

# Sovereign Debt Default and Debt Ownership: Domestic Debt as a Commitment Device for Debt Repayment

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## Abstract

Major developed countries have experienced a significant run-up in public debt after the onset of the global financial crisis in 2008. However, the impact on sovereign debt ownership varies across countries. Specifically, the share of debt held by domestic banks has increased in GIIPS countries but declined in non-GIIPS countries. I explain the cross-country differences in debt ownership using a dynamic equilibrium model with strategic and non-discriminatory defaults, in which sovereign debt can serve as collateral for expanding private investments. The key insight is that the share of debt held domestically is positively correlated with the government's incentive to default. Consequently, the model predicts that the share of domestically-held debt is strictly increasing in total debt only in highly-indebted countries whose debts have low collateral value. The key policy implication is that changes in debt ownership are important indicators for the optimality of public debt level. Using data from a panel of 11 countries between 2007 and 2014, I find evidence consistent with these predictions.

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<sup>†</sup>The most recent version of this paper is available at [this link](#).

# 1 Introduction

It has long been recognized that changes in sovereign debt ownership have important implications for the real economy. For example, [Diamond \(1965\)](#) argues that, when domestically-held debts and capital are perfect substitutes, domestic debt issuance reduces investment through crowding out capital accumulation; while externally-held debts affect the real interest rate via its effects on the share of income transferred abroad. Less clear is how sovereign debt ownership is determined, and how it should change in response to changes in government borrowing. In the wake of the recent global financial crisis, during which stabilization policies adopted by the governments in major developed countries have led to a rapid and significant increase in public debts, these questions are particularly relevant.

Specifically, shares of sovereign debt held by domestic banks steadily declined over the past decade in major developed countries.<sup>1</sup> This trend changed after the onset of the global financial crisis in 2008. As illustrated by figure 1, sovereign debts issued by peripheral countries in the Euro Area, such as Greece, Italy, Ireland, Portugal, and Spain (the “GIIPS”), were increasingly held by their domestic banking sectors, but the opposite was observed for non-GIIPS countries.<sup>2</sup> Recent literature has focused on the former. For instance, [Becker and Ivashina \(2014\)](#) provide empirical evidence that GIIPS governments pressured domestic banks to purchase their debts through financial repression. [Farhi and Tirole \(2014\)](#) argue that domestic banks in the GIIPS countries optimally diversify as little as possible when they can count on government bailouts. However, few have paid attention, at the same time, to the continually declining shares of domestic debt in the non-GIIPS countries. Given that both GIIPS and non-GIIPS countries have experienced a significant run-up in public debt issuance during the same period, how could one explain the cross-country differences in debt ownership in a unified framework?

The paper answers this question by using a modified dynamic equilibrium model of

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<sup>1</sup>See, for example, [Abbas et al. \(2014\)](#) and [Reinhart and Rogoff \(2011\)](#).

<sup>2</sup>Non-GIIPS countries include Belgium, Finland, France, Germany, Netherlands, the United Kingdom, and the United States. Data are obtained from [Merler and Pisani-Ferry \(2012\)](#).

[Bolton and Jeanne \(2011\)](#) to allow for strategic and non-discriminatory defaults and endogenous debt ownership. In the model, both domestic banks and foreign investors hold sovereign debts because these debts can serve as collateral for private debts, which can then be used to expand their private investments. Returns on private investments are subject to a productivity shock. Debt ownership affects the government’s incentive to default because debt repayment to foreign investors is an *ex-post* loss of resources from the perspective of the domestic country, but, at the same time, default would destroy productive collateral for domestic banks and incur a direct output loss.<sup>3</sup> Therefore, the welfare maximizing debt ownership depends on the trade-off between these two opposing incentives. The paper first analyzes, for an exogenous amount of public debt, the equilibrium default policy, and debt ownership. It also derives the conditions under which the equilibrium share of public debt held by domestic banks is increasing in total debts. Then, it characterizes the optimal level of public debt and the corresponding equilibrium debt ownership. Finally, using data from a panel of 11 countries between 2007 and 2013, the paper presents empirical evidence consistent with these theoretical results.

The contributions of this paper are both theoretical and empirical. Theoretically, I develop a new argument for “financial repression”, i.e. formal or informal pressure from the government placed on the domestic banking sector to absorb sovereign debts, as suggested empirically by [Becker and Ivashina \(2014\)](#). In particular, I argue that domestic debt is a commitment device for debt repayment, so the share of debt held by domestic banks is positively correlated with the government’s incentive to default. The key variables that affect this incentive are: 1) the collateral value of government debt and 2) the level of government debt. Because collateral values vary across countries, they could, therefore, explain the cross-country differences in debt ownership, despite the fact that the governments in GIIPS and non-GIIPS countries have both significantly expanded their borrowing after the global financial crisis. This paper also has an important policy implication. Specifically, I argue

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<sup>3</sup>Such direct output loss in default is exogenous, in the spirit of [Arellano and Ramanarayanan \(2012\)](#) and [Arellano \(2008\)](#). See section 3 for more in-depth discussion.

that the government should pay close attention to changes in debt ownership as it conducts fiscal policy, because my welfare analysis of the model shows that changes in debt ownership are key indicators for the optimality of public debt level.

There are three main theoretical results. First, the share of domestic debt in equilibrium is strictly increasing in total debt only in highly-indebted countries whose debts have low collateral value.<sup>4</sup> Because sovereign debts in these countries are less productive, defaults become more desirable as their levels of total debt increase. Therefore, if these countries want to raise their debt capacities to finance increasing deficits, a larger fraction of newly issued debts must be held by the domestic banking sector, or otherwise their incentives to default are greater than those expected by the foreign investors, who would then refuse to lend.<sup>5</sup> In contrast, sovereign debts are more productive in moderately-indebted countries whose debts have high collateral value. When these countries borrow more, their incentives to default, in fact, decrease, because doing so would destroy valuable collateral for private investments. For these countries, the equilibrium share of domestic debt is strictly decreasing in total debt.

Second, the equilibrium probability of default is more sensitive to an increase in total debt if the collateral value of sovereign debt is lower. In equilibrium, the default probability is the ratio of debt-repayments to foreign investors to net-loss of investment output when there is default. For countries whose debts have lower collateral value, their loss of investment output is smaller when they default on their debts. I show that, not only their incentives to default are higher, they are also more sensitive to changes in fiscal conditions. Therefore, in response to the same increase in total debt, even though only a smaller fraction of newly

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<sup>4</sup>While I assume the collateral values of sovereign debt are exogenous, one can think of countries with similar debt levels as having different expected deficits and thus different default probabilities. A version of the model in which the collateral value is endogenized as a decreasing function of debt (with different sensitivities) yields similar qualitative results.

<sup>5</sup>It is not possible, in equilibrium, to force the domestic banks to absorb *all* sovereign debts in *arbitrary* amount. Assume a fixed level of deficit. If all debts are held by domestic banks, they would expect the government to repay with probability one because repayment of debt expands domestic investment and involves no transfer of resources to foreign investors. This effectively pins down the price of debt and, therefore, a unique debt level. In fact, it is the lower bound of the government's debt capacity.

issued debts are held by foreign investors, their probabilities of default still increase by relatively more.

Third, if the share of domestic debt is increasing in total debt, the level of total debt is suboptimally excessive. As government borrowing increases, newly issued public debts are held, in equilibrium, by both domestic banks and foreign investors. The optimal level of government borrowing depends on the trade-offs, in states where there is no default, between a declining expected marginal contribution of sovereign debt to private investment for domestic banks and increasing debt-repayments to foreign investors. I show that when debts are “moving back” home, as observed in the GIIPS countries, this is an indicator that the later effect dominates, and the governments should reduce borrowing.

