Why Are Banks Not Re-capitalized During Crises? A Political Economy Explanation *

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[Updated Version]

Abstract

I develop a model where governments have an incentive to keep their financial sectors undercapitalized during crises. Protected by limited liability, highly levered banks buy domestic bonds that are correlated with their other sources of revenue. In anticipation, governments set milder capital requirements to increase their future debt capacities when they most need to borrow. Myopic governments are more likely to induce high private sector debt, triggering a "race to the bottom" in capital regulation among countries. Using a general equilibrium model, I can rationalize, in the context of the Euro crisis, the increasing demand for domestic government bonds in the periphery, the crowding-out effect in private lending, and the reluctance to recapitalize the banking sector.

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1 Introduction

Yields on European peripheral government bonds reached record high between the second half of 2011 and 2012[1]. Two years later, with banks acting as buyers of last resorts for domestic government debt, bond spreads have narrowed and concerns about the fragility of the financial sector replaced those about the creditworthiness of sovereigns.

I summarize the empirical evidence that motivates this paper in three stylized facts. First, peripheral banks increased the exposure to domestic government bonds as the domestic sovereign became riskier. Starting in mid-2009, European peripheral spreads over the German Bund have widened, reaching record high at the end of 2011. The share of government debt domestically held also expanded during the same period. Figure 1 shows the positive correlation between the 10-year government bond spread (dashed line) and the share of government debt held by domestic banks (solid line) in Italy, Spain, Portugal, and Ireland. The increasing *share* of domestically owned debt can result from increasing domestic holdings and/or foreign outflows. Interestingly, in the GIIPS countries, domestic purchases have been higher than foreign outflows[2]. Figure C1 in the Appendix shows bond spreads and banks' *level* of holdings of domestic bonds. On the other hand, in the non Eurozone countries and in the core Euro countries, banks' holdings of domestic government debt decreased or remained constant during the same period. Figure C2 in the Appendix shows the bond spreads and banks' holdings of domestic government debt for Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, and UK.

Second, peripheral banks reduced lending to the private sector during the crisis. Figure 2 shows domestic banks' lending to private non-financial sector (solid line) and government debt held by domestic banks (dashed line) for Italy, Spain, Portugal, and Ireland. Banks reduced private lending and purchased domestic government bonds.

[1] 10-year (on-the-run) government bonds yields: Italy reached 7.24% on 25 November 2011, Spain reached 7.57% on 24 July 2012, Portugal reached 10.77% on 24 July 2012, and Ireland reached 13.79% on 18 July 2011. Source: Bloomberg.

[2] Banks and other institutional investors (insurance companies, pension funds, and investment funds) have been the main buyer of domestic sovereign debt.

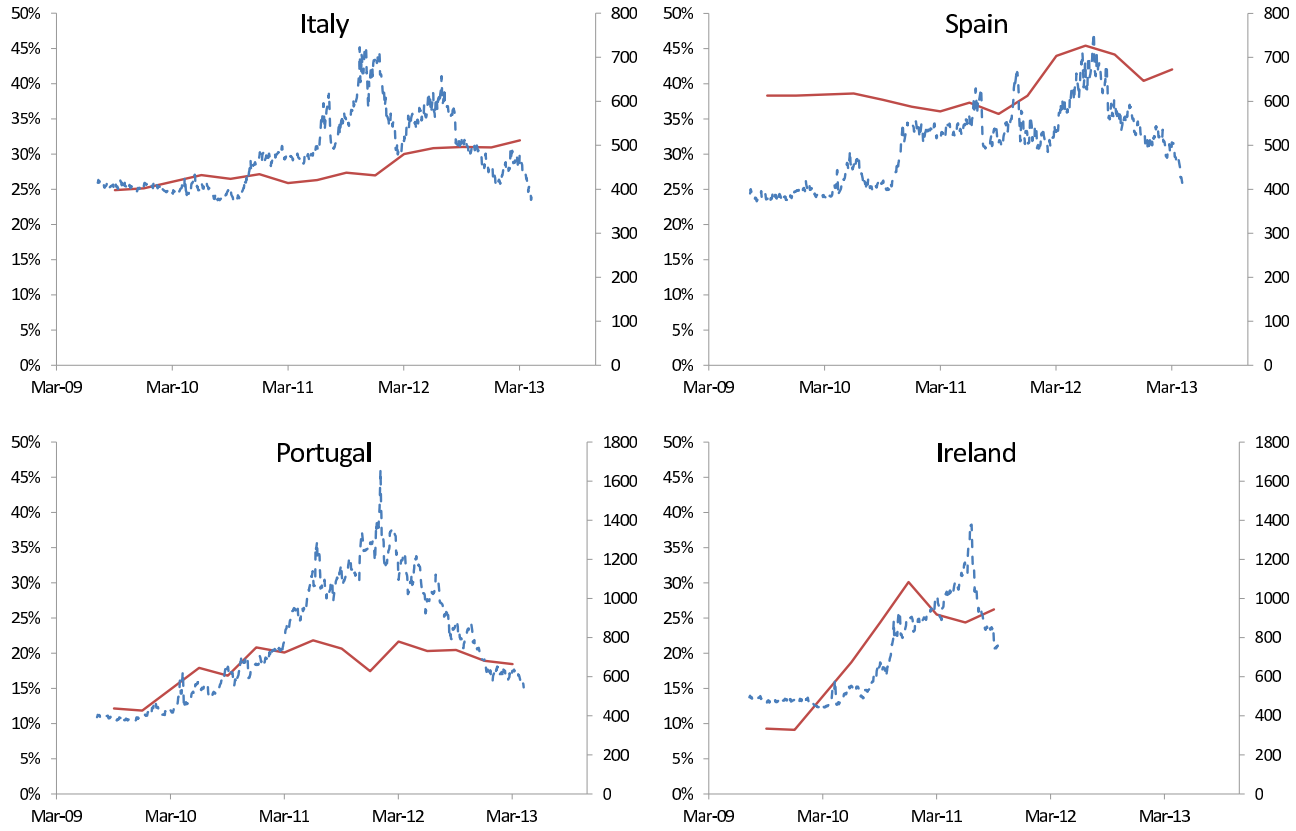

Figure 1. **Bond Spreads and Share of Government Debt Held by Domestic Banks.** This figure shows the 10-year bond spreads vs. German bond (dashed line, secondary axis (bps)) and the share of sovereign debt owned by domestic banks (solid line, primary axis, (%)) for Italy, Spain, Portugal, and Ireland. Source: Bloomberg and and Arslanalp and Tsuda (2012).

Third, the European financial sector is undercapitalized and politics has been so far reluctant to recapitalize it. In October 2011, the European Banking Authority (EBA) warned that banks had to raise $146 bn to meet new capital requirements. Acharya, Engle, Pierret (2013) show that the required capitalization resulting from EBA stress tests underestimates the one implied by market data[3]. In the four years following the first EBA stress test, European policy makers have failed to adopt measures to recapitalize banks[4]. It is also evident that

[3]They demonstrate that the discrepancy arises because of the reliance on regulatory risk weights in determining required levels of capital once stress-test losses are taken into account.

[4]Basel III Accord is implemented through CRD IV. The proposal "applies to all EU banks (more than 8,300). It strengthens their resilience in the long term by increasing the quantity and quality of capital they

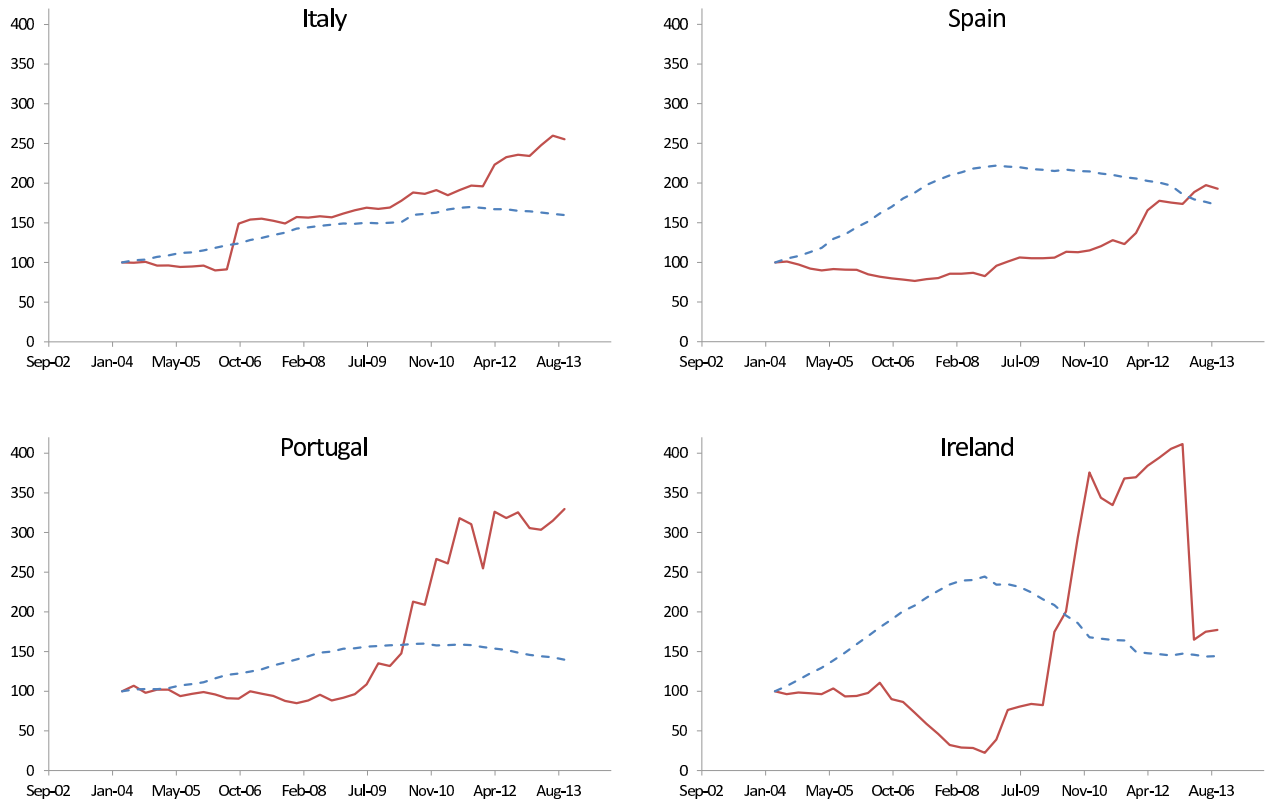

Figure 2. **Crowding-out Private Lending.** The figure shows domestic banks' lending to private non-financial sector (solid line) and government gross debt held by domestic banks (dashed line) for Italy, Spain, Portugal, and Ireland. Quantities are normalized to 100 in March 2004. Source: BIS and Arslanalp and Tsuda (2012).

the zero risk weight carried by Euro denominated sovereign bonds does not reflect their real credit risk[5]. However, increasing the capital requirement on peripheral bonds during the crisis

have to hold.". Member states were expected to implement the directive into national law by the end of 2012. The deadline was not respected and the Directive was put in place in January 2014. Member states have some autonomy in the implementation. "They can adjust the level of the counter-cyclical buffer to their economic situation and to protect economy/banking sector from any other structural variables and from the exposure of the banking sector to any other risk factors related to risks to financial stability." (source: www.europa.eu)

[5]Capital requirements in the Eurozone follow the Capital Requirements Directive (CRD) that implemented the Basel II and Basel III capital standards. The Basel accords are signed by members of the Basel Committee on Banking Supervision. Members are "senior officials responsible for banking supervision or financial stability issues in central banks and authorities with formal responsibility for the prudential supervision of banking business where this is not the central bank."

would encourage the sell off, worsening the funding pressure for troubled countries. The recent statement of Danièle Nouy[6] perfectly illustrates this point: "Sovereigns are not risk-free assets. That has been demonstrated, so now we have to react. What I would admit is that maybe it's not the best moment in the middle of the crisis to change the rules [...] it will have to be decided − probably, some rules on the division of risk for those exposures, just like for any risk, should be implemented: some kind of large exposure limits so you don't put all your eggs in the same basket. That's a simple principle that is quite good."

This paper proposes a new channel for the increasing home bias during crisis. Highly levered banks buy domestic government bonds because of the high correlation with their other sources of revenue. While, in case of domestic sovereign default, banks are protected by limited liability, home sovereign debt guarantees the highest payoff in the good state of the world (*Fact 1*). Because of this risk-shifting incentive, undercapitalized banks reduce lending to invest in the relatively more attractive domestic sovereign debt (*Fact 2*). Anticipating this mechanism, governments face a trade-off when setting capital requirements for domestic financial sector. Compared to well capitalized banks, highly levered bank buy more domestic bonds (risk-shifting), reducing lending to the private sector and government tax collection. Myopic governments are willing to bear the cost of distortion in the lending market to induce banks to act as buyers of last resort for government debt (*Fact 3*). Moreover, by increasing their debt capacity, governments attract foreign investors, triggering a "race to the bottom" in capital regulation among different countries.

