measured by sovereign CDS spreads (Chart 2).

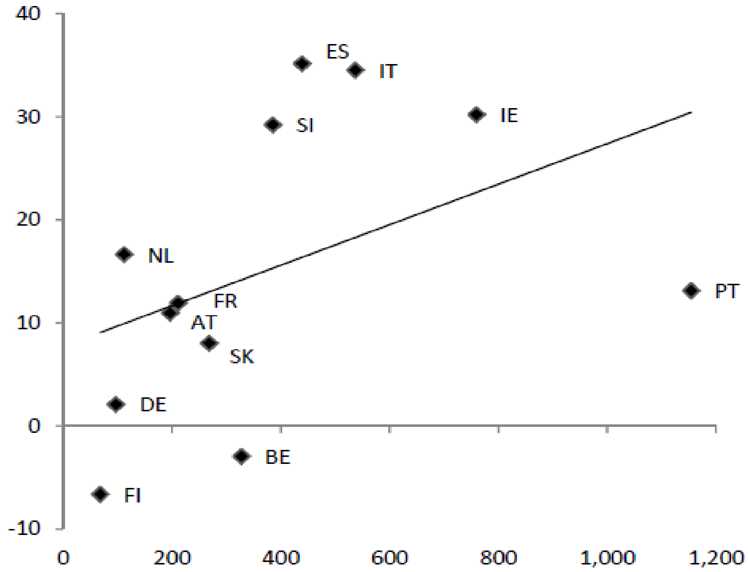

Chart 2: Change in the stock of domestic sovereign bonds held by MFIs (between Nov-2011 and July-2012, in p.p., y-axis) and sovereign CDS spreads (average in Nov-2011, in b.p., x-axis)

This paper aims to explain the re-emergence of home bias in the acquisition of sovereign bonds by euro area banks during the sovereign debt crisis. A crucial element in the proposed explanation is the fact that, during this episode, the creditworthiness of some euro area banks became intertwined with that of their respective sovereign. A large and expanding body of literature looks at the reasons for the emergence of this correlation between bank and sovereign creditworthiness, labelled the bank-sovereign nexus. In this paper, instead, the focus is narrowed down to a specific question: how the presence of a bank-sovereign nexus, affects banks' sovereign bond portfolio choices.

[3]The relevance of this activity is put into perspective in Chart A1 in the annex, which shows the sizeable increase of the share of domestic government bonds on the balance sheets of banks during the sovereign debt crisis, particularly in vulnerable euro area countries.

To help motivate the empirical analysis that is the main contribution of this paper, we illustrate in a simple theoretical model how the existence of a bank-sovereign nexus tilts the risk-return calculus of banks in favour of domestic sovereign bonds. The home bias arises as bank shareholders earn the credit risk premium on domestic sovereign debt while the underlying credit risk materialises in states of the world in which the bank has a significant chance of being insolvent anyway. A portion of sovereign credit risk is, therefore, shifted to bank creditors and not internalised in the bank's portfolio allocation decision. The model suggests that incentives to invest in domestic sovereign debt are stronger when, first, the probability of default of the domestic sovereign is higher and, second, the bank-sovereign nexus is stronger. In the first case the credit risk premium that can be collected is larger while, in the second, a greater portion of credit risk is shifted to bank creditors.

The main part of this paper tests the predictions of the simple theoretical model empirically using a novel bank-level dataset. We focus, in particular, on the period when two longer-term refinancing operations with a maturity of three years were introduced by the ECB. In this period banks stepped up their acquisitions of domestic government bonds in a context of elevated pricing of sovereign credit risk for issuers in vulnerable euro area countries. Panel regressions based on individual bank data reveal that the incentive mechanism described above is a significant determinant of domestic sovereign bond purchases during this episode. The empirical analysis also shows, however, that this mechanism is not relevant on average over the entire sample considered (spanning 2008 Q1 to 2015 Q2), as it requires the coexistence of non-trivial levels of sovereign credit risk and a material intensity of the bank-sovereign nexus to become relevant.

In the next section we place our paper in the context of the related literature before introducing our simple theoretical framework in section 3. Subsequently, we outline our empirical strategy and describe the data sources in section 4. Section 5 presents the results of our empirical analysis, while section 6 concludes.

2 Literature review

The recent literature on sovereign credit risk and domestic bank fragility can be grouped into three strands.

A first strand identifies three channels that give rise to a co-movement of bank and sovereign credit risk premia. First, domestic banks lend to their sovereign. The value of banks' claims on the sovereign diminishes whenever the creditworthiness of the domestic government deteriorates, linking the market prices of bank and sovereign credit risk. Such direct exposures are studied in Bolton and Jeanne (2011), Gennaioli et al. (2014) and Cooper and Nikolov (2013). Second, national financial safety nets transmit risk from banks to sovereigns as bank bailouts and guarantees on bank liabilities weaken sovereign creditworthiness (in Attinasi et al (2010), Ejsing and Lemke (2011), Gerlach et al. (2010), Dieckmann and Plank (2012) and Kallestrup et al (2013)) and vice-versa, from the sovereign to banks, as a weakened sovereign creditworthiness undermines the value of the ultimate fiscal backstops for bank solvency (e.g. Cooper and Nikolov (2013)). Third, banks and sovereigns are exposed to common factors. The strength of the balance sheet of both depends on the state of the local economy.

The second strand of literature aims to explain the purchases of domestic sovereign bonds by banks located in euro area countries under stress. Two competing explanations for the home bias in sovereign debt can be identified: financial repression by governments or risk shifting strategies of domestic banks. Financial repression refers to government policies or practices intended to confer benefits to the government as a borrower at the expense of the lender.[4] Among the proponents of the financial repression hypothesis is Uhlig (2014), who argues that supervisory rules induce banks in countries with weak fiscal fundamentals to purchase domestic bonds and refinance these via repos with a multilateral central bank. Becker and Ivashina (2014) find evidence that direct government ownership as well as influence via banks' boards of directors are channels used to exercise financial repression. Similarly, Horvath et al. (2015) report evidence that home bias in government bond purchases is higher for banks owned by risky sovereigns. Acharya and Rajan (2013) argue that myopic governments might repress their domestic lenders to hold large amounts of domestic sovereign debt so as to secure access to external financing. In their model, large holdings of domestic sovereign bonds by the local banking sector make a sovereign default very costly for the government. Therefore, financial repression serves to both channel domestic savings to the sovereign and to reassure foreign creditors that the government is willing to pay back its outstanding debt.[5]

The risk shifting hypothesis, instead, maintains that bank purchases of government debt are motivated by the aim to maximise expected re-

[4]Becker and Ivashina (2014) trace the origins of the term "financial repression" to Shaw (1973) and McKinnon (1973).

[5]A very similar argument is put forward by Broner et al (2014). They argue that the expected returns on sovereign debt are higher for domestic creditors at times of fiscal stress because sovereigns are less likely to default on them. Thus, the share of sovereign debt absorbed by domestic agents increases when sovereign credit risk is higher – however, contrary to Acharya and Rajan's (2013) conclusion – without any financial repression.

turns for bank shareholders, i.e. is a voluntary, optimal portfolio choice rather than an investment imposed by government action. Because of limited liability, the pay-off structure of bank portfolio decisions is asymmetric for bank shareholders in the sense that the downside is capped by their participation in the capital of the bank, while the upside it not restricted. Accordingly, risk can be shifted from bank shareholders to bank creditors.[6] Consistent with this view, Horvath et al. (2015) find that home bias in sovereign bond purchases is greater if bank corporate governance regimes are more shareholder-friendly. Risk shifting by undercapitalised banks is among the driving factors of domestic sovereign bond purchases in Acharya and Steffen (2015). They focus on banks' incentives to fund long-term bonds issued by euro area sovereigns under stress via short-term unsecured funding and earn the carry spread. In addition to risk shifting, their empirical analysis identifies regulatory capital arbitrage and the availability of Eurosystem funding in full allotment mode as factors that induce banks to engage in carry trades. Crosignani (2015) emphasises the interrelationship between the tendency of undercapitalised banks to invest in assets whose returns materialise in good states of the world – like domestic sovereign debt – and the willingness of governments to recapitalise banks. Sovereigns with difficult access to financial markets might be unwilling to recapitalise weak (but still solvent) domestic banks so that the latter will continue to act as buyers of last resort of government debt, which they would be less inclined to do if they were well capitalised. In principle risk shifting could also involve the purchase of government bonds issued by other (non-domestic) risky sovereign issuers. Farhi and Tirole (2015) show, however, that as long as bank balance sheet and fiscal shocks within one country are at least slightly positively correlated and fiscal shocks across countries are not perfectly correlated, risk shifting will concentrate entirely on domestic sovereign bonds.

The third strand of literature studies the impact of domestic sovereign bond purchases on the supply of credit to the non-financial private sector. Broner et al. (2014) argue that purchases of domestic sovereign bonds crowd out bank credit to the private sector because domestic banks find it difficult to obtain credit from abroad at times of sovereign stress while they in addition absorb a larger share of sovereign issuances. In this case, the private and public sector compete for the same, limited, pool of savings. Popov and van Horen (2013) find evidence that banks exposed to stressed euro area sovereign bonds increased lending in the

[6] The classic risk-shifting or asset substitution problem was first studied in Jensen and Meckling (1976). They show that shareholders of a firm can transfer wealth from its debtors by engaging in risky projects.

syndicated loan market much less compared to non-exposed banks, suggesting a negative impact on credit supply. Becker and Ivashina (2014) document a contraction of bank credit related to the expansion of domestic sovereign debt held by lenders. Finally, Altavilla et al. (2015) find that an increase in sovereign credit risk, owing to the exposures of lenders to government debt, has an economically and statistically significant effect on their lending to the private sector in stressed euro area countries.

In this paper the existence of a bank-sovereign nexus - as identified in the first strand of literature - is taken as the starting point for the analysis. The precise reasons that may have led to the development of this nexus are not important for the analysis. The conclusions hold regardless of whether the original cause of the nexus was bank exposure to the sovereign - induced by financial repression or by risk shifting - or any of the other plausible reasons previously cited. Our analysis contributes to the second strand of the literature by postulating and empirically confirming using a novel bank-level dataset that once a bank-sovereign nexus has developed, it generates economic incentives for home bias in government bond purchases by banks. This implies that if the creditworthiness of banks and the sovereign are somehow intertwined, home bias emerges as an optimising economic choice. While, therefore, the analysis presented in this paper does not rule out that the "original sin" giving rise to the bank-sovereign nexus may have been financial repression, it argues that a potent self-feeding mechanism rooted in risk shifting induces banks to expand their exposures vis-a-vis the domesic government further as soon as sovereign credit risk increases.

3 A simple model

We use a very simple model to illustrate how the presence of a bank-sovereign nexus affects banks' pricing of domestic sovereign bonds. This illustration is intended to motivate the main contribution of our paper, which is the empirical validation provided in the next sections that the purchases of domestic sovereign bonds by euro area banks during the final quarter of 2011 and the first quarter of 2012 to a large extent reflect risk shifting considerations.