The existing empirical literature that studies the relationship between debt supply and sovereign default risk focuses on *total* debt supply.<sup>6</sup> My theoretical results suggest that total debt supply should be used in conjunction with data on debt ownership to assess sovereign default risk. For each country in my sample between 2007 and 2014, I construct a proxy for the collateral value of sovereign debt, which, according to the model, should be observationally equivalent to the ratio of private debt issued by domestic banks to their holdings of domestic sovereign debt. This proxy is strongly and significantly correlated with the *strength of legal rights index* from the World Bank’s World Development Indicators, suggesting that it could capture some important aspects regarding the quality of institutions.<sup>7</sup> Using this proxy, I then provide the first evidence that the collateral value of sovereign debt is a key determinant of debt ownership.

There are three main empirical results. First, consistent with the model, I show that sovereign debt issued by GIIPS countries, on average, does have significantly lower collateral value than that issued by non-GIIPS countries. Second, results from instrumental variable (IV) regressions of the share of domestically-held debt and default risk on total debt and

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<sup>6</sup>See, for example, [Aizenman et al. \(2013\)](#).

<sup>7</sup>The strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending.

collateral value suggest that debt ownership and default risk are, indeed, more sensitive to changes in total debt if the collateral value of debt is lower. The 5-Year CDS spread is used as a proxy for default risk. The instrumental variable approach is used to mitigate the empirical problem that the proxy for collateral value is endogenous. The strength of legal rights index is used as an instrument for my proxy for collateral value.

Third, using 5-Year CDS spreads as a proxy, I show with strong statistical significance that a country’s default risk increases with externally-held debts but decreases with domestically-held debts. The externally-held component of total debt-to-GDP ratio, in fact, have more predictive power on 5-Year CDS spreads than total debt-to-GDP ratio. Again, the instrumental variable approach is used because debt ownership is endogenous in my model. The result is consistent with my theory, which argues that changes in externally-held and domestically-held debt have opposite impacts on the government’s incentive to default.

I argue that the empirical results distinguishes this paper from the “risk-shifting” explanation to changes in debt ownership in the GIIPS countries. For example, [Farhi and Tirole \(2014\)](#) argues that due to the convex payoff structure of equity, increasing holding of risky sovereign debts could be particularly attractive to domestic banks during a sovereign debt crisis. This explanation suggests that domestically-held debt should be positively correlated with default risk. Indeed, the regression coefficient is positive when default risk is directly regressed on domestically-held debt. According to my theory, however, this is not the correct approach because of omitted-variable bias. Both default risk and domestically-held debt are negatively correlated with the collateral value of sovereign debt. This implies that, without using instrumental variables, the regression coefficient on domestically-held debts suffers an upward bias. My result shows that the regression coefficient is negative after this omitted-variable bias is corrected.

The remainder of the paper is organized as follows. Section [2](#) reviews literature. Section [3](#) describes the model set-up. Section [4](#) derives equilibrium debt-ownership, default probability, and the optimal level of total debt. Their implications are then discussed. Section [5](#)

presents empirical evidence consistent with theoretical results. Section 6 concludes.

## 2 Relation to Literature

This paper’s main concern is the increasing share of public debt held by domestic banks during turbulent times as, for example, [Broner et al. \(2014\)](#). They emphasize the role of creditor discrimination, whereas this paper focuses on the non-discriminatory default. [Broner et al. \(2010\)](#) also assume non-discriminatory default. Their model, however, do not allow for default in equilibrium, whereas the default probability is endogenously dependent on realized shocks in this paper. [Farhi and Tirole \(2014\)](#), [Uhlig \(2013\)](#), [Crosignani \(2014\)](#), and [Drechsler et al. \(2013\)](#) focus on risk-shifting and moral hazard, while this paper focuses on role of domestic debt as a commitment device for debt sustainability, an argument also used by the contemporaneous work of [Chari et al. \(2015\)](#). [Chari et al. \(2015\)](#) focuses on the optimality of financial repression. They show that the government finds it optimal to force domestic bankers to hold government debt when its expenditure is unusually high. In contrast, this paper focuses on explaining the cross-country differences in debt ownership in response to exogenous changes in the level of total debt.

This paper also relates to debt sustainability and foreign borrowing. [Mengus \(2014\)](#) argues that, if domestically-held sovereign debts are imperfectly observed, government bailout of domestic banks does not affects its ability to borrow. In his model, default is either certain, not allowed, or sunspot. This paper, on the other hand, focuses on debt ownership when the collateral value and the total level of sovereign debt differs, and the default probability is always dependent on fundamentals. [Guembel and Sussman \(2009\)](#) developed a political theory that suggests repayment of externally-held debts is optimal when the interest of the median voter are aligned more with the foreign creditors than with the poor domestic tax payers. This paper, instead, emphasizes the role of sovereign debts as productive collateral as a deterrent for defaults, with positive default probability in equilibrium. [Bolton and Jeanne](#)

(2011) study the relative total supplies of government debt between risky and safe countries when their economies are financially integrated. They assume an exogenous probability of default and a symmetric equilibrium where domestically- and externally-held sovereign debts are always equal. This paper employs a modified version of their model to study the relationship between sovereign default and debt ownership. Therefore, different from Bolton and Jeanne (2011), both probability of default and debt ownership are endogenous in this paper.

Additionally, this paper contributes to the growing literature about the relationship between sovereign debt supply and interest-rate spreads, for example, Krishnamurthy and Vissing-Jorgensen (2012), Fontana and Scheicher (2010), and Cecchetti et al. (2010). These literatures focus on total debt supply as an explanatory variable for interest-rate spreads that measures default risk. This paper argues and demonstrates from an empirical standpoint that it is important to distinguish domestically- and externally-held debts, because their effects on government's incentive to default are opposite.

### 3 Model

Consider a three-period model of a small open economy. This economy is populated by a benevolent government and domestic bankers. The rest of the world consists of foreign investors. All variables without subscripts belong to domestic bankers throughout the paper. Whenever needed, the subscripts “D” (“F”) represent domestic bankers (foreign investors), which shall be described below. There is a private, homogenous, and non-storable consumption good. Time is divided into three periods,  $t = 0, 1, 2$ .

#### 3.1 Domestic Bankers

There is a continuum measure one of domestic bankers, of which a fraction  $w \in [0, 1]$  are productive. Productive bankers have access to an investment technology  $f(\cdot)$  at  $t = 1$ , where  $f(\cdot)$  is strictly increasing and concave with  $f(0) = 0$ . Bankers are *ex-ante* identical at  $t = 0$ ,



and their types will only be revealed at  $t = 1$ .<sup>8</sup>

Returns on investment are subject to a non-negative productivity shock,  $\tilde{A} \geq 0$ , which has a differentiable cumulative distribution function (CDF),  $\Pi : [0, \infty) \rightarrow [0, 1]$ , and probability density function,  $\pi : [0, \infty) \rightarrow \mathbb{R}$ . The productivity shock,  $\tilde{A}$ , is realized at  $t = 1$  before any investment decision is made. An investment of  $I$  at  $t = 1$  yields a (net) return of  $\tilde{A}f(I) \geq 0$  at  $t = 2$ , but  $I$  is constrained by the amount of private deposits  $d$  that productive bankers can raise from non-productive bankers.

Specifically, let  $b_D$  be the amount of domestic debts (in face value) held by domestic bankers. The amount of private deposits  $d$  to be raised, after government default and the productivity shock is observed, is limited by the market value of sovereign debts held at  $t = 1$ , i.e.:

$$d \leq \lambda p_1 b_D \tag{1}$$

where  $\lambda \geq 0$  represents the *collateral* value of sovereign debt issued, and  $p_1$  is its price at  $t = 1$ .<sup>9</sup> In other words, productive bankers have to offer their existing holding of sovereign debts as collateral and receive deposits from non-productive bankers in exchange. Assume, without loss of generality, that there is no partial recovery. Sovereign debts at  $t = 1$  are traded among non-productive bankers at equilibrium price  $p_1$  that equals one when there is no default, and zero otherwise. Investment returns are non-negative and strictly increasing in  $I$ , so the above inequality is always binding in equilibrium.

The collateral value of sovereign debt,  $\lambda$ , is the key friction in the model because it imposes limits on the maximum amount of investments  $I$ . Perhaps, more importantly, it

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<sup>8</sup>Non-productive Bankers plays no significant role in the model, except to supply fund to those who are productive. This assumption is reasonable to the extent that the distribution of sovereign debts within the domestic banking sector is not the focus of this paper. My model implies all bankers holds the same amount of public debt at  $t = 1$  before private debts are issued.

<sup>9</sup>Alternatively, because the productivity shock is realized before private debts are issued, one could also assume that productive bankers can use output at  $t = 2$  as collateral, i.e.  $d \leq \theta \tilde{A}f(I) + \lambda p_1 b_D$ , for some  $\theta \in [0, 1]$ . When  $f(\cdot)$  is piece-wise linear, which shall be assumed, this increases the equilibrium investment by a factor of  $1/(1 - \theta \tilde{A})$ . But the qualitative conclusion remains unchanged. Hence, I assume  $\theta = 0$  for simplicity.

induces a downward-sloping demand curve for sovereign debts and acts as the key driver for equilibrium debt ownership.  $\lambda$  can be interpreted as follows. First, along the lines of [Holmström and Tirole \(1993\)](#), it represents the degree to which public debt provides liquidity to expand firms' ability to invest. Or, in [Barro \(1974\)](#)'s term, sovereign debts is a net-wealth to the bankers so long as it is more efficient than private debts in intertemporal transfers. Second,  $\lambda$  is also positively related to the “money-like” component of sovereign debt prices that is not accounted for by standard asset pricing models, as suggested by [Krishnamurthy and Vissing-Jorgensen \(2012\)](#) and [Greenwood et al. \(2015\)](#). Based on these interpretations, it is reasonable to assume  $\lambda$  is large for non-GIIPS countries such as Germany and the U.S., and  $\lambda$  is small for countries at greater risk of sovereign default, such as the GIIPS countries.<sup>10</sup>

Both types of domestic bankers receive an initial endowment  $y_t > 0$  at both  $t = 0$  and  $t = 1$ . They are risk-neutral and make portfolio and investment decisions so as to maximize their expected utility  $U(c_0, c_1, c_2) = c_0 + c_1 + c_2$ , where  $c_t \geq 0$  is their consumption at date  $t$ . I assume they are price takers and also take as given total debt issued and the probability of default. The asset market opens only once at  $t = 0$ , where domestic bankers and foreign investors trade sovereign debts at  $p_0$ . At  $t = 1$ , after the productivity shock  $\tilde{A}$  and their types (i.e. whether they have access to investment technology) are realized, and the government default decision is made, productive bankers maximize their investments, according to inequality (1), by obtaining private debts from non-productive bankers backed by their holding of sovereign debts purchased at  $t = 0$ .<sup>11</sup> If there is no default, the utility of

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<sup>10</sup>The parameter  $\lambda$  is exogenous and independent of endogenous variables of interest, such as total debts and the probability of default. This could seem to be at odds with empirical evidence. For example, [Krishnamurthy and Vissing-Jorgensen \(2012\)](#) present evidence that the “money-like” (or simply non-default) component of U.S. Treasury yields is declining in total debt supply. Hence, alternatively, one could specify  $\lambda$  as a decreasing function of total debts. All that matters, however, is the existence of some exogenous differences (say, for example, quality of institutions) between countries with different  $\lambda$ .

<sup>11</sup>If domestic bankers can trade among themselves after their types are realized at  $t = 1$ , productive bankers would purchase all sovereign debts from non-productive bankers at  $p_1 = 1$ , so their holdings increase from  $b_D$  to  $b_D/(1 - w)$ . But this has no qualitative impact on the results.

a representative banker at  $t = 1$  and  $t = 2$  is

$$U_{\text{No Default}} = y_1 + b_D - T + w \underbrace{\tilde{A}f(y_1 + \lambda b_D)}_{I_{\text{No Default}}} \quad (2)$$

where  $T$  is the amount of lump-sum tax levied by the (domestic) government to pay off its debts. If there is default, the corresponding utility is

$$U_{\text{Default}} = (1 - c)y_1 + w \underbrace{\tilde{A}f((1 - c)y_1)}_{I_{\text{Default}}} \quad (3)$$

where  $c \in [0, 1]$  represents an exogenous domestic cost of default.<sup>1213</sup> This cost is introduced to make sure that default is more costly as income  $y_1$  increases, consistent with [Mendoza and Yue \(2012\)](#) and [Arellano and Ramanarayanan \(2012\)](#). In other words, I assume that  $c$  is chosen such that  $\frac{\partial}{\partial y_1}(f(y_1 + \lambda b_D) - f((1 - c)y_1)) > 0$  for all  $b_D \geq 0$ . At  $t = 0$ , the representative bank optimizes its portfolio by investing in domestic debts ( $b_D$ ), i.e.

$$\begin{aligned} \max_{b_D} U = \max_{b_D} y_0 - p_0 b_D \\ + (1 - \Pi(a^*))E[U_{\text{No Default}}|\tilde{A} > a^*] + \Pi(a^*)E[U_{\text{Default}}|\tilde{A} < a^*] \end{aligned} \quad (4)$$

where  $p_0$  is the price of sovereign debt at  $t = 0$ , and  $a^*$  is determined by the government default policy, which shall be explained below.

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<sup>12</sup>The sources of domestic cost include: 1) capital market exclusion (e.g. [Aguiar and Gopinath \(2006\)](#) and [Arellano and Heathcote \(2010\)](#)), 2) increasing cost of borrowing (e.g. [Sturzenegger and Zettelmeyer \(2007\)](#)), 3) economic sanctions (e.g. [Mitchener and Weidenmier \(2010\)](#)), 4) declining international trade (e.g. [Arteta and Hale \(2008\)](#) and [Rose \(2005\)](#)), and 5) declining productivity ([Mendoza and Yue \(2012\)](#)).

<sup>13</sup>See [Panizza et al. \(2009\)](#) for an excellent literature review. Alternatively, there are also empirical evidence about the non-linear (negative) effects of the level of debts on output growth. For example, [Reinhart and Rogoff \(2010\)](#) suggest that, below a certain threshold, the level of debts has little correlation with output growth. Once a certain threshold is passed, however, the level of debts and output growth are increasingly negative correlated.

## 3.2 Government

At  $t = 0$ , the government needs to finance an exogenous amount  $g$  of deficits by issuing debts of amount  $T$  (in face value) to both domestic bankers and foreign investors at the same market price,  $p_0$ . Then, after the productivity shock  $\tilde{A}$  is realized at  $t = 1$ , the government decides whether to default on its debts. It makes the default decision to maximize the welfare of domestic bankers. If the government decides not to default, it pays off its debts by levying a lump-sum tax of  $T$  on domestic bankers at  $t = 2$ . If the government defaults, it has to default on both domestic bankers and foreign investors. In other words, default is non-discriminatory.<sup>14</sup>

## 3.3 Foreign Investors

Foreign investors are risk neutral with preferences, endowments, and investment technology identical to the representative domestic banker. Assume that their investment returns are subject to the same productivity shock,  $\tilde{A}$ . Foreign investors can also purchase domestic debts at  $p_0$ , the same market price offered to the domestic bankers. Let  $b_F$  be the amount of domestic debt held by foreign investors. There is no foreign government.

# 4 Equilibrium

## 4.1 Government Default Policy

At  $t = 1$ , the government defaults if and only if  $U_{\text{Default}} \geq U_{\text{No Default}}$ , which leads to the following proposition.

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<sup>14</sup>The same assumption is made by [Farhi and Tirole \(2014\)](#) and [Gennaioli et al. \(2014\)](#). [Brutti \(2011\)](#) points out that this assumption hinges on both the anonymity and the increasing integration of secondary markets for sovereign debts, which is consistent with the large haircuts suffered by domestic financial institutions during the recent European sovereign debt crisis. [Broner et al. \(2010\)](#) argues that existence of functional secondary markets makes discriminatory defaults very difficult. Foreign creditors anticipate the opportunistic behaviors of the government, and therefore sell their debts in the secondary markets to domestic creditors when default is likely.

**Proposition 1.** *The default policy for the domestic government can be characterized by a threshold rule. Then, the government defaults if and only if*

$$\tilde{A} \leq a^* \equiv \frac{T - b_D - cy_1}{w(f(y_1 + \lambda b_D) - f((1 - c)y_1))} \quad (5)$$

*In other words, default happens if and only if the realized productivity shock,  $\tilde{A}$ , is sufficiently low. This threshold  $a^*$  is monotonically decreasing in: 1)  $b_D$ , the amount of debt held domestically, 2)  $\lambda$ , the collateral value of domestic sovereign debts, 3)  $c$ , the domestic cost of default.*

**Proof.** See Appendix [A.1](#).

This proposition characterizes the government default policy as a threshold rule. In particular, the government defaults at  $t = 1$  if and only if the realized productivity shock  $\tilde{A}$  falls below  $a^*$ .

The default threshold,  $a^*$ , is given by the default incentive for domestic government per unit of default dis-incentive. In the numerator,  $T - b_D$ , is the debt-repayment to foreign investors, which is an *ex-post* resource loss from the perspective of domestic bankers. The denominator represents the net-loss in investment output when there is default. Domestically-held debts,  $b_D$ , can be interpreted as a commitment device for government to repay its debts. To see this, consider a case where all debts are held by foreign investors, and the domestic cost of default  $c$  is zero. This implies that the denominator of equation (5) equal zero, or  $a^*$  equals infinity. As shown by figure [2](#), the government always defaults, so no level of debt is sustainable. Therefore, some debts must be held domestically in any equilibrium.

The government has little incentive to default when: 1) these debts are valuable in terms of expanding investments, i.e.  $\lambda$  is large, 2) most debts are held by domestic bankers, i.e.  $b_D$  is large, and/or 3) the domestic cost of default  $c$  is high. As we shall see, in equilibrium,  $T - b_D$  is the amount of sovereign debts held by foreign investors. The key insight in equation (5) is the asymmetric impact between domestically-held debts and externally-held debts on

the government's incentive to default.

**Prediction 1.** *The government's incentive to default increases with externally-held debts but decreases with domestically-held debts.*

## 4.2 Portfolio Choices and Investments of Domestic Bankers

At  $t = 0$ , domestic bankers take as given: 1) the government's default policy  $a^*$ , 2) the price of government debt,  $p_0$ , 3) total debt issued,  $T$ , and maximize their utility by choosing their own debt holding,  $b_D$ , according to equation (4). The FOC implies

$$p_0 = (1 - \Pi(a^*)) (1 + w\lambda_R E[\tilde{A} | \tilde{A} > a^*] f'_{\text{No Default}}) \quad (6)$$

where  $f'_{\text{No Default}} = f'(y_1 + \lambda b_D)$ . The price of domestic (risky) debt,  $p_0$ , equals its expected payoff. If the realized productivity shock  $\tilde{A}$  is above  $a^*$ , the government repays its debt. This happens with probability  $1 - \Pi(a^*)$ . There is also a non-default (or liquidity) component,  $w\lambda E[\tilde{A} | \tilde{A} > a^*] f'_{\text{No Default}}$ , because domestic debts can serve as collateral to obtain private loans for expanding investments. This component is proportional to  $\lambda$ , the amount of private loan allowed per unit of domestic sovereign debt holding (or collateral value).

In equilibrium, the price of government debt,  $p_0$ , must satisfy equation (6). Because foreign investors have the same preferences as the domestic bankers, equation (6) is also the pricing equation for foreign investors. Default policy,  $a^*$  must satisfy equation (5), so that *ex-ante* beliefs in default probability is consistent with the government default policy at  $t = 1$ . Debt holdings,  $b_D$  and  $b_F$  must satisfy the government budget constraints, i.e.

$$T = b_D + b_F \quad (7)$$

$$g = p_0 T \quad (8)$$

Equation (7) states that, when the government decides not to default, a lump-sum tax of  $T$

is levied at  $t = 2$  on domestic bankers to repay both domestic and foreign debt holders, so  $T$  is also the total government borrowing (in face value). Equation (8) says that the revenue raised by total debt issuance,  $p_0 T$ , must be equal to the primary deficit,  $g$ .

For a given level of total debt  $T$ , let  $\mathbf{x} = (\mathbf{a}^*, \mathbf{p}_0, \mathbf{b}_D, \mathbf{b}_F)$  be the corresponding equilibrium solution that satisfies the above equations. The following assumptions are made to simplify the analysis.

**Assumption 1.** *The productivity shock  $A$  is uniformly distributed in  $[0, 1]$ .*

**Assumption 2.** *The investment technology  $f(\cdot)$  is piece-wise linear:*

$$f(I) = \min(k, I) + (1 - \gamma) \max(0, I - k) \quad (9)$$

where  $k$  is some constants between  $y_1$  and  $(1 - c)y_1$ , and  $\gamma \in [0, c]$ .

This specification of investment technology is inspired by Mengus (2014) for tractability. The investment technology  $f(\cdot)$  is strictly concave. The degree of concavity is positively related by  $\gamma$ , which is assumed to be bounded above by the domestic cost of default  $c$ , so default is more likely when endowment  $y_1$  is low, i.e.  $\frac{\partial a^*}{\partial y_1} < 0$ . The constant  $k$  is chosen such that the marginal productivity is higher when there is default.

### 4.3 Probability of Default

The equilibrium probability of default  $\Pi(a^*)$  at  $t = 0$  must be consistent with proposition (1), the government's default policy. It must also be consistent with equation (8) and (6), the market clearing conditions.

**Proposition 2.** *Given assumptions 1 and 2, the equilibrium probability of default  $\Pi(a^*)$  is*

$$\Pi(a^*) = \frac{1}{w\lambda(1 - \gamma)} \left[ \sqrt{(1 + w\lambda(1 - \gamma))^2 - w\lambda(1 - \gamma)\frac{2g}{T}} - 1 \right] \quad (10)$$

where  $T$  is the total debt level,  $g$  is the primary deficit,  $\lambda$  is the collateral value of sovereign debt, and  $\gamma \in [0, c)$  is the degree of concavity in the investment technology  $f(\cdot)$ . In addition,  $\frac{d\Pi(a^*)}{dT} > 0$  and  $\frac{d^2\Pi(a^*)}{dTd\lambda} < 0$ .

**Proof.** See Appendix A.2.

In other words,  $\Pi(a^*)$  can be expressed a function of total debt-to-deficit ratio,  $T/g$ . Clearly, equation (10) implies that these two variables are positively correlated. Intuitively, when debt-to-deficit ratio increases, some fraction of the newly issued debts are held by domestic bankers, so the overall impact on the government's incentive to default is not necessarily clear. Proposition (2) states that the overall impact is strictly positive.<sup>15</sup> Less clear is the role of the collateral value of sovereign debt on  $\Pi(a^*)$ . The proposition says, in equilibrium, the probability of default is more sensitive to increase in total debt if the collateral value of sovereign debt is lower. The government's incentive to default, according to equation (5), is expressed as the ratio of debt-repayments to foreign investors to net-loss of investment output when there is default. For countries whose debts have lower collateral value, their costs of default, in terms of loss of investment output, are smaller. Therefore, their incentives to default are not only higher but also more sensitive to changes in fiscal conditions. Therefore, in response to the same increase in total debt, their probabilities of default increase by relatively more.

**Prediction 2.** *The probability of default is more sensitive to increases in total debt if the collateral value of sovereign debt is lower.*

#### 4.4 Shares of Domestic Debt held by Domestic Bankers

One can obtain the equilibrium share of debt held by domestic banks,  $b_D/T$ , in closed-form.

**Proposition 3.** *The equilibrium share of sovereign debt held by domestic bankers,  $b_D/T$ ,*

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<sup>15</sup>This result is robust to different specification of investment technology  $f(\cdot)$ , provided that  $f(\cdot)$  is not “too concave”.



given the level of total debt issued  $T$ , and the collateral value of domestic debt,  $\lambda$ , is

$$\frac{b_D}{T} = \frac{1}{1 + w\lambda(1 - \gamma)a^*} - \frac{(c - \gamma)wa^*}{T(1 + w\lambda(1 - \gamma)a^*)}y_1 \quad (11)$$

where  $c \in (0, 1]$  is the domestic cost of default,  $\gamma \in [0, c]$  is the degree of concavity in the investment technology  $f(\cdot)$ , and the government's default policy,  $a^*$ , satisfies equation (10). Furthermore,  $b_D/T$  is strictly decreasing in  $\lambda$  and  $c$  but strictly increasing in  $\gamma$ .

**Proof.** See Appendix A.3.

The equilibrium share of domestic debts,  $b_D/T$ , contains two components. The first term,  $\frac{1}{1 + w\lambda(1 - \gamma)a^*}$ , is the reciprocal of the *minimum* marginal contribution of one unit of domestic sovereign debts to output in states where there is no default, given the default policy  $a^*$ .<sup>16</sup> The higher the marginal contribution, the less debts are needed to be domestically held to prevent default, in equilibrium, for a given level of total debts  $T$ .

To see the intuition, consider a case where the domestic cost of default is zero.<sup>17</sup> If,  $\lambda$ , the collateral value of the domestic sovereign debt is also zero, the government has no incentive to repay its debts at  $t = 1$ , according to equation (5). Why? When there is no default, the government must levy a lump-sum tax on domestic banks for debt repayments. This is a net cash outflow when the sovereign debts are not productive. Thus, the probability of default must be one, which is recognized in equilibrium, implying that all debts must be held by domestic banks. Domestic debt holding is, therefore, a commitment device for debt repayment. The higher the collateral value of sovereign debt  $\lambda$ , the less incentive for the government to default, and therefore less debts are held by domestic bankers.

The second term,  $\frac{(c - \gamma)wa^*}{T(1 + w\lambda(1 - \gamma)a^*)}y_1$ , represents the impact of domestic cost of default on the equilibrium share of domestic debt. If  $c$  is high, then a large fraction of endowment  $y_1$  is lost when the government defaults, which in turn, discourages the government from

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<sup>16</sup>Note that  $a^*$  can also be interpreted as the minimum realization of productivity shock  $\tilde{A}$  such that the government does not default, so it does affect the *ex-ante* marginal contribution of one unit of domestic sovereign debt to output.

<sup>17</sup>This implies, by assumption,  $\gamma$  is also zero.

defaulting. Consequently, less debts are needed to be held by domestic bankers to sustain an equilibrium. But this effect is weaker as the amount of total debt  $T$  increases because, on per-unit basis, this cost is decreasing in  $T$ .

How does  $\gamma$ , the degree of concavity in the investment technology  $f(\cdot)$ , affect the equilibrium debt ownership? When  $\gamma$  increases, the marginal gain in outputs from not defaulting declines. Therefore, an increase in  $\gamma$  have a positive impact on the both terms through the denominator because the loss of investments from government default decreases. At the same time, however, such increase also implies the effective domestic cost of default,  $(1 - \gamma) - (1 - c) = c - \gamma$ , declines, which negatively contributes to numerator of the second term. The overall effect is negative, implying that equilibrium share of domestic debt increases in  $\gamma$ .

In the empirical section, I will test the following prediction of proposition 3.

**Prediction 3.** *The share of debt held by domestic bankers,  $b_D/T$ , is negatively related to the collateral value of sovereign debt,  $\lambda$ .*

**Proposition 4.** *Assume the domestic cost of default  $c$  is strictly positive, and degree of concavity in the investment technology  $f(\cdot)$ ,  $\gamma \in [0, c)$ . Given the level of total debt issued  $T$ , the equilibrium share of (risky) domestic debt,  $b_D/T$ , as defined by equation (11), has the following properties:*

1. *If a local extremum exists for  $b_D/T$  (as a function of  $T$ ), then it is also the unique global minimum.*
2. *For any  $T > 0$ , there exists  $\underline{\lambda} > 0$  such that for all  $\lambda < \underline{\lambda}$ ,  $b_D/T$  is strictly increasing in  $T$ .*
3. *Suppose  $c$  is sufficiently small. There exists  $\bar{\lambda}$ ,  $\underline{T} > 0$  such that, for all  $\lambda > \bar{\lambda}$  and  $T < \underline{T}$ ,  $b_D/T$  is strictly decreasing in  $T$ .*
4. *If  $cy_1(1 + w)$  is larger (smaller) than  $\frac{gw\lambda(1-\gamma)}{(1+w\lambda(1-\gamma))^2}$ ,  $b_D/T$  is increasing (decreasing) in  $T$  if  $T$  is sufficiently large.*

**Proof.** See Appendix A.4.

This proposition establishes the main result of this section. Changes in the equilibrium share of debt held by domestic bankers with respect to changes in total debt  $T$  depends crucially on  $\lambda$ , the collateral value of domestic sovereign debt, and it is determined by two opposite forces: 1) productivity of sovereign debt at non-default states and 2) effective domestic cost of default per unit of debt. Consider an increase in total debt  $T$ . Because the government needs to finance an exogenous deficit  $g$  through debt financing. Such increase would suppress debt prices and raise the probability of default  $\Pi(a^*)$  in equilibrium, according to equation (6). This raises the minimum payoff in states where the government does not default, which in turn, has a negative impact on the first term in equation (11) because less debts is needed to be held by domestic bankers to sustain an equilibrium. Clearly, this impact is positively related to the collateral value of sovereign debt  $\lambda$ . The impact of an increase in  $T$  on the effective domestic cost of default is not as clear. On one hand, higher default probability implies that it is more likely to incur the domestic cost of default  $c$ , so this has a negative impact on  $b_D/T$ . On the other hand, such cost per unit of total debts  $T$  is declining in  $T$ , as reflected by the denominator of the second term in equation (11), so this has a positive impact on  $b_D/T$ . The overall impact depends on  $\lambda$  and the level of total debts  $T$ , as shall be discussed below.

Property (2) says, given strictly positive domestic cost of default  $c > 0$ , the second impact dominates when the collateral value of sovereign debt  $\lambda$  is small, implying that  $b_D/T$  is increasing in  $T$ . Take, for example, a GIIPS country whose debts have very small collateral value,  $\lambda \approx 0$ . Figure 3 plots its share of debt held by domestic banks,  $b_D/T$  as a function of  $T$ . The function is strictly increasing for all level of  $T$  because the impact on per-unit domestic cost of default is much stronger than that on marginal productivity of sovereign debt. Defaults are less costly as total debt  $T$  increases, more debts have to be held by domestic bankers to prevent the government from defaulting. Increasing default probability does increase the marginal productivity of its debts in non-default states, but the overall impact

is minimal because  $\lambda$  is close to zero.

Property (3) says, if the sovereign debts of a country has high collateral value  $\lambda$ , and the total level of its debt  $T$  is not too high, the positive impact on marginal productivity of its debt dominates the negative impact on per-unit domestic cost of default, so the share of debts held by domestic banks is decreasing in  $T$ . As shown by figure 4, for a country whose collateral value of sovereign debt is relatively high, with  $\lambda = 0.2$  and the level of deficit  $g = 0.5$ ,  $b_D/T$  is strictly decreasing in  $T$  when the total debt-to-deficit ratio is below 125%, during which the positive impact on marginal debt productivity dominates (i.e. figure 4b). Once the debt-to-deficit ratio is above 125%, however, the negative impact on domestic cost of default dominates, so  $b_D$  becomes strictly increasing in  $T$ . Figure 5 shows that, for countries such as Germany and the U.S., where the collateral value of sovereign debt are very high, the positive impact on marginal debt productivity always dominates for any level of debt  $T$ , implying that  $b_D/T$  is strictly decreasing in  $T$ . Property (1) establishes that the three examples discussed above, in fact, cover all possibilities. Finally, as  $T \rightarrow \infty$ , the derivative of  $\frac{\partial}{\partial T} \frac{b_D}{T}$  is

$$\lim_{T \rightarrow \infty} \frac{\partial}{\partial T} \left( \frac{b_D}{T} \right) = \underbrace{-\frac{gw(1-\gamma)\lambda}{1+w(1-\gamma)\lambda}}_{\text{Marginal Effect From Sovereign Debt Productivity}} + \underbrace{(c-\gamma)y_1(1+w)(1+w(1-\gamma)\lambda)}_{\text{Marginal Effect From Domestic Cost of Default}} \quad (12)$$

Property (4) states that, for any collateral value of sovereign debt  $\lambda$ , if domestic cost of default  $c$  is high relative to deficit  $g$ , then  $b_D/T$  shall eventually be increasing in  $T$ . Consider, again, the above example for countries whose debts has high collateral value. Figure 6 plots the equilibrium share of debt held by domestic bankers, when the domestic cost of debt  $c$  increases from 10% to 20% with the same  $\lambda = 0.5$ . Consistent with proposition 3, given the level of total debt  $T$ ,  $b_D/T$  is lower when  $c$  is high because of lower incentive to default. More importantly,  $b_D/T$  strictly decreasing in  $T$  when  $c = 10\%$ . When  $c = 20\%$ , however,  $b_D/T$  eventually becomes increasing in  $T$  once the debt-to-deficit reaches around 150%. This

is because the marginal decline in per-unit domestic cost of default is higher when  $c$  is high, so more sovereign debts are needed to be held by domestic bankers to sustain a equilibrium when  $T$  is high.

**Prediction 4.** *The share of debt held by domestic banks,  $b_D/T$  is strictly increasing in total debts,  $T$ , only in highly-indebted countries whose debts have low collateral value,  $\lambda$ .*

## 4.5 Optimal Level of Total Debt for a given level of deficit $g$

For a given level of deficit  $g$ , what is the relationship between debt composition and the optimal level of debts  $T$ ? Given the collateral value of sovereign debt  $\lambda$  for country R, its government chooses  $T$  to maximizes the utility of the representative banker, such that the default probability  $\Pi(a^*)$  satisfies equation (5) and the (equilibrium) share of domestic debts held by domestic banks, satisfies equation (11). In other words, suppose  $b_D^*(T)$  is the equilibrium portfolio for domestic banks at  $t = 0$  for given  $T$ , the government's problem at  $t = 0$  is:

$$\begin{aligned} \max_T U = \max_T y_0 - p_0 b_D^* \\ + (1 - \Pi(a^*)) E[U_{\text{No Default}} | \tilde{A} > a^*] + \Pi(a^*) E[U_{\text{Default}} | \tilde{A} < a^*] \end{aligned} \quad (13)$$

subject to equilibrium conditions (6) - (11), where  $U_{\text{No Default}}$  and  $U_{\text{Default}}$  satisfies, respectively, equation (2) and (3). The following proposition characterizes the optimal level of total debts:

**Proposition 5.** *The FOC to domestic government's problem (13) is*

$$\begin{aligned} \left( \frac{T}{1 - \Pi(a^*)} \right) \frac{dU(T, b_D)}{dT} = & \underbrace{w\lambda(1 - \gamma)E[\tilde{A} | \tilde{A} > a^*]}_{\text{Marginal Value of Sovereign Debts}} \times b_D \\ & - \underbrace{(T - b_D)}_{\substack{\text{Debt Repayments} \\ \text{to foreigners}}} \end{aligned} \quad (14)$$

where  $T$  and  $b_D$  satisfy equation (11). In addition,

1. If  $\lambda$  is sufficiently small, then  $U(T, b_D)$  is strictly decreasing in  $T$ .
2. Suppose  $\frac{dU(T, b_D)}{dT}|_{(T^*, b_D^*)} = 0$ . Then  $U(T^*, b_D^*)$  is the global maximum.
3.  $\frac{\partial}{\partial T} \left( \frac{b_D}{T} \right) |_{(T', b_D')} > 0 \implies \frac{dU(T, b_D)}{dT} |_{(T', b_D')} < 0$ .

**Proof.** See Appendix A.5.

Equation (14) states that the optimal level of government borrowing depends on the trade-offs, in states where there is no default, between a declining expected marginal contribution of sovereign debt to private investment for domestic banks and increasing debt-repayments to foreign investors. Issuing more sovereign debts is beneficial because domestic banks can use them as collaterals to expand investments. At the same time, however, it is also harmful because of increasing debt repayments to foreign banks, which is an *ex-post* loss of resources from the perspective of domestic bankers.

Imagine an equilibrium where all sovereign debts are held by domestic bankers. According to equation (5), there is no incentive for the government to default, so  $\Pi(a^*)$  is zero, which corresponds to a particular level of total debts  $T = b_D$ . Suppose the government expands its borrowing. According to proposition 2,  $\Pi(a^*)$  must also increase. Therefore, newly issued debts must be held, in equilibrium, by both domestic bankers and foreign investors. The debt ownership that is sustainable in equilibrium for the increased level of total debt is determined by proposition 3.

Is it optimal for the government to borrow more? Given that the increased level of debt is sustainable, when the government decides whether or not to borrow more, it cares only about the trade-offs in the no-default states. Suppose the government increases  $T$  by one unit, then the lump-sum tax levied for debt-repayment obviously also increases by one unit, of which  $T - b_F$  is the net transfer of resources to foreign investors. This hurts domestic bankers. Because some of the newly issued debts must be held by domestic bankers, however,

increasing  $T$  also beneficial because these debts help expand investments by domestic bankers. This benefit is large when the collateral value of sovereign debt  $\lambda$  is high, so the government should issue more debts. On the other hand, if  $\lambda$  is sufficiently small, this benefit is close to zero, so additional debt issuance is not desirable.

Property (3) characterizes the conditions under which the later is true. More importantly, it relates the optimal level of debt to debt ownership and provides an observable indicator for (suboptimally) excessive level of debts. This property states that, if it is observed that the share of debt held by domestic bankers increases as government increases its borrowing, then the level of debts is suboptimally high, and the government should reduce its borrowing.

## 5 Empirical Evidence

In this section, I provide empirical evidence for the following predictions from my model:

1. The probability of default  $\Pi(a^*)$  increases with externally-held debts  $b_F$  but decreases with domestically-held debts  $b_D$ .
2. The probability of default  $\Pi(a^*)$  is more sensitive to increases in total debt  $T$  if the collateral value of sovereign debt  $\lambda$  is lower.
3. The share of debt held by domestic bankers,  $b_D/T$ , is negatively related to the collateral value of sovereign debt,  $\lambda$ .
4. The share of debt held by domestic banks  $b_D/T$  is strictly increasing in total debts  $T$  only in highly-indebted countries whose debts have low collateral value  $\lambda$ .

## 5.1 A Proxy for the Collateral Value of Sovereign Debts and its Instrument

### 5.1.1 Theoretical Proxy

Because the productivity shock  $\tilde{A}$  is non-negative, and the investment technology  $f(\cdot)$  is strictly increasing, the marginal return from investment is strictly positive with probability one. This implies equation (1), the borrowing constraint, always binds in equilibrium. In other words, the collateral value of sovereign debt,  $\lambda$ , should be observationally equivalent to the ratio of private debt issued by domestic banks to their holdings of domestic sovereign debt. Given this, one can construct a proxy  $\hat{\lambda}$  for  $\lambda$ :

$$\hat{\lambda} = \frac{\text{Private debt issued by domestic banks (in face Value)}}{\text{Domestic sovereign debts held by domestic Banks (in face Value)}} \quad (15)$$

where data for the denominator, domestic sovereign debts held by domestic banks, are obtained from [Merler and Pisani-Ferry \(2012\)](#), and data for the numerator, private debts issued by domestic banks, are obtained from Eurostat.

Proposition 4 suggests that the share of domestic debt, in equilibrium, is strictly increasing in total debt only in highly-indebted countries whose debts have low collateral value. For countries whose debts have high collateral value, the opposite is predicted by the theory as long as their total debt levels are not too high. If the theory is to be consistent with figure 1, which plots the share of public debt held by domestic banks for both GIIPS and non-GIIPS countries, it is clear that  $\hat{\lambda}$  must at least be smaller on average in GIIPS countries than non-GIIPS countries.

Table 1 provides summary statistics for  $\hat{\lambda}$ , with annual from 2007 to 2014. With the notable exception of Ireland and Belgium, the result is consistent with the theory. On average,  $\hat{\lambda}$  for Greece, Italy, Portugal and Spain are significantly smaller than  $\hat{\lambda}$  of the non-GIIPS countries (except Belgium). The sovereign debts for Greece have the smallest average collateral value with  $\hat{\lambda} = 0.102$ , and it is consistently the smallest throughout the sample. Average  $\hat{\lambda}$  for Italy and Portugal are, respectively, 2.314 and 2.359, which is larger than that



of Greece. But their values are still significantly less than their non-GIIPS counterparts. For instance, the average  $\hat{\lambda}$  for Germany and France are, respectively, 3.385 and 5.304. For Finland, Netherlands, and the United Kingdom, their average  $\hat{\lambda}$  are even higher but so are their standard deviations.

Statistical comparison is difficult because of the size of sample is small. Additionally, to compare means of  $\hat{\lambda}$  between countries, standard t-test cannot be used because their distributions are not normal. Therefore, I use the non-parametric [Wilcoxon \(1946\)](#) signed rank test. The hypothesis is as follow:

$$\begin{cases} H_0 : \text{Mean of } \hat{\lambda} \text{ for non-GIIPS country } i = \text{Mean of } \hat{\lambda} \text{ for GIIPS country } j \\ H_1 : \text{Mean of } \hat{\lambda} \text{ for non-GIIPS country } i > \text{Mean of } \hat{\lambda} \text{ for GIIPS country } j \end{cases}$$

for any combination of non-GIIPS countries  $i$  and GIIPS countries  $j$  in the sample. The test statistics,  $W$ , equals:

$$W = \sum_{T=2007}^{2013} (\text{sign}(x_{\text{non-GIIPS},T} - x_{\text{GIIPS},T}) \times \text{Rank}_{\text{non-GIIPS,GIIPS},T}) \quad (16)$$

where  $x_{i,T}$  is the observation for country  $i$  in year  $T$ , and, for country  $i$  and  $j$ ,  $\text{Rank}_{i,j,T}$  is the rank of the value of  $|x_{\text{non-GIIPS},T} - x_{\text{GIIPS},T}|$  in year  $T$  among the sample. For small sample,  $W$  follows a distribution with an expected value of zero and a variance  $\frac{T(T+1)(2T+1)}{6}$ . Using critical values computed by [Wilcoxon \(1946\)](#), I conclude that again, with the exception of Belgium and Ireland, the null hypotheses are all rejected at 5% significant level.

### 5.1.2 An Instrument for $\hat{\lambda}$

Although  $\hat{\lambda}$  is a theoretically motivated proxy for the collateral value of sovereign debt, it is not appropriate to be used to test my empirical predictions because  $\hat{\lambda}$  is constructed, in part, by using domestically-held debts, which, by definition, cannot be independent of the share of domestically-held debt  $b_D/T$  nor total debt  $T$ . Because of this joint-determination

problem, an instrument for  $\hat{\lambda}$  must be used.

I use the *strength of legal rights index* (creditor rights) from the World Bank’s World Development Indicators as an instrument for  $\hat{\lambda}$ . The index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. It ranges from 0 to 12, with higher scores indicating that these laws are better designed to expand access to credit. This variable is used by [Gennaioli et al. \(2014\)](#) to measure the quality of financial institutions.<sup>18</sup> To gauge the strength of this instrument, I run various specifications of regression of  $\hat{\lambda}$  on creditor rights. Table 2 shows that creditor rights are positively correlated to  $\hat{\lambda}$  at 1% significant level whether or not controlling for country or year fixed-effects. When I include both country and year fixed-effects and adjust for autocorrelations in the error term, as shown in column (4), one unit increase in the score for creditor rights is associated with a 19% increase in  $\hat{\lambda}$ , and approximately 30% of the variation in  $\hat{\lambda}$  is explained. The intuition for this result is clear: Better creditor rights enables the banks ability to issue private debts with less government debt as collateral. This means, according to equation (15), the instrument drives  $\hat{\lambda}$  via the numerator.

## 5.2 Relationship between Default Risk, Domestic, and External Debts

Prediction 1 states that the impacts of changes in domestically-held debt ( $b_D$ ) and externally-held debt ( $b_F$ ) on default risk are opposite. Because both  $b_D$  and  $b_F$  are endogenous in my model, I instrument by the collateral value of debt ( $\lambda$ ) and total debt ( $T$ ), which are, by assumption, exogenous. Creditor rights and debt-to-GDP ratio are used as proxies, respectively, for  $\lambda$  and  $T$ . To verify the strength of these instruments, table 3 shows the results for the regressions of  $b_D$  and  $b_F$  on creditor rights and debt-to-GDP ratio. Creditor rights are negatively correlated with  $b_D$  at the 5% level (column (1) and (3)), and positively

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<sup>18</sup>[Gennaioli et al. \(2014\)](#) argues that government defaults should lead to declines in private credit, and these decline should be larger in countries where financial institutions are more developed and banks hold more government bonds. Probability of default and externally-held debts are exogenous in their model, and their level of total debt is fixed at one. Different from their paper, I study the impact of changes in total debts and collateral values of sovereign debt on default risk and debt-ownership.

correlated with  $b_F$  at 1% level (column (4)). A one unit increase in the score for creditor rights is associated with roughly 2% decrease in  $b_D$  (column(3)) and 4% in  $b_F$  (column (4)). The Debt-to-GDP ratio are positively correlated with both  $b_D$  and  $b_F$  at the 1% level (column (1),(2), and (4)). A one percentage point increase in the debt-to-GDP ratio is associated with a 0.174 percentage point increase in  $b_D$  and a 0.865 percentage point increases in  $b_F$ . The R-squared are about 40% for  $b_D$  and 78% for  $b_F$ . Overall, creditor rights and debt-to-GDP ratios are strong instruments for  $b_D$  and  $b_F$ .

Using these instruments, I now estimate various specifications of the second-stage pooled OLS regression:

$$\begin{aligned} (\text{Default Risk})_{i,t} = & \alpha_i + \nu_t + X'_{i,t}\theta + \beta_1(\text{Domestically-held Debt-to-GDP})_{i,t} \\ & + \beta_2(\text{Externally-held Debt-to-GDP})_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (17)$$

In equation (17), the coefficient  $\alpha_i$  represents country-fixed effects, which control for all time-invariant country-specific (e.g., political or historic) factors affecting default risk. The coefficient  $\nu_t$  captures time effects, controlling for common shocks across countries (e.g., changes in world interest rates). To control for remaining possible sources of endogeneity, i.e. country-specific time-varying shocks, the vector  $X'_{i,t}$  contains variables that capture the most common predictors of an increase in default risk, which is, again, proxied by 5-year CDS Spreads (in basis points). Most of these variables are used in [Aizenman et al. \(2013\)](#). Current account balance-to-GDP ratio and real GDP growth are included because default risk tends to be negatively correlated with output growth, as shown by [Mendoza and Yue \(2012\)](#). [Aizenman et al. \(2013\)](#) shows that inflation tends to be positively correlated with default risk. The error term,  $\varepsilon_{i,t}$ , is assumed to be AR(1). The results are in table 5.

In the baseline specification, I restrict  $\beta_1 = \beta_2$ , i.e column (1) and (3), which equivalent to regressing 5-Year CDS spreads on total debt-to-GDP ratio. Consistent with existing literature, the parameter estimate is positive and significant, regardless of whether controls

are added. According to column (3), a one percentage point increase in total debt-to-GDP ratios is associated with a 4.1 basis points increase in 5-Year CDS spreads.

Then, I decompose the total debt-to-GDP ratio into externally-held debt-to-GDP ratio and domestically-held debt-to-GDP ratio, which are instrumented by creditor rights and debt-to-GDP ratios. According to the theory,  $\beta_1 > 0$  and  $\beta_2 < 0$ .

Consistent with the theory, whenever included, the coefficient on externally-held debt-to-GDP ratio is positive and statistically significant in column (2), (4) and (6). Moreover, the estimated parameters are robust across specifications. One percent increase in external debt-to-GDP ratio is associated with a roughly 11 basis points increase in 5-Year CDS spreads. The magnitude of the regression coefficient is significantly larger than that for total debt-to-GDP ratio. Perhaps, more surprisingly, the R-squared in column (3) and (4) are, respectively, 0.43 and 0.46. In other words, externally-held debt-to-GDP ratio explains more variations in the 5-Year CDS Spreads than total debt-to-GDP ratio.

This brings the focus to the role of domestically-held debt-to-GDP ratio, i.e.  $\beta_2$ , in column (2), (5), and (6). The coefficients vary significantly across column (5) and (6). Specifically, the coefficient is positive at the 1% significance level when externally-held debt-to-GDP is excluded. When externally-held debt-to-GDP is included, however, the coefficient becomes negative at 10% significant level. In the latter case, one percent increase in domestically-held debt-to-GDP ratio is associated with roughly 12 basis points decrease in 5-Year CDS spreads, which is consistent with prediction 1.

At the first glance, however, this result would seem to be at odd with the observation that share of domestically-held debt increases in the GIIPS countries, which are generally perceived to have higher default risks. In other words, why should domestically-held debt and default risk not be positively correlated? I argue that this is precisely what distinguishes this paper from the “risk-shifting” explanation to this observed phenomenon. For example, [Farhi and Tirole \(2014\)](#) argues that due to their convex payoff structure of equity, increasing holding of risky sovereign debts could be particularly attractive to domestic banks during

a sovereign debt crisis. This explanation suggests that domestically-held debts should be positively correlated with default risk,  $\beta_2 > 0$ . Indeed, this is true when default risk is directly regressed on domestically-held debt. But my theory argues that this is not the correct approach because of omitted-variable bias. Both default risk and domestically-held debt are negatively correlated with the collateral value of sovereign debt. This implies that, without using instrumental variables, the regression coefficient on domestically-held debts suffers an upward bias. My result shows that the regression coefficient is negative after this omitted-variable bias is corrected.

### 5.3 Relationship between Default Risk, Total Debt, and Collateral Value of Sovereign Debt

Prediction 2 says that the marginal effect of changes in total debt on default risk is decreasing in the collateral value of debt. Therefore, I estimate various specifications of the pooled OLS regression:

$$\begin{aligned}
(\text{Default Risk})_{i,t} = & \alpha_i + \nu_t + X'_{i,t}\theta + \beta_1(\text{Total Debt-to-GDP})_{i,t} \\
& + \beta_2(\text{Total Debt-to-GDP} \times \text{Collateral Value})_{i,t} \\
& + \beta_3(\text{Total Debt-to-GDP} \times \text{GIIPS})_{i,t} + \varepsilon_{i,t}
\end{aligned} \tag{18}$$

where default risk is proxied by the 5-Year CDS spreads, GIIPS is a dummy variable that equals one for GIIPS countries and zero otherwise, and collateral value, measured as the ratio of private debts issued by domestic banks to their holdings of domestic sovereign debt, is instrumented by creditor rights. As in equation (17), the coefficient  $\alpha_i$  represents country-fixed effects, the coefficient  $\nu_t$  captures time-fixed effects. As controls, I also include the vector  $X'_{i,t}$ , which contains inflation, current account balance-to-GDP ratio and real GDP growth. The error term,  $\varepsilon_{i,t}$ , is assumed to be AR(1).

The theory predicts that  $\beta_2 < 0$ . Regression results shown in table 6 are consistent

with this prediction. When the interaction term between debt-to-GDP ratio and collateral value is included, as indicated by column (3) and (6),  $\beta_2$  is negative at the 5% significance level, and  $\beta_1$  is positive at 1% significance level. In other words, the marginal effect of debt-to-GDP ratio on 5-year CDS spreads depends negatively on the collateral value of sovereign debts. When the collateral value is zero, a one percentage point increase in debt-to-GDP ratio is associated with a roughly 5.4 basis points increase in 5-year CDS spreads. When the collateral value increase by one percent, however, this marginal effect drops by 1.41 basis points.

To further test the theory, I divide the countries in my sample into two groups: GIIPS and non-GIIPS. GIIPS countries include Greece, Italy, Ireland, Portugal, and Spain; non-GIIPS countries include Belgium, Finland, France, Germany, Netherlands, the United Kingdom, and the United States. Figure 1 shows that share of domestically-held debt increases as total debt increases in GIIPS countries, but the opposite is observed in non-GIIPS countries. Proposition 4 suggests, if the observed data is consistent with the theory, then the marginal effect of changes in total debt on default risk must be higher in GIIPS countries than non-GIIPS countries. Therefore,  $\beta_3$  should be positive (when the  $\beta_2$  is omitted). Results from table 6 is consistent with this hypothesis. When the interaction term between debt-to-GDP ratio and GIIPS dummy is included, as indicated by column (2) and (4),  $\beta_3$  is positive at the 1% significance level, but  $\beta_1$  is not significant. In other words, the marginal effect of debt-to-GDP ratio on 5-year CDS spreads is larger in GIIPS countries than non-GIIPS countries. For GIIPS countries, a one percentage point increase in debt-to-GDP ratio is associated with roughly 5.6 basis points increase in 5-year CDS spreads. For non-GIIPS countries, however, this marginal effect is statistically insignificant.

## 5.4 Relationship between Share of Domestically-held Debt, Total Debt, and Collateral Value of Sovereign Debt

Both prediction 3 and 4 concern the effect of changes in total debt and the collateral value of debt on the share of domestically-held debt. Specifically, prediction 3 states that, holding constant the level of total debt, an increase in the collateral value of debt is associated with a decline in the share of domestically-held debt. Prediction 4 says the marginal effect of changes in total debt on the share of domestically-held debt is declining in the collateral value of debt.

$$\begin{aligned}
 (\text{Share of Domestically-held Debt})_{i,t} &= \alpha_i + \nu_t + X'_{i,t}\theta + \beta_1(\text{Total Debt-to-GDP})_{i,t} \\
 &\quad + \beta_2(\text{Collateral Value})_{i,t} \\
 &\quad + \beta_3(\text{Total Debt-to-GDP} