Bailouts, Moral Hazard, and Banks' Home Bias for Sovereign Debt*

Gaetano Gaballo† Ariel Zetlin-Jones‡

October 22, 2015

Abstract

We show that banks' home bias for domestic sovereign debt may be privately and socially valuable. We develop a model of financial intermediation in which banks are subject to managerial moral hazard and ex ante optimality requires lenders to commit to ex post inefficient bank liquidations. A benevolent Sovereign may desire to enact bailouts to prevent such liquidations thereby neutralizing lenders' commitment. If banks hold domestic sovereign debt, an ex post bailout financed with newly issued sovereign debt lowers the value of banks' assets and reduces the effectiveness of the bailout. If the price of domestic debt is sensitive to the size of the bailout, banks' losses on domestic debt may render bailouts infeasible. Therefore, home bias may be private and socially valuable as a mechanism to deter bailouts and restore lenders' commitment.

*This paper is in preparation for the November 2015 Carnegie-Rochester-NYU Conference on Public Policy.

†Gaballo: Banque de France, Monetary Policy Research Division [DGEI-DEMFI-POMONE], 31 rue Croix de Petits Champs 41-1391, 75049 Paris Cedex 01, France. Email: gaetano.gaballo@banque-france.fr.

‡Zetlin-Jones: Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213. Email: azj@andrew.cmu.edu.

1 Introduction

European banks may have strong incentives to hold European sovereign debt due to regulatory advantages in capital requirements, but Basel III regulations provide little to no additional advantages in favor of home-country debt. However, since the beginning of the European debt crisis, banks' holdings of domestic sovereign debt have increased dramatically across most of Europe[1]. Recently, policymakers have expressed concern that banks' increased bias towards home-country debt – so-called home bias – may frustrate their efforts to restrain financial segmentation, one of the main perceived causes of the prolonged economic slowdown in Europe which began in 2010.

The conventional political economy view on the level and rise of banks' home bias for sovereign debt is that it is the result of explicit or implicit regulations imposed on banks by governments. When sovereign debt is largely held domestically, the Sovereign has weaker incentives to default and therefore may be able to sustain larger amounts of sovereign debt. This conventional view suggests that home bias is a policy to discipline the Sovereign's temptation to default on its own debt. According to this view, banks have weak incentives to acquire domestic debt and governments must use regulations to incentivize banks' to do so.

In this paper, we analyze a complementary mechanism in which the financial sector has *its own incentives* to acquire domestic sovereign debt in favor of foreign sovereign debt and this home bias also generates *social* value. In our model, the Sovereign's temptation to intervene in domestic financial markets following adverse shocks, via bailouts, limits the ex ante efficiency of the financial sector. By acquiring domestic sovereign debt issues, the financial sector makes the value of its assets contingent on the Sovereign's credit risk. Such ex ante acquisitions by the financial sector can reduce the ability of the Sovereign to pursue ex post domestic bailouts and thereby increase the ex ante efficiency of the financial sector. In other words, home bias is a strategy of the financial sector to impose discipline on domestic policymakers' temptation to enact bailouts. We conclude that banks' home bias may be an unintended consequence of domestic financial bailout policies.

We explore the link between bailouts and banks' home bias by developing a dynamic model of intermediation subject to moral hazard as in Holmstrom and Tirole (1998) that incorporates a Sovereign with discretion to intervene ex post in domestic financial markets. In this model, ex ante investment choices of a bank (made jointly by its creditors and its owners) impact optimal ex post interventions of the Sovereign. We show that the

[1] See Asonuma et al. (2015) and Broner et al. (2014)

bank optimally chooses to bias its investment portfolio towards domestic sovereign debt and away from higher return private investments or foreign sovereign debt in order to limit ex post domestic interventions by the Sovereign.

In our model, as in Calomiris and Kahn (1991) or Diamond and Rajan (2001), bank runs, or bank liquidations, in which bank creditors decide to not re-finance the bank serve as a useful disciplining device to resolve the bank owners' moral hazard problem. When these liquidations are ex post inefficient, a benevolent Sovereign who lacks commitment has an ex post incentive to intervene and prevent the liquidation with a bailout. If such bailouts are expected to succeed, creditors correctly anticipate that the threat of liquidation is empty. Thus, as in Chari and Kehoe (2013), bailouts limit the capacity of creditors to resolve the bank's moral hazard problem and worsen ex ante efficiency of the bank. In contrast to Chari and Kehoe (2013), we show that market mechanisms may suffice to impose discipline on the Sovereign's lack of commitment so that ex ante regulations are unnecessary.

The Sovereign's ex post incentive to bailout the bank motivates private agents to pursue strategies that prevent the Sovereign from successfully enacting bailouts. We show that investing in domestic sovereign debt is one such strategy. The basic idea is that if the Sovereign issues external debt to finance a bailout, it concurrently lowers the value of banks' holdings of domestic debt and imposes capital losses on the very banks it is trying to rescue. If banks hold domestic sovereign debt and the the price of this debt is sensitive to the size of the bailout, banks' losses on domestic debt may be sufficient to render ex post bailouts ineffective. As a result, bailouts do not occur in equilibrium. Domestic sovereign debt, in contrast to other assets, has the feature of generating banks' capital losses contingent on the bailout policy of the Sovereign. In this sense, home bias is an optimal mechanism to discipline ex post public interventions.

Our theory suggests regulations on banks' asset holdings are not needed to incentivize banks to hold domestic issues in contrast to findings in Chari et al. (2014) and Uhlig (2013). Moreover, restrictions preventing banks from acquiring domestic sovereign debt may have unintended, negative consequences on welfare. In our model, such restrictions limit the ability of banks and the financial sector more broadly from imposing discipline on the Sovereign.

The optimality of banks' home bias in our model relies on two key conditions. First, bailouts require sufficiently large transfers of resources from the government to the financial sector so as to have a meaningful impact on the default risk associated with the government. Second, changes in government default risk impose losses on bank balance sheets. In other words, changes in government default risk are not selective in the sense that they are not only imposed on foreign holders of domestic sovereign debt.

We view these assumptions in our model as motivated by and in line with recent empirical evidence. Acharya et al. (2014) find that Sovereign credit risk increases considerably after government bailouts suggesting that bailouts induce large changes on the Sovereign's balance sheet. Gennaioli et al. (2014) provide evidence that domestic banks' balance sheets deteriorate when the domestic Sovereign defaults on its debt and that Sovereign default is less likely in countries with a high degree of home bias.

We also examine the effect of changes in the level of Sovereign debt on the extent of banks' home bias in our model. If a change in the level of Sovereign debt increases the Sovereign's ability to raise resources to finance a bailout, then this change will be associated with an increase in home bias. Intuitively, an increase in the Sovereign's bailout capacity requires banks to increase their exposure to domestic Sovereign debt to render potential bailouts unsuccessful. One might conjecture that an increase in the Sovereign's default risk in the absence of a bailout would induce a decrease in the Sovereign's bailout capacity. Such a conjecture would imply that an observed increase in the spread on a Sovereign's debt would reduce the Sovereign's bailout capacity and therefore lead to a fall in banks' home bias. Our model suggests this relationship is less clear. We show that the Sovereign's bailout capacity depends on the Sovereign's default risk *conditional* on enacting the bailout which is an out-of-equilibrium event.

To examine the relationship between changes in Sovereign default risk and home bias in our model, we analyze two stylized models of Sovereign default. In the first model, increases in Sovereign Debt are *unbacked* in the sense that increases in Sovereign debt are not accompanied by changes in the ability of the Sovereign to raise revenues. In the second model, increases in Sovereign debt are *partially backed* in the sense that increases in Sovereign debt are accompanied by increases in the ability of the Sovereign to raise revenues. In both of these models, an increase in the indebtedness of the Sovereign leads to an increase in Sovereign default risk in equilibrium. However, increases in Sovereign debt reduce the Sovereign's bailout capacity in the unbacked model but improve the Sovereign's bailout capacity in the partially backed model.

These results provide an interpretation for the findings in Battistini et al. (2013) that, in response to a common risk factor, European banks increase their domestic exposures, instead of diversifying, increasing the fragmentation of the Euro Sovereign debt market in periods of higher default risk. Moreover, with unbacked debt, our model predicts that increases in sovereign default risk are correlated with increases in the risk of inefficient liquidations, or bank run-like events. This feature of our model is consistent with evidence in Gilchrist and Mojon (2014) who find that there is a high correlation between

Sovereign and domestic banks' credit risk in Europe. Moreover, Acharya and Steffen (2013) document that banks that have not been bailed out typically have significant exposures to their government's credit risk suggesting that home bias may be an effective deterrent to bailouts.

Our findings also have implications for existing policy proposals within the European Union such as the possible creation of a Eurobond. Our theory suggests that member countries' banks may have strong incentives to acquire these Eurobonds to strengthen ex ante corporate governance within the financial system. Thus, the creation of Eurobonds may improve ex ante efficiency of the financial sector, but might actually make the European financial system appear to be *less* resilient to future adverse financial shocks by limiting the potential scope for ex post interventions.

Our model sheds new light on observations on banks' home bias in Europe. First, we provide a new rationale for the high average level of home bias observed in the data; home bias is large in the sense that on average, home Sovereign debt accounts for 85% [2] of banks' holdings of Euro-denominated Sovereign Debt. Our theory suggests this level may not solely be due to bank regulations incentivizing banks to acquire own currency denominated debt. Second, differences in the evolution of banks' holdings of home Sovereign debt across time in Europe may be attributed to changes in fiscal imbalances and the implied Sovereign bailout capacity. We briefly discuss the cases of Ireland, Spain and Greece in the context of the European crises of 2010.

2 Optimal Home Bias

In this section, we introduce a model based on Holmstrom and Tirole (1998) that we extend to incorporate an additional round of moral hazard and investment in government debt. We demonstrate that home bias may arise as an optimal response to the inability of the government to commit to not pursue bailout.