The general equilibrium two-period model builds on Acharya, Rajan (2013). There are two countries with a government and a financial sector. The latter can invest in its own lending technology, in domestic, and non-domestic government bonds. The government maximizes spending by issuing debt and levying taxes on the banks' revenues from lending. There is a small probability that the economy is hit by an exogenous shock between $t = 1$ and $t = 2$ that destroys the second period revenues from lending. If the shock hits the economy, the government has zero tax collection and is forced to default. Governments can also strategically default and suffer an immediate cost. The government is responsible for capital regulation.

[6]Chair of the Suvervisory Board of the Single Supervisory Mechanism (SSM). Excerpt from the Financial Times website (9 February 2014). Source: ft.com

Enforcing low capital requirements, it encourages domestic banks to risk-shift and demand more domestic bonds. In such case, in equilibrium, the government has higher debt capacity, pays lower interest rates on debt, and banks reduce private lending. By enforcing stricter capital requirements, the government breaks the risk-shifting mechanism: diminished demand for domestic bonds lowers the government debt capacity, stimulating lending and interest rates. Myopic governments are more willing to use capital regulation to increase their debt capacity being less concerned about the induced distortion in the lending market.

Admittedly, while this paper focuses on risk-shifting, other drivers are likely to contribute to the increasing exposure of banks to domestic government bonds, namely moral suasion, regulatory arbitrage, and information advantage. While lack of available micro-level data impedes clean identification, I provide empirical evidence supporting the risk-shifting channel. Using stress test data from the European Banking Authority (EBA), I show that highly levered banks and "local" (geographically undiversified) banks have increased the relative holdings of domestic sovereign debt relative to better capitalized and geographically diversified banks.

Related Literature. There is a vast literature on the links between sovereign risk and domestic financial sector. In the theoretical literature, Acharya, Rajan (2013) explain why governments repay their debt. In a partial equilibrium model, short horizon governments set up entanglements between sovereign debt and the financial sector to increase the debt capacity. This paper extends their model in several directions. First, home bias, assumed in their model, is a key choice variable in this paper. Second, in a general equilibrium setting, this model can study government bond prices. Finally, this paper introduces capital regulation and studies its interaction with banks' and governments' incentives. Gennaioli, Martin, Rossi (2014) present a model where default is costly because of the negative effect on the domestic financial sector that owns public bonds for liquidity reasons. Acharya, Drechsler, Schnabl (2014) model a loop between sovereign and bank credit risk. The cost of government bailout of the financial sector increases the sovereign credit risk. I assume sovereign credit risk and study what the government can do to increase its debt capacity. Bolton, Jeanne (2011) show that banks diversifying their assets generate contagion. This paper shows that banks are undiversified during crises in an attempt to invest in securities correlated with the performance of the sovereign. Broner, Erce, Martin, Ventura (2013) show that, in turbulent times, purchases of government debt displace productive investments because of ad hoc dimestic regulation. The role of government bond secondary markets is also analyzed by

Broner, Martin, Ventura (2010). They show that sovereign risk is eliminated as the government will not default on domestics who own the sovereign bonds during crises. Finally, Drechsel, Drechsler, Marques-Ibanez, Schnabl (2013) study the behavior and motives of banks borrowing from ECB during the Euro crisis. Their findings are consistent with this paper as they show that banks used the LOLR to risk-shift.

On the empirical side, Acharya, Steffen (2013) show that Eurozone undercapitalized and large banks engaged in a carry trade behavior, placing a bet on the convergence of the periphery. Becker and Ivashina (2014) show that peripheral governments used moral suasion to pressure domestic banks to buy government bonds. As discussed in Section 4, I reconcile the risk-shifting and moral suasion hypotheses. Arslanalp, Tsuda (2012) build a dataset of investor holdings of sovereign debt for 24 major advanced economies. They document a growing home bias in the euro area and show that foreign banks outflows from peripheral debt cannot explain the growing imbalance. Brutti, Saure (2013) also show that peripheral countries experienced an increasing home bias in the government bond market. Finally, Acharya, Engle, Pierret (2013) claim that the zero risk weights on Euro denominated sovereign debt left the European financial sector undercapitalized. With this model, I ask what are the incentives of regulators and governments when setting the capital requirements.

The remainder of the paper is organized as follows. The next session illustrates the setup and the agents' problem. Section 3 defines the equilibrium and solves the model. Section 4 shows that the proposed mechanism is empirically relevant. Section 5 concludes.

2 Model

In this Section, I setup the economy and define the equilibrium. The economy starts at $t = 0$ and terminates at $t = 2$. There are two symmetric countries: I, S. Each country has a government and a banking sector[7]. There is universal risk neutrality.

[7] I will also refer to the banking sector as the financial or private sector

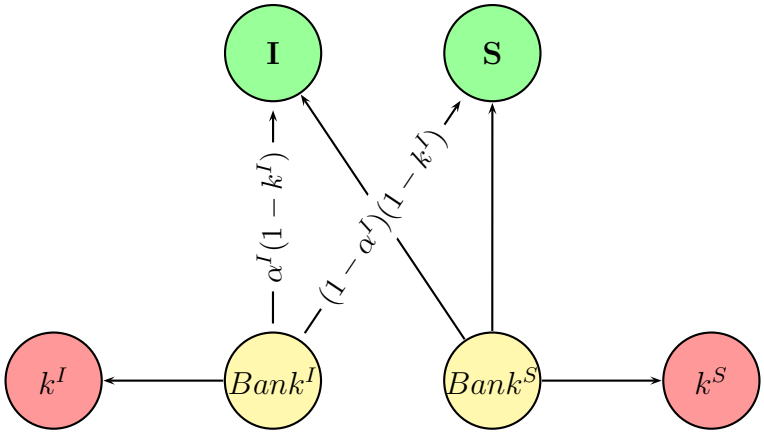

Figure 3. **Investment Opportunities.** This figure illustrates the investment opportunities of the two financial sectors. Each financial sector can invest in (1) lending to the domestic economy, (2) domestic government bonds, and (3) non-domestic government bonds.

Financial Sector. The financial sector starts with an initial level of debt L and receives endowment of 1 at $t = 0$. It maximizes profits investing in domestic government bonds, foreign government bonds, and lending to the domestic economy. The financial sector is hit by a negative shock between $t = 1$ and $t = 2$ with probability $1 - \theta$. If the shock hits, the second period revenues from lending are zero. Hence, an investment of k in the lending technology at $t = 0$ yields $f(k)$ at $t = 1$ with probability 1 and $f(k)$ at $t = 2$ with probability $\theta \in (0, 1)$. I assume that $f(\cdot)$ is continuous, strictly increasing, strictly concave, and satisfies Inada conditions. Banks can also invest $1 - k$ in government bond markets. In particular, they invest $\alpha(1 - k)$ in the domestic bond market and $(1 - \alpha)(1 - k)$ in the foreign bond market. The choice variable $\alpha \in [0, 1]$ captures the *home bias* of the financial sector. If $\alpha = 1$ there is "perfect home bias" and banks invest only domestically. On the other hand, if $\alpha = 0$, banks invest in foreign bonds only. Banks maximize profits and are subject to limited liability. Figure 3 illustrates the investment opportunities in this economy.

Government. The government starts with zero initial debt and wants to maximize (worthless) spending. Politicians want to be reelected and spend on populist measures so to keep their voters happy. The government issues debt D at $t = 1$ maturing at $t = 2$, and decides whether to default at $t = 2$. In case of default, the government suffers an immediate cost of default $(1 + r)C(\alpha, k)$, where $C > 0$, $C_1 > 0$, and $C_2 > 0$. The cost function is decreasing

in the (domestic banks) foreign bond investment $(1-\alpha)(1-k)$ as the government takes into account the negative effect of a sovereign default on the domestic economy[8]. I assume the government needs a strictly positive debt issuance to ensure the functioning of the domestic lending market. Finally, the government taxes revenues from lending in both periods at an exogenous and time-invariant tax rate τ. The government has a discount factor β: if $\beta = 1$ the government has long horizon, if $\beta = 0$ the government is myopic and only cares about spending at $t = 1$[9]. Figure 4 illustrates the timeline of the two-period economy for a representative country.

2.1 Government Debt Capacity

What is the government debt capacity? The government chooses at $t = 2$ whether to default on the debt D issued at $t = 1$. The government defaults if not *able* and/or not *willing* to pay. The government is willing to pay if $D(1+r) \leq (1+r)C(\alpha, k)$, i.e. if the cost of default is greater than the payment due to bondholders. On the other hand, the government is able to repay if $D(1+r) \leq \tau f(k)$, i.e. if tax collection is greater than the payment due to bondholders. Anticipating that the government might default, investors are willing to buy government bonds if the two inequalities above (willingness-to-pay and availability-to-pay) hold in expectation at $t = 1$. Hence, the government maximum debt capacity is given by

$$D = min \left\{ C(\alpha, k), \frac{\tau\theta f(k)}{1+r} \right\} \tag{1}$$

The government payoff is the discounted sum of expected tax collection and debt issuance minus debt repayment to bondholders.

$$V = \underbrace{\tau f(k) + \tau\beta\theta f(k)}_{\text{tax collection}} + \underbrace{(1 - \beta\theta(1+r))D}_{\text{govt debt}} \tag{2}$$

[8] See, for example, Acharya, Rajan (2013), Gennaioli, Martin, Rossi (2014).

[9] This is the case where a government with a mandate terminating at $t = 1$ is sure not to be reelected.

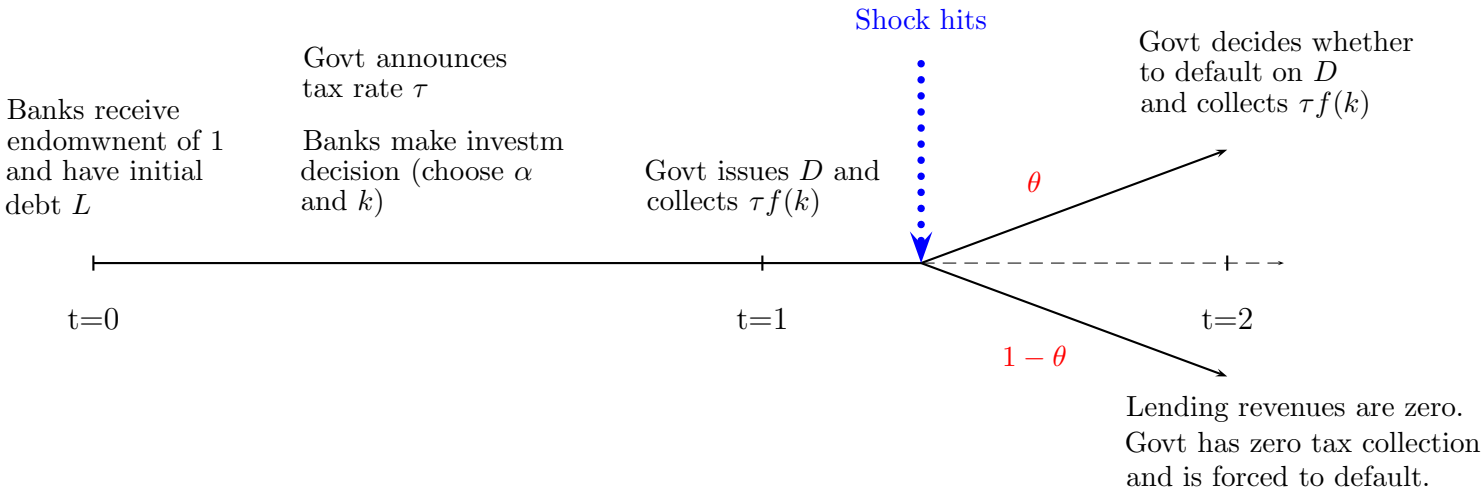

Figure 4. **Timeline.** This figure illustrates the timeline of the economy for a representative country.