We consider two countries and two banks headquartered in each of the countries. Sovereigns issue zero-coupon bonds with a face value of 1. They do not honor their obligations in all states of the world. For simplicity, we assume that the haircut in case of sovereign default is 100%. Banks are leveraged and subject to limited liability. In the case of bankruptcy, bank assets are transferred to bank creditors (i.e. bank shareholders are wiped out).

Let $D_k^j = \{0,1\}$ be a variable equal to 1 if default occurs. The subscript $k = \{s,b\}$ denotes either a sovereign ($k = s$) or a bank ($k = b$); the superscript $j = \{x,y\}$ denotes the country - x or y. Domestic bank and sovereign defaults are assumed to be correlated. As discussed in section 2, there are several rationales for this assumption.[7] By contrast, the default of the foreign sovereign is assumed to effectively have no bearing on the probability of default of the bank.[8] We, therefore, posit that the probability of a bank default has the following form:

$$\Pr(D_b^j = 1) = \alpha^j + \gamma^j \Pr(D_s^j = 1) \tag{1}$$

Here γ^j captures the strength of the sovereign-bank nexus, while the idiosyncratic component in bank credit risk is reflected in α^j. To simplify the notation let the unconditional probability of default of sovereign j ($\Pr(D_s^j = 1)$) be equal to d_s^j. (1) implies that the probability of the bank being solvent is:

$$\Pr(D_b^j = 0) = 1 - \Pr(D_b^j = 1) = 1 - \alpha^j - \gamma^j d_s^j \tag{2}$$

We denote the risk-free rate with r and assume that there are risk-neutral, non-leveraged investors who purchase sovereign and bank bonds in competitive markets. The assumption implies that in equilibrium the expected returns of the two sovereign bonds will equal r:

$$1 + r = \Pr(D_s^j = 0)(1 + i_s^j), \text{ for } j = \{x,y\} \tag{3}$$

where i_s^j denotes the yield on sovereign bonds issued by country j.

From the perspective of bank shareholders in country x, the expected return from investing in sovereign bonds issued in country $j = \{x,y\}$ is denoted by R_{sj}^x. For the bank shareholder to receive the payout from the investment in a bond, the bank needs to still be solvent as otherwise bank shareholders are wiped out. Moreover the sovereign issuer of the

[7] To recall, first, domestic banks may have lent to their sovereigns. Second, sovereigns are the ultimate backstops in a domestic banking crisis, providing deposit insurance and capital injections to contain systemic risk. And third, the strength of the balance sheet of both the domestic banks and the sovereign depends on the state of the local economy.

[8] The possibility that the probability of default of one sovereign is correlated to that of another one implies that a correlation of domestic bank and sovereign defaults may also introduce some correlation beetwen the bank and a non-dometic sovereign. Farhi and Tirole (2015) have shown, however, that as long as the correlation of fiscal shocks across sovereigns is not perfect, risk shifting into domestic sovereign bonds dominates. In view of this and for presentational simplicity, we abstract from the possibility that a default of a non-domestic sovereign affects the probability of default of the bank.

bond itself must not have defaulted. Therefore, the expected returns are:

$$R_{sj}^{x} = \Pr(D_b^x = 0 \cap D_s^j = 0)(1 + i_s^j) \tag{4}$$

This expression can be equivalently written as:

$$R_{sj}^{x} = \Pr(D_b^x = 0 | D_s^j = 0) \Pr(D_s^j = 0)(1 + i_s^j) \tag{5}$$

which, using (3), simplifies to:

$$R_{sj}^{x} = \Pr(D_b^x = 0 | D_s^j = 0)(1 + r) \tag{6}$$

If the bond invested in has been issued by the domestic sovereign, then conditioning on the sovereign being solvent ($D_s^x = 0$) implies through (1) and (2) that the expected return is:

$$R_{sx}^{x} = (1 - \alpha^x)(1 + r) \tag{7}$$

It is important to note that the expression capturing the conditional probability of the bank being solvent only contains a term for the idiosyncratic bank risk (α^x) but not for spillover of domestic sovereign risk (γ^x).

By contrast, if the bond invested in has been issued by the foreign sovereign, then conditioning on that sovereign being solvent ($D_s^y = 0$) has no bearing on the solvency of the bank, which according to (1) is only linked to the probability of default of the domestic sovereign. In this case the expected return is therefore:

$$R_{sy}^{x} = (1 - \alpha^x - \gamma^x d_s^x)(1 + r) \tag{8}$$

While for the risk-neutral outside investors the two sovereign bonds generate the same expected return given the prevailing market prices, from the perspective of bank shareholders, investment in domestic government bonds promises a higher expected return, with the return differential being equal to:

$$R_{sx}^{x} - R_{sy}^{x} = \gamma^x d_s^x (1 + r) \tag{9}$$

The differential is positive for $\gamma^x > 0$ and $d_s^x > 0$.It also increases in both γ^x and d_s^x. Essentially, bank shareholders earn the full domestic sovereign default risk premium, while a large part of the default risk is borne by bank creditors and not internalised. The expression $\gamma^x d_s^x$ captures the "neglected" portion of domestic sovereign credit risk. A higher probability of domestic sovereign default - a higher d_s^x - tilts the risk-return calculus in favour of domestic debt because banks can collect a higher risk premium. Similarly, a stronger bank-sovereign nexus - reflected in a high γ^j - leads to stronger incentives to invest in domestic sovereign debt because a larger fraction of the default risk can be shifted to bank creditors.[9]

4 Empirical strategy

The crucial prediction emerging from the preceding theoretical analysis is that banks face incentives to invest in domestic sovereign debt when their own default probability is strongly linked to that of the domestic sovereign and the probability of default of their respective sovereign is higher. In this section we set out our strategy for empirically testing this prediction.

To transpose the theoretical prediction to one that is testable we need to map the strength of the incentives to invest in domestic sovereign debt - a concept that is not observable - to a measurable bank behaviour. In the empirical analysis we focus on observed bank purchases of domestic government bonds. The tested hypotheses thus are that: (i) conditional on a strong bank-sovereign nexus banks acquire more domestic government bonds the riskier the sovereign issuer is and, (ii) conditional on high domestic sovereign credit risk, domestic sovereign bond purchases increase the stronger the bank-sovereign nexus is. There is a large body of literature that highlights that banks hold sovereign bonds for reasons other than their expected pecuniary returns. For instance, Gennaioli et al. (2014) maintain that banks hold government bonds as a buffer against the materialisation of liquidity shocks, in the spirit of Holmstrom and Tirole (1993). Other authors, such as Bonner (2015) and Popov and van Horen (2013) highlight the relevance of the preferential treatment of government bonds in bank capital and liquidity regulation as a driver for holding government bonds. These explanations are not necessarily mutually exclusive and in the testing of our hypothesis we, therefore, need to control for these motivations.

To test the hypotheses we exploit the cross-sectional variation in the extent to which a bank's solvency is linked to that of their respective sovereign using bank-level data. For bank purchases of domestic sovereign bonds and other bank balance sheet information, we use a confidential dataset of selected balance sheet indicators for a sample of individual monetary financial institutions (MFIs), collected for the compilation of

[9] If the increased risk faced by creditors would be appropriately recognised by them and fully priced in banks' cost of funding then no net benefit would accrue for bank shareholders. In practice, however, this risk is unlikely to be fully priced in, owing, for instance, to deposit insurance which reduces the sensitivity of deposit funding costs to banks' risk profile (Demirguc-Kunt and Huizinga (2004)).

the aggregate monetary statistics. The MFIs included in the dataset account for approximately 70% of total outstanding amounts of main assets of euro area MFIs. The data is available at a monthly frequency starting in June 2007.

In addition, testing the theoretical prediction requires a measure of the strength of the nexus between each bank and the respective sovereign, which is not directly observable. The first step in our empirical strategy is, therefore, to construct such a measure. We employ 5-year Credit Default Swap (CDS) spreads for the banks in our sample and the respective sovereigns, obtained from Datastream, Reuters and Bloomberg.[10] CDS spreads are a market price for the insurance premium against default of a debtor. They, therefore, embody the market evaluation of the debtor's probability of default and the associated loss given default. We construct a measure for γ_i (the correlation between an individual bank i's default probability and the probability of default of the respective sovereign) by calculating rolling correlations between each bank's CDS spread and the CDS spread of the respective sovereign over a backward-looking twelve-month window.[11] In keeping with this approach, we use the CDS spread on each sovereign to measure its probability of default (d_{si}).[12] In the empirical analysis the sovereign CDS spread is used in demeaned form (across time and countries).

The proxy used for γ_i represents a faithful mapping of our theoretical analysis to the empirical domain. This, however, comes at a cost as the proxy requires the use of quoted CDS spreads. These are only available for a sub-set of the banks included in our sample, thereby reducing our

[10] In cases where an entity in our sample is part of an international banking group, the domestic jurisdiction is the one where this entity is located and not that of its parent. As CDS are not typically observed for such sub-group entities, the CDS of the parent group is used. This is consistent with the logic of the theoretical model, as in such cases the capital backstop is primarily provided by the parent.

[11] This correlation should be a good measure for γ, to the extent that the loss given default of both the bank and the sovereign does not contribute significantly to the variability in the respective CDS spread. Indeed, it is common practice in the literature to assume a constant loss given default (or, equivalently, recovery rate) when extracting estimates of probabilities of default from CDS, see, for instance, Radev (2013) and Lucas et al. (2013). Moreover, the linear relationship between the CDS spread and the probability of default that is implied by this calculation is a good approximation only for non-distressed debtors (Radev (2013)). Partly for this reason, we have excluded selected distressed banks and countries (Greece, Cyprus) from our analysis.

[12] The assumption made in section 3 of a 100% loss given sovereign default (or 0% recovery rate) simplifies the interpretation of the CDS spread as a market-based evaluation of d_s. Strictly speaking, however, to derive an accurate market-based measure of the probability of default from CDS spreads would require implementing the procedure described in O'Kane (2008).

cross-section to 120 banks.

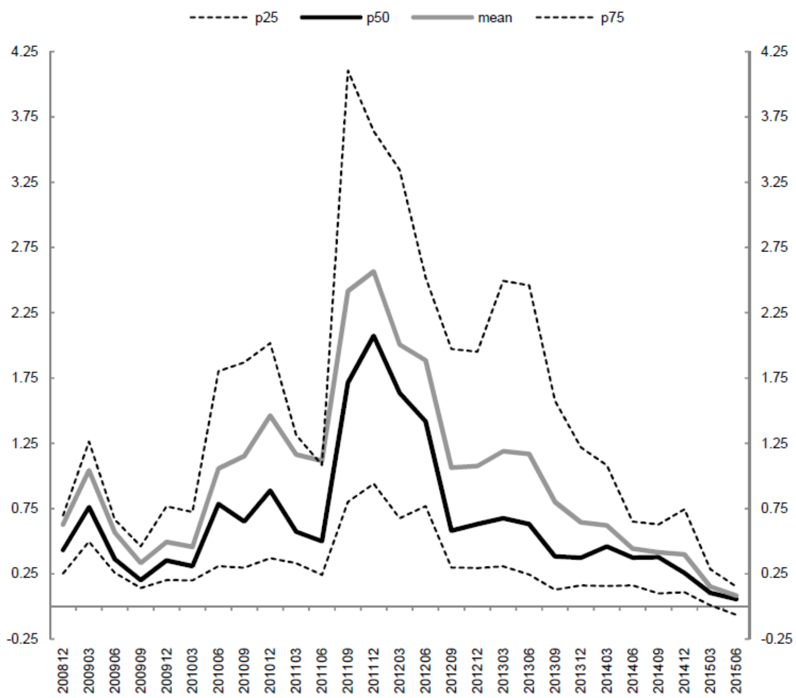

Chart 3: The strength of bank i's nexus with its respective sovereign multiplied by the sovereign CDS spread ($\rho_i \equiv \gamma_i d_{si}$)

As shown in equation (9), the product of each bank's nexus with its respective sovereign and the probability of sovereign default linearly increases the ex ante return differential in favour of domestic bonds. Therefore, we use ρ_i - the interaction between γ_i and the CDS spread of the respective sovereign ($\rho_i \equiv \gamma_i d_{si}$) - to capture euro area banks' incentives for risk-shifting via investments in domestic sovereign bonds. Chart 3 depicts the evolution of ρ_i. Its cross-sectional distribution shifts up only gradually until mid-2011: the median ρ_i in June 2011 roughly corresponds to the one observed at the start of the period shown in the chart. During the final two quarters of 2011, however, the median value quadruples.[13] Charts A3 and A4 in the annex reveal that this surge reflects increases in both components of ρ_i. First, the bank-sovereign nexus (γ_i) intensifies for the vast majority of euro area banks, reflected in a marked increase of the median γ_i accompanied by a compression

[13] From 0.5 in June to 2.07 in December 2011.

of the inter-quartile range surrounding it (see Chart A3). Second, the sovereign credit risk as measured by CDS spreads on bonds issued by euro area governments peaks (see Chart A4).

We are in particular interested in understanding to what extent the marked acquisition of domestic sovereign bonds by euro area banks in the period following the introduction of the 3-year longer-term refinancing operations by the ECB (labelled VLTROs) in December 2011 and until the de-escalation of the sovereign debt crisis in July 2012 can be explained by risk-shifting via investment in domestic sovereign bonds. These purchases increased euro area banks' holdings of domestic government bonds by 21%. The same episode has been studied by Acharya and Steffen (2015) and Horvath et al. (2015) among others.

Having specified measures for ρ_i and defined the main period under investigation, we proceed in estimating panel equations of the following type:

$$B_{it} = \alpha_i + t + \beta_1 \rho_{it} + \beta_2 \rho_{it} dummyVLTRO + \Gamma X_{it} + \varepsilon_{it} \qquad (10)$$

where B_{it} denotes purchases of domestic government bonds by bank i in quarter t.[14] B_{it} measures changes in holdings of domestic government bonds on the basis of transactions only. Thus, pure valuation effects that can change the reported amount of government bonds held do not not affect our results. To control for unobservable time-invariant bank-specific factors that can affect banks' decisions to purchase domestic sovereign debt, (10) includes bank fixed effects (α_i). In addition, (10) includes a set of time dummies (t) to account for aggregate shocks. As previously defined, ρ_{it} is the product of the strength of bank i's nexus with its respective sovereign (γ_{it}) and the demeaned CDS spread of the respective sovereign (d_{sit}). The time window over which γ_{it} is calculated precedes the period of the purchases to avoid reverse causality that would arise if a contemporaneous window was chosen.[15] To separately identify the period we are primarily interested in, we include in addition an interaction term of ρ_{it} and a dummy variable $dummyVLTRO$ that is equal to

[14] To reduce excessive volatility in the observations of the dependent variable, we convert the data to quarterly frequency.

[15] Using a contemporary window is problematic because the increase of banks' direct exposure vis-a-vis their domestic sovereign in general strengthens the bank-sovereign nexus (see the literature cited in section 2). The estimated regression coefficient would therefore be biased upwards and include the causal effect of a stronger nexus on banks' purchases of domestic debt and the feedback effect of increased exposure to the sovereign on the strength of the bank-sovereign nexus. Given that our dependent variable is the flow of government bond purchases, which is not a very persistent variable, the use of a lagged window for the calculation of γ_i should address any endogeneity issues.

1 in the final quarter of 2011 and the first quarter of 2012, i.e. in the period when the two VLTROs were announced and settled. Finally, X_{it} denotes a vector of bank and country-specific controls intended to capture the additional motivations for holding government bonds referred to above. Both B_{it} and the bank-specific controls included in X_{it} are defined as ratios to each bank's main assets. We scale by main assets because we are interested in studying changes in banks' portfolio composition, rather than a change in domestic government bond holdings that is proportional to an overall change in the size of the bank.[16] Tables A1 and A2 in the annex present summary statistics and pair-wise correlations of our explanatory variables.[17]

5 Empirical results

We estimate regressions of the type given by equation (10), using panel fixed effects for a sample covering the period 2008 Q1 to 2015 Q2. Table 1 presents a first set of results, focusing exclusively on our main variable of interest – ρ_{it} – and its components – γ_{it} and d_{sit}. The interaction term of ρ_{it} and $dummyVLTRO$ is statistically significant (see column (1)), confirming the prediction of the simple model presented in Section 3 for the period of the two VLTROs.[18, 19] The coefficient on ρ_{it} on its own,

[16]The approach of scaling bank-specific variables by a measure of bank size is standard in empirical banking analysis. For example, Cornett et al. (2011) study how banks manage their holdings of liquid assets, the adjustment of bank lending on the balance sheet and total credit origination using dependent and explanatory variables scaled by total assets.

[17]Greece and Cyprus have been excluded from the analysis to minimize the impact of the voluntary private sector involvment in the context of the Greek EU-IMF programme (i.e. the haircut on Greek sovereign bonds held by the private sector) on our analysis.

[18]All p-values reported in the paper are based on cluster-robust standard errors. Since our analysis includes explanatory variables that do not vary within a country, the clustering is at the country level, as suggested in Bertrand et al. (2004). The results do not change if instead the standard errors allow for clustering only at the level of individual banks.

[19]To check the robustness of the result we also use two additional definitions of the VLTRO dummy. First, we set it equal to one in 2012Q2 in addition to 2011Q4 and 2012Q1. The interaction term with this redefined dummy remains significant and the remaining results do not change. Second, we set the dummy equal to one 2012 Q2 and Q3 in addition to 2011Q4 and 2012Q1. In this case, the interaction term becomes insignificant. Further cross-checks reveal that the strongest relation between ρ_{it} and the net purchases of domestic sovereign bonds is observed for the time period surrounding the settlement of the two credit operations with a maturity of 3 years (in the first quarter of 2012, as the first VLTRO was settled in January, and the second in March 2012). Redefining the VLTRO dummy - so as to include additional quarters after the actual settlement of the VLTROs - waters down the effect.

which captures the average effect over the entire sample period turns out, however, not to be significant. The risk-shifting mechanism likely requires the coexistence of non-trivial levels of sovereign credit risk and a material intensity of the bank-sovereign nexus to become relevant. Such conditions prevailed in the period in which the VLTROs were announced and settled (see Chart 3 and Charts A3 and A4 in the annex).

To allow for the possibility that a sovereign risk shock or a change in the strength of the bank-sovereign nexus can affect bank portfolio choice directly, over and above their interaction, column (2) reports the results of a specification where the two variables are also included separately. Importantly, the coefficient on the interaction term of ρ_{it} and the VLTRO period dummy retains its significance and size in this specification. At the same time, the coefficient on the sovereign CDS is also significant and has a negative sign. This finding indicates that the relationship between sovereign credit risk premia and bank purchases of domestic sovereign bonds depends on the strength of banks' nexus with their sovereign. In the absence of a bank-sovereign nexus (i.e. when γ_{it} - and therefore ρ_{it} - is close to zero) banks scale down their domestic sovereign bond portfolios when sovereign credit risk premia increase, as the increased risk is internalised by the bank. For higher levels of the bank-sovereign nexus, however, less of the increased domestic sovereign risk is internalised and the attractiveness of the higher nominal yield eventually dominates, thereby leading to higher purchases of domestic sovereign bonds.

Indeed, for a nexus equal to the cross-sectional median during the VLTRO period, a 1 pp increase in sovereign CDS leads to purchases of domestic sovereign bonds relative to main assets of 0.034 percent per quarter.[20] A CDS increase in the order of magnitude of 3.5 pp – corresponding to the difference between German and Italian sovereign CDS spreads in that period – implies additional purchases of domestic sovereign bonds of 0.12 percent of main assets per quarter. Bearing in mind that on average such purchases amounted to 0.23 percent of main assets, the size of the coefficient is economically meaningful. In a similar vein, a strengthening of the bank-sovereign nexus during the VLTRO period is accompanied by an expansion of banks' portfolios of domestic sovereign bonds. While the impact of γ_{it} is negligible for CDS

[20]Recalling that ρ_i is the product of γ_i and d_{si}, specification 2 presented in Table 1 implies that the relation between sovereign CDS and domestic sovereign bond purchases during the VLTRO period has the following form: $\frac{\partial B_i}{\partial d_{si}}|_{d\_VLTRO=1} = 0.007\gamma_i + 0.069\gamma_i - 0.036 = 0.076\gamma_i - 0.036$. The cross-sectional median of γ_i during the VLTRO period is 0.9272 (see Table A1 in the annex). Therefore, $\frac{\partial B_i}{\partial d_{si}}|_{d\_VLTRO=1} = 0.034$.

Fixed effects estimation *Dependent Variable:*	*(1)* B_i	*(2)* B_i	*(3)* B_i
ρ_i *(lag)*	***-0.021***	***0.007***	***0.030***
	(0.153)	*(0.590)*	*(0.148)*
ρ_i *(lag)*dummyVLTRO*	***0.062******	***0.069******	
	(0.008)	*(0.004)*	
γ_i *(lag)*		-0.025	-0.026
		(0.666)	*(0.671)*
d_{si} *(lag)*		-0.036**	-0.028**
		(0.013)	*(0.040)*
Constant	0.189*	0.193	0.199*
	(0.092)	*(0.102)*	*(0.098)*
Observations	2,760	2,760	2,760
R-squared	0.030	0.031	0.029
Number of banks	120	120	120
Time dummies	yes	yes	yes

*Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively*

Table 1: Baseline specification

B_i denotes purchases of domestic government bonds divided by main assets. ρ_i is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1.

levels close to the cross-sectional mean in our sample,[21] this no longer holds for banks located in countries under stress. An increase in the nexus of one standard deviation (0.21 see lower panel of Table A1 in annex), corresponds to additional purchases of domestic sovereign bonds in the order of magnitude of 0.18 percent of bank main assets within one quarter for a bank located in Spain, 0.20 in Italy and 0.80 in Portugal.[22]

The findings in column (2) suggest that the drivers of the observed purchases of domestic government bonds in the VLTRO period are consistent with the prediction of the simple theoretical framework presented in section 3, thereby supporting the risk shifting hypothesis. At the same time, column (3) reports the results of estimating the same specification as in column (2) but without the interaction term of ρ_{it} and the VLTRO period dummy. On average during the sample period considered, this mechanism was not a significant driver of domestic sovereign bond purchases. In view of this, we conduct several robustness checks of our result for the VLTRO period, before turning to the question of why the results in this period may differ from those obtained for the entire sample period.

5.1 Robustness analysis

As a first check we estimate the same model using OLS and a set of time and country dummies instead of bank fixed effects. Fixed effects panel estimations rely on the time variability of explanatory variables. The significance of factors that differ across cross-sectional units but remain rather stable over time is absorbed by the bank fixed effects. By contrast, OLS allows us to identify the impact of variables that vary less strongly over time at the expense of potential omitted variable bias due to unobserved bank-specific characteristics. This outcome is presented in the annex; the results remain by and large unchanged (see Table A3 in the annex).

Subsequently, we check whether the findings remain valid when additional control variables are included. We start with the specification presented in column (2) of Table 1 and sequentially add controls. The

[21] Recall that the CDS spreads on domestic sovereign bonds are included in demeaned form, therefore the variable d_{si} equals zero whenever the sovereign CDS are at their sample mean (across time and countries).

[22] $\frac{\partial B_i}{\partial \gamma_i}|_{d\_VLTRO=1} = 0.007 * d_{si} + 0.069 * d_{si} - 0.025 = 0.076 d_{si} - 0.025$. For a d_{si} of 2.7 p.p. (corresponding to the demeaned CDS on Spanish sovereign bonds during the VLTRO period) $\frac{\partial B_i}{\partial \gamma_i}|_{d\_VLTRO=1} = 0.18$; for a d_{si} of 3 p.p. (corresponding to the demeaned CDS on Italian sovereign bonds during the VLTRO period) $\frac{\partial B_i}{\partial \gamma_i}|_{d\_VLTRO=1} = 0.2$; for a d_{si} of 11 p.p. (corresponding to the demeaned CDS on Portuguese sovereign bonds during the VLTRO period) $\frac{\partial B_i}{\partial \gamma_i}|_{d\_VLTRO=1} = 0.8$

fundamental findings carry through in all specifications (see Table 2 below).

An initial set of controls captures the structure of banks' balance sheets and bank size. These are lagged by one period to minimize potential endogeneity problems. The first variable refers to banks' access to stable funding. Banks with a lower endowment of stable funding facing funding pressure might have been inclined to tilt their portfolio composition towards liquid assets, like domestic sovereign bonds. We therefore include each banks' share of core deposit funding in column (2). The variable is not significant and does not materially affect the size or significance of the coefficient of the interaction term $\rho_{it} * dummyVLTRO$. The second control refers to bank size, which may affect banks' propensity to take on exposure to domestic government debt as larger banks may factor in a higher probability of being bailed out by the government in case of need, due to the potential systemic fallout of allowing them to fail - the "too big to fail" problem. Similar to what we find for the share of core deposit funding, bank size (defined as the logarithm of banks' main assets) is not significant and does not materially affect the size or significance of the coefficient of the interaction term $\rho_{it} * dummyVLTRO$ (column (3)).

Subsequently, in column (4), we control for banks' capital base. The variable – labelled leverage ratio – is a ratio of capital and reserves reported by banks in the context of the compilation of the monetary statistics over main assets. Banks with a weaker capital position might have stronger incentives to acquire domestic sovereign bonds, as the fraction of losses that will not be absorbed by shareholder equity and thus effectively shifted to bank creditors increases.[23] This is among the driving factors of carry trades identified by Acharaya and Steffen (2014). By contrast, our analysis suggests that banks' capital position does not have a statistically significant role in determining government bond purchases. This finding is in line with the evidence reported in Becker and Ivashina (2014). These authors, however, interpret this finding as evidence against the risk shifting hypothesis as, following Crosignani (2015) and Drechsler et al. (2014), they consider that risk shifting should be associated with less capitalised banks. In our analysis, instead, bank

[23] In addition, banks with low capital buffers may be further inclined to purchase sovereign bonds as minimum regulatory capital ratios assign a zero risk weight to sovereign exposures vis-a-vis euro area governments (although this consideration is not captured by the variable used for capital, which is a leverage ratio that does not take into account the risk weights of the assets held). While this would explain why sovereign bonds are prefered to lending to the private sector (in which case scarce bank capital will need to be set aside), it does not per se imply that domestic sovereign bonds would be more attractive than bonds issued by other euro area countries.

capitalisation enters as a control, whereas the intensity of the motive to risk-shift is captured by the bank-sovereign nexus variable. In this context, it is nevertheless plausible that the intensity of the nexus would be stronger for less capitalised banks, as the pricing of their riskiness would rely more heavily on the availability of a sovereign capital backstop.[24]

In a next step we control for banks' existing holdings of liquid assets. The liquidity ratio includes interbank lending, holdings of government bonds, of debt securities issued by the private sector (including banks) and of equity. Banks that already hold large quantities of safe and liquid assets – which are also eligible for inclusion in the calculation of regulatory liquidity ratios – might be less inclined to purchase sovereign bonds. This is found to be the case (see column (5)). The size of banks' pre-existing sovereign bond portfolio scaled by main assets is included for a similar reason. We find evidence of 'mean-reversion' in the sense that banks which already hold large quantities of domestic sovereign bonds tend to purchase less (see column (6)).

The last control included in Table 2 is real GDP growth in the economy where each bank is located. As discussed in section 2, the state of the economy affects the balance sheets of both banks and the government, thereby imparting a correlation in their respective probabilities of default. At the same time, real GDP growth may act as a proxy for the ex-ante risk-adjusted attractiveness of alternative domestic assets, such as loans to firms and households, effectively capturing the opportunity costs of holding sovereign debt. The result in column (7) does not reveal a significant influence of this factor on banks' decisions to purchase domestic sovereign bonds, although the sign of the estimated coefficient conforms with the reasoning for including this variable.

The results remain unchanged when we use OLS and a set of time and country dummies instead of panel fixed effects (see Table A4 in the annex). The main finding that during the VLTRO period, first, ρ_{it} has a statistically significant and economically meaningful impact on banks' purchases of domestic sovereign bonds and, second, the relation between sovereign CDS and bank purchases of domestic sovereign bonds depends on the value of a bank's nexus with its sovereign - emerge as overall robust features.

Our results also remain robust when including interaction terms of the bank-specific characteristics with the VLTRO period dummy (see Table A5 in the annex). The significance and size of ρ_{it} is barely affected. It is also noteworthy that we do not find evidence of stronger

[24]The period of the VLTROs predates the introduction of the Bank Resolution and Recovery Directive, which introduced requirements for creditor bail-in before public capital support can be deployed.

Fixed effects estimation	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable:	B_i	B_i	B_i	B_i	B_i	B_i	B_i
ρ_i (lag)	0.007	0.009	0.008	0.007	0.006	0.004	0.006
	(0.590)	(0.510)	(0.508)	(0.560)	(0.629)	(0.753)	(0.647)
ρ_i (lag)*dummyVLTRO	**0.069*** **	**0.068*** **	**0.069*** **	**0.069*** **	**0.069*** **	**0.061*** **	**0.070*** **
	(0.004)	(0.003)	(0.004)	(0.006)	(0.005)	(0.005)	(0.004)
γ_i (lag)	-0.025	-0.023	-0.031	-0.026	-0.025	-0.046	-0.025
	(0.666)	(0.689)	(0.595)	(0.659)	(0.667)	(0.452)	(0.664)
d_{si} (lag)	-0.036**	-0.037**	-0.037**	-0.035**	-0.037**	-0.025**	-0.037**
	(0.013)	(0.020)	(0.013)	(0.018)	(0.012)	(0.039)	(0.019)
core deposits ratio (lag)		0.004					
		(0.167)					
log of main assets (lag)			-0.076				
			(0.170)				
leverage ratio (lag)				0.002			
				(0.666)			
liquidity ratio (lag)					-0.004***		
					(0.006)		
sov. bonds ratio (lag)						-0.057***	
						(0.001)	
real GDP gr. rate							-0.003
							(0.655)
Constant	0.193	0.095	1.005	0.182	0.322**	0.466***	0.175
	(0.102)	(0.471)	(0.124)	(0.137)	(0.014)	(0.003)	(0.139)
Observations	2,760	2,760	2,760	2,760	2,760	2,760	2,760
R-squared	0.031	0.032	0.032	0.031	0.033	0.062	0.031
Number of banks	120	120	120	120	120	120	120
Time dummies	yes	yes	yes	yes	yes	yes	yes

Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively

Table 2: Sensitivity analysis

'B_i' denotes purchases of domestic government bonds divided by main assets. 'ρ_i' is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1. 'core deposits ratio ' is the ratio of core deposits (deposits from households and non-financial corporations) and main assets. 'log of main assets' is the log of each bank's main assets. 'leverage ratio' is capital and reserves divided by main assets. 'liquidity ratio' is the sum of interbank lending, holdings of government bonds, debt securities issued by the private sector and equity, divided by main assets. 'sov bonds ratio' is the holdings of government bonds issued by euro area sovereigns divided by main assets. 'real GDP gr. rate' is the real GDP growth rate in the country where each bank is located.

purchases of domestic sovereign bonds by weakly capitalised lenders during the VLTRO period. This suggests that risk-shifting incentives due to the existence of a bank-sovereign nexus rather than a more general "gambling for resurrection" motive by undercapitalised banks explain the observed surge in banks' domestic sovereign bond purchases.

In a next set of robustness analyses we include all previously discussed controls at the same time (see Table 3, column (1)) and add one-by-one a set of variables capturing the changes in banks' funding. We consider the flows of core deposits to capture the effect of changes in the availability of stable funding and the flows of other deposits and wholesale funding to capture the impact of changes in more volatile funding components.

We augment the baseline from column (1) using lags of the funding flow variables and in addition use contemporary flows in an alternative specification for the following reason. A bank that plans to increase its domestic sovereign bond portfolio needs to simultaneously raise the necessary funds.[25] At the same time, a bank that has seen an inflow of funds would need to ceteris paribus 'park' these funds until they are deployed towards a more permanent use.[26] In this regard, domestic sovereign bonds are a natural choice, since the sovereign bond portfolio can be expanded or scaled down quickly and with small transaction costs if the resources are needed for alternative investment. In the first case the envisaged asset expansion induces an equal expansion of bank liabilities, in the latter an exogenous increase in liabilities needs to be accommodated on the asset side of banks' balance sheets. Using contemporary flows nests both directions and, therefore, suffers from reverse causality. The standard route followed in empirical literature is to use past flows (as past inflows should not be a mechanical reflection of a current asset expansion). The usage of lagged flows should in principal allow us to capture the causal effect from an exogenous funding increase on banks' purchases of sovereign bonds. At the same time, lags of rather volatile funding sources – like wholesale or non-core deposits – might be very weakly correlated with the contemporaneous flows and thus suffer from a problem similar to 'weak instruments'.

Table 3 presents the results. The inclusion of funding flows does not materially affect the size or significance of our main variable of interest ($\rho_{it} * dummyVLTRO$). None of the lagged flows added to the baseline specification are significant when included on their own (see columns (2), (4), (6)) or all at the same time (column (8)). Turning to the contemporary funding flows we find a significant relation between domestic sov-

[25] Unless it pursues a pure re-composition of the asset side of its balance sheet.

[26] Unless it recomposes its liability structure.

Fixed effects estimation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		lagged flow	contemp. flow	lagged flow	contemp. flow	lagged flow	contemp. flow	lagged flow	contemp. flow
Dependent Variable:	B_i	B_i	B_i	B_i	B_i	B_i	B_i	B_i	B_i
ρ_i (lag)	0.007	0.008	0.008	0.008	0.009	0.008	0.009	0.008	0.012
	(0.598)	(0.543)	(0.585)	(0.561)	(0.497)	(0.573)	(0.538)	(0.536)	(0.411)
ρ_i(lag)*dummyVLTRO	**0.059*****	**0.060*****	**0.060*****	**0.059*****	**0.056****	**0.060*****	**0.060*****	**0.060*****	**0.056*****
	(0.009)	(0.010)	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)
γ_i (lag)	-0.045	-0.048	-0.045	-0.046	-0.046	-0.046	-0.044	-0.048	-0.045
	(0.462)	(0.440)	(0.461)	(0.451)	(0.455)	(0.448)	(0.466)	(0.439)	(0.457)
d_{si} (lag)	-0.025*	-0.026*	-0.025*	-0.026*	-0.023*	-0.026*	-0.024*	-0.027*	-0.022
	(0.074)	(0.063)	(0.073)	(0.064)	(0.095)	(0.065)	(0.086)	(0.062)	(0.112)
core deposits ratio (lag)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	(0.239)	(0.264)	(0.241)	(0.271)	(0.245)	(0.265)	(0.254)	(0.279)	(0.264)
log of main assets (lag)	0.002	-0.001	-0.004	-0.001	0.005	0.001	0.003	0.002	0.001
	(0.973)	(0.983)	(0.931)	(0.985)	(0.919)	(0.982)	(0.946)	(0.973)	(0.978)
leverage ratio (lag)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.003
	(0.409)	(0.429)	(0.411)	(0.446)	(0.368)	(0.453)	(0.444)	(0.488)	(0.410)
sov. bonds ratio (lag)	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
liquidity ratio (lag)	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.310)	(0.253)	(0.304)	(0.297)	(0.403)	(0.279)	(0.238)	(0.265)	(0.294)
real GDP gr. rate	0.001	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002
	(0.849)	(0.769)	(0.861)	(0.758)	(0.792)	(0.743)	(0.786)	(0.750)	(0.726)
flow of core deposits		**0.008**	**-0.009**					**0.008**	**-0.009**
		(0.369)	(0.525)					(0.364)	(0.527)
flow of other deposits				**-0.002**	**0.027***			**-0.003**	**0.030***
				(0.781)	(0.075)			(0.676)	(0.055)
flow of wholesale funding						**-0.002**	**0.008****	**-0.002**	**0.010****
						(0.610)	(0.023)	(0.554)	(0.019)
Constant	0.369	0.410	0.437	0.408	0.325	0.385	0.365	0.383	0.381
	(0.564)	(0.526)	(0.513)	(0.530)	(0.598)	(0.557)	(0.577)	(0.551)	(0.568)
Observations	2,760	2,752	2,760	2,752	2,760	2,752	2,760	2,752	2,760
R-squared	0.063	0.063	0.064	0.063	0.068	0.063	0.065	0.063	0.071
Number of banks	120	119	120	119	120	119	120	119	120
Time dummies									

Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively

Table 3: Sensitivity analysis

'B_i' denotes purchases of domestic government bonds divided by main assets. 'ρ_i' is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1. 'core deposits ratio ' is the ratio of core deposits (deposits from households and non-financial corporations) and main assets. 'log of main assets' is the log of each bank's main assets. 'leverage ratio' is capital and reserves divided by main assets. 'liquidity ratio' is the sum of interbank lending, holdings of government bonds, debt securities issued by the private sector and equity, divided by main assets. 'sov bonds ratio' is the holdings of government bonds issued by euro area sovereigns divided by main assets. 'real GDP gr. rate' is the real GDP growth rate in the country where each bank is located. 'flow of core deposits' is the change in core deposits divided by main assets. 'flow of other deposits' is the change of other deposits divided by main assets. 'flow of wholesale funding' is flow of bond and money market funding scaled by main assets.

ereign bond purchases and increases in volatile funding sources (wholesale funding and other deposits). Banks may be unwilling to expand their loan portfolios on the basis of funding inflows that may quickly reverse, as argued, for instance, by Butt et al. (2014). Instead, part of these inflows seems to have been used to build-up liquidity buffers in the form of domestic sovereign bonds. Core deposits, on the other hand, seem not to relate to banks' purchases of sovereign bonds. As these flows are sticky and do not expose the recipient to the risk of an unexpected sharp reversal they seem not to be accompanied by an accumulation of precautionary liquidity buffers. Using OLS augmented with a set of time and country dummies instead of fixed effects does not alter the findings (see Table A6 in the annex).

5.2 Why is the VLTRO period special?

We now turn to the question of why we find evidence for risk shifting in domestic sovereign bonds between the final quarter of 2011 and the first quarter of 2012 while the relation turns out not to be statistically significant outside this period. There are two readings of this result.

A benign interpretation would suggest that banks were eager to build up liquidity buffers in this period. Within the category of assets that can serve this purpose, domestic sovereign bonds offered the best risk-return profile. The VLTROs were introduced in a period of financial market turbulence. Banks that were facing funding pressure or feared that funding pressure might materialise in the not-too-distant future might have been inclined to borrow from these operations and expand their stock of assets that can be easily sold or deposited with the Eurosystem. Banks' attempt to frontload the refinancing of maturing long-term bonds at the VLTROs has already been documented (ECB 2012). Such an 'on-balance-sheet' liquidity buffer can be maintained in several forms. Investing in domestic sovereign debt, however, dominates in terms of its risk-return characteristics the two next best alternatives – holding excess reserves with the Eurosystem or holding other sovereign bonds denominated in euros. While the predominant motivation of banks in that particular period might have been to self-insure against liquidity risk, investments in domestic sovereign bonds allowed them to generate a positive carry spread on top.

A less benign interpretation would argue that the availability of long-term funding at a price that is not sensitive to banks' own risk profile allowed banks to actively pursue carry trades with a predominant profitability motive, a view supported, for instance, by Acharya and Steffen (2015).

To shed some light on this question, we include measures of banks' recourse to Eurosystem credit operations in our regression analysis and report the results in Table 4. A chronic high reliance on Eurosystem funding is typically symptomatic of a loss of access to market funding. In column (2) we add the ratio of outstanding Eurosystem credit to main assets, while in (3) we also include its interaction with the VLTRO dummy. The coefficients are not significant suggesting that the surge in purchases of domestic sovereign bonds was not driven by banks without market access which actively pursue carry trades funded via repos with the central bank.

In a next step we include the lagged flow of Eurosystem credit (column (4)) and additionally its interaction with the VLTRO dummy (column (5)), while contemporary flows and an interaction with the dummy are shown in the next two columns. The lagged flow of Eurosystem credit when interacted with the VLTRO dummy seems to significantly relate to banks' expansion of domestic sovereign bond portfolios. In addition, we find a significant positive relationship between the contemporary flow of Eurosystem credit and domestic sovereign bond purchases (see columns (6) and (7)). The strength of the relationship has the same order of magnitude as the one of the flow of other deposits or wholesale funding. This finding speaks in favour of the 'benign' precautionary motive for the induced purchases of sovereign bonds. If a pure 'carry trade' motive as in Acharaya and Steffen (2014) was the driving force, given that central bank liquidity was supplied elastically as to fully accommodate banks' demand (subject to the availability of eligible collateral), one would expect a coefficient much closer to 1. According to specification (5) a flow of Eurosystem credit scaled by main assets of 1.5 percentage points (corresponding to the mean during the VLTRO period) was accompanied by additional purchases of domestic sovereign bonds of 0.035 percent of main assets. Put in perspective to the observed average per quarter purchases of 0.223 percent of main assets, the amounts are small even if not fully negligible. Throughout specifications (2)-(7) the size and significance of the interaction term $\rho_{it} * dummyVLTRO$ remains by and large unchanged compared to the baseline (1).

To sum up, the observed strong expansion of banks' domestic sovereign bond portfolios during the final quarter of 2011 and the first quarter of 2012 seems to reflect both banks' attempts to build up liquidity buffers and – to a much lesser extent – the active pursuit of carry trades. In both cases, the risk shifting mechanism meant that acquisitions of domestic government bonds were a strategy that offered higher ex ante returns than alternatives, such as the acquisition of non-domestic sovereign bonds.

Fixed effects estimation Dependent Variable:	(1) baseline B_i	(2) ES credit B_i	(3) B_i	(4) lagged flows B_i	(5) B_i	(6) contemp. flows B_i	(7) B_i
ρ_i (lag)	0.008	0.008	0.011	0.007	0.007	0.010	0.010
	(0.536)	(0.537)	(0.396)	(0.600)	(0.602)	(0.451)	(0.448)
ρ_i (lag)*dummyVLTRO	**0.060*** **	**0.059** **	**0.047** **	**0.060*** **	**0.060** **	**0.053*** **	**0.055*** **
	(0.010)	(0.011)	(0.016)	(0.010)	(0.011)	(0.008)	(0.007)
γ_i (lag)	-0.048	-0.048	-0.047	-0.048	-0.047	-0.042	-0.041
	(0.439)	(0.437)	(0.450)	(0.442)	(0.451)	(0.477)	(0.477)
d_{si} (lag)	-0.027*	-0.026*	-0.028*	-0.027*	-0.027*	-0.019	-0.019
	(0.062)	(0.064)	(0.056)	(0.062)	(0.063)	(0.148)	(0.139)
core deposits ratio (lag)	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	(0.279)	(0.301)	(0.297)	(0.249)	(0.250)	(0.273)	(0.288)
log of main assets (lag)	0.002	0.003	0.003	-0.001	-0.002	0.017	0.018
	(0.973)	(0.952)	(0.948)	(0.986)	(0.968)	(0.745)	(0.733)
leverage ratio (lag)	0.002	0.002	0.002	0.003	0.003	0.003	0.003
	(0.488)	(0.487)	(0.518)	(0.415)	(0.436)	(0.393)	(0.390)
sov. bonds ratio (lag)	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***	-0.056***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
liquidity ratio (lag)	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.265)	(0.283)	(0.283)	(0.299)	(0.321)	(0.349)	(0.346)
real GDP gr. rate	0.002	0.002	0.001	0.001	0.002	0.004	0.004
	(0.750)	(0.758)	(0.841)	(0.804)	(0.753)	(0.558)	(0.578)
flow of core deposits	0.008	0.008	0.009	0.008	0.008	-0.008	-0.008
	(0.364)	(0.357)	(0.329)	(0.345)	(0.324)	(0.589)	(0.567)
flow of other deposits	-0.003	-0.003	-0.003	-0.002	-0.002	0.032**	0.032**
	(0.676)	(0.671)	(0.715)	(0.767)	(0.765)	(0.049)	(0.049)
flow of wholesale funding	-0.002	-0.002	-0.003	-0.001	-0.001	0.013**	0.013**
	(0.554)	(0.546)	(0.495)	(0.756)	(0.734)	(0.011)	(0.011)
Eurosystem credit ratio (lag)		**-0.001**	**-0.001**				
		(0.792)	(0.551)				
ES credit ratio (lag) * dummyVLTRO			**0.015**				
			(0.362)				
flow of Eurosystem credit				**0.010**	**0.006**	**0.024** **	**0.026** **
				(0.132)	(0.325)	(0.042)	(0.030)
flow of Eurosystem credit * dummyVLTRO					**0.023*** **		**-0.016**
					(0.009)		(0.183)
Constant	0.383	0.371	0.365	0.386	0.402	0.253	0.250
	(0.551)	(0.577)	(0.576)	(0.544)	(0.524)	(0.702)	(0.705)
Observations	2,752	2,752	2,752	2,752	2,752	2,760	2,760
R-squared	0.063	0.063	0.064	0.064	0.065	0.075	0.075
Number of banks	119	119	119	119	119	120	120
Time dummies	yes	yes	yes	yes	yes	yes	yes

*Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively*

Table 4: The role of Eurosystem credit

For a definition of 'B_i', 'ρ_i', 'γ_i ', 'd_{si} ', 'dummyVLTRO', 'core deposits ratio ', 'log of main assets', 'leverage ratio', 'liquidity ratio', 'sov bonds ratio', 'real GDP gr. rate', 'flow of core deposits', 'flow of other deposits' and 'flow of wholesale funding' see the notes to Table 3. 'Eurosystem credit ratio' is the ratio of outstanding credit obtained from the Eurosystem divided by main assets. 'flow of Eurosystem credit' is the change in credit obtained from the Eurosystem divided by main assets.

6 Conclusions

We find evidence of risk shifting via acquisitions of domestic sovereign bonds in the final quarter of 2011 and the first quarter of 2012 - an episode of marked increases in the domestic sovereign bond portfolios by euro area banks located in vulnerable countries. For this period, we show that if banks' creditworthiness is correlated with that of their domestic sovereign, surges of sovereign credit risk lead to expansions of banks' exposures to their government. Furthermore, in the presence of sovereign credit risk, banks' tendency to purchase domestic sovereign debt increases with a stronger bank-sovereign nexus.

Risk shifting behaviour emerges in the period following the conduct of the VLTROs by the ECB as this period featured the co-existence of, on the one hand, elevated sovereign credit risk and, on the other, a significant intertwining of bank and sovereign creditworthiness. In these circumstances, the risk shifting mechanism implies that acquiring domestic sovereign bonds dominates, from the perspective of bank shareholders, alternative ways to maintain an on-balance-sheet liquidity buffer, or indeed to execute carry trades, such as investing in non-domestic government bonds. Banks' home bias in the purchases of sovereign bonds in that period is, therefore, found to stem from an incomplete internalisation of domestic sovereign credit risk.

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Annex I Background charts and tables

FULL SAMPLE	p25	p50	mean	p75	sd	N
d. sov. bond purchases/m. assets	-0.0574	0.0000	0.0511	0.1315	0.7501	2760
corr(sov CDS, bank CDS)*sov. CDS [ρ_i]	-0.5643	-0.2241	0.1593	0.3803	1.2670	2760
corr(sov CDS, bank CDS) [γ_i]	0.5312	0.7650	0.6480	0.8928	0.3365	2760
sovereign CDS [d_{si}]	-0.9022	-0.5009	0.1633	0.4893	1.7786	2760
core deposits ratio	8.5070	26.9244	29.2290	44.9388	23.6103	2760
log of main assets	9.7109	10.6526	10.6549	11.7028	1.4027	2760
leverage ratio	3.8621	7.0498	9.1729	10.7669	10.7872	2760
liquidity ratio	19.8832	31.9184	33.2439	43.7583	20.6431	2760
sov. bonds ratio	0.0776	3.8206	5.6282	8.3532	6.9056	2760
Eurosystem credit ratio	0.0000	0.0000	3.3936	4.2765	6.1370	2760
real GDP gr. rate	-1.0507	0.6073	0.2116	1.9074	2.7910	2760
flow of core deposits	-0.2739	0.0475	0.2749	0.7504	1.5209	2760
flow of other deposits	-0.6349	0.0000	-0.0493	0.5291	1.8743	2760
flow of ECB credit	0.0000	0.0000	-0.0679	0.0000	2.1892	2760
flow of wholesale funding	-1.7591	-0.2180	-0.3783	0.7762	3.9294	2760

VLTRO PERIOD (2011Q4-2012Q1)	p25	p50	mean	p75	sd	N
d. sov. bond purchases/m. assets	-0.0050	0.0000	0.2299	0.3660	0.9020	224
corr(sov CDS, bank CDS)*sov. CDS [ρ_i]	-0.2822	0.7957	1.6178	2.7587	2.3212	224
corr(sov CDS, bank CDS) [γ_i]	0.8755	0.9272	0.8504	0.9555	0.2113	224
sovereign CDS [d_{si}]	-0.3038	0.8827	1.8917	2.7421	2.8684	224
core deposits ratio	7.8906	25.3901	27.9141	42.5509	23.0274	224
log of main assets	9.7708	10.7392	10.7307	11.7127	1.3456	224
leverage ratio	3.8216	7.0695	8.4603	10.5276	8.9842	224
liquidity ratio	23.3979	34.9288	35.5597	45.9770	20.6853	224
sov. bonds ratio	0.0458	3.5187	4.9406	6.9373	6.4901	224
Eurosystem credit ratio	0.0000	0.8874	4.6207	7.0343	6.9814	224
real GDP gr. rate	-1.0507	0.7256	0.3879	1.4852	1.9970	224
flow of core deposits	-0.5036	0.0191	0.1844	0.6824	1.5520	224
flow of other deposits	-1.0232	-0.0749	-0.2910	0.4924	2.3392	224
flow of ECB credit	0.0000	0.0000	1.4727	2.2918	2.9943	224
flow of wholesale funding	-2.2045	-0.2105	-0.4703	1.0792	4.9930	224

Table A1: Summary statistics

	d. sov. bond purchases	ρ_i	γ_i	d^s_i	core dep. ratio	log of m. assets	lever. ratio	sov. bonds ratio	liquidity ratio	ES credit ratio	real GDP gr. rate	flow of core deposits	flow of oth. deposits	flow of ECB credit
d. sov. bond purchases/m. assets	1													
*corr(sov CDS, bank CDS)*sov. CDS [ρ_i]*	0.0497*	1												
corr(sov CDS, bank CDS) [γ_i]	-0.0008	0.0823*	1											
sovereign CDS [d_{si}]	0.0421*	0.8450*	0.1012*	1										
core deposits ratio	0.0304	0.009	-0.0245	-0.0094	1									
log of main assets	0.0169	0.0147	0.0864*	-0.022	-0.1422*	1								
leverage ratio	-0.0428*	0.0860*	0.0012	0.1245*	-0.1163*	-0.1669*	1							
sov. bonds ratio	0.0216	-0.0079	-0.0423*	-0.0305	0.1559*	0.1303*	-0.0330*	1						
liquidity ratio	0.0018	0.0168	0.0320*	0.0386*	0.1018*	0.1905*	-0.1865*	0.3805*	1					
Eurosystem credit ratio	0.0168	0.2583*	0.0307	0.2797*	-0.1565*	0.0278	-0.009	0.0387*	-0.02	1				
real GDP gr. rate	-0.0413*	-0.2075*	-0.1211*	-0.1647*	0.0287	-0.0521*	0.0550*	0.0796*	0.0289	-0.1403*	1			
flow of core deposits	0.0036	0.0015	0.0126	0.0046	0.2032*	-0.0616*	-0.0676*	0.0414*	0.0783*	0.0023	0.0186	1		
flow of other deposits	0.0822*	-0.0484*	0.0105	-0.0561*	-0.012	-0.0011	-0.0393*	-0.0144	0.0085	-0.024	-0.0005	0.03	1	
flow of ECB credit	0.0827*	0.1033*	0.0157	0.1113*	-0.0058	0.0264	-0.0139	-0.0067	0.0073	0.1609*	-0.0038	-0.0051	-0.0556*	1
flow of wholesale funding	0.0425*	-0.0478*	0.001	-0.0147	0.0048	0.0162	-0.0236	-0.0071	0.0279	-0.0710*	0.0307	-0.0156	-0.1194*	-0.1767*

Table A2: Pairwise correlations

OLS & time and country dummies Dependent Variable:	*(1)* B_i	*(2)* B_i	*(3)* B_i
ρ_i *(lag)*	**-0.012**	**0.019**	**0.040****
	(0.386)	*(0.108)*	*(0.043)*
ρ_i *(lag)*dummyVLTRO*	**0.058****	**0.068*****	
	(0.014)	*(0.006)*	
γ_i *(lag)*		-0.038	-0.038
		(0.462)	*(0.472)*
d_{si} *(lag)*		-0.043***	-0.034**
		(0.007)	*(0.017)*
Constant	0.251**	0.239**	0.252**
	(0.034)	*(0.043)*	*(0.036)*
Observations	2,760	2,760	2,760
R-squared	0.034	0.035	0.033
Number of banks	120	120	120
Country dummies	yes	yes	yes
Time dummies	yes	yes	yes

*Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively*

Table A3: Robustness check

B_i denotes purchases of domestic government bonds divided by main assets. ρ_i is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1.

OLS & time and country dummies Dependent Variable:	(1) B_i	(2) B_i	(3) B_i	(4) B_i	(5) B_i	(6) B_i	(7) B_i
ρ_i (lag)	-0.006	-0.006	-0.007	-0.008	-0.006	-0.005	-0.007
	(0.781)	(0.790)	(0.743)	(0.738)	(0.777)	(0.826)	(0.751)
ρ_i (lag)*dummyVLTRO	0.062*	0.062*	0.062*	0.063*	0.062*	0.063*	0.065*
	(0.092)	(0.090)	(0.092)	(0.089)	(0.092)	(0.079)	(0.092)
γ_i (lag)	-0.105*	-0.104*	-0.109*	-0.105*	-0.105*	-0.104*	-0.105*
	(0.058)	(0.062)	(0.055)	(0.056)	(0.055)	(0.063)	(0.058)
d_{si} (lag)	-0.012	-0.013	-0.012	-0.013	-0.013	-0.013	-0.017
	(0.237)	(0.212)	(0.245)	(0.214)	(0.219)	(0.174)	(0.241)
core deposits ratio (lag)		0.002**					
		(0.014)					
log of main assets (lag)			0.011				
			(0.387)				
leverage ratio (lag)				-0.002			
				(0.395)			
liquidity ratio (lag)					-0.001**		
					(0.019)		
sov. bonds ratio (lag)						-0.009*	
						(0.059)	
real GDP gr. rate							-0.007
							(0.548)
Constant	0.364***	0.281***	0.257**	0.376***	0.383***	0.390***	0.318**
	(0.001)	(0.001)	(0.034)	(0.001)	(0.001)	(0.001)	(0.023)
Observations	2,635	2,635	2,635	2,635	2,635	2,635	2,635
R-squared	0.037	0.040	0.037	0.038	0.038	0.042	0.037
Number of banks	120	120	120	120	120	120	120
Country dummies	yes	yes	yes	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes	yes	yes	yes

*Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively*

Table A4: Robustness check

'B_i' denotes purchases of domestic government bonds divided by main assets. 'ρ_i' is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1. 'core deposits ratio ' is the ratio of core deposits (deposits from households and non-financial corporations) and main assets. 'log of main assets' is the log of each bank's main assets. 'leverage ratio' is capital and reserves divided by main assets. 'liquidity ratio' is the sum of interbank lending, holdings of government bonds, debt securities issued by the private sector and equity, divided by main assets. 'sov bonds ratio' is the holdings of government bonds issued by euro area sovereigns divided by main assets. 'real GDP gr. rate' is the real GDP growth rate in the country where each bank is located.

Fixed effects estimation Dependent Variable:	(1) B_i	(2) B_i	(3) B_i	(4) B_i	(5) B_i	(6) B_i
ρ_i (lag)	0.007	0.007	0.008	0.007	0.007	0.003
	(0.590)	(0.594)	(0.515)	(0.588)	(0.614)	(0.812)
ρ_i (lag)*dummyVLTRO	0.069***	0.065***	0.069***	0.073***	0.069***	0.059***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.005)
γ_i (lag)	-0.025	-0.025	-0.031	-0.026	-0.024	-0.047
	(0.666)	(0.662)	(0.587)	(0.650)	(0.678)	(0.448)
d_{si} (lag)	-0.036**	-0.036**	-0.037**	-0.034**	-0.038***	-0.024**
	(0.013)	(0.032)	(0.012)	(0.021)	(0.009)	(0.045)
core deposits ratio (lag)		0.004				
		(0.201)				
core deposits ratio (lag)*dummyVLTRO		0.005*				
		(0.089)				
log of main assets (lag)			-0.076			
			(0.173)			
log of main assets (lag)*dummyVLTRO			-0.010			
			(0.843)			
leverage ratio (lag)				0.002		
				(0.644)		
leverage ratio (lag)*dummyVLTRO				-0.005		
				(0.183)		
liquidity ratio (lag)					-0.004***	
					(0.008)	
liquidity ratio (lag)*dummyVLTRO					0.003	
					(0.360)	
sov. bonds ratio (lag)						-0.058***
						(0.001)
sov. bonds ratio (lag)*dummyVLTRO						0.022**
						(0.024)
Constant	0.193	0.102	1.003	0.181	0.328**	0.468***
	(0.102)	(0.437)	(0.126)	(0.136)	(0.012)	(0.003)
Observations	2,760	2,760	2,760	2,760	2,760	2,760
R-squared	0.031	0.034	0.032	0.032	0.034	0.065
Number of banks	120	120	120	120	120	120
Time dummies	yes	yes	yes	yes	yes	yes

*Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively*

Table A5: Robustness check

'B_i' denotes purchases of domestic government bonds divided by main assets. 'ρ_i' is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1. 'core deposits ratio ' is the ratio of core deposits (deposits from households and non-financial corporations) and main assets. 'log of main assets' is the log of each bank's main assets. 'leverage ratio' is capital and reserves divided by main assets. 'liquidity ratio' is the sum of interbank lending, holdings of government bonds, debt securities issued by the private sector and equity, divided by main assets. 'sov bonds ratio' is the holdings of government bonds issued by euro area sovereigns divided by main assets.

OLS & time and country dummies Dependent Variable:	(1) B_i	(2) lagged flow B_i	(3) contemp. flow B_i	(4) lagged flow B_i	(5) contemp. flow B_i	(6) lagged flow B_i	(7) contemp. flow B_i	(8) lagged flow B_i	(9) contemp. flow B_i
ρ_i (lag)	-0.002	-0.001	-0.002	-0.002	-0.002	-0.002	0.001	-0.001	0.001
	(0.930)	(0.954)	(0.932)	(0.930)	(0.936)	(0.928)	(0.975)	(0.954)	(0.950)
ρ_i(lag)*dummyVLTRO	**0.059****	**0.059****	**0.059****	**0.059****	**0.055****	**0.059****	**0.060****	**0.059****	**0.056****
	(0.011)	(0.012)	(0.010)	(0.010)	(0.013)	(0.011)	(0.011)	(0.012)	(0.012)
γ_i (lag)	-0.096*	-0.096*	-0.095*	-0.093*	-0.097**	-0.093*	-0.092*	-0.096*	-0.092*
	(0.058)	(0.057)	(0.068)	(0.060)	(0.050)	(0.057)	(0.061)	(0.054)	(0.063)
d_{si} (lag)	-0.016	-0.017	-0.016	-0.016	-0.013	-0.016	-0.016	-0.017	-0.012
	(0.362)	(0.348)	(0.366)	(0.365)	(0.478)	(0.365)	(0.352)	(0.348)	(0.482)
core deposits ratio (lag)	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.017)	(0.013)	(0.016)	(0.019)	(0.017)	(0.020)	(0.017)	(0.015)	(0.016)
log of main assets (lag)	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027
	(0.142)	(0.142)	(0.150)	(0.144)	(0.132)	(0.144)	(0.128)	(0.143)	(0.124)
leverage ratio (lag)	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.389)	(0.387)	(0.386)	(0.382)	(0.415)	(0.389)	(0.396)	(0.390)	(0.422)
sov. bonds ratio (lag)	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*	-0.011*
	(0.061)	(0.062)	(0.062)	(0.063)	(0.062)	(0.063)	(0.061)	(0.063)	(0.062)
liquidity ratio (lag)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.624)	(0.559)	(0.628)	(0.607)	(0.661)	(0.604)	(0.567)	(0.561)	(0.598)
real GDP gr. rate	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	(0.688)	(0.649)	(0.687)	(0.630)	(0.643)	(0.630)	(0.688)	(0.649)	(0.639)
flow of core deposits		**0.011**	**-0.003**					**0.011**	**-0.003**
		(0.270)	(0.865)					(0.273)	(0.820)
flow of other deposits				**-0.000**	**0.030****			**0.000**	**0.033****
				(0.971)	(0.046)			(0.973)	(0.033)
flow of wholesale funding						**-0.001**	**0.008****	**0.001**	**0.010****
						(0.905)	(0.014)	(0.852)	(0.008)
Constant	0.022	0.026	0.022	0.028	0.011	0.026	0.021	0.025	0.008
	(0.937)	(0.925)	(0.938)	(0.912)	(0.999)	(0.917)	(0.946)	(0.988)	(0.847)
Observations	2,750	2,743	2,750	2,743	2,750	2,743	2,750	2,743	2,750
R-squared	0.045	0.046	0.045	0.045	0.051	0.045	0.047	0.046	0.054
Number of banks	120	119	120	119	120	119	120	119	120
Country dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes

*Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively*

Table A6: Robustness check

'B_i' denotes purchases of domestic government bonds divided by main assets. 'ρ_i' is the product of the strength of each bank's nexus with its respective sovereign (γ_i) and the CDS spread of the respective sovereign (d_{si}). 'dummyVLTRO' is a dummy variable equal to 1 in the 2011Q4 and 2012Q1. 'core deposits ratio ' is the ratio of core deposits (deposits from households and non-financial corporations) and main assets. 'log of main assets' is the log of each bank's main assets. 'leverage ratio' is capital and reserves divided by main assets. 'liquidity ratio' is the sum of interbank lending, holdings of government bonds, debt securities issued by the private sector and equity, divided by main assets. 'sov bonds ratio' is the holdings of government bonds issued by euro area sovereigns divided by main assets. 'real GDP gr. rate' is the real GDP growth rate in the country where each bank is located. 'flow of core deposits' is the change in core deposits divided by main assets. 'flow of other deposits' is the change of other deposits divided by main assets. 'flow of wholesale funding' is flow of bond and money market funding scaled by main assets.

OLS & time and country dummies Dependent Variable:	(1) Baseline B_i	(2) ES credit B_i	(3) B_i	(4) lagged flows B_i	(5) B_i	(6) contemp. flows B_i	(7) B_i
ρ_i (lag)	0.016	0.016	0.018	0.015	0.015	0.017	0.017
	(0.277)	(0.282)	(0.192)	(0.325)	(0.313)	(0.263)	(0.269)
ρ_i *dummyVLTRO	**0.069*** **	**0.069*** **	**0.053*** **	**0.069*** **	**0.069*** **	**0.061*** **	**0.063*** **
	(0.006)	(0.004)	(0.009)	(0.006)	(0.007)	(0.005)	(0.004)
γ_i (lag)	-0.056	-0.056	-0.054	-0.055	-0.054	-0.048	-0.048
	(0.367)	(0.365)	(0.377)	(0.374)	(0.380)	(0.407)	(0.408)
d_{si} (lag)	-0.044**	-0.044***	-0.046***	-0.044**	-0.044**	-0.035**	-0.035**
	(0.017)	(0.008)	(0.005)	(0.016)	(0.016)	(0.028)	(0.026)
core deposits ratio (lag)	0.002**	0.002***	0.002***	0.002**	0.002***	0.002**	0.002**
	(0.014)	(0.005)	(0.006)	(0.012)	(0.010)	(0.013)	(0.015)
log of main assets (lag)	0.025	0.025	0.024	0.025	0.025	0.026	0.025
	(0.164)	(0.161)	(0.160)	(0.165)	(0.156)	(0.131)	(0.132)
leverage ratio (lag)	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.399)	(0.431)	(0.423)	(0.405)	(0.419)	(0.427)	(0.419)
sov. bonds ratio (lag)	-0.010*	-0.010*	-0.010*	-0.010*	-0.010*	-0.011*	-0.011*
	(0.062)	(0.057)	(0.058)	(0.061)	(0.062)	(0.059)	(0.058)
liquidity ratio (lag)	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.562)	(0.608)	(0.625)	(0.543)	(0.559)	(0.636)	(0.637)
real GDP gr. rate	-0.000	-0.000	-0.001	-0.000	0.000	0.001	0.001
	(0.975)	(0.977)	(0.879)	(0.972)	(0.991)	(0.847)	(0.862)
flow of core deposits	0.012	0.012	0.013	0.012	0.013	-0.003	-0.003
	(0.262)	(0.270)	(0.248)	(0.252)	(0.243)	(0.825)	(0.812)
flow of other deposits	-0.001	-0.001	-0.000	-0.000	-0.000	0.034**	0.034**
	(0.892)	(0.894)	(0.973)	(0.988)	(0.990)	(0.039)	(0.039)
flow of wholesale funding	-0.001	-0.001	-0.001	0.000	0.000	0.013***	0.013***
	(0.859)	(0.869)	(0.819)	(0.909)	(0.933)	(0.009)	(0.008)
Eurosystem credit ratio (lag)		**0.000**	**-0.000**				
		(0.871)	(0.877)				
ES credit ratio (lag) * dummyVLTRO			**0.020**				
			(0.279)				
flow of Eurosystem credit				**0.013***	**0.009**	**0.027*** **	**0.030*** **
				(0.095)	(0.204)	(0.041)	(0.040)
flow of Eurosystem credit * dummyVLTRO					**0.024*** **		**-0.013**
					(0.022)		(0.256)
Constant	-0.045	-0.048	-0.037	-0.056	-0.057	-0.017	-0.011
	(0.793)	(0.779)	(0.822)	(0.752)	(0.740)	(0.921)	(0.949)
Observations	2,752	2,752	2,752	2,752	2,752	2,760	2,760
R-squared	0.046	0.046	0.047	0.047	0.048	0.059	0.059
Number of banks	119	119	119	119	119	120	120
Country dummies	yes	yes	yes	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes	yes	yes	yes

Notes: Cluster-robust p-values are reported in parentheses; *, ** and *** denote significance at 10%, 5% and 1% levels, repectively

Table A7: Robustness check

For a definition of 'B_i', 'ρ_i', 'γ_i ', 'd_{si} ', 'dummyVLTRO', 'core deposits ratio ', 'log of main assets', 'leverage ratio', 'liquidity ratio', 'sov bonds ratio', 'real GDP gr. rate', 'flow of core deposits', 'flow of other deposits' and 'flow of wholesale funding' see the notes to Table 3. 'Eurosystem credit ratio' is the ratio of outstanding credit obtained from the Eurosystem divided by main assets. 'flow of Eurosystem credit' is the change in credit obtained from the Eurosystem divided by main assets.

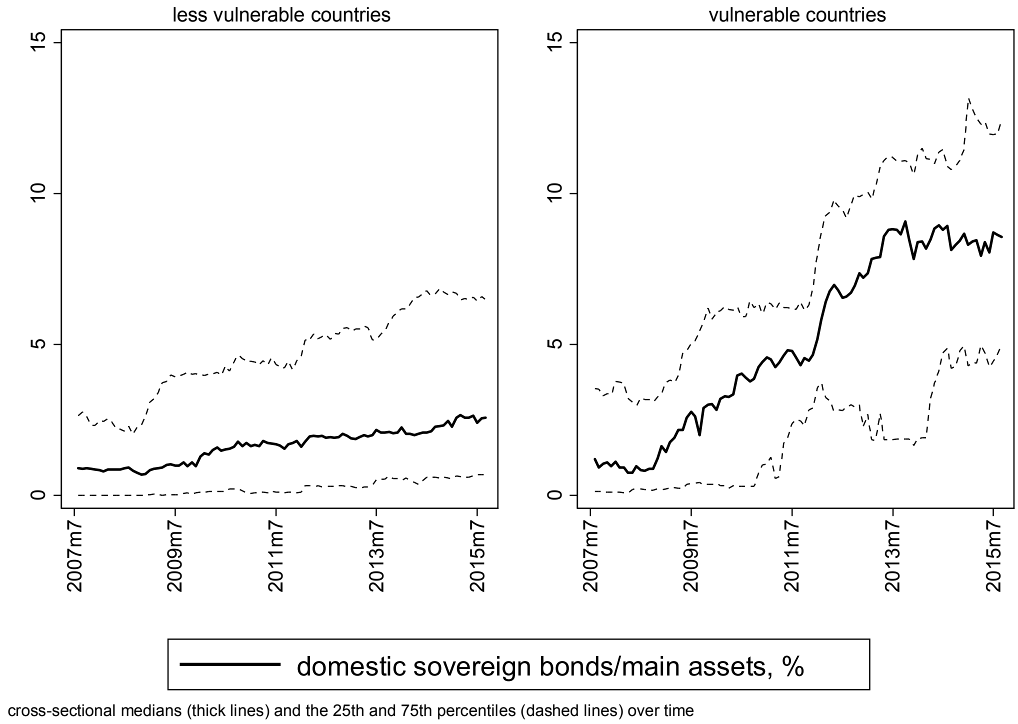

Chart A1: Euro area banks' holdings of domestic sovereign bonds

The group of 'vulnerable countries' comprises IT, ES, PT, IE, SI. The group of 'less vulnerable countries' includes the remaining euro area member states excluding GR and CY. Greece and Cyprus have been excluded from the analysis to minimise the impact of the voluntary private sector involvement in the context of the second Greek EU-IMF programme (i.e. the haircut on Greek sovereign bonds held by the private sector) on our analysis.

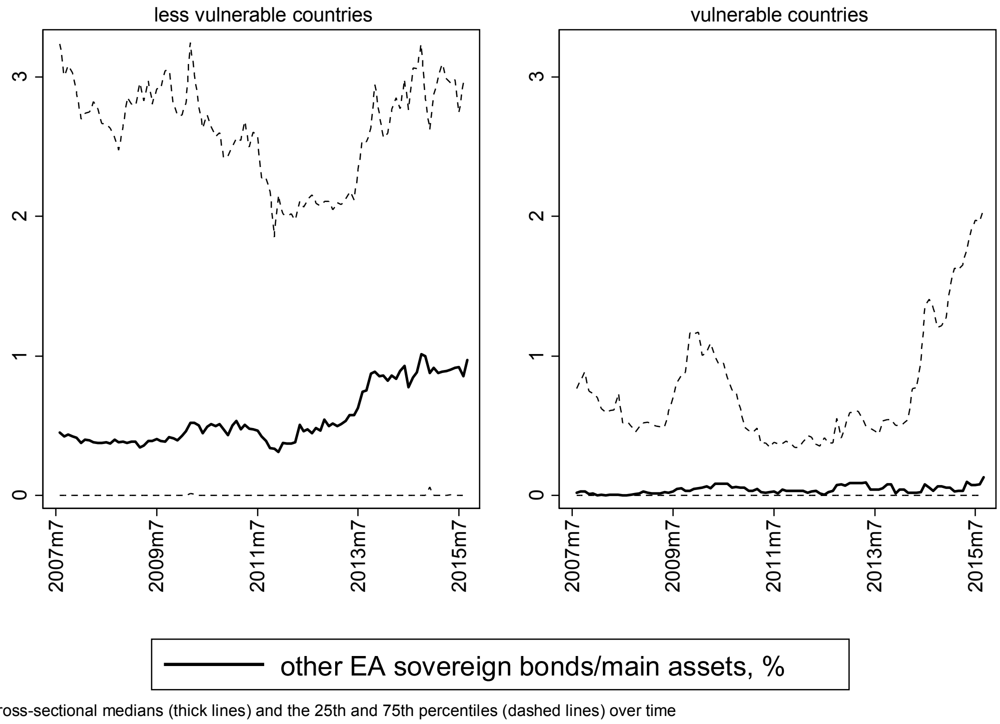

Chart A2: Euro area banks' holdings of bonds issued by euro area sovereigns other than the domestic

The group of 'vulnerable countries' comprises IT, ES, PT, IE, SI. The group of 'less vulnerable countries' includes the remaining euro area member states excluding GR and CY. Greece and Cyprus have been excluded from the analysis to minimise the impact of the voluntary private sector involvement in the context of the second Greek EU-IMF programme (i.e. the haircut on Greek sovereign bonds held by the private sector) on our analysis.

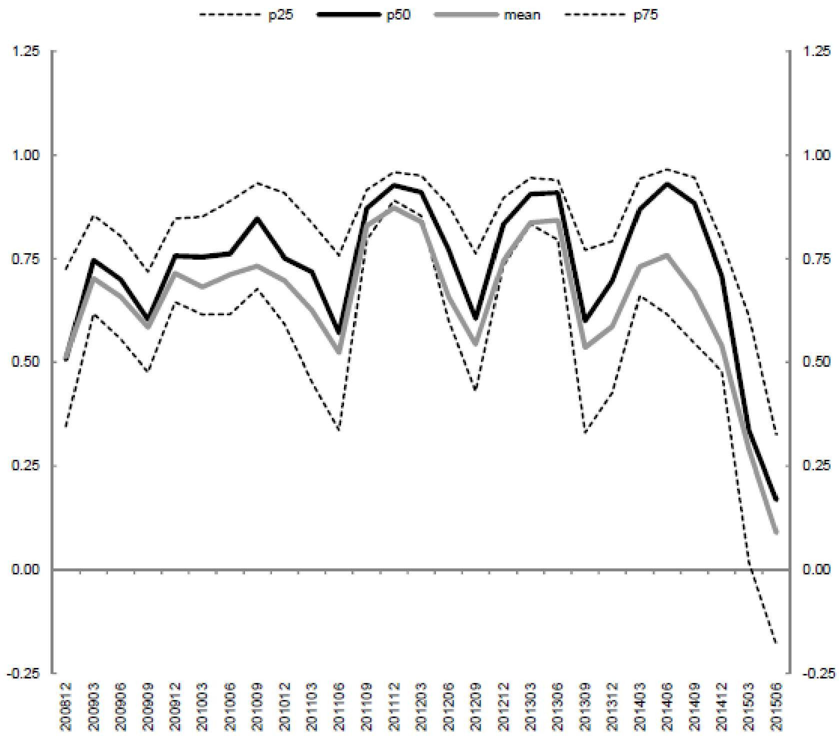

Chart A3: The strength of banks' nexus with their respective domestic sovereign.

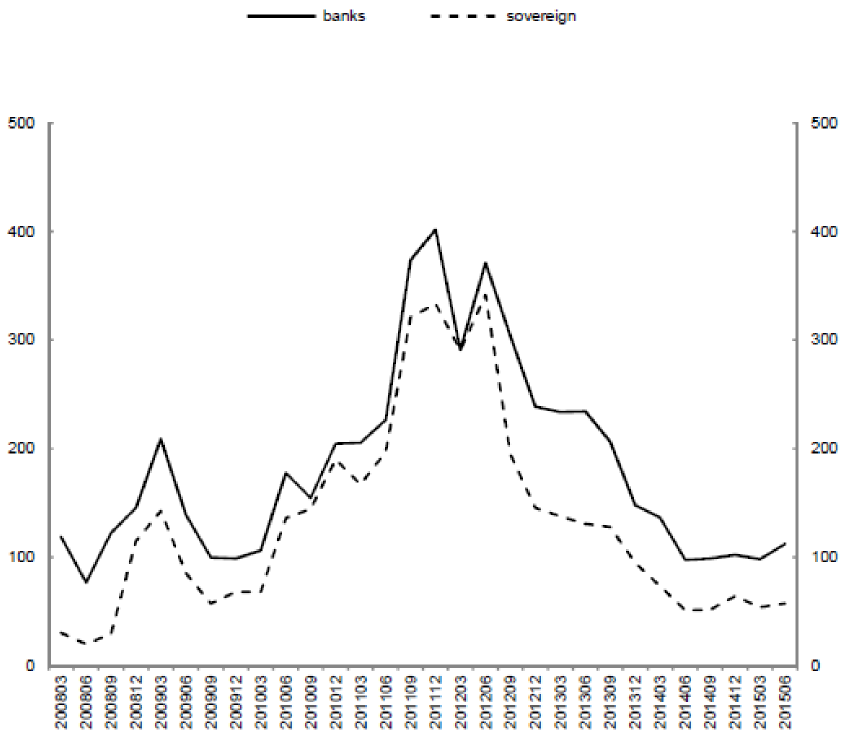

Chart A4: The evolution of average bank and sovereign CDS spreads.

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Desislava C. Andreeva
European Central Bank, Frankfurt am Main, Germany; email: desislava.andreeva@ecb.europa.eu

Thomas Vlassopoulos
European Central Bank, Frankfurt am Main, Germany; email: thomas.vlassopoulos@ecb.europa.eu

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

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