2.1 Environment

The model is set in discrete time with three periods, $t = 0, 1, 2$. There are two agents: a *lender* and a *borrower*. Both the lender and the borrower are risk neutral and do not discount consumption across periods. We think of the lender a representing a large group of depositors, and the borrower as a bank manager or a representative of the

[2] See Committee on the Global Financial System (2011) and European Systemic Risk Board (2015) for a detailed overview.

owners of the bank's inside equity. For ease of exposition, we refer to the borrower as a *bank*. The bank is initially endowed with resources of size A and, in period 0, has a access to a stochastic constant returns to scale private investment opportunity subject to two instances of moral hazard. The bank also has access to a public investment opportunity, that is, the bank may purchase government debt. The bank is protected by *limited liability* in the sense that in all periods and all histories the bank's consumption is non negative.

Each unit of private investment in period 0 earns either a high rate of return equal to R or a low rate of return equal to 0 in period 2. In period 1, an additional, stochastic amount funding equal to $\rho \geqslant 0$ per unit of period 0 investment is required to continue private investments. We call ρ a *liquidity shock* as it represents additional cash needs. The bank may choose to exert high effort or *shirk* (exert low effort) in both period 1 and period 2. The bank's effort choices impact both the distribution of liquidity shocks and the distribution of private investment returns.

If the bank exerts effort in period 1, the liquidity shock is zero, $\rho = \rho_g = 0$ ("good") with probability p_h and is positive, $\rho = \rho_b > 0$ ("bad") with probability $1 - p_h$. If the bank shirks in period 1, the liquidity shock is positive $\rho = \rho_b$ with probability 1.

If the bank exerts effort in period 2, the per unit return is R in period 2 with probability p_h and 0 with probability $1 - p_h$. If the bank shirks in period 2, the per unit return is R with probability $p_h - \Delta p$ and 0 with probability $1 - p_h + \Delta p$. We make the natural assumption that $p_h > \Delta p > 0$. [3]

In any period, the bank obtains a private benefit $B > 0$ per unit of private investment should it shirk. The bank's effort choice in each period is unobservable by the lender while the realization of both the liquidity shock in period 1 and the rate of return in period 2 are observable by the lender.

In period 0, the bank may also undertake public investment by purchasing public debt with the scale of public investment observed by the lender. We let R^S denote the implicit rate of return earned by the bank's public investment in period 1. Section 2.2 assumes R^S is exogenous. In Section 2.3, we endogenize R^S and consider how R^S changes when the government pursues ex post interventions.

Contracts with Limited Private Commitment. We define a *contract* to be a collection of functions $C = \{I, h, x(\rho), R_f(\rho)\}$ which specify the scale of investment I, the *portfolio allocation* $h \in [0, 1]$ which describes the fraction of the total investment scale to be invested in public debt, a *continuation rule* as a function of the liquidity shock $x(\rho)$, and a rate of

[3]Of course, our analysis is robust to a more symmetric or general assumption about how bank effort impacts the distribution of liquidity shocks and returns.

return to pay the bank in the event the project pays R as a function of the liquidity shock $R_f(\rho)$.

The lender faces limited private commitment. Specifically, we assume that in period 1 after the realization of the liquidity shock ρ_j, the bank may propose to implement a new continuation contract $C_1(\rho_j) = \{I, h, \hat{x}, \hat{R}_f\}$ by paying a transaction cost $\kappa I(1-h)$ where κ represents a per private investment unit cost of re-negotiation.[4] Note that the continuation contract cannot alter the prevailing scale I or the portfolio allocation h. Conditional on paying the re-negotiation cost, the continuation contract is implemented only if it increases ex post welfare for both the lender and the bank. This re-negotiation game gives to rise to *credibility* constraints that potentially restrict long-term contracts. We will say a contract is *credible*, or immune to re-negotiation if for all liquidity shocks, there exists no continuation contract which increases ex post welfare for both the lender and the bank (and respects the bank's period 2 incentive constraint).

2.2 Optimal Contracts without Government Interventions

To simplify the analysis, we follow Holmstrom and Tirole (1998) and analyze contracts which maximize the bank's net return subject to the participation constraint of the lender (the principal), the incentive constraints of the bank (the agent) and the credibility constraints. We begin by analyzing a benchmark case without government intervention and with R^S as exogenous and fixed.

Definition 1 (Optimal Contracts without Government Interventions)**.** *The optimal contract maximizes the bank's objective*

$$\Psi I - A \tag{1}$$

where the expected rate of return paid to the bank, Ψ, satisfies

$$\Psi = p_h x(\rho_g) p_h R_f(\rho_g) + (1-p_h) x(\rho_b) p_h R_f(\rho_b), \tag{2}$$

subject to the lender's participation constraint

$$I h R^S + I(1-h)\left[p_h x(\rho_g) p_h R + (1-p_h) x(\rho_b)(p_h R - \rho_b)\right] - \Psi I \geqslant I - A, \tag{3}$$

the period 2 incentive constraint of the bank

$$R_f(\rho_j)\Delta p \geqslant B(1-h), \tag{4}$$

[4] Zetlin-Jones (2014) provides a micro-foundation for a re-negotiation game which endogenizes this cost per unit κ.

the period 1 incentive constraint of the bank

$$x\left(\rho_g\right)p_hR_f\left(\rho_g\right) - x(\rho_b)p_hR_f\left(\rho_b\right) \geqslant B(1-h)/p_h, \tag{5}$$

and the credibility constraints – for all liquidity shocks ρ_j*, there exists no continuation contract* $C_1(\rho_j) = \{I, h, \hat{x}, \hat{R}_f\}$ *such that*

$$I\left[hR^s + (1-h)\hat{x}\left(p_h(R-\hat{R}_f) - \rho_b - \kappa\right)\right] \geqslant I\left[hR^s + (1-h)x_jp_h(R-R_{fj})\right] \tag{6}$$

$$\hat{x}p_h\hat{R}_f \geqslant x_jp_hR_{fj} \tag{7}$$

with at least one strict inequality and satisfying $\hat{R}_f\Delta p \geqslant B(1-h)$*, i.e. the bank's period 2 incentive constraint.*

Note that Definition 1 implicitly assumes that high effort in both periods is optimal. Formally, we restrict attention to underlying parameters such that high effort in both periods is useful in the sense that any lending arrangement which induces high effort dominates those which call for low effort in any period.

The constraints (4) and (5) ensure that the bank will provide effort in both periods 1 and 2. Since the bank enjoys private benefits from shirking proportional to $I(1-h)$ but receives returns $R_f(\rho)$ proportional to I, in principle, contracts which allocate a greater fraction of the investment portfolio to public debt feature more relaxed incentive constraints. This effect is reflected in constraints (4) and (5) which become more slack as h increases. In spite of this benefit, if private investments are sufficiently superior to public debt, then optimal contracts feature no investment in public debt.

Characterizing the Optimal Contract. In characterizing optimal contracts, we proceed under the conjecture that the credibility constraints faced by the lender and the bank are slack. Below, we describe conditions on the re-negotiation cost, κ such that this conjecture is verified.

To conserve on notation, we let $x_j = x(\rho_j)$ and similarly for R_{fj}. It is useful to observe that conditional on a portfolio allocation, h, and a continuation rule, $x(\rho)$, the minimal rates of return paid to the bank which induce effort satisfy

$$R_{fb} = \frac{B(1-h)}{\Delta p} \quad \text{and} \quad R_{fg} = \frac{B(1-h)}{x_g p_h^2} + \frac{x_b B(1-h)}{x_g \Delta p}. \tag{8}$$

Next, define $\rho_1 = p_hR$, and similarly $\rho_0 = p_h\left(R - B/\Delta p\right)$. The value ρ_1 represents the expected social return to investment from period 1 to period 2 without incorporating the costs of moral hazard. The value ρ_0 represents the expected return to investment after paying the bank the minimum return needed to induce effort in period 2.

Our characterization parallels that of Holmstrom and Tirole (1998). First, we conjecture that the lender's participation constraint binds. Note that this will be the case as long as the rate of return paid to the lender, which is proportional to the total scale of investment I, is less than 1 – we verify this conjecture later. If (3) binds, then the objective (1) can be written as

$$m(h, x_g, x_b)I(h, x_g, x_b, R_{fg}, R_{fb}) - A \tag{9}$$

where

$$m(h, x_g, x_b) = hR^s + (1-h)\left[p_h x_g p_h R + (1-p_h)x_b(p_h R - \rho_b)\right] - 1. \tag{10}$$

Note that $m(\cdot)$ represents the bank's expected rate of return on investment which depends only on the portfolio allocation, h and the continuation rule x. Hence, the rate the bank is paid conditional on private project returns being successful, R_{fg} and R_{fb} only determine the scale of investment. From the lender's participation constraint (3), the scale of investment is decreasing in the rates of return R_{fj} and thus the optimal contract minimizes these rates of return.[5] That is, R_{fb} and R_{fg} are the minimal rates that induce effort and satisfy (8).

Substituting (8) into (3) with equality yields the scale of investment as a function only of h, x_g, and x_b:

$$I(h, x_g, x_b) = \frac{A}{1 - hR^S - (1-h)\left[x_g p_h \rho_1 - B + x_b\left((1-p_h)(\rho_0 - \rho_b) - p_h(\rho_1 - \rho_0)\right)\right]}. \tag{11}$$

Equations (10) and (11) show that the objective is strictly increasing in x_g so that for any h, the optimal continuation decision following a good liquidity shock satisfies $x_g = 1$.

We can then define the value to the bank of any contract with $x_g = 1$ and any x_b and h as

$$V(x_b, h) = m(h, 1, x_b)I(h, 1, x_b) - A. \tag{12}$$

We now impose a sequence of parametric restrictions which make our problem economically relevant. First, the public investment return R^S is low enough to ensure that the bank does not optimally acquire government debt. Second, a commitment to liquidate the bank following a bad liquidity shock improves the ex ante value of the optimal contract by relaxing the bank's incentives to shirk. Third, private investment returns are small enough so that private investments are not self-financing (that is, the lender's

[5]This argument requires that $m(h, x_g, x_b) > 0$ in the optimal contract. As in Holmstrom and Tirole (1998), this is necessarily the case as long as $p_h R - (1-p_h)\rho_b > 1$.

participation constraint binds). Fourth, the re-negotiation costs are large so that a commitment to liquidate following bad liquidity shocks is credible. Finally, we assume that ex post, liquidation of the bank is inefficient.

Assumption 1. *Returns on the public investment are lower than the marginal utility of consumption, i.e.* $R^S < 1$.[6]

Straightforward algebra demonstrates that $R^S \leqslant 1$ implies $V_h(x_b, h) \leqslant 0$, and thus the value of the bank $V(x_b, h)$ is strictly decreasing in the fraction of the bank's portfolio allocated to public investment. While an increase in h does relax the incentive constraints of the bank, this force is not sufficient to overturn the fact that the rate of return on public investment is dominated by the rate of return on the private investment. As a result, the optimal contract features no public investment, or $h = 0$.

Assumption 2. *Expected returns and the cost of moral hazard satisfy*

$$p_h \frac{B}{\Delta p} - (1 - p_h) \frac{\rho_1 - \rho_b}{p_h \rho_1 - 1} B > 0. \tag{13}$$

Assumption 2 ensures that on the margin, a decrease in the liquidation rate following a bad liquidity shock, x_b, leads to an increase in the value of the contract to the bank. To see this, consider the impact on the value associated with a decrease in x_b. From (10), observe that such a decrease reduces the rate of return $m(h, 1, x_b)$. However, the same decrease in x_b causes the scale of investment to rise since it relaxes the period 1 incentive constraint of the bank and reduces R_{fg} (as seen in (8)).

When Assumption 2 holds, $V_{x_b}(x_b, 0) \leqslant 0$. On the margin, when $h = 0$, the incentive benefits of reducing x_b are given by the first term in (13) while the costs of reducing the rate of return are given by the second term in (13). Hence, under Assumption 2, the benefits of reducing x_b outweigh the costs and a commitment to liquidate following a bad liquidity shock is optimal, or $x_b = 0$.

Assumption 3. *Expected returns and the cost of moral hazard satisfy*

$$\max\{p_h \rho_1 - B, \rho_0 - (1 - p_h)\rho_b - B\} < 1. \tag{14}$$

Assumption 3 bounds the rate of return paid to the lender so that the lender's participation constraint binds in the optimal contract. The requirements $p_h \rho_1 - B < 1$ and $\rho_0 - (1 - p_h)\rho_b - B < 1$ imply that the marginal cost of providing funds to the

[6]Technically, we require that R^S is small relative to the discount rate of lender, which in our model is equal to 1.

bank is larger than the marginal return for the lender when the liquidation strategy is $x_g = 1, x_b = 0$ and $x_g = x_b = 1$, respectively. Since these two liquidation strategies entail different moral hazard costs, we require both conditions to be satisfied.[7]

Assumption 4. *Expected returns and the cost of renegotiation satisfy*

$$\rho_0 > \kappa > \rho_0 - \rho_b > 0. \tag{15}$$

The conditions in Assumption 4 imply that a threat to liquidate following a good liquidity shock is not credible (since $\rho_0 > \kappa$), that a threat to liquidate following a bad liquidity shock is credible (since $\kappa > \rho_0 - \rho_b$), and that liquidation following a bad liquidity shock is ex post inefficient (since $\rho_0 - \rho_b > 0$).

The spread between κ and the returns from providing the needed liquidity and continuing private investments measures the extent to which additional resources are required to induce a renegotiation. Since $\rho_0 > \kappa$, it is immediate, following a good liquidity shock, this spread is negative so that any threat to liquidate the bank following such a shock is not credible – of course, continuation after such a shock is credible. A threat to liquidate following a bad liquidity shock is credible because the spread between cost of renegotiation (κ) and the benefits ($\rho_0 - \rho_b$) is positive.

Note that in the absence of re-negotiation costs – i.e. if $\kappa = 0$ – both the lender and the bank can made better off by continuing private investments in spite of the presence of the bank's moral hazard because $\rho_0 - \rho_b > 0$. In this sense, liquidation following a bad liquidity shock is ex post inefficient. Following the literature on banking panics beginning with Diamond and Dybvig (1983), we think of ex post inefficient liquidations as resembling banking panics.

Proposition 1. *Under Assumptions 1-4, the optimal contract features no public investment ($h = 0$), continuation after a good liquidity shock ($x_g = 1$) and liquidation of private investments after a bad liquidity shock ($x_b = 0$) and such liquidation is ex post inefficient.*

Imagine for a moment that a benevolent government that lacks commitment can costlessly raise resources to bailout the bank. That is, this government can inject resources so as to induce a re-negotiation between the lender and the bank. (Below, we formalize the government action and the costs of raising resources). Since liquidation is ex post inefficient, if the costs of raising resources are sufficiently small, then by injecting these resources, the government can induce a Pareto improvement for the borrower and lender.

[7] One might also notice that this assumption resembles one made in Holmstrom and Tirole (1998) but accounts for the fact that our model features features two instances of moral hazard.

The required size of the injection is simply $\kappa - (\rho_0 - \rho_b) > 0$. In this sense, when $\rho_0 > \rho_b$, a government that lacks commitment has a temptation to bailout the bank and induce a re-negotiation contract that calls for continuation following bad liquidity shocks. Notice also that the spread between the transaction cost κ and the gains from re-negotiation $\rho_0 - \rho_b$ determines the amount of resources needed for the government to bailout the bank.

If the bank and the lender rationally anticipate such a government bailout, then the threat to liquidate the bank following a bad liquidity shock is not credible. In other words, the optimal contract we have described would not be time consistent. Thus, the lack of government commitment worsens ex ante incentives of the bank.

In the next section, we show that when the return on public investment (R^S) is sensitive to the size of the government bailout, private agents – the lender and bank – may be able to impose discipline on the government and resolve the government's time inconsistency problem.

2.3 Optimal Contracts with Government Interventions

In this section, we formally introduce a third agent – a *domestic government* – or Sovereign. This government faces a lack of commitment problem in the sense that it may attempt to intervene in private markets when it perceives it has an ability to implement a Pareto improvement. We introduce a simple model of government debt pricing where the value of government debt decreases with the stock of debt. We show that the set of credible continuation rules that the bank can implement depends critically on the interaction between government debt prices, the size of government interventions, and the fraction of the bank's portfolio invested in domestic government debt.

The government issues bonds in period 0 and may issue additional bonds in period 1. Each bond is a claim on one unit of consumption in period 2. Let D_t denote the amount of debt issued by the government in period t, evaluated in terms of the amount of period 2 consumption that the government has promised to pay. Let the period 0 outstanding stock of debt in be exogenously specified. The government may choose to bail out the bank by injecting resources in period 1. The government may make this bailout conditional on the bank entering a re-negotiation and continuing its investments.[8] We assume that the government must raise bailout funds externally by issuing new debt D_1 and the new debt is equal in seniority to the debt issued in period 0.

[8]An alternative interpretation is that the government simply takes ownership of the bank and remits balances to the lender of the bank.

Finally, we introduce pricing functions for government debt $q_0(D_0)$ and $q_1(D_0, D_1)$ where $q_{0,D_0}(D_0) < 0$ and $q_{1,D_1}(D_0, D_1) < 0$. The natural assumption $q_{t,D_t} < 0$ implies that increases in the stock of government debt lower the price of the government debt. One interpretation of this assumption, which we formalize below, is the idea that an increase in the indebtedness of the government raises the probability that the government cannot repay its debt obligations thereby lowering the value of a promised unit of consumption by the government.

Given these price functions, in the absence of an intervention, the bank expects to earn a rate of return on domestic government debt $R^S = q_1(D_0, 0)/q_0(D_0)$. For any amount of debt issued in period 1, the government raises resources equal to $q_1(D_0, D_1)D_1$ which is typically non-monotonic in D_1. Intuitively, the price of government debt is decreasing in the amount of debt the government issues and if the price decreases quickly enough, then total resources raised from a debt issue are declining in the size of the issue.

We consider the problem of a benevolent government, acting under discretion. This government may be tempted to inject resources into the bank to induce the lender and the bank to renegotiate their status quo contract in case of a bad liquidity shock. We begin by examining the size of the bailout needed by the government to induce renegotiation conditional for any portfolio allocation h and investment scale of the bank, I.

If the bank invests hI resources in domestic debt in period 0, since the period 0 price of domestic government debt is q_0, in period 1 the bank owns hI/q_0 claims to period 2 consumption. If the government issues new debt in the amount D_1 and injects the proceeds into the bank, then the value of the bank increases by the amount q_1D_1 and the total value of the bank's initial domestic debt claims becomes hIq_1/q_0. Under a successful re-negotiation, the bank's private investments yield expected output net of re-negotiation costs equal to $(1-h)I(\rho_0 - \rho - \kappa)$. Hence, the total value of the bank in period 1 following any liquidity shock ρ, any debt issue size D_1 and re-negotiation, which we denote by the function F, is given by

$$F(h, I, D_1) = hI\frac{q_1(D_0, D_1)}{q_0(D_0)} + q_1(D_0, D_1)D_1 + (1-h)I(\rho_0 - \rho - \kappa). \tag{16}$$

Notice, the renegotiated value of the bank depends on the size of the additional government debt issue in two ways. First, the government itself faces a tradeoff in that the larger the size of the debt issue, D_1, the harder it may be for the government to raise revenue from issuing debt as its price, $q_1(D_0, D_1)$ falls. Second, new debt issues dilute the remaining value of the bank by diluting the value of government debt claims that the bank holds.

If there exists D_1 such that

$$F(h, I, D_1) \geqslant hI\frac{q_1(D_0, 0)}{q_0(D_0)} + (1-h)Ix(\rho)(\rho_0 - \rho) \tag{17}$$

then it is feasible for the government to induce a Pareto improvement for both the lender and the bank. The right hand side of inequality (17) represents the remaining value of the bank if there is no renegotiation. This remaining value depends on the value of the bank's public debt holdings without an intervention, the level and return of its private investments, and the planned continuation rule.

If inequality (17) is satisfied for some D_1, then the government faces an ex post temptation to pursue bailouts since it may induce a Pareto improvement to the status quo continuation contract. We embed this temptation as a policy rule for the government. That is, we assume that if D_1 exists such that inequality (17) is satisfied, then the government implements a bailout. Such a policy would arise in an environment where a benevolent government lacks commitment and in period 1 maximizes the ex post value of the bank subject to the lender's participation constraint, and besides the impact on debt prices, there are no additional costs of period 1 debt issues.