2.2 Banks' Problem

At $t = 0$ banks can invest in domestic government bonds, non-domestic government bonds, and lending. Given Inada conditions, banks optimally invest $k > 0$ in lending. Depending on whether the shock hits the economy, there are two states of the world at $t = 2$. In the bad state, that materializes with probability $1 - \theta$, the lending technology is hit by a shock that destroys $t = 2$ revenues. In this case, the government has zero tax collection at $t = 2$ and is therefore forced to default. The financial sector obtains the first period lending net revenues and the expected revenues from foreign bonds, minus debt repayment, subject to limited liability.

$$\underline{\Pi} = [\quad \underbrace{(1-\tau)f(k)}_{\substack{t=1 \text{ revenues} \\ \text{from lending}}} \quad + \underbrace{\theta^*(1+r^*)(1-\alpha)(1-k)}_{\substack{\text{expected revenues} \\ \text{from foreign bonds}}} - L]^+$$

where r^* and θ^* indicate foreign rate and foreign probability of the good state. On the other hand, in the good state, the banking sector obtains net revenues from lending in both periods, expected revenues from foreign and domestic bond investments minus debt repayment, subject

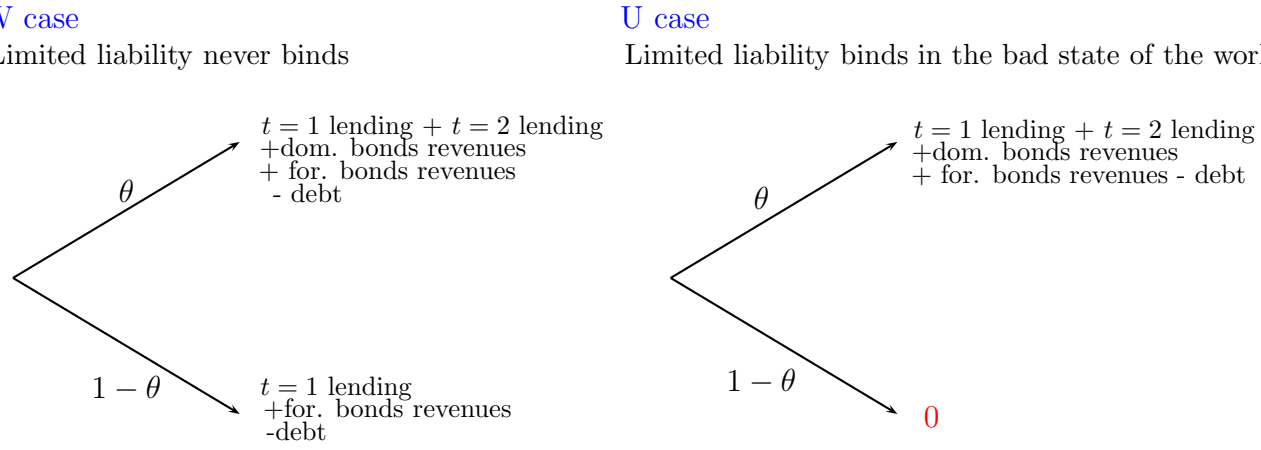

Figure 5. **Financial Sector Problem.** This figure shows the payoffs of the financial sector in the good state of the world (w.p. θ) and in the bad state of the world (w.p. $1-\theta$) in the "Low debt case" and in the "High debt case".

to limited liability.

$$\overline{\Pi} = [\underbrace{2(1-\tau)f(k)}_{\substack{\text{expected revenues} \\ \text{from lending}}} + \underbrace{\theta^*(1+r^*)(1-\alpha)(1-k)}_{\substack{\text{expected revenues} \\ \text{from foreign bonds}}} + \underbrace{(1+r)\alpha(1-k)}_{\substack{\text{expected revenues} \\ \text{from domestic bonds}}} - L]^+$$

Depending on whether the limited liability constraint is binding, there are two relevant cases[10]. First, the case where the initial private debt L is low and the limited liability does not bind. Banks are "well capitalized" (W case) and solve at $t = 0$

$$max_{k,\alpha} \underbrace{(1-\tau)(1+\theta)f(k)}_{Lending} + \underbrace{\alpha\theta(1-k)(1+r) + \theta^*(1-\alpha)(1-k)(1+r^*)}_{\text{Bond Markets}} - L \qquad (3)$$

Second, the case where the initial private debt L is high and the limited liability binds. Banks

[10] If the limited liability constraint is (is not) binding, the initial debt L is "low" ("high"). Corollary 1 in Section 3 shows that there is a threshold level of debt $\overline{L}$ such that the limited liability constraint binds if and only if $L \geq \overline{L}$.

are "undercapitalized" (U case) and solve at $t = 0$

$$max_{k,\alpha} \underbrace{2(1-\tau)f(k)}_{\text{Lending}} + \underbrace{\alpha(1-k)(1+r) + \theta^*(1-\alpha)(1-k)(1+r^*)}_{\text{Bond Markets}} - L \tag{4}$$

Figure 5 illustrates, for each case, the payoffs at $t = 2$.

3 Solution

In this Section, I define the equilibrium and solve the model. Superscripts indicate countries.

Definition 1. *Given initial endowments, initial debt levels L^i, tax rates τ^i, cost functions C^i, lending technologies f^i, probabilities θ^i, where $i = I, S$, an equilibrium is*

- *prices of government bonds r^I and r^S*
- *debt issuance D^I and D^S*
- *governments' default decisions at $t = 2$*
- *financial sectors investment decisions α^I, k^I, α^S, k^S.*

such that

- *bond markets clear*
- *financial sectors maximize profits*
- *governments maximize spending*

Market clearing implies that, for each country, the sum of domestic and foreign demand of government debt must be equal to the government supply, given by (1). The two bond market clearing conditions are

$$\alpha^I(1-k^I) + (1-\alpha^S)(1-k^S) = D^I$$
$$\alpha^S(1-k^S) + (1-\alpha^I)(1-k^I) = D^S$$

Given the level of initial debt and interest rates, banks solve (3) or (4). The optimal home

bias α is

$$\text{In the H region} \quad \begin{cases} \alpha = 1 & \text{if } 1+r > \theta^*(1+r^*) \\ \alpha = 0 & \text{if } 1+r < \theta^*(1+r^*) \\ \alpha \in [0,1] & \text{if } 1+r = \theta^*(1+r^*) \end{cases} \tag{5}$$

$$\text{In the L region} \quad \begin{cases} \alpha = 1 & \text{if } \theta(1+r) > \theta^*(1+r^*) \\ \alpha = 0 & \text{if } \theta(1+r) < \theta^*(1+r^*) \\ \alpha \in [0,1] & \text{if } \theta(1+r) = \theta^*(1+r^*) \end{cases} \tag{6}$$

Given risk neutrality, a well capitalized financial sector (W region) invests only in the government debt with the highest risk-adjusted return. On the other hand, domestic government bonds become relatively more attractive for undercapitalized banks (U region). In fact, investing in foreign bonds is less profitable for undercapitalized banks as revenues are entirely used in the bad state of the world to repay the initial debt L. In the U region, there is an incentive to risk-shift buying domestic securities, placing a bet on the upside while being protected by limited liability in the downside.

This paper claims that banks in the periphery of the Euro area have this risk-shifting incentive. For example, a highly leveraged Portuguese bank with substantial lending to the domestic economy, has an incentive to buy Portuguese bonds (rather than German or Italian bonds). In case of Portuguese sovereign default, the bank would go bankrupt in any case (even if it had purchased German or Italian bonds) since its revenues from lending are highly correlated with the performance of the home sovereign. Investing in domestic securities, the bank can exploit the positive correlation in the good state of the world (high revenues from lending *and* bonds), while being protected by limited liability in case of default. In the following four subsections, I show that (i) when both financial sectors are well capitalized there is perfect risk sharing, (ii) undercapitalization of (at least) one financial sector induces home bias and crowding out of private lending, and, under certain conditions, (iii) governments have an incentive to keep their financial sectors undercapitalized, and (iv) governments can trigger a "race to the bottom" among countries in capital regulation.

3.1 Well Capitalized Banks

Assume that the two countries have the same $\theta \in (0,1)$, $\tau \in (0,1)$, $f(\cdot)$, $C(\cdot)$, and differ in the initial level of private debt L^i. Moreover, assume that $C(0,k) < \frac{\tau\theta f(k)}{1+r} < C(1,k)$. As shown in Lemma 1, this assumption guarantees that if the domestic financial sector has perfect home bias ($\alpha = 1$), the government is constrained by the availability-to-pay constraint, and if the domestic financial sector invests only abroad ($\alpha = 0$), the government is constrained by the willingness-to-pay constraint. With the domestic financial sector holding only domestic securities and lending activities, investors anticipate that the government will be willing to repay the debt not to incur in the high cost of default. On the other hand, when bonds are entirely held abroad, investors fear that the government may strategically default as the cost of default is low. In this case, the government debt capacity is given by the willingness-to-pay constraint.

Lemma 1. *There exist levels of home bias $\overline{\alpha}_H \in (0,1)$ and $\overline{\alpha}_L \in (0,1)$, such that only the availability-to-pay constraint binds before the willingness-to-pay constraint if $\alpha > \overline{\alpha}_L$ in the L region and $\alpha > \overline{\alpha}_H$ in the H region. The willingness-to-pay constraint binds before the availability-to-pay constraint if $\alpha < \overline{\alpha}_L$ in the L region and $\alpha < \overline{\alpha}_H$ in the H region.*

The home bias of the domestic financial sector determines the debt capacity of the government. If the sovereign debt is primarily held domestically ($\alpha > \overline{\alpha}$), investors realize that the government is unlikely to strategically default as it would incur in a high immediate cost. In such case, investors worry that the government might be forced to default for liquidity reasons as tax collection may not be high enough to repay debtholders. On the other hand, if sovereign debt is primarily held abroad ($\alpha < \overline{\alpha}$), investors fear that the government may not be willing to repay its debt as the cost of default might be less than the payment due to bondholders. Equilibrium prices determine the optimal home bias (equations (5)-(6)) and clear the bond markets.

Depending on the financial sectors' capitalization, the economy can be in four states: WW, UW, WU, UU. The first (second) letter refers to whether the financial sector of country I (country S) has high or low initial debt. Suppose that both financial sectors are well capitalized (WW region). The following Lemma shows that there is perfect risk sharing in equilibrium, i.e. banks invest in both sovereign bonds and have the same home bias.

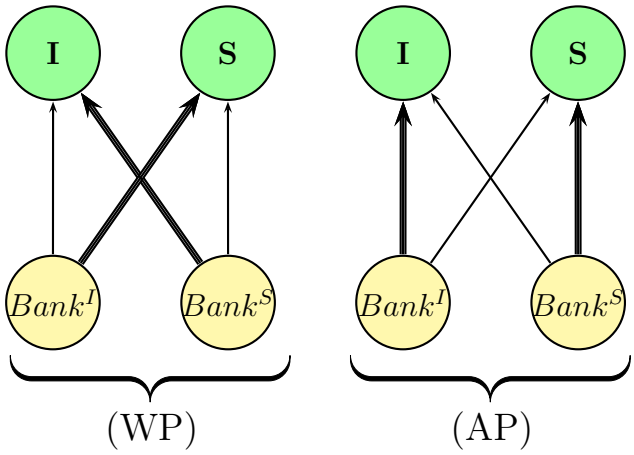

Figure 6. **WW Equilibrium.** This figure illustrates the continuum of equilibria in the WW region. The left panel shows the case where home bias is low and governments' debt capacity is given by the (WP) constraint. The right panel shows the case where home bias is high and governments' debt capacity is given by the (AP) constraint.

Lemma 2. *If both countries have low initial private debt, financial sectors have the same home bias in equilibrium.*

Risk neutral banks invest in government bonds with the highest return. In equilibrium, both countries have strictly positive debt capacities and identical equilibrium prices, quantities, and home bias. Depending on the home bias, there are two types of equilibria: the "low home bias equilibrium" and the "high home bias equilibrium". As shown in Appendix A, there exists a threshold $\underline{A}$ such that, if the home bias is $\alpha \in [0, \underline{A}]$, both governments are constrained by the willingness-to-pay constraint. Similarly, if $\alpha \in [\overline{A}, 1]$ for some threshold $\overline{A}$, governments are constrained by the availability-to-pay constraint. Figure 6 illustrates the two types of equilibria. In both cases there is a continuum of equilibria.

3.2 Equilibrium Home Bias

Assume $f(k) = \epsilon\sqrt{k}$ and $C(\alpha, k) = z - (1-\alpha)(1-k)$ where $z > 0$ is a constant such that $C(0,k) < \frac{\tau\theta f(k)}{1+r} < C(1,k)$. Suppose now that (at least) one country has an undercapitalized financial sector (the economy is in either UW, WU, or UU state). Undercapitalized banks invest abroad if the foreign rates are high enough to overcome the relative attractiveness of domestic bonds. In such case, foreign banks, regardless of their capitalization, invest only

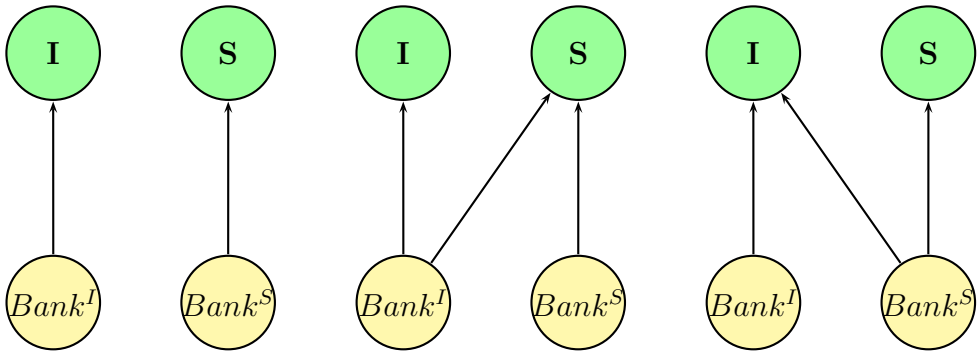

Figure 7. **Equilibrium Home Bias.** The figure shows the three candidate equilibria when (at least) one country has an under-capitalized financial sector.

domestically, taking advantage of high returns. Figure 7 illustrates the candidate equilibria when at least one country has high private debt. When the two countries are identical, except for the initial private debt L^i, both financial sectors have perfect home bias in equilibrium, and interest rate, lending, and government debt capacity depend only on the capitalization of the domestic financial sector.

Proposition 1. *If one or more countries have high initial private debt, there is perfect home bias in equilibrium. Interest rate, debt capacity, and lending only depend on the capitalization of the domestic banks, and* $r_W > r_U$, $D_U > D_W$, *and* $k_W > k_U$.

Superscripts indicate whether banks are well capitalized or undercapitalized. Hence, the unique equilibrium is the one illustrated in the left panel of Figure 7. The other two candidate equilibria, where one banking sector also buys foreign government bond, violate market clearing. In case the domestic financial sector has perfect home bias, by Lemma 1, sovereign debt capacity is given by the availability to pay constraint and bond issuance cannot exceed the expected tax collection. If domestic banks are undercapitalized, high demand for domestic bonds crowds out lending, reducing the tax base. Because of the limited tax collection, the government debt capacity is too low to accommodate an eventual foreign demand. In equilibrium, only domestic buyers invest in government debt. On the other hand, if domestic banks are well capitalized and foreign banks are not, the domestic rate must be very high to induce foreign investors to buy domestic bonds. In such case, sovereign debt capacity goes

down as the government cannot credibly commit to repay expensive bonds with the proceeds from tax collection. Again, in equilibrium, there is perfect home bias.

Given that government debt is entirely held domestically, equilibrium prices and quantities depend on the capitalization of the *domestic* financial sector.

Well Capitalized Banks:	Undercapitalized Banks:
$k_W = \frac{(1-\tau)(1+\theta)}{(1-\tau)(1+\theta)+2\theta^2\tau}$	$k_U = \frac{1-\tau}{1-\tau(1-\theta)}$
$1+r_W = \frac{\epsilon}{2\theta}\sqrt{(1-\tau)(1+\theta)((1-\tau)(1+\theta)+2\tau\theta^2)}$	$1+r_U = \epsilon\sqrt{(1-\tau)(1-\tau(1-\theta))}$
$D_W = \frac{2\tau\theta^2}{(1-\tau)(1+\theta)+2\tau\theta^2}$	$D_U = \frac{\tau\theta}{1-\tau(1-\theta)}$

Compared to well capitalized banks, undercapitalized banks buy more domestic bonds and cut lending ($k_U < k_W$). The resulting lower tax collection reduces the government debt capacity as investors fear that the sovereign might be unable to repay them at $t = 2$. However, in equilibrium, the high demand for bonds overcomes the negative effect of lower tax collection increasing the domestic government debt capacity ($D_U > D_W$), and lowering the interest rate ($r_U < r_W$). Since first period lending is riskless, bonds are riskier than lending. As uncertainty increases (θ goes down), banks sell risky bonds to invest in the relatively safer lending technology. Interest rates and sovereign debt capacity go down as higher tax collection cannot compensate lower demand for bonds. What determines whether a bank is undercapitalized or well capitalized?

Corollary 1. *There exist a unique private debt level $\overline{L}$ such that banks are undercapitalized if $L > \overline{L}$ and well capitalized if $L \leq \overline{L}$. As uncertainty increases, the threshold $\overline{L}$ goes down.*

Private debt level of undercapitalized banks is greater than the threshold level $\overline{L}$ that depends on the productivity ϵ, the tax rate τ, and the probability θ. Given the initial debt level L, as uncertainty increases, banks are more likely to fall in the U region and risk-shift, buying domestic bonds in equilibrium. The following Section illustrates the incentives of the government.

3.3 Keeping the Financial Sector Under-capitalized

In this Section, I show that, when both countries have under-capitalized banks ($L^I > \overline{L}$ and $L^S > \overline{L}$), sufficiently myopic governments have an incentive to keep the domestic financial sector undercapitalized to increase their debt capacity. Banks with high private debt buy more domestic securities and lend less driving down tax collection. As governments collect taxes in both periods and issue bonds at $t = 1$ only, myopic governments are willing to accept lower tax collection (and crowding-out in the lending market) to increase their current first period debt capacity. On the other hand, forward looking government internalize the distortion. Suppose a government can choose at $t = 0$ the level of initial private debt of the financial sector[11].

Proposition 2. *Suppose that both countries have under-capitalized financial sectors. There exist a level of myopia $\overline{\beta}$ such that government j recapitalizes domestic banks if and only if $\beta^j > \overline{\beta}$. Following re-capitalization, a government lowers its debt capacity, pays higher interest rate on debt, stimulates lending and tax collection.*

A government re-capitalizes its banks if

$$\underbrace{\tau\epsilon(1+\beta\theta)(\sqrt{k_W}-\sqrt{k_U})}_{\text{increased tax collection}} \geq \underbrace{(D_U - D_W)}_{\text{lower debt issuance}} + \underbrace{\beta\theta((1+r_W)D_W - (1+r_U)D_U)}_{\text{higher payments to bondholders}}$$

Re-capitalization is optimal if the benefit from increased tax collection is greater than the cost of lower debt issuance and higher payments to bondholders. A myopic government is more likely to keep its financial sector under-capitalized bearing the cost of distorting lending. When both economies have high private debt, a sufficiently myopic government has an incentive not to re-capitalize its financial sector. The next Section analyzes the equilibrium of an economy with well capitalized banks and suggests that governments might engage in a "race to the bottom" in capital regulation to increase their debt capacity.

[11] Governments, through national central banks, can influence the capital adequacy standards and are responsible, through the European Commission, for their implementation into the EU legal framework.

3.4 Race to the Bottom in Capital Regulation

One of the most common explanation for the recent increase in purchases of peripheral Euro debt by European institutions is regulatory arbitrage. Under the Capital Requirement Directive (CRD), "exposures to Member States' central governments and central banks denominated and funded in the domestic currency of that central government and central bank shall be assigned a risk weight of 0%[12]." Government bonds are therefore a cheap way to buy risk for European banks. In this paper, I can rationalize the current zero risk weight regulation as an equilibrium outcome. Choosing low risk weights, governments induce under-capitalization, increasing their debt capacity. Suppose now the economy is in the WW equilibrium with perfect risk sharing.

Proposition 3. *Suppose both countries have well capitalized financial sectors, the economy is in the high home bias equilibrium, and $\beta^j > \overline{\beta}$ for $j = I, S$. Governments trigger a "race to the bottom" in capital regulation driving the economy to the UU region.*

Whether in the WW region a government wants to encourage risk-shifting of domestic banks depends on type of the initial equilibrium. If the economy is in the low home bias equilibrium, debt capacity, prices, and lending depend on the cost of default C. If the latter is sufficiently high, the government might be better off with a well capitalized financial sector. If governments are sufficiently myopic and the economy is in the high home bias equilibrium, both governments' dominating strategy is to induce undercapitalization of the domestic financial sector and benefit from increased debt capacity and lower rates.

4 Supporting Empirical Evidence

This Section provides supporting empirical evidence for the risk-shifting channel proposed in the main model. Admittedly, other motives are also likely to contribute to the increasing home bias, namely (i) moral suasion, (ii) regulatory arbitrage, and (iii) information advan-

[12]Directive 2006/48/EC, Annex VI, Part 1(4)

tage[13]. First, under the moral suasion hypothesis, governments may force domestic financial institutions to buy more domestic bonds when yields are high and demand for sovereign bonds is low. In exchange for purchases of domestic securities, governments might, for example, promise a more tolerant supervision. Second, the pattern seen in the data might be driven by regulatory arbitrage as sovereign bonds carry a zero risk weight. In order to improve their low Tier 1 Ratio, GIIPS banks might replace private sector lending (that carries a positive risk weight) with purchases of domestic government bonds. Third, home investors might prefer domestic securities as their information advantage may increase during crises. Home investors might, for example, better evaluate the increased domestic political risk compared to foreign investors.

While I am unable to disentangle these different motives and to show causality in the risk-shifting hypothesis, in the remainder of this Section I show that highly leveraged banks have increased the relative holdings of domestic sovereign debt compared to better capitalized banks. Moreover, I show that banks with revenues originating mainly from domestic activities ("local" banks) also engaged in a similar behavior compared to banks with more revenues originating abroad ("international" banks). In Section 2, for simplicity, I assumed that banks cannot lend to the foreign private sector. Should the financial sector invests abroad, the limited liability constraint might not bind in the bad state of the world as proceeds from foreign activities offset the effects of default. Hence, banks would risk-shift only if a large share of non-bond investments originate from the home private sector[14].

For this purpose, I construct a dataset using the European Banking Authority (EBA) stress tests and Bankscope. The EBA conducted eight stress tests between October 2009 and June 2013 in order to "ensure the orderly functioning and integrity of financial markets and the stability of the financial system in the EU"[15]. With the exception of the first stress test,

[13]An additional motive that might drive bank behavior is the emergence of re-denomination risk, namely the risk that foreign sovereign debt might be re-denominated in the foreign currency in case of Euro breakup. I disregard this particular channel given that its effect is ambiguous. In fact, in case of Euro breakup, a peripheral bank might be better off with foreign, say German, government bonds as it would benefit from the hypothetical currency appreciation.

[14]The results of Section 3 still hold if the financial sectors invest domestically a fraction $\gamma > \overline{\gamma}$ of the total private sector lending, for some $\overline{\gamma} \in (0, 1)$.

[15]The EBA conducted three "EU-wide Stress Tests" (October 2009, March 2010, December 2010),

the Authority disclosed data on "Gross Direct Long Exposures" of a sample of systemically important European banks[16]. I merge the EBA sample with Bankscope to obtain data on banks' total assets and capitalization. Table B1 in the Appendix shows the full list of EBA banks and the sample used in the analysis. I discard banks with two or less EBA observations or no Bankscope information/match. The final sample consists of a panel of 58 banks from 21 countries. The dataset comprises exposures of each bank to 30 sovereigns.

Table B2 shows the summary statistics for the period 2010Q1-2013Q2 for the entire sample, as well as subsamples of GIIPS and Core banks[17]. Core banks are larger than peripheral banks and the total assets of both groups remained basically unchanged during the crisis. Yet, the composition of balance sheets changed. GIIPS banks increased their exposure to government bonds by 32%, from \$19.3 bn to \$25.7 bn, driven by the increase of peripheral bonds (32.2%) and, in particular, domestic bonds (36.2%). On the other hand, while Core banks exposure to sovereign bonds remained constant, the composition changed. In average, in a flight to quality, they increased holdings of domestic safe debt (31%) reducing the holdings of GIIPS risky debt (−14.1%). Panel C and Panel D show the evolution of capitalization. Tier 1 Ratio increased for both subsamples. However, the capitalization of GIIPS and Core banks diverged as the latter group increased this capitalization ratio more (33.5% compared to 19%) and sooner. In 2010Q1 GIIPS banks had leverage, defined as Equity/Assets, of 6.8 which remained stable till 2013Q2. Core banks started with a higher leverage of 4.1 that increased to 5.0 by 2013Q2. For the purpose of this paper, I will take advantage, within each subsample, of the substantial

three"Capital Exercises" (September 2011, December 2011, June 2012), and two "Transparency Exercises" (December 2012, June 2013). The EBA did not disclose data on sovereign exposure on the October 2009 test. The number of banks that participated in the remaining seven stress tests are, respectively (i) 91, (ii) 90, (iii) 65, (iv) 61, (v) 61, (vi) 64, (vii) 64. Data are publicly available on the EBA website (http://www.eba.europa.eu) and were released in July 2010 (second stress test), July 2011 (third stress test), December 2011 (first Capital Exercise), October 2012 (second and third Capital Exercises), and December 2013 (Transparency Exercises).

[16]Gross Direct Long Exposures are the "direct debt exposures to central and local governments. The exposures to be considered are the on-balance sheet exposures (accounting information) and should be identified on an immediate borrower basis (e.g. an exposure of 100 towards Country A, collateralized with bonds issued by Country B, is reported on Country A but not on Country B)." Source: 2011 EBA EU-Wide Stress Test: Methodological Note. Moreover, "Central bank deposits are not included. [...] the definition does not include exposures to counterparts (other than sovereigns) with full or partial guarantees from central, local or regional governments." Source: Capital Buffers for Addressing Market Concerns Over Sovereign Exposures: Methodological Note.

[17]Core banks are headquartered in Austria, Germany, Denmark, Finland, France, Netherlands, and UK.

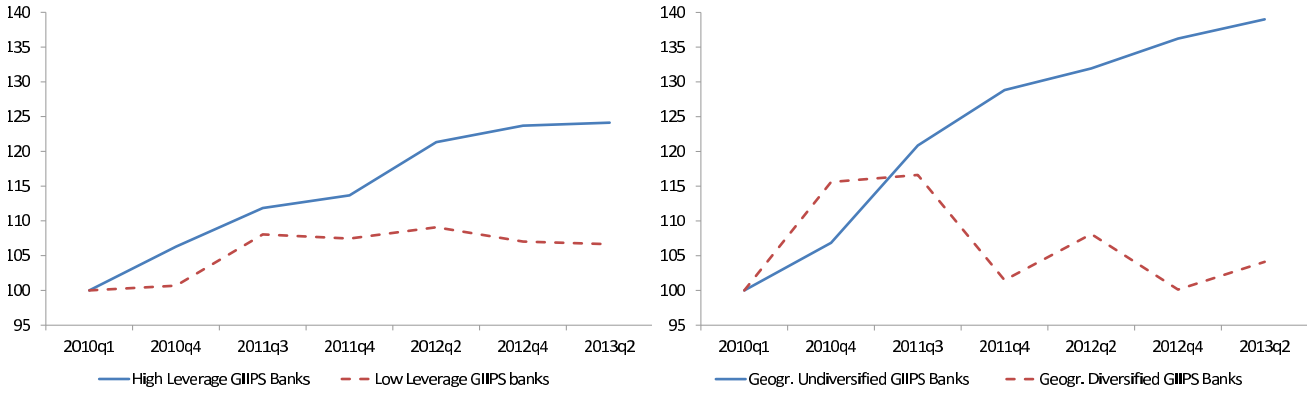

Figure 8. **Risk-shifting and Home Bias (GIIPS Banks).** This figure shows the evolution of home bias (normalized at 100 in 2010Q1) of GIIPS banks from 2010Q1 to 2013Q2. Home Bias is defined as Exposure to Domestic Government Debt divided by Total Exposure to Government Debt. The left panel illustrates the increase in home bias for high leverage (solid blue line) and low leverage (red dashed line) GIIPS banks. Leverage is Book Value of Equity divided by Total Assets. High leverage banks and low leverage banks are respectively the top and bottom 25% of banks ordered by leverage. The right panel illustrates the increase in home bias for geographically undiversified (solid blue line) and geographically diversified (red dashed line) GIIPS banks. Geographical diversification is the Total Exposure at Default (EAD) to Foreign Countries divided by Total Assets as of 2010Q4. EAD is from the 2011 EBA Stress Test. Geographically diversified and undiversified banks are respectively the top and bottom 25% of banks ordered by Foreign EAD divided by Assets. The two lines are constructed using a weighted average where weights are given by the total exposure to sovereigns divided by total assets as of 2010Q4. The sample is formed by 16 banks from Italy, Ireland, Portugal, and Spain. Greek banks are excluded because of data availability (see Table B1 in the Appendix). Source: Bankscope, European Banking Authority.

cross-sectional heterogeneity in capitalization.

The risk-shifting hypothesis suggests that the bank capitalization at time t should explain the change in home bias between time t and time $t + j$. Home bias is defined as holdings of domestic sovereign bonds divided by total government bond holdings. My measure of capitalization is leverage, namely Equity/Total Assets as of 2010Q1. Using the substantial heterogeneity in leverage within the subset of GIIPS banks[18], the left panel of Figure 8 shows

[18]For example, Bank of Ireland and Banco BPI had leverage below 5, and Banco Popolare and UBI Banca had leverage above 8.5.

that highly leveraged banks increased the home bias compared to low leverage banks. The two groups correspond to the top and bottom quartile of the 2010Q1 leverage distribution. More leveraged banks increased their home bias by 24.1% between 2010Q1 and 2013Q2. During the same period, low leveraged banks increased by only 6.6%. Similarly, the right panel divides banks in "local" (geographically diversified) and "international" (geographically diversified) banks. Geographical diversification is measured by the Total Exposure at Default (EAD) to Foreign Countries divided by Total Assets as of 2010Q4. EAD, released in the 2010Q4 stress test, measures the total bank exposure to different countries. It includes defaulted and non-defaulted exposures to residential and commercial real estate, corporations, and institutions. The home bias of undiversified banks increased by 39% and the home bias for diversified banks increased only 4.1% between 2010Q1 and 2013Q2.

I now ask whether Figure 8 is consistent with the aforementioned alternative explanations. Under the moral suasion hypothesis, the government induces domestic banks to hold more bonds during periods of financial turmoil. As the government wants to maximize the demand for its debt, its first best is to induce *every* bank to increase holdings of domestic bonds. To be consistent with data, the heterogeneity documented in Figure 8 must originate from some friction in the moral suasion process. The findings are consistent with moral suasion as long as the government has more power to influence undercapitalized and local banks. Under the regulatory arbitrage hypothesis, undercapitalized banks increase their holdings of domestic government bonds to improve their regulatory capital. As *every* Euro denominated European government bond carries a zero capital weight, banks should also increase their relative holdings of non domestic GIIPS bonds, a trend not seen in data. For example, an undercapitalized Spanish bank willing to increase its Tier 1 Ratio using sovereign bonds should be indifferent between Italian and Spanish bonds. However, according to data, Spanish banks have been net seller of foreign GIIPS bonds and net buyer of domestic ones. It is also unclear why, under the regulatory arbitrage hypothesis, geographical diversification should matter. Under the information advantage hypothesis, peripheral banks increased their natural information advantage with respect to domestic securities. While it is plausible that this effect is stronger for local banks, it is not clear why the information advantage would be negatively

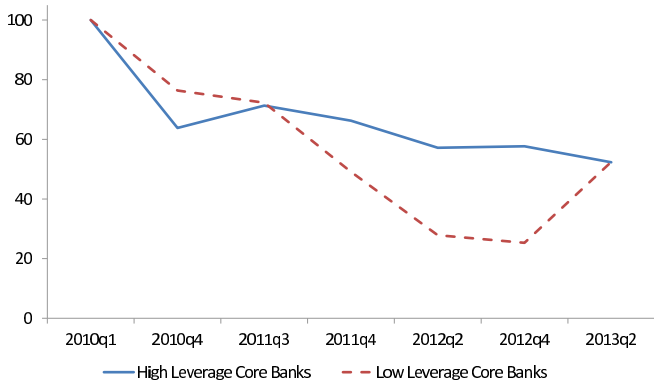

Figure 9. **Risk-shifting and Exposure to GIIPS (Core Banks).** This figure shows the evolution of exposure to GIIPS countries (normalized at 100 in 2010Q1) of Core banks from 2010Q1 to 2013Q2. Exposure to GIIPS is defined as Exposure to Greek, Italian, Irish, Portuguese and Spanish government debt divided by total exposure to government debt. The plot illustrates the increase in exposure to GIIPS for high leverage (solid blue line) and low leverage (red dashed line) GIIPS banks. Leverage is Book Value of Equity divided by Total Assets. High leverage banks and low leverage banks are respectively the top and bottom 25% of banks ordered by leverage. The two lines are constructed using a weighted average where weights are given by the total exposure to sovereigns divided by total assets as of 2010Q1. The sample is formed by 25 banks from Austria, Denmark, Finland, France, Germany, Netherlands, and UK (see Table B1 in the Appendix). Source: Bankscope, European Banking Authority.

correlated with capitalization[19].

Finally, I ask whether the purchases of domestic bonds in the periphery simply reflect an increased risk appetite in Europe. Figure 9 shows the evolution of the exposure to GIIPS sovereign debt for the subset of Core European banks. Again, the solid and dashed line illustrate the trends for high and low leverage banks respectively. In a flight to quality, core banks reduced their exposure to the periphery. The similar pattern of high and low levered banks confirms that the relation between banks' capitalization and government bonds purchases is present in the periphery only.

[19] Figure C2 in the Appendix shows the change in home bias for high leverage *and* geographically undiversified banks compared to low leverage *and* geographically diversified banks. Consistent with the discussion in this Section, the first group of banks increase the relative purchases of domestic securities more relative to the second group (25.9% and 7.4% respectively).

5 Conclusion

Financial sectors in Greece, Italy, Ireland, Portugal, and Spain experienced an increasing home bias in government debt as sovereigns became riskier. I propose a model where highly leveraged banks invest in domestic bonds because of the high correlation with their other sources of revenues. Protected by limited liability, banks cut lending to invest in the relative more attractive domestic sovereign debt. Anticipating this mechanism, myopic governments set low capital requirements to encourage risk-shifting, increasing their debt capacity, when they most need to borrow. Sufficiently myopic governments may trigger a "race to the bottom" in capital regulation, bearing the cost distortion in the respective lending markets. The model can rationalize, in the context of the Euro crisis, the increasing demand for domestic government bonds in the periphery, the crowding out effect in private lending, and the hesitancy to re-capitalize the financial sector. While I am unable to disentangle the different channels in play, recent EBA stress test data support the proposed risk-shifting hypothesis as undercapitalized banks have drive the purchases of domestic bonds.

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Appendix

A Derivations and Proofs

Proof of Lemma 1. From the maximization problem of the banking sector

$$k^W = \left(\frac{\epsilon(1+\theta)(1-\tau)}{2(\alpha\theta(1+r)+\theta^*(1-\alpha)(1+r^*))}\right)^2 \tag{A.1}$$

$$k^U = \left(\frac{\epsilon(1-\tau)}{\alpha(1+r)+\theta^*(1-\alpha)(1+r^*)}\right)^2 \tag{A.2}$$

From (1), the (AP) constraint binds before the (WP) constraint if and only if

$$\frac{\tau\theta f(k)}{1+r} < C(\alpha, k)$$

Since the LHS is decreasing in α (see equation (A.1)) and the RHS is strictly increasing in α, there exists a unique

$$\overline{\alpha} := \left\{\overline{\alpha} \in (0,1) \middle| C(\overline{\alpha}, k) = \frac{\tau\theta f(k)}{1+r}\right\}$$

such that the willingness-to-pay constraint binds before the availability-to-pay constraint if $\alpha < \overline{\alpha}$ and the availability-to-pay constraint binds before the willingness-to-pay constraint if $\alpha > \overline{\alpha}$ □

Proof of Lemma 2. I want to show that in equilibrium the two financial sectors have equal home bias. First, I can rule out the equilibria where a government does not receive funds in equilibrium. By (6), that $r^I = r^S = r$ and $k^I = k^S = k$. Hence, there are three cases: (i) both countries are constrained by (AP), (ii) one country is constrained by (WP) and one country by (AP), (iii) both countries are constrained by (WP). In case (i) and (iii), in equilibrium, banks have the same home bias since $\alpha^I(1-k) + (1-\alpha^S)(1-k) = D$ and $\alpha^S(1-k) + (1-\alpha^I)(1-k) = D$. Case (i): in order to have the (AP) binding, it must be that $\alpha < \frac{2\theta^2\tau(2-z)}{2\theta^2\tau + z(1-\tau)(1+\theta)}$. Prices, lending and debt capacity are

$$1 + r^{AP} = \frac{\epsilon}{2\theta}\sqrt{(1+\theta)(1-\tau)((1+\theta)(1-\tau)+2\tau\theta^2)} \tag{A.3}$$

$$k^{AP} = \frac{(1+\theta)(1-\tau)}{(1+\theta)(1-\tau)+2\tau\theta^2} \tag{A.4}$$

$$D^{AP} = \frac{2\tau\theta^2}{(1+\theta)(1-\tau)+2\tau\theta^2} \tag{A.5}$$

Case (ii): suppose I is constrained by (WP) and S is constrained by (AP). I want to show that there is no equilibrium in this case. By symmetry the two countries must have the same $\overline{\alpha}$.

Hence, $\alpha^S > \alpha^I$. The two market clearing conditions can be written $(1-k)(2-\alpha^S) = z$ and $(\alpha^S + 1 - \alpha^I)(1-k) = \frac{\theta\tau\epsilon\sqrt{k}}{1+r}$. Since (AP) binds for S, it must be $\frac{\tau\theta\epsilon\sqrt{k}}{1+r} < z - (1-\alpha^S)(1-k) = 1-k$. Market clearing condition for country S implies $1-k < \frac{\tau\theta\epsilon\sqrt{k}}{1+r}$, leading to a contradiction. Case (iii): in order to have the (WP) binding, it must be that $\alpha > \frac{4\tau\theta^2 - z}{2\tau\theta^2}$. Prices, lending and debt capacity are

$$1 + r^{WP} = \frac{\epsilon}{2\theta}(1+\theta)(1-\tau)\sqrt{\frac{2-\alpha}{2-\alpha-z}} \tag{A.6}$$

$$k^{WP} = \frac{2-z-\alpha}{2-\alpha} \tag{A.7}$$

$$D^{WP} = \frac{z}{2-\alpha} \tag{A.8}$$

□

Proof of Proposition 1. I will prove the result for a generic country, omitting country superscripts to simplify notation. First, I show that there is no equilibrium where a government issues zero debt in equilibrium. I assumed the government needs a strictly positive debt issuance to ensure the functioning of the domestic lending market. Since the lending technology satisfies Inada conditions, the financial sector optimally invests $k > 0$ in lending. To do so, in case the government has zero funds from the foreign financial sector, domestic banks are willing to invests a strictly positive amount $\alpha(1-k) > 0$ in domestic government bonds. Second, I show that there is no equilibrium where both financial sectors invest in both countries. In such equilibrium both banking sectors are indifferent between investing at home or abroad. In the UU region, it must be $(1+r^I) = \theta^S(1+r^S)$ and $(1+r^S) = \theta^I(1+r^I)$. In the UW region, it must be $(1+r^I) = \theta^S(1+r^S)$ and $(1+r^S)\theta^S = \theta^I(1+r^I)$. In both cases (the WU case is symmetric to the UW case) we reach a contradiction since $\theta^i < 1$ for $i = I, S$. Finally, having discarded the equilibria above, we are left with the three equilibria in Figure A1, namely when at least one financial sector has zero home bias and both countries have strictly positive debt issuance in equilibrium. Using (5)-(6), I show that these are not equilibria in the UU and UW region (WU region follows from symmetry). For each case, I reach a contradiction. Case A: $(1+r^I) \leq \theta^S(1+r^S)$ and $(1+r^S) \leq \theta^I(1+r^I)$ in the UU region, $(1+r^I) \leq \theta^S(1+r^S)$ and $(1+r^S)\theta^S \leq \theta^I(1+r^S I)$ in the UW region. Case B: $(1+r^I) = \theta^S(1+r^S)$ and $(1+r^S) \leq \theta^I(1+r^I)$ in the UU region, $(1+r^I) = \theta^S(1+r^S)$ and $(1+r^S)\theta^S \leq \theta^I(1+r^S I)$ in the UW region. Case C follows by symmetry. HH region: From Lemma 2 we know that only the three cases in Figure 4 are possible equilibria. I show that only the first equilibrium, namely the case where both countries have perfect home bias is an equilibrium. First, I show that the other two cases are not equilibria. Suppose we are in the second case where I banks invest in both countries and S banks have perfect home bias. In order to induce the I banks to invest non-domestically it must be that $1 + r^I = \theta(1+r^S)$. Hence, $r^S > r^I$ and $k^S < k^I$. Moreover, as $\alpha^S = 1$, only the availability-to-pay constraint

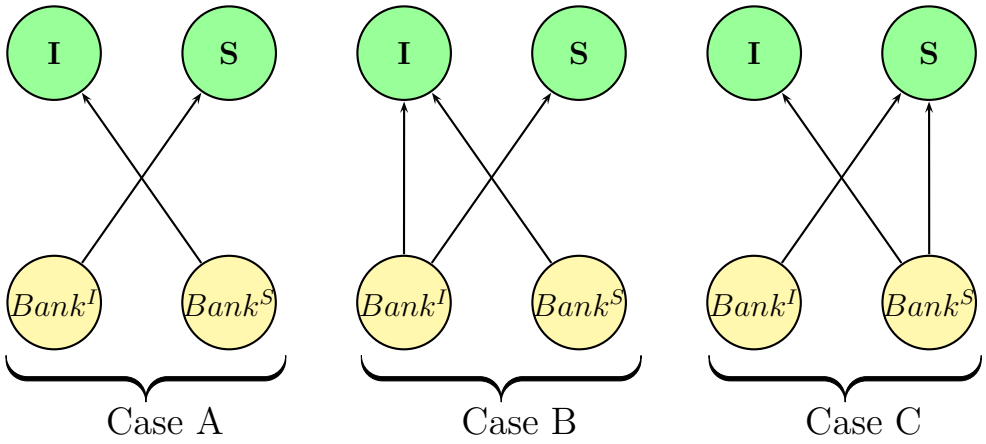

Figure A1. **Cases A, B, C.** This figure illustrates the three cases where at least one financial sector has zero home bias and both governments have strictly positive debt issuance in equilibrium.

binds for country S. Bond market clearing conditions are

$$\alpha^I(1-k^I) = min\left\{\frac{\tau\theta\epsilon\sqrt{k^I}}{1+r^I}, z-(1-\alpha^I)(1-k^I)\right\} \tag{A.9}$$

$$(1-k^S)+(1-\alpha^I)(1-k^I) = \frac{\tau\theta\epsilon\sqrt{k^S}}{1+r^S} \tag{A.10}$$

If the I government is constrained by (AP), there is no equilibrium as the LHS(A.3)<LHS(A.4) and RHS(A.3)>RHS(A.4). If the I government is constrained by (WP), (A.3) simplifies to $1-k^I = z$. Again we reach a contradiction since $(1-k^S)+(1-\alpha^I)(1-k^I) > 1-k^I$ and $z = C(1,k^S) > \frac{\tau\theta\epsilon\sqrt{k^S}}{1+r^S}$. By symmetry we can rule out the third equilibrium in Figure 4 where I banks have perfect home bias and S banks invest in both bond markets. I now show that the first candidate equilibrium in the figure is indeed an equilibrium. In this case both financial sectors have perfect home bias. Bond market clearing conditions are

$$(1-k^I) = \frac{\tau\theta\epsilon\sqrt{k^I}}{1+r^I}$$

$$(1-k^S) = \frac{\tau\theta\epsilon\sqrt{k^S}}{1+r^S}$$

Plugging the optimal choice of lending $k = \left(\frac{\epsilon(1-\tau)}{1+r}\right)^2$, $r^I = r^S = r$ and

$$1 + r^U = \epsilon\sqrt{(1-\tau)(1-\tau(1-\theta))} \tag{A.11}$$

$$k^U = \frac{1-\tau}{1-\tau(1-\theta)} \tag{A.12}$$

$$D^U = \frac{\tau\theta}{1-\tau(1-\theta)} \tag{A.13}$$

where both countries have same equilibrium quantities and prices. UW region: Again, I rule out the second and third equilibria in Figure 4 (these two equilibria are now not symmetric since S banks are in the L region). Similar to above, in the second equilibrium it must be that $1 + r^I = \theta(1 + r^S)$. It is then easy to show that $k^I > k^S$. Again, markets do not clear. In the third equilibrium, since S banks invest in both bond markets it must be that $r^S = r^I = r$ and $k^S > k^I$. Market clearing conditions are

$$(1-k^I) + (1-\alpha^S)(1-k^S) = \frac{\tau\theta\epsilon\sqrt{k^I}}{1+r^I}$$

$$\alpha^S(1-k^S) = min\left\{\frac{\tau\theta\epsilon\sqrt{k^S}}{1+r^S}, z - (1-\alpha^S)(1-k^S)\right\}$$

Similarly to above, we can show that market clearing conditions do not hold in this case. I now analyze the last equilibrium where $\alpha^I = \alpha^S = 1$. Plugging the optimal choices of lending in the bond market clearing conditions we get

$$1 + r^S = \frac{\epsilon}{2\theta}\sqrt{(1-\tau)((1-\tau)(1+\theta)^2 + 2\tau\theta^2(1+\theta))} \tag{A.14}$$

$$k^S = \frac{(1-\tau)(1+\theta)}{(1-\tau)(1+\theta) + 2\theta^2\tau} \tag{A.15}$$

$$D^S = \frac{2\tau\theta^2}{(1-\tau)(1+\theta) + 2\tau\theta^2} \tag{A.16}$$

where $k^S > k$, $r^S > r$, and $D > D^S$. Country I quantities and prices are unchanged from the UU equilibrium. □

Proof of Corollary 1. From the maximization problem in the L region, we have that $\overline{L} = (1-\tau)\epsilon\sqrt{k} + (1+r)(1-k)$. Plugging in the equilibrium values for k^W and r^W, we get

$$\overline{L} = \frac{\epsilon\sqrt{(1-\tau)(1+\theta)}}{\sqrt{(1-\tau)(1+\theta) + 2\tau\theta^2}}\left(1 - \tau(1-\theta)\right) \tag{A.17}$$

□

Proof of Proposition 2. Governments recapitalize domestic banks if

$$\underbrace{\tau\epsilon(1+\beta\theta)(\sqrt{k_W}-\sqrt{k_U})}_{\text{increased tax collection}} \geq \underbrace{(D_U - D_W)}_{\text{lower debt issuance}} + \underbrace{\beta\theta((1+r_W)D_W - (1+r_U)D_U)}_{\text{higher payments to bondholders}} \tag{A.18}$$

Plugging the equilibrium levels of lending, debt, and interest rates the above expression can be rewritten as

$$\epsilon(1+\beta\theta(1-\theta))A \geq \theta B \tag{A.19}$$

where $A = \frac{\sqrt{(1-\tau)(1+\theta)}}{\sqrt{(1-\tau)(1+\theta)+2\tau\theta^2}} - \frac{\sqrt{1-\tau}}{1-\tau(1-\theta)}$ and $B = \frac{1}{1-\tau(1-\theta)} - \frac{2\theta}{(1-\tau)(1+\theta)+2\tau\theta^2}$

By Proposition 1, $B > 0$. A can be either positive or negative. We can therefore rearrange (A.19) to write $\beta \geq \overline{\beta}$ where

$$\overline{\beta} = \begin{cases} \dfrac{\theta B - \epsilon A}{\epsilon\theta(1-\theta)A} & if \quad A \geq 0 \\ 1 & if \quad A < 0 \end{cases}$$

The second part of the proposition follows from Proposition 1. □

Proof of Proposition 3. I derived equilibrium prices and quantities in the high home bias equilibrium in (A.3)-(A.5). By Proposition 2, both governments benefit from forcing their banks to be undercapitalized. the claim does not hold when the economy is in the low home bias equilibrium and governments are constrained by the willingness-to-pay constraint. Hence, the UU region is the Nash equilibrium when the players (governments) are sufficiently myopic. □

B Additional Tables

Table B1. **EBA Sample.** This table provides a list of all banks that took part in at least one of the seven European Banking Authority (EBA) stress tests. The EBA conducted two "EU-wide stress tests" (March 2010 and December 2010), three "Capital Exercises" (September 2011, December 2011, and June 2012), and two "Transparency Exercises" (December 2012, June 2013). Together with the EBA identifier, this table shows the number of stress tests observations (Tot. Obs.) for each bank. The number of banks that participated in the seven stress tests are, respectively (i) 91, (ii) 90, (iii) 65, (iv) 61, (v) 61, (vi) 64, (vii) 64. EBA ID is not available (na) for banks that took part in the first stress test only. The column BvD ID shows the Bankscope identifier for the banks in the final sample. I excluded banks with two or less EBA observations (N.O.: not enough observations). N.B.D. (No Bankscope Data) indicates those banks for which data were not available on Bankscope. N.B.M. (No Bankscope Match) indicates those banks for which there was no Bankscope match. The last seven columns summarize whether a bank participated in each of the seven stress tests. The final sample has 58 banks.

EBA ID	Bank Name	Country	BvD ID	Tot Obs.	Stress Tests		Capital Exercises			Transp. Exercise	
					Mar10	Dec10	Sep11	Dec11	Jun12	Dec12	Jun13
AT001	Erste Group Bank	AT	AT46146	7	x	x	x	x	x	x	x
AT002	Raiffeisen Zentralbank Osterreich	AT	AT44096	7	x	x	x	x	x	x	x
AT003	Oesterreichische Volksbanken	AT	AT44482	2		x	x				
BE004	Dexia	BE	BE0458548296	3	x	x	x				
BE005	KBC Bank	BE	BE0462920226	7	x	x	x	x	x	x	x
CY006	Cyprus Popular Bank	CY	N.B.M.	4	x	x	x	x			
CY007	Bank of Cyprus	CY	CYC165	7	x	x	x	x	x	x	x
DK008	Danske Bank	DK	DK61126228	7	x	x	x	x	x	x	x
DK009	Jyske Bank	DK	DK17616617	7	x	x	x	x	x	x	x
DK010	Sydbank	DK	DK12626509	7	x	x	x	x	x	x	x
DK011	Nykredit	DK	DK10519608	6		x	x	x	x	x	x
FI012	OP-Pohjola Group	FI	FI02425221	7	x	x	x	x	x	x	x
FR013	BNP Paribas	FR	FR662042449	7	x	x	x	x	x	x	x
FR014	Credit Agricole	FR	FR784608416	7	x	x	x	x	x	x	x
FR015	BPCE	FR	FR10708	7	x	x	x	x	x	x	x
FR016	Societe General	FR	FR552120222	7	x	x	x	x	x	x	x
DE017	Deutsche Bank	DE	DE13216	7	x	x	x	x	x	x	x
DE018	Commerzbank	DE	DE13190	7	x	x	x	x	x	x	x
DE019	Landesbank Baden-Wurttemberg	DE	DE47734	7	x	x	x	x	x	x	x
DE020	DZ Bank	DE	DE17881	7	x	x	x	x	x	x	x
DE021	Bayerische Landesbank	DE	DE13109	7	x	x	x	x	x	x	x
DE022	Norddeutsche Landesbank	DE	DE13584	7	x	x	x	x	x	x	x
DE023	HRE Holding	DE	DE16697	7	x	x	x	x	x	x	x
DE024	WestLB	DE	N.B.M.	3	x	x	x				
DE025	HSH Nordbank	DE	DE19978	7	x	x	x	x	x	x	x
na	Deutsche Postbank	DE	N.O.	1	x						
DE026	Helaba	DE	N.O.	6	x		x	x	x	x	x
DE027	Landesbank Berlin	DE	DE14104	7	x	x	x	x	x	x	x
DE028	DekaBank	DE	DE13229	7	x	x	x	x	x	x	x
DE029	WGZ Bank	DE	N.B.D.	7	x	x	x	x	x	x	x
GR030	EFG Eurobank Ergasias	GR	GR094014250	4	x	x				x	x
GR031	National Bank of Greece	GR	GR094014201	4	x	x				x	x
GR032	Alpha Bank	GR	GR094014249	4	x	x				x	x
GR033	Piraeus Bank	GR	N.O.	4	x	x				x	x
GR034	ATEbank	GR	N.O.	2	x	x					
GR035	TT Hellenic Postbank	GR	N.O.	2	x	x					
HU036	OTP Bank	HU	HU10537914	7	x	x	x	x	x	x	x

na	FHB Jelzalogbank	HU	N.O.	1	x						
IE037	Allied Irish Banks	IE	IE024173	7	x	x	x	x	x	x	x
IE038	Bank of Ireland	IE	GBRC000206	7	x	x	x	x	x	x	x
IE039	Irish Life and Permanent	IE	IE222332	6		x	x	x	x	x	x
IT040	Intesa Sanpaolo	IT	ITTO0947156	7	x	x	x	x	x	x	x
IT041	Unicredit	IT	ITRM1179152	7	x	x	x	x	x	x	x
IT042	Banca Monte Paschi Siena	IT	ITSI0097869	7	x	x	x	x	x	x	x
IT043	Banco Popolare	IT	ITVR0358122	7	x	x	x	x	x	x	x
IT044	UBI Banca	IT	ITBG0345283	7	x	x	x	x	x	x	x
LU045	Banque et Caisse d'Epargne	LU	LULB30775	7	x	x	x	x	x	x	x
na	Banque Raiffeisen	LU	N.O.	1	x						
MT046	Bank of Valletta	MT	MTC2833	7	x	x	x	x	x	x	x
NL047	ING Bank	NL	NL33031431	7	x	x	x	x	x	x	x
NL048	Rabobank	NL	NL30046259	7	x	x	x	x	x	x	x
NL049	ABN AMRO	NL	NL34370515	7	x	x	x	x	x	x	x
NL050	SNS Bank	NL	NL16062338	7	x	x	x	x	x	x	x
NO051	DNB	NO	N.B.D.	6		x	x	x	x	x	x
PL052	PKO Bank Polski	PL	PL016298263	7	x	x	x	x	x	x	x
PT053	Caixa Geral de Depositos	PT	PT500960046	7	x	x	x	x	x	x	x
PT054	BCP	PT	PT501525882	7	x	x	x	x	x	x	x
PT055	ESFG	PT	LULB22232	7	x	x	x	x	x	x	x
PT056	Banco BPI	PT	PT501214534	7	x	x	x	x	x	x	x
SI057	NLB	SI	SI5860571	7	x	x	x	x	x	x	x
SI058	Nova KBM	SI	SI5860580	6		x	x	x	x	x	x
ES059	Banco Santander	ES	ESA39000013	7	x	x	x	x	x	x	x
ES060	BBVA	ES	ESA48265169	7	x	x	x	x	x	x	x
ES061	Jupiter	ES	N.O.	2		x	x				
ES062	Caixa	ES	ESG58899998	7	x	x	x	x	x	x	x
ES063	Base	ES	N.O.	1		x					
ES064	Banco Popular Espanol	ES	ESA28000727	7	x	x	x	x	x	x	x
ES065	Banco de Sabadell	ES	N.O.	2	x	x					
ES066	Diada	ES	N.O.	2	x	x					
ES067	Breogan	ES	N.O.	2	x	x					
ES068	Mare Nostrum	ES	N.O.	1		x					
ES069	Bankinter	ES	N.O.	2	x	x					
ES070	Espiga	ES	N.O.	2	x	x					
ES071	Banca Civica	ES	N.O.	2	x	x					
ES072	Ibercaja	ES	N.O.	2	x	x					
ES073	Unicaja	ES	N.O.	2	x	x					
ES074	Banco Pastor	ES	N.O.	2	x	x					
ES075	Bilbao Bizkaia Kutxa	ES	N.O.	2	x	x					
ES076	Unnim	ES	N.O.	2	x	x					
ES077	Kutxa	ES	N.O.	2	x	x					
ES078	Banco Grupo Cajatres	ES	N.O.	2	x	x					
ES079	Banca March	ES	N.O.	2	x	x					
ES080	Caja Vital Kutxa	ES	N.O.	2	x	x					
ES081	Caixa Ontinyent	ES	N.O.	2	x	x					
ES082	Colonya, Caixa de Pollena	ES	N.O.	2	x	x					
na	Bankia	ES	N.O.	1	x						
na	Banco Base	ES	N.O.	1	x						
na	Cajasur	ES	N.O.	1	x						
na	Banco Mare Nostrum	ES	N.O.	1	x						
na	Caja Sol	ES	N.O.	1	x						
na	Banco Guipuzcoano	ES	N.O.	1	x						
ES083	Bankia	ES	N.O.	1		x					
SE084	Nordea	SE	N.B.D.	7	x	x	x	x	x	x	x
SE085	SEB	SE	N.B.D.	7	x	x	x	x	x	x	x
SE086	Svenska Handelsbanken	SE	N.B.D.	7	x	x	x	x	x	x	x
SE087	Swedbank	SE	N.B.D.	7	x	x	x	x	x	x	x
GB088	RBS	GB	GBSC045551	7	x	x	x	x	x	x	x
GB089	HSBC	GB	GB00617987	7	x	x	x	x	x	x	x
GB090	Barclays	GB	GB01026167	7	x	x	x	x	x	x	x
GB091	Lloyds Banking Group	GB	GBSC095000	7	x	x	x	x	x	x	x

Table B2. **Summary Statistics.** This table provides summary statistics of the sample of banks in Table C1 from 2010Q1 to 2013Q2. Banks are split in two categories depending on their country: GIIPS banks (Greece, Italy, Ireland, Portugal, and Spain) and Core banks (Austria, Germany, Denmark, Finland, France, Netherlands, and UK). Panel A shows the evolution of Total Assets, Exposure to Sovereigns (Total, GIIPS, and Domestic Sovereigns), Home Bias (Domestic Exposure/Total Sovereign Exposure), and Exposure to GIIPS/Total Sovereign Exposure. Panel B normalizes the quantities in Panel C to 100 in 2010Q1. Panel C shows the evolution of banks' capitalization measured by Tier 1 Ratio (T1R), Leverage (Equity/Assets), and Risk Weighted Assets. Panel D normalizes the quantities in Panel A to 100 in 2010Q1.

Panel A	**Sample Banks**	**2010Q1**	**2010Q4**	**2011Q3**	**2011Q4**	**2012Q2**	**2012Q4**	**2013Q2**
Total Assets (m EUR)	GIIPS	3,510	3,547	4,032	3,975	3,761	3,400	3,328
	Core	9,696	9,301	9,576	9,847	9,505	9,701	9,297
	All	6,512	6,264	6,663	6,690	6,432	6,199	5,965
Total Exposure (m EUR)	GIIPS	23.5	24.1	26.1	25.2	28.8	27.8	31.0
	Core	39.3	40.8	38.8	36.3	38.6	39.4	40.1
	All	30.6	31.3	30.9	28.7	31.0	30.9	32.4
Exposure to GIIPS (m EUR)	GIIPS	19.3	20.9	21.7	20.8	24.3	22.8	25.7
	Core	8.8	7.0	5.5	4.8	4.3	4.4	4.7
	All	11.8	11.1	9.9	9.0	9.8	10.1	11.2
Domestic Exposure (m EUR)	GIIPS	18.1	19.7	20.6	19.7	23.4	22.1	24.7
	Core	16.0	19.2	18.8	19.0	20.5	21.0	21.0
	All	15.2	17.2	17.0	17.0	19.0	19.0	19.9
Home Bias (Dom. Exposure/ Tot. Sov. Expos.)	GIIPS	0.78	0.83	0.85	0.86	0.88	0.86	0.86
	Core	0.51	0.56	0.56	0.60	0.60	0.60	0.58
	All	0.60	0.65	0.65	0.69	0.70	0.71	0.71
Exposure to GIIPS/ Total Sovereign Exposure	GIIPS	0.87	0.89	0.90	0.91	0.91	0.90	0.90
	Core	0.16	0.13	0.11	0.10	0.08	0.08	0.08
	All	0.41	0.39	0.35	0.35	0.33	0.35	0.36

Panel B	Sample Banks	2010Q1	2010Q4	2011Q3	2011Q4	2012Q2	2012Q4	2013Q2
Total Assets (m EUR)	GIIPS	100.0	101.1	114.9	113.2	107.1	96.9	94.8
	Core	100.0	95.9	98.8	101.6	98.0	100.1	95.9
	All	100.0	96.2	102.3	102.7	98.8	95.2	91.6
Total Exposure (m EUR)	GIIPS	100.0	102.8	111.4	107.3	122.9	118.7	132.2
	Core	100.0	103.9	98.9	92.5	98.2	100.3	102.0
	All	100.0	102.0	100.8	93.6	101.2	100.9	105.7
Exposure to GIIPS (m EUR)	GIIPS	100.0	108.0	112.3	107.5	125.8	118.0	132.7
	Core	100.0	79.7	62.2	54.2	49.2	50.1	52.9
	All	100.0	94.1	83.8	76.5	82.9	85.4	94.6
Domestic Exposure (m EUR)	GIIPS	100.0	108.8	113.5	108.7	129.0	121.6	136.2
	Core	100.0	119.5	117.0	118.4	127.7	130.7	131.0
	All	100.0	113.1	111.6	111.7	124.8	125.2	131.3
Home Bias (Dom. Exposure/ Tot. Sov. Expos.)	GIIPS	100.0	105.6	107.9	109.2	112.2	109.9	109.6
	Core	100.0	109.8	110.7	118.9	118.4	118.1	115.1
	All	100.0	108.5	107.7	114.8	116.8	118.1	117.2
Exposure to GIIPS/ Total Sovereign Exposure	GIIPS	100.00	102.26	103.47	104.85	105.49	103.86	104.41
	Core	100.00	78.88	65.32	59.42	50.46	49.71	52.37
	All	100.00	94.58	85.19	84.92	81.10	86.60	87.24

Panel C	Sample Banks	2010Q1	2010Q4	2011Q3	2011Q4	2012Q2	2012Q4	2013Q2
T1R	GIIPS	10.4	10.2	10.2	10.7	11.5	12.0	12.4
	Core	11.0	12.6	13.4	12.9	13.2	13.6	14.7
	All	10.8	11.7	12.1	11.8	12.3	12.8	13.7
E/A	GIIPS	6.8	6.6	6.6	6.0	5.5	5.6	6.9
	Core	4.1	4.3	4.3	4.3	4.3	4.7	5.0
	All	5.5	5.4	5.6	5.4	5.1	5.5	6.1
RWA (m EUR)	GIIPS	179.6	184.7	173.6	185.8	166.3	171.9	152.7
	Core	297.1	286.1	284.9	284.0	267.1	260.5	251.7
	All	232.6	226.7	224.1	224.4	202.9	205.4	199.6

Panel D	Sample Banks	2010Q1	2010Q4	2011Q3	2011Q4	2012Q2	2012Q4	2013Q2
T1R	GIIPS	100.0	98.3	98.3	103.0	110.4	115.0	119.0
	Core	100.0	114.4	122.3	117.5	120.0	124.0	133.5
	All	100.0	107.9	111.6	109.3	113.4	118.3	126.6
E/A	GIIPS	100.0	96.7	95.8	87.5	79.8	82.5	101.3
	Core	100.0	105.7	105.8	105.8	105.2	116.2	122.1
	All	100.0	97.2	101.1	97.1	92.9	99.9	111.0
RWA	GIIPS	100.0	102.8	96.7	103.4	92.6	95.7	85.0
	Core	100.0	96.3	95.9	95.6	89.9	87.7	84.7
	All	100.0	97.4	96.3	96.5	87.2	88.3	85.8

C Additional Plots

Figure C1. **Bond Spreads and Banks' Holdings of Domestic Bonds.** The figure shows the 10-year bond spreads vs. German bond (dashed line, secondary axis (bps)) and the aggregate holding of sovereign debt by domestic banks (solid line, primary axis, (bn Euro)) for Italy, Spain, Portugal, and Ireland. Source: Bloomberg and Arslanalp and Tsuda (2012).

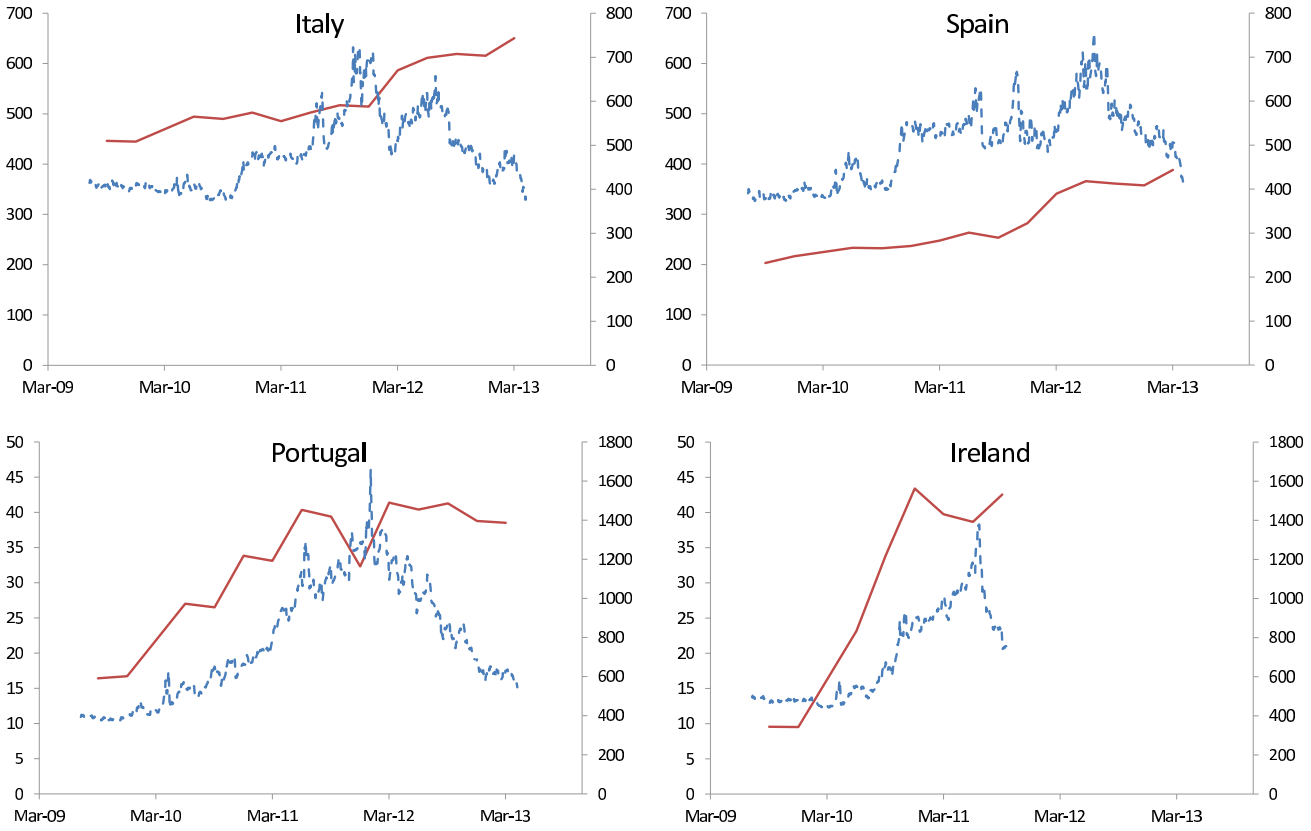

Figure C2. **Bond Spreads and Banks' Holdings by Domestic Banks in non GIIPS Countries.** The figure shows the 10-year bond spreads vs. German bond (dashed line, secondary axis (bps)) and the aggregate holding of sovereign debt by domestic banks (solid line, primary axis, (bn Euro)) for Austria, Finland, France, Netherlands, Belgium, Germany, Denmark, and UK. The spread for 10-year German bonds is the difference with the U.S. Treasury Bill. Source: Bloomberg and and Arslanalp and Tsuda (2012).

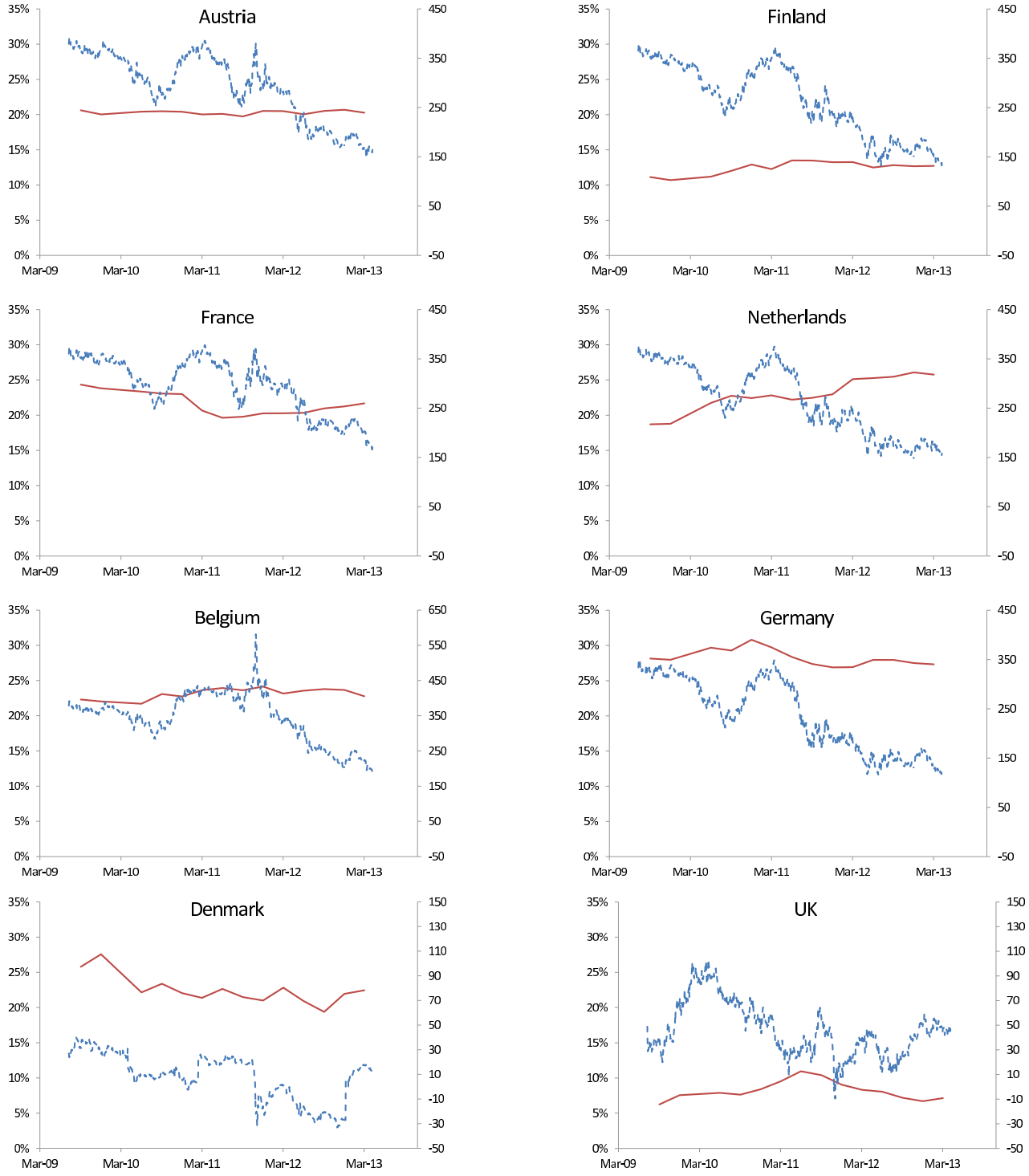

Figure C3. **Government Bond Holdings and Private Lending in non GIIPS Countries.** The figure shows the domestic banks' lending to private non-financial sector (dashed line) and government gross debt held by domestic banks (solid line) for Austria, Finland, France, Netherlands, Belgium, Germany, Denmark, and UK. Quantities are normalized to 100 in March 2004. Source: BIS and Arslanalp and Tsuda (2012).

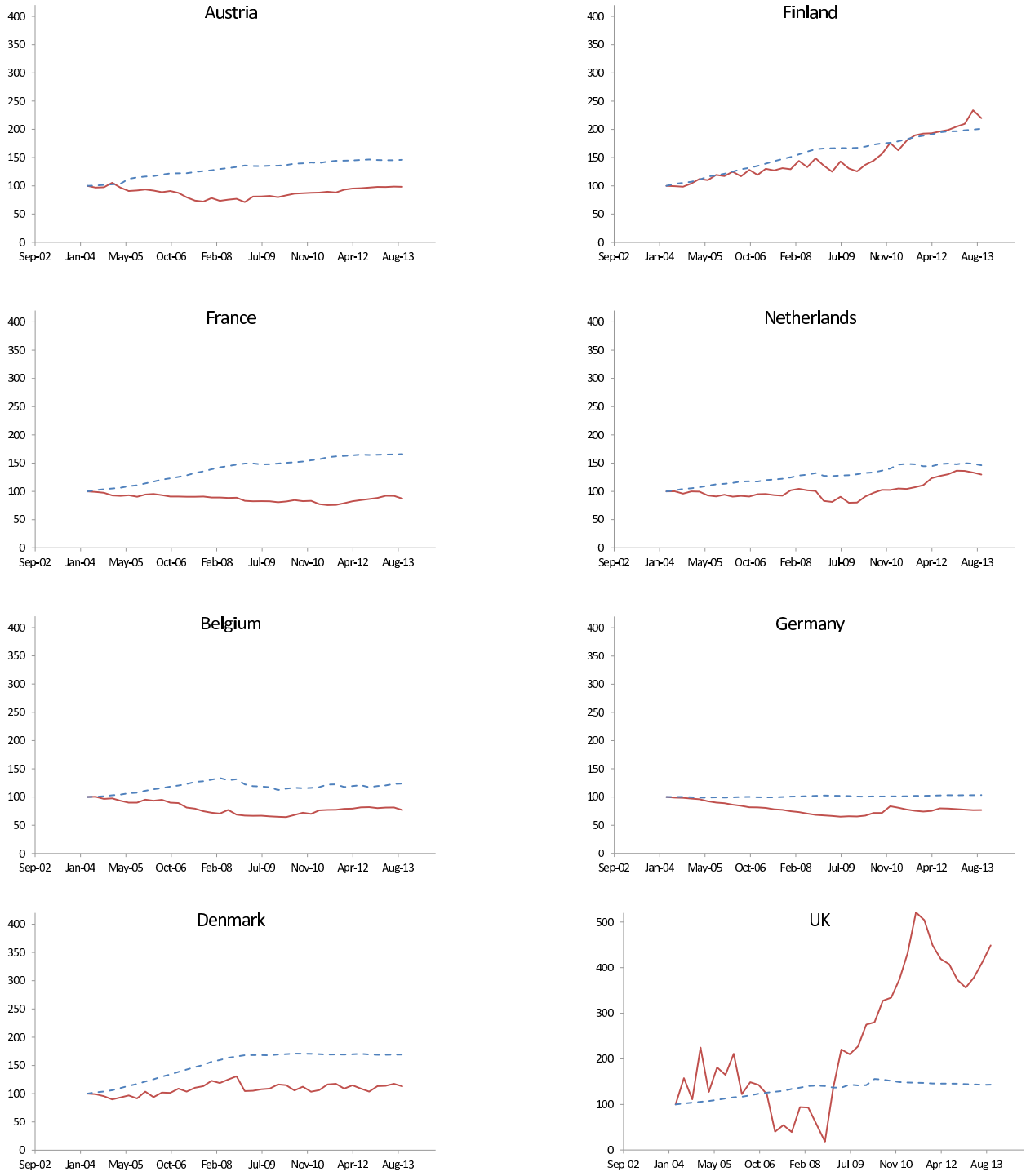

Figure C4. **Risk-shifting and Home Bias (GIIPS Banks).** This figure shows the evolution of home bias (normalized at 100 in 2010Q1) of GIIPS banks from 2010Q1 to 2013Q2. Home Bias is defined as Exposure to Domestic Government Debt divided by Total Exposure to Government Debt. The plot illustrates the increase in home bias for high leverage and geographically undiversified (solid blue line) and low leverage and geographically diversified (red dashed line) GIIPS banks. Leverage is Book Value of Equity divided by Total Assets. Geographical diversification is the Total Exposure at Default (EAD) to Foreign Countries divided by Total Assets as of 2010Q4. EAD is from the 2011 EBA Stress Test. Geographically diversified and undiversified banks are respectively the top and bottom 25% of banks ordered by Foreign EAD divided by Assets. High leverage and geographically undiversified banks and low leverage and geographically diversified banks are respectively the top and bottom 25% of banks ordered by leverage and geographical undiversification. The two lines are constructed using a weighted average where weights are given by the total exposure to sovereigns divided by total assets as of 2010Q4. The sample is formed by 16 banks from Italy, Ireland, Portugal, and Spain. Greek banks are excluded because of data availability (see Table C.1 in the Appendix). Source: Bankscope, European Banking Authority.