Formally, we strengthen our definition of credible contracts and say that a status quo contract C is *credible with an active government* if and only if for all liquidity shocks, ρ_j, there exists no value of government debt D_1 such inequality (17) is satisfied.

Definition 2 (Optimal Contracts with Government Interventions)**.** *The optimal contract with government interventions maximizes the bank's objective* (1) *subject to the lender's participation constraint* (3)*, the bank's incentive constraints* (4) *and* (5)*, and the credibility constraints with an active government.*

Credible Continuation Rules. We now demonstrate our main result – that when the price of government debt is sufficiently sensitive to the size of the ex post bailout pursued by the government, then the optimal contract features a strictly positive portfolio allocation to public debt, or $h > 0$. Below we describe how we interpret this finding as a rationale for home bias.

For any h, the lack of government commitment implies that a policy of $x_b = 0$ may no longer be credible – of course, a policy of $x_b = 1$ is always credible. To determine the optimal contract, we must then determine the set of portfolio allocations h such that a policy of $x_b = 0$ is credible.

Let $\bar{H} = \{h : x_b = 0 \text{ is credible.}\}$ and let $\underline{h} = \inf_h \bar{H}$ denote the smallest element of $\bar{H}$. Since $V_h(x_b, h) < 0$, the value of the optimal contract necessarily satisfies

$$V = \max\{V(0, \underline{h}), V(1, 0)\} \tag{18}$$

so that the optimal contract either features $x_b = 0$ and $h = \underline{h}$ or $x_b = 1$ and $h = 0$. We proceed by demonstrating that there exists an initial level of debt for the government such that $\underline{h} > 0$ and $V(0, \underline{h}) > V(1, 0)$.

Towards this end, it is useful to first understand how an increase in the portfolio allocation to public debt impacts the ability of the government to pursue a bailout. To do so, first note that the credibility constraint (inequality (17)) depends on the status quo contract through the choice of h and $I(h, x_g, x_b)$. We let $\hat{I}(h) = I(h, 1, 0)$ where from (11), the scale of investment for any h is given by

$$\hat{I}(h) = \frac{A}{1 - hR^s - (1-h)(p_h\rho_1 - B)}. \tag{19}$$

If $h \in \bar{H}$ – that is, h is credible – then the maximum net benefit of renegotiation

$$G(h, D_0) = F(h, \hat{I}(h), D_1^*(D_0, h)) - h\hat{I}(h)\frac{q_1(D_0, 0)}{q_0(D_0)} \tag{20}$$

satisfies $G(h, D_0) \leqslant 0$, where the particular bailout size, $D_1^*(D_0, h)$ is given by

$$D_1^*(D_0, h) = \arg\max_{D_1}\left\{h\hat{I}(h)\frac{q_1(D_0, D_1)}{q_0(D_0)} + q_1(D_0, D_1)D_1\right\}. \tag{21}$$

The bailout size $D_1^*(D_0, h)$ is the bailout which maximizes the the renegotiated value of the bank. This bailout size balances a trade-off between two alternative ways to increase the value of the bank. Increasing D_1 increases the value of the bank by allowing for a direct injection of resources, $q_1 D_1$, but it also depresses the value of the bank's domestic debt holdings through the pricing function q_1. Alternatively, the government can, in principle, increase the value of the bank's domestic debt holdings via q_1 by reducing its external exposure D_1, or even taxing the bank (negative D_1). When $G(h, D_0) \leqslant 0$, for any D_1, a bailout of size $q_1(D_0, D_1)D_1$ will be unsuccessful.

Consider then the effect of an increase in h on the credibility constraint which is measured as $G_h(h, D_0)$. If $G_h(h, D_0) < 0$, then an increase in h makes bailouts more difficult to implement and this may potentially relax the credibility constraints. In order for the optimal contract to feature $h > 0$, it must be that for some D_0 and some h, an increase in h relaxes the credibility constraint.

We use the effect of an increase in h on the government's ability to implement bailouts to prove that there exist D_0 such that $h > 0$ is optimal using perturbation methods. Suppose for some D_0, say $\bar{D}_0$ that $G(0, \bar{D}_0) = 0$. We argue that if the government debt price in period 1 following a bailout of size $D_1^*(\bar{D}_0, 0)$ is sufficiently below the initial debt price, $q_0(\bar{D}_0)$, then $G_h(0, \bar{D}_0)$ is strictly negative so that an increase in h makes bailouts strictly more difficult for the government By continuity, this implies that for some level of initial debt in the neighborhood of $\bar{D}_0$, the optimal contract features strictly positive h.

To illustrate this result, note that

$$G_h(0, \bar{D}_0) = \\ = \hat{I}(0) \left[\frac{q_1(\bar{D}_0, D_1^*(\bar{D}_0, 0))}{q_0(\bar{D}_0)} - \frac{(1 - R^s)}{1 - (p_h \rho_1 - B)}(\rho_0 - \rho_b) + \frac{(1 - R^s)}{1 - (p_h \rho_1 - B)}\kappa - \frac{q_1(\bar{D}_0, 0)}{q_0(\bar{D}_0)} \right]. \tag{22}$$

The impact of a small increase in h can be decomposed into two forces. The first force, captured by the first two terms in brackets in (22), represents the change in the re-negotiated value of the bank. This force reflects the change in ex post returns from the change in the portfolio allocation – higher exposure to public debt ($q_1(\bar{D}_0, D_1^*)/q_0(\bar{D}_0)$) and lower exposure to private investments, which earn a net rate of return equal to $\rho_0 - \rho_b$. The second force, captured by the third and fourth term in brackets in (22) reflects changes in the net cost of re-negotiation. This force reflects an increase from reduced renegotiation costs – recall these costs are proportional to the amount of private investment done by the bank – and a decrease from a larger amount of public investment which is valued at rate $q_1(\bar{D}_0, 0)/q_0(\bar{D}_0)$.

Combining terms from the right hand side of (22), note that if

$$\frac{q_1(\bar{D}_0, D_1^*(\bar{D}_0, 0))}{q_0(\bar{D}_0)} - \frac{q_1(\bar{D}_0, 0)}{q_0(\bar{D}_0)} + \frac{(1 - R^s)}{1 - (p_h \rho_1 - B)}(\kappa - (\rho_0 - \rho_b)) < 0, \tag{23}$$

then $G_h(0, \bar{D}_0) < 0$ and an increase in h strictly relaxes the credibility constraint. Suppose next that $G_{D_0}(0, \bar{D}_0) \neq 0$ so that some change in the initial indebtedness of the domestic government – either an increase or decrease – increases the ability of the government to pursue a bailout. Then, a small increase in h can counter-act this ability and ensure $x_b = 0$ is credible.

Proposition 2. *If $\bar{D}_0$ exists such that $G(0, \bar{D}_0) = 0$, the inequality (23) is satisfied and $G_{D_0}(0, \bar{D}_0) \neq$*

0, *then for some* D_0 *in an open neighborhood of* $\bar{D}_0$, *the optimal contract features strictly positive home bias – that is,* $h > 0$.[9]

In Figure 1 we present an illustrative example in which $h > 0$ is optimal. The dashed lines represent the values $V(x_b, h)$ for $x_b = 0$ and $x_b = 1$. For h sufficiently small (roughly below 0.3), under full commitment, liquidation following bad liquidity shocks dominates continuation. The opposite holds when h is larger than this value. Without government interventions, the optimal contract features $h = 0$ and $x_b = 0$.

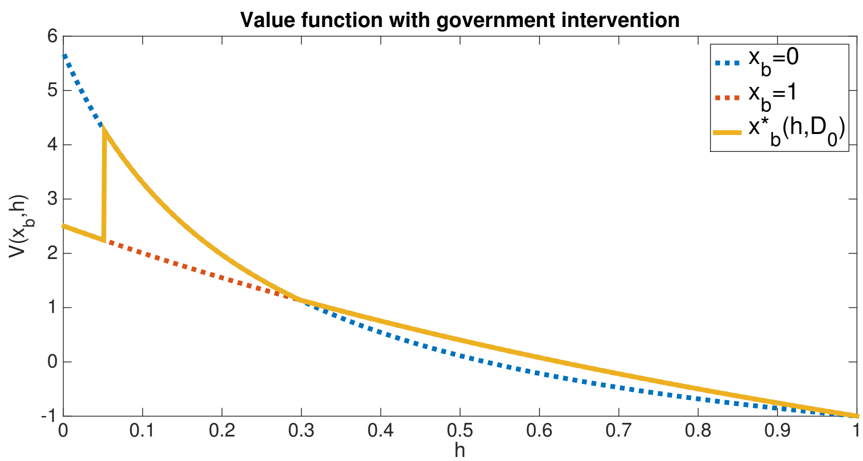


Figure 1: Value function to bank associated with $x_b = 0$ and $x_b = 1$

With government interventions, the contract featuring $h = 0$ and $x_b = 0$ is not credible. The solid yellow line represents the best continuation rule that is credible for all h. For sufficiently low values of h (roughly below 0.05), the choice of $x_b = 0$ is not credible, so that maximal value that can be attained has $x_b = 1$. For values of h between roughly 0.05 and 0.3, the choice of $x_b = 0$ is credible and dominates the choice of $x_b = 1$. For values of h larger than 0.3, although $x_b = 0$ may be credible, continuation dominates liquidation, so that the maximal value is associated with $x_b = 1$. Since the optimal contract is the point on the solid yellow line that yields the largest value, this contract has the property that $h = \underline{h}$ and $x_b = 1$.

Figure 1 illustrates the costs and benefits associated with a policy of home bias. While home bias relaxes the credibility constraints and allows the lender and the bank to commit to liquidate following bad liquidity shocks, home bias also requires the bank to invest

[9]We state this proposition in terms of the function $G(h, D_0)$ to highlight the necessary conditions for home bias to be optimal. Given functional forms for the price of government debt, it is straightforward to determine conditions on underlying parameters such that the conditions of the Proposition – specifically, existence of such a $\bar{D}_0$ – are satisfied.

in assets with ex ante dominated returns. The difference in values $V(0,0) - V(0, \underline{h})$ represents the costs of investing in government debt for the bank and, therefore, the implicit cost associated with the government's lack of commitment. The difference in values $V(0, \underline{h}) - V(1, 0)$ represents instead the benefit of maintaining credible liquidation. If this spread were negative, while it would be feasible for the bank to credibly commit to liquidate, it would not be optimal to do so.

The Importance of Sensitive Debt Prices and Home Bias. The key condition for $h > 0$ to be optimal that is embedded in inequality (23) is that $q_1(D_0, D_1)$ is sufficiently responsive to changes in D_1. That is, $q_1(\bar{D}_0, D_1^*(\bar{D}_0, 0))$ must be sufficiently smaller than $q_1(\bar{D}_0)$. When (23) is satisfied, this decline in the price of government debt associated with an attempted bailout imposes an endogenous renegotiation cost for the government, suggesting that potential declines in debt prices play the same role for the government as κ plays for the lender and the bank: these costs are paid only when a re-negotiation occurs. In other words, domestic public debt has the feature of generating losses for the bank contingent on the bailout policy of the domestic sovereign.

Corollary 3. *In the optimal contract, if any asset has a rate of return less than 1 and a period 1 price which is insensitive to the bailout policy of the domestic government, then that asset is not purchased by the bank.*

Consider foreign sovereign debt as an example of such an asset. If the foreign government has no incentive to enact bailouts on the domestic bank, and if the return on foreign government debt is strictly less than 1, then it is immediate that the domestic bank in our model has no incentives to acquire foreign sovereign debt. In this sense, we interpret the choice of $h > 0$ to represent *home bias* in our model.

Comparative Statics. Proposition 2 relies on the condition that $G_{D_0}(0, \bar{D}_0) \neq 0$ which does not restrict how a change in D_0 affects the ability of the government to pursue a bailout. Whether $G_{D_0}(0, \bar{D}_0) > 0$ or $G_{D_0}(0, \bar{D}_0) < 0$ will determine the local comparative statics of the optimal choice of h with respect to D_0.

Corollary 4. *If $G_{D_0}(0, \bar{D}_0) < 0$, then h is strictly decreasing for $D_0 < \bar{D}_0$ and D_0 in a neighborhood of $\bar{D}_0$. If $G_{D_0}(0, \bar{D}_0) > 0$, then h is strictly increasing for $D_0 > \bar{D}_0$ and D_0 in a neighborhood of $\bar{D}_0$.*

From (20), one can easily prove that $G_{D_0}(0, \bar{D}_0)$ is equal in sign to $q_{1,D_0}(D_0, D_1^*(D_0, 0))$ (via an envelope condition). Notice that $q_{1,D_0}(D_0, D_1^*(D_0, 0))$ is generally different from

$q_{1,D_0}(D_0, 0)$. The value, $q_{1,D_0}(D_0, D_1^*(D_0, 0))$, represents the impact of an increase in D_0 on the counterfactual price of government debt that would obtain if the government implements the maximal bailout size, $D_1^*(D_0, 0)$. If the impact is strictly negative, then an increase in D_0 leads to a decline in the counterfactual price which increases the endogenous renegotiation cost of the bailout. Thus, an increase in D_0 relaxes the credibility constraint and so the optimal contract calls for a decrease in h. In contrast, if the impact is strictly positive, then an increase in D_0 leads to a rise in this counterfactual price which reduces the endogenous renegotiation cost of the bailout, tightens the credibility constraint, and induces an increase in h. In the next section, we further elaborate on this point by introducing a simple model of government debt pricing.

3 Implications of Increases in Government Debt

In this section, we introduce a simple model of debt pricing to illustrate our model's predictions for how the government's debt position impacts the extent of home bias as well as the size and fragility of the financial sector.

3.1 A Simple Model of Debt Pricing

We begin with a stylized pricing model which maps the risk of government default in period 2 into the price of government debt in periods 0 and 1. In particular, we assume that the domestic government defaults with some probability and that this probability increases with the size of debt issued by the government. The prices associated with government debt determine the endogenous returns earned on public assets in our model of financial intermediation.

In this stylized pricing model, domestic government debt is priced by a representative financial agent who values consumption according to

$$c_0 + \sigma^{-1} c_1 + \sigma^{-2} c_2, \text{ with } \sigma < 1,$$

has a sufficiently large endowment, and does not have access to the banking technology captured by the domestic bank in our model. We allow $\sigma > 1$ to capture the idea that this financial agent has a relatively stronger incentive to postpone consumption than the lender. No arbitrage implies that the financial agent should be indifferent between consuming immediately or investing in any asset which gives a one period return of σ.

Let the repayment probability of the government be stochastic and evolve with the stock of issued debt. In period 0, each private agent (either the bank or the financial agent) perceives that a unit of government debt will deliver 1 unit of consumption good in period 2 with probability $\eta_0(D_0)$. In period 1, each private agent perceives that a unit of government debt will deliver 1 unit of consumption in period 2 with probability $\eta_1(D_0, D_1)$. The two probabilities may differ as the government may increase its debt when implementing a bailout. If private agents anticipate that credible contracts will be implemented so that the government issues no additional debt in period 1, then they rationally expect $\eta_0(D_0) = \eta_1(D_0, 0)$.

By no arbitrage, the period zero price of government debt q_0 is determined by

$$q_0(D_0) = \frac{\eta_0(D_0)}{\sigma^2}, \tag{24}$$

so that the price is equal to the discounted expected payment. Analogously, the period 1 price conditional on an amount of additional debt issued by the government D_1 satisfies

$$q_1(D_0, D_1) = \frac{\eta_1(D_0, D_1)}{\sigma}. \tag{25}$$

These debt pricing results have two important implications for choices made by the bank in our model. First, since $\sigma < 1$, the period 1 price of government debt is always larger than the expected rate of return on government debt, $\eta(D_0, D_1)$. Thus, since the bank and the lender do not discount period 2 consumption, for all (D_0, D_1), it is efficient for the bank to sell its holdings of government debt to the financial agent in period 1. Second, in the absence of a bailout, the realized rate of return on period 0 purchases of government debt by the bank are given by $R^S = q_1(D_0, 0)/q_0(D_0) = \sigma < 1$. In other words, the return of a one period investment in government debt is bounded strictly below one. Again, we rely on the fact that $q_1(D_0, 0) = \sigma q_0(D_0)$ is a rational expectation at time 0 in an equilibrium where an optimal credible contract with active government is implemented.

In order for the debt prices (24) and (25) to have properties consistent with our assumptions in Section 2.3, we require $\eta_{0,D_0}(D_0) < 0$ and $\eta_{1,D_1}(D_0, D_1) < 0$. These assumptions on default rates emerge in essentially any model of government default. We now explore the implications of two particular examples of government default risk to better understand the comparative statics of our model.

3.2 Increase in Unbacked Public Debt

Consider first a simple specification of the government's repayment probability. Suppose government revenues are uniformly distributed between T_{min} and T_{max} with $T_{max} > T_{min}$ and $D_0 \geqslant T_{min}$ then the repayment probability perceived in period 0 is

$$\eta_0(D_0) = \min\left\{\frac{T_{max} - D_0}{T_{max} - T_{min}}, 1\right\}, \tag{26}$$

and that perceived in period 1 is

$$\eta_1(D_0, D_1) = \min\left\{\frac{T_{max} - D_0 - D_1}{T_{max} - T_{min}}, 1\right\}. \tag{27}$$

We think of this specification as allowing us to examine the effects of an increase in *unbacked* debt, i.e. an increase in debt that is not accompanied by any change in the ability of the government to raise additional revenues.

It is straightforward to see with this specification of debt prices that

$$q_{1,D_0}(D_0, D_1^*(D_0, h)) = \frac{1}{\sigma}\eta_{1,D_0}(D_0, D_1^*(D_0, h)) = \frac{-1}{\sigma(T_{max} - T_{min})} < 0. \tag{28}$$

Our discussion of Corollary 4 then suggests that we should expect an increase in government debt to lead to a decrease in home bias.

Figure 2 illustrates the comparative statics of the optimal contract and its implications for various levels of the initial debt of the government and two levels of σ. We postpone discussion of the effect of changes in σ to Section 3.4 below.

In the top-left panel of Figure 2, the solid lines represent the optimal choice of h for two values of σ. The horizontal dashed lines depict a critical threshold in h and represent the maximal amount of home bias such that a contract with home bias and a commitment to liquidate following bad liquidity shocks is better than a contract with no home bias and no commitment to liquidate. That is, the critical threshold is the value of h such that $V(0, h) = V(1, 0)$.

When D_0 is small or large, the optimal contract has no home bias. For small D_0, no home bias arises either because for any h, the government may enact a bailout or because the amount of h required to prevent a bailout is above the critical threshold. For large enough D_0, no home bias arises because for every h, the government cannot enact a bailout and so $h = 0$ is credible. For intermediate values of D_0, the optimal contract has $h > 0$ indicating a strictly positive degree of home bias.

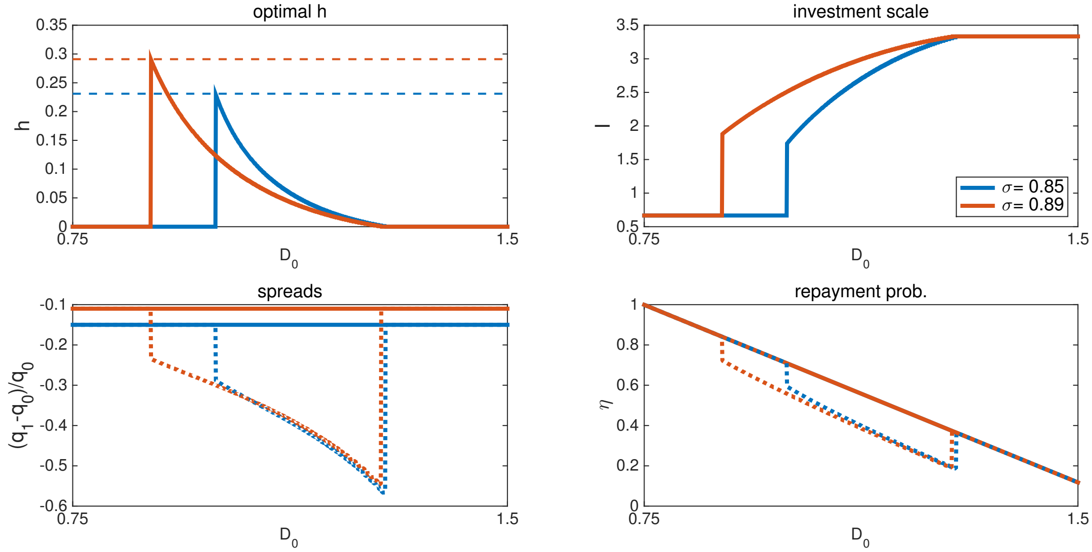


Figure 2: Comparative statics with unbacked debt. Calibration: $p_h = 0.9$, $\rho_1 = 1.3$, $B = 0.2$, $\rho_0 = 1.1$, $\rho_b = 0.5$, $\kappa = \rho_0 - \rho_b + 0.01$, $A = 0.1$, $T_{max} = 1.6$ $T_{min} = 0.75$. The calibration satisfies Assumption 1-4

When strictly positive home bias is optimal, an increase in debt induces a decline in home bias. The decline in home bias is caused by a reduced ability of the government to raise additional funds to finance a bailout as its initial default probability increases. Note that the probability of liquidation of the bank is increasing in the initial indebtedness of the government. In this sense, public and private default risks are correlated in our model.

Therefore, an *unbacked* increase in government debt leads to a jump in home bias starting from low levels of government debt and then smoothly decreases home bias for high levels of government debt. Furthermore, such an increase leads to greater probability of ex post inefficient liquidations of the bank, which may resemble a crisis, and larger ex ante investments in the bank.

In the top-right panel of Figure 2 we plot the size of total investment in the bank as a function of the initial indebtedness of the government and observe that this size is increasing in D_0. Since total investment is determined by lender's participation constraint, an increase in investment is driven by an increase in the rate of return promised by the bank. The top-right panel of figure 2 then reflects two forces which lead the rate of return to increase. First, as D_0 increases above a certain threshold, the financial sector switches from continuing after bad liquidity shocks to liquidating after bad liquidity shocks. This switch provides better incentives to the bank to exert effort and increases the rate of return on bank investments. Second, as D_0 continues to increase, a commitment to liquidate following bad liquidity shocks requires less investment in return-dominated public debt as the government's ability to pursue bailouts is weaker when it has greater initial debt.

In the bottom-left panel of Figure 2, a dotted line plots the counterfactual change in the price of the sovereign debt that would result from a bailout; the equilibrium spread is represented with a solid line instead. Of course, the counterfactual outcome would not be observed in equilibrium as the bailout is never implemented. Nevertheless, this panel gives us a measure of the market "punishment" that prevents a successful bailout. By assumption, the new debt issued to finance a bailout decreases the repayment probability. In this example, the value of the debt decreases between 25% and 55% depending on the initial stock of debt. The higher is the initial stock of debt, the higher is the fall in debt value that a bailout would cause. This fall in value corresponds to the loss in the bank's capital that prevents the injection of resources from having a net benefit.

Finally, in the bottom-right panel of Figure 2, we plot the repayment probability without a bailout as the solid lines and the counterfactual repayment probability should a bailout occur as the dashed lines. An increase in the initial level of debt decreases the probability of repayment. This decrease is linear because of the linear form of (30). A bailout would decrease this probability even further, generating a downward pressure on the debt value documented in the bottom-left panel. Notice that the counterfactual repayment probability is a decreasing function of D_0 – we will contrast this feature of of the model with unbacked debt below when increases in debt are partially backed.

3.3 Increase in Partially Backed Public Debt

We now illustrate the a small modification to the process for government default may lead to different implications for the response of home bias to a change in government debt. Specifically, let the maximum of government revenues in period 2 vary with the initial indebtedness of the government according to the linear rule,

$$T_{max} = \underline{T} + \phi D_0, \tag{29}$$

with $\underline{T}$ and $\phi > 0$ are two constant parameters.

Under this specification of government revenues, the perceived probability of repayment in period 0 satisfies

$$\eta_0(D_0) = \min\left\{\frac{\underline{T} + (\phi - 1)D_0}{\underline{T} + \phi D_0 - T_{min}}, 1\right\} \tag{30}$$

and in period 1 satisfies

$$\eta_1(D_0, D_1) = \min\left\{\frac{\underline{T} + (\phi - 1)D_0 - D_1}{\underline{T} + \phi D_0 - T_{min}}, 1\right\}. \tag{31}$$

We think of this specification as allowing us to examine the effects of an increase in *partially backed* debt, i.e. an increase in debt that is accompanied by an increase in the ability of the government to raise additional revenues. One may also think of increases in partially backed debt as corresponding to a situation where a country is experiencing increased growth which expands the government's fiscal capacity.

With this specification of debt prices, we see that

$$\begin{aligned} q_{1,D_0}(D_0, D_1) &= \frac{1}{\sigma}\eta_{1,D_0}(D_0, D_1) \\ &= \frac{(\bar{T} + \phi D_0 - T_{min})(\phi - 1) - \phi(\bar{T} + \phi D_0 - D_0 - D_1)}{(\bar{T} + \phi D_0 - T_{min})^2}. \end{aligned} \tag{32}$$

The impact of D_0 on the counterfactual repayment probability following a bailout depends critically on the level of the bailout the government pursues, D_1 – specifically at $D_1 = D_1^*(D_0, h)$. If this maximal bailout size D_1^* is sufficient large, or if

$$D_1^*(D_0, h) > \frac{1}{\phi}\bar{T} + \frac{\phi - 1}{\phi}T_{min} \tag{33}$$

then an increase in D_0 can in fact raise this counterfactual repayment probability. As a result, increases in D_0 may reduce the endogenous renegotiation costs associated with a bailout. From our discussion of Corollary 4 then, we should expect an increase in government debt to lead to an increase in home bias. Loosely speaking, in this model of the government's repayment probability, an increase in initial indebtedness raises the period 1 fiscal capacity of the government and therefore improves the government's bailout ability. This improved bailout ability leads banks to acquire more government debt ex ante in an effort to prevent ex post bailouts.

Figure 3 replicates Figure 2 assuming (29) instead of a fixed T_{max} and illustrates the comparative statics of the optimal contract and its implications for various levels of the initial debt of the government and two levels of σ.

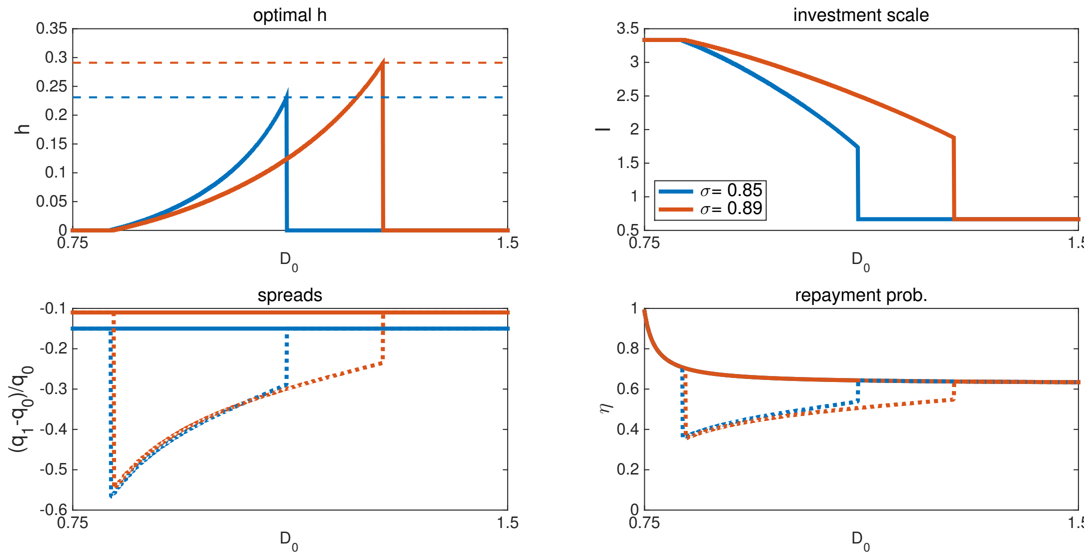


Figure 3: Comparative statics with partially backed debt. Calibration: $p_h = 0.9$, $\rho_1 = 1.3$, $B = 0.2$, $\rho_0 = 1.1$, $\rho_b = 0.5$, $\kappa = \rho_0 - \rho_b + 0.01$, $A = 0.1$, $T_{min} = 0.75$ $\underline{T} = -1.2$ and $\phi = 2/0.75$. The calibration satisfies Assumption 1-4

Our numerical example has been calibrated in such a way that, despite the increase in maximum revenue associated with an increase in debt, an increase in government debt leads to a decrease in the repayment probability. We illustrate this feature of our model in the bottom-right panel of Figure 3 where the solid lines, which represent the government's repayment probability in the absence of a bailout, are decreasing as D_0 increases. The dashed lines in the bottom right panel of Figure 3 show that the counterfactual repayment probability is actually increasing in D_0 which the demonstrates that $q_{1,D_0} > 0$.

The top-left panel of Figure 3 shows the optimal choice of h as a function of the level of initial debt, D_0, for two levels of σ. Similar to Figure 2, home bias is strictly optimal only for intermediate values of D_0. In contrast to the results from the previous section, when D_0 is small, the government is unable to pursue bailouts even when $h = 0$ because T_{max} is initially too close to D_0, i.e. the fiscal capacity of the government is too small relative to the size of the needed bailout when $h = 0$.

For large enough D_0, no home bias is also optimal again either because the government can prevent liquidations via bailouts for all values of h, or because the h required to prevent bailout is above the critical threshold (plotted by the dashed lines in the top right panel of Figure 3).

In the intermediate case, we see that a strictly positive degree of home bias is optimal and an increase in D_0 is associated with an increase in home bias. In particular, the higher is the fiscal capacity of the government, the higher is the home bias needed to effectively deter government intervention.

Therefore, a *partially backed* increase in government debt may smoothly increase home bias for low levels of government debt and causes home bias to jump downwards at a high enough level of government debt. Note from the top right panel of Figure 3 that increases in initial government debt lead to decreases in total bank investment because such increases either cause more resources to be allocated to return-dominated public debt or they cause the bank to switch from a policy of liquidating after bad liquidity shocks to one of continuing after bad liquidity shocks. These effects reduce the return the bank can promise to the lender and therefore reduce the overall size of the bank. Lastly, an increase in government debt leads to a decrease in the probability ex post inefficient liquidation or bank crises.

Similarly to Figure 2, in the bottom-left panel of Figure 3, the dashed line plots the counterfactual change in the price of the government debt that would result from a bailout; the equilibrium spread is represented with a solid line instead. The higher the initial stock of debt, the lower the fall in debt value that would arise from a bailout. This fall in value corresponds to the loss in the bank's capital that prevents the injection of resources from having a net benefit.

3.4 A Decrease in Financial Returns

Here we discuss the impact of an exogenous change in domestic government debt prices. One can interpret this price effect as being driven by a change in the rate of interest earned by the financial agent, which is captured by the parameter σ.

Figures 2 and 3 reveal the effect of a decrease in σ from $\sigma = 0.89$ to $\sigma = 0.85$. on home bias of banks for various levels of initial (totally or partially unbacked, respectively) government debt, D_0. First observe that a reduction in σ causes the region of initial debt levels for which a strictly positive home bias is optimal to shrink. That is, for some levels of initial debt where home bias is optimal for high σ, the decrease in σ leads banks to reduce their home bias to zero. Second, for any level of D_0 such that strictly positive home bias remains optimal, banks increase h in response to a decrease in σ.

Driving these two opposite responses of home bias for different levels of initial government debt are two basic effects of a reduction in σ: i) the reduction increases the ability of the government to enact bailouts by increasing the price of period 1 issues of government debt and ii) the reduction widens the gap between the return on private and public investments. The increased capacity of the government to issue new debt implies that a greater degree of home bias is required to prevent bailouts leading to an increase in the degree of home bias. The increased spread between public and private assets, however, increases the (ex ante) costs associated with investing in public debt leading to an wider region of initial indebtedness for which home bias is not optimal. Figures 2 and 3 show how these two forces interact.

4 Recent Evidence on Banks' Home Bias in Europe

We have shown that an increase in *unbacked* debt causes home bias decreases; in contrast, an increase in *partially backed* debt causes home bias to increase. For both unbacked and partially backed debt, the price of government debt decreases in equilibrium. Therefore, an increase in home bias is compatible with an increase in the risk premium associated with sovereign debt as was observed during the recent crises in the Euro zone.

In this section, we examine the positive predictions of our theory qualitatively. We argue that our model provides a new interpretation of some of the stylized facts relating to banks' home bias during the recent sovereign debt crises in the Eurozone. Of course, our theory is not the only rationale for the evolution of home bias in the Euro area: we view our theory as providing a first step in developing a careful empirical investigation into the causes of home bias. Nonetheless, there are qualitative aspects of the data that, we believe, our theory can help to interpret. We focus on seven countries during the period 2000-2015: Italy, Spain, France, Germany, Portugal, Ireland and Greece.

On the Existence and Increase of Home Bias. *After the introduction of the Euro currency, home bias declined across Europe until 2008 and these declines are uncorrelated with the level of domestic public debt. Beginning in 2008, home bias exhibits a rapid increase in all countries, except in Greece.*

Figure 4, panels (a) and (b) illustrate two measures from the data on banks' home bias which are closest to the portfolio allocation, h in our model. Panel (a) shows banks' holdings of home-country sovereign debt as a fraction of banks' holdings of Euro-denominated debt. Panel (b) shows banks' holdings of home-country sovereign debt as a fraction of total assets. Panel (c) depicts how much of domestic sovereign debt is held by domestic banks while Panel (d) depicts debt-to-GDP ratios across Europe.

In Panel (a), we observe a downward trend in home bias across most of Europe. This trend can be rationalized by the introduction of the Euro in 1998, which eliminated two clear advantages domestic debt had over other Euro-area sovereign debt: i) that domestic debt was not subject to exchange rate risk and so may have had greater collateral value in private exchange, and ii) that debt denominated in domestic currency is assigned a zero risk-weight in calculating capital requirements (as well, domestic debt was eligible collateral for exchange with the domestic central bank). During this period, Figure 4 Panel (d) demonstrates that there was no clear trend in the indebtedness of countries in our sample.

Since 2008 and the beginnings of the European debt crisis, banks' holdings of domestic sovereign debt have increased dramatically across most of Europe. The sharp increase in home bias coincides with the rise in sovereign default risk across Europe as seen in Figure 4 Panel (d). One might have expected banks to further diversify their portfolio holdings of sovereign debt as as sovereign credit risk increased with debt-to-GDP ratios. Instead, the data show sovereign credit markets became more segmented as banks increased home bias.

Our model helps to understand not only the existence of home bias but also its positive co-movement with the level of public debt. In our model, an increase in sovereign debt which is partially backed by an increase in tax revenues induces a smooth increase in home bias. This increase happens even in presence of a an increase in Sovereign default risk as has been widely documented in literature.

The Cases of Greece, Ireland and Spain. *Since 2008, home bias of Greek banks initially rises and then quickly decreases. In contrast to other countries in Europe, Ireland experiencing a large bailout of the financial sector by the domestic government. In Spain the domestic government did not bailout Spanish banks but ultimately these banks received bailout funds from the European Stability Mechanism.*

Our theory predicts that an increase in debt that is unbacked may induce a decrease in home bias rather than an increase. As the Sovereign debt crisis in Greece continued, we observe a large decline in home bias by Greek banks. Panel (b) of Figure 4 illustrates this contrast.

The political economy rationale of home bias might predict the opposite behavior – that is, as Greek default became more likely (or more severe), one should expect the government to induce Greek banks to acquire more Greek debt in an effort to improve the government's position in sovereign debt market. Similar predictions might arise from theories of home bias based on an idea of banks' gambling for redemption – such a theory would predict that home bias should increase when banks are relatively willing to accumulate home-country default risk once their exposure is sufficiently large.

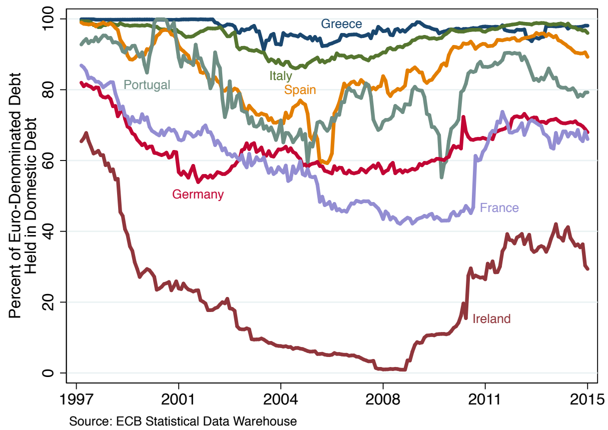
In our model, banks' home bias aligns the lender's private interest in mitigating the moral hazard of the bank with the social desire for policies that strengthen the efficiency of the financial sector and reduces the government risk of default induced by bailouts. In an Economic Union, however, there may be additional bailout authorities besides the domestic Sovereign. Our theory suggests that if an integrated banking system is to minimize both moral hazard of banks and moral hazard of governments (to enact bailouts), these bailout authorities must issue debt.

The recent European crises helps to test the usefulness of home bias as a deterrent to bailouts. Our model suggests that widespread home bias prevented or lowered the frequency of bailouts across much of Europe since 2008. One notable exception, however, is Ireland where the Sovereign was able to sustain a domestic bailout of its banking system for two years, from September 2008 to November 2010. Figure 4 Panel (a) demonstrates that Ireland is an outlier in our sample as its level of home bias is well below 50 percent over the entire period we study.

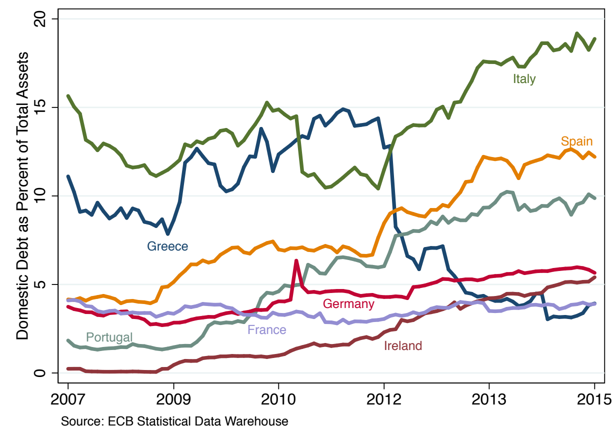
Spain provides an example of a country with an experience very different from Ireland. Large injections to the Spanish financial sector were desired but not implemented by the Spanish government – arguably because in part, Spanish banks featured a high degree of home bias. Instead, bailouts were enacted with the support of various financial stability programs implemented by the Eurosystem.[10] While the Eurosystem has spending capacity, in contrast to domestic Sovereigns, it does not issue debt. Therefore, there was no market mechanism which the financial sector could make use of to impose endogenous renegotiation costs on the Eurosystem and prevent these bailouts.

In particular, we argue for a broader conclusion from the normative implications of our model. We argue that the inability of the Eurosystem to sustain commitments to not bailout the financial sectors of member countries could increase moral hazard in Europe and decrease the long-run efficiency of these financial sectors. Recently, policymakers have investigated the creation of Eurobonds. Surprisingly, our theory predicts that banks in the Eurozone may seek to purchase these Eurobonds because then these banks may be able to effectively prevent European bailouts through market discipline. Our theory suggests that member countries' banks may have strong incentives to acquire these Eurobonds to strengthen ex ante corporate governance within the financial system. Thus, the creation of Eurobonds may improve ex ante efficiency of the financial sector, but might actually make the European financial system appear to be *less* resilient to future adverse financial shocks by limiting the potential scope for ex post interventions.

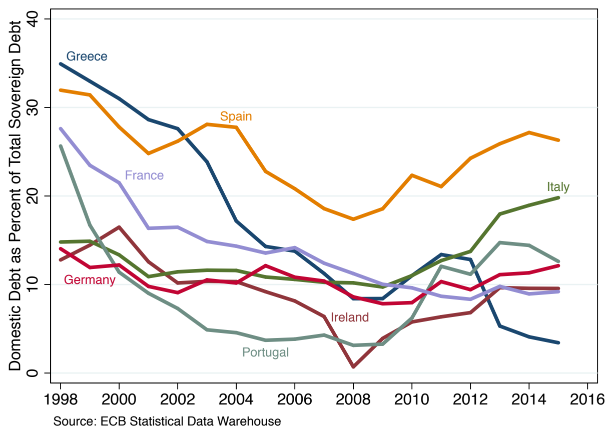
[10]Specifically, Spain received support from the European Financial Stability Facility (EFSF), the European Stability Mechanism (ESM), and the and European Financial Stabilisation Mechanism (EFSM).



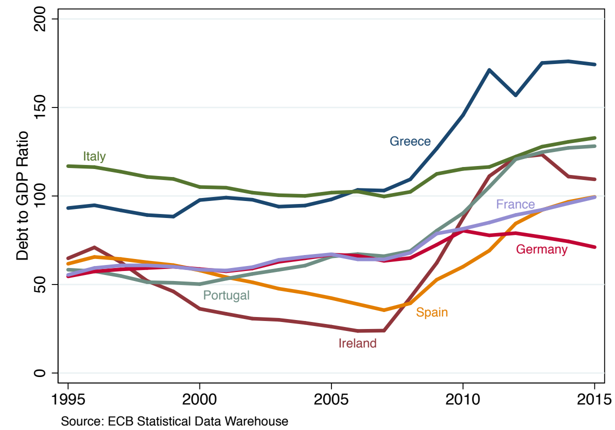
(a)



(b)



(c)



(d)

Figure 4: a) European Banks' Home Bias, measured as the ratio of domestic sovereign debt relative to all euro-denominated sovereign debt held by domestic banks; b) Banks holding of domestic sovereign vs banks total assets (2007-2014); c) Banks holdings of domestic sovereign vs total sovereign debt; d) European Public Debt vs GDP.

5 Conclusion

We have developed a theory in which domestic banks have private incentives to acquire domestic sovereign debt in favor of foreign sovereign debt or other productive, private investments resembling a home bias for domestic sovereign debt. We have shown that banks' home bias is not only privately valuable but is socially valuable as well. Our theory helps shed light on banks home bias through Europe over the period 2000-2015 and provides a natural starting point for an empirical investigation into the tradeoffs involved with banks' home bias.

References

Acharya, V. V., I. Drechsler, and P. Schnabl (2014): "A Pyrrhic Victory? - Bank Bailouts and Sovereign Credit Risk," *The Journal of Finance*, 69, 2689–2739. 4

Acharya, V. V. and S. Steffen (2013): "The "Greatest" Carry Trade Ever? Understanding Eurozone Bank Risks," CEPR Discussion Papers 9432, C.E.P.R. Discussion Papers. 5

Asonuma, T., S. Bakhache, and H. Hesse (2015): "Is Banks' Home Bias Good or Bad for Public Debt Sustainability?" IMF Working Papers 15/44, International Monetary Fund. 2

Battistini, N., M. Pagano, and S. Simonelli (2013): "Systemic Risk and Home Bias in the Euro Area," European Economy - Economic Papers 494, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission. 4

Broner, F., A. Erce, A. Martin, and J. Ventura (2014): "Sovereign debt markets in turbulent times: Creditor discrimination and crowding-out effects," *Journal of Monetary Economics*, 61, 114–142. 2

Calomiris, C. W. and C. M. Kahn (1991): "The Role of Demandable Debt in Structuring Optimal Banking Arrangements," *American Economic Review*, 81, 497–513. 3

Chari, V., A. Dovis, and P. J. Kehoe (2014): "On the Optimality of Financial Repression," *unpublished*. 3

Chari, V. and P. J. Kehoe (2013): "Bailouts, Time Inconsistency, and Optimal Regulation," NBER Working Papers 19192, National Bureau of Economic Research, Inc. 3

Diamond, D. and R. Rajan (2001): "Liquidity risk, liquidity creation, and financial fragility: A theory of banking," *Journal of Political Economy*, 109, 287–327. 3

Diamond, D. W. and P. H. Dybvig (1983): "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy*, 91, 401–19. 11

Gennaioli, N., A. Martin, and S. Rossi (2014): "Sovereign Default, Domestic Banks, and Financial Institutions," *Journal of Finance*, 69, 819–866. 4

Gilchrist, S. and B. Mojon (2014): "Credit Risk in the Euro Area," NBER Working Papers 20041, National Bureau of Economic Research, Inc. 4

Holmstrom, B. and J. Tirole (1998): "Private and Public Supply of Liquidity," *Journal of Political Economy*, 106, 1–40. 2, 5, 7, 9, 11

Committee on the Global Financial System (2011): "The impact of sovereign credit risk on bank funding conditions," *CGFS Papers*, 2011. 5

European Systemic Risk Board (2015): "Report on the regulatory treatment of sovereign exposures," March 2015. 5

Uhlig, H. (2013): "Sovereign Default Risk and Banks in a Monetary Union," NBER Working Papers 19343, National Bureau of Economic Research, Inc. 3

Zetlin-Jones, A. (2014): "Efficient Financial Crises," *unpublished*. 7

Appendix

Proof of Proposition 2

Proof. The objective of the proof is to show that $G_h(0,\bar{D}_0) < 0$ where $\bar{D}_0$ is defined by $G(0,\bar{D}_0) = 0$. In other words, we need to show that the bailout capacity of the government decreases with home bias exactly at the point where, in absence of home bias, the resources of the government are just sufficient to bailout the bank. This condition together with $G_{D_0}(0,\bar{D}_0) \neq 0$ implies by continuity the existence of an optimal $h > 0$.

The G function is given by

$$G(h,\bar{D}_0) = h\hat{I}(h)\frac{q_1(D_0, D_1^*(D_0,0))}{q_0(D_0)} + (1-h)\hat{I}(h)(\rho_0 - \rho_b - \kappa) + q_1(D_0, D_1^*(D_0,0))D_1^*(D_0,0) - h\frac{q_1(D_0,0)}{q_0(D_0)}\hat{I}(h),$$

where

$$\hat{I}(h) = \frac{A}{1 - hR^s - (1-h)(\rho_h\rho_1 - B)},$$

is the scale of the investment with liquidation after a bad liquidity shock. Note that we maintain the notation R^s for the ex-ante rationally expected return of public investment in case of a credible commitment.

The strategy for the proof is to separately look at the derivative of each component of the G function with respect to h and then check the sign of the overall variation.

For future reference, it is useful to establish two preliminary results. The first result concerns the derivative of the scale of the investment $\hat{I}$ with respect to h:

$$\hat{I}_h(0) = A\frac{B - \rho_1\rho_h + R^s}{\left(1 - hR^s - (1-h)(\rho_h\rho_1 - B)\right)^2} < 0,$$

and in particular,

$$\hat{I}_h(0) - \hat{I}\,(0) = \hat{I}\,(0)\left(\frac{R^s - 1}{1 - (\rho_h\rho_1 - B)}\right) < 0. \tag{34}$$

The above inequality means that introducing sovereign debt in the capital reduces the scale of investment when its return is lower than that of the private asset. The second preliminary result relates the maximal bailout $D_1^*\,(D_0,h)$ which is given by

$$q_{1,D_1}(D_0, D_1^*(D_0,0))\left(\frac{h\hat{I}(h)}{q_0(D_0)} + D_1^*\,(D_0,h)\right) + q_1(D_0, D_1^*(D_0,0)) = 0,$$

that is,

$$D_1^*\left(D_0,h\right)=-\frac{q_1(D_0,D_1^*(D_0,0))}{q_{1,D_1}(D_0,D_1^*(D_0,0))}-h\frac{\hat{I}(h)}{q_0(D_0)}.$$

Now we are ready to look at the four terms that determine the sign of G_h: first,

$$\begin{aligned}
&\frac{\partial\left(hI(h)\frac{q_1(D_0,D_1^*(D_0,h))}{q_0(D_0)}\right)}{\partial h}|_{h=0}=\\
&=\frac{q_1(D_0,D_1^*(D_0,h))}{q_0(D_0)}(h\hat{I}_h(h)+\hat{I}(h))|_{h=0}+q_{1,D_1}D_{1,h}^*\frac{h\hat{I}(h)}{q_0(D_0)}|_{h=0}=\\
&=\frac{q_1(D_0,D_1^*(D_0,0))}{q_0(D_0)}\hat{I}\left(0\right)>0;
\end{aligned}$$

second,

$$\begin{aligned}
&\frac{\partial\left(\left(1-h\right)\hat{I}(h)(\rho_0-\rho_b-\kappa)\right)}{\partial h}|_{h=0}=\left(\left(1-h\right)\hat{I}_h(h)-\hat{I}(h)\right)(\rho_0-\rho_b-\kappa)|_{h=0}=\\
&=\hat{I}\left(0\right)\left(\frac{R^s-1}{1-(\rho_h\rho_1-B)}\right)(\rho_0-\rho_b-\kappa)>0;
\end{aligned}$$

third,

$$\begin{aligned}
\frac{\partial\left(q_1(D_0,D_1^*(D_0,h))D_1^*(D_0,h)\right)}{\partial h}|_{h=0} &= q_1D_{1,h}^*|_{h=0}+q_{1,D_1}D_{1,h}^*D_1^*|_{h=0}=\\
&= D_{1,h}^*\left(q_1+q_{1,D_1}\left(-\frac{q_1}{q_{1,D_1}}\right)\right)=0;
\end{aligned}$$

and fourth,

$$\frac{\partial\left(-h\frac{q_1(D_0,0)}{q_0(D_0)}\hat{I}\left(h\right)\right)}{\partial h}|_{h=0}=-(h\hat{I}_h(h)+\hat{I}(h))\frac{q_1(D_0,0)}{q_0(D_0)}|_{h=0}=-\hat{I}\left(0\right)\frac{q_1(D_0,0)}{q_0(D_0)}<0.$$

Therefore the final condition on the overall variation is:

$$\left(\frac{q_1(D_0,D_1^*(D_0,0))}{q_0(D_0)}-\frac{q_1(D_0,0)}{q_0(D_0)}+\frac{(R^s-1)\left(\rho_0-\rho_b-\kappa\right)}{1-(\rho_h\rho_1-B)}\right)\hat{I}\left(0\right)<0.$$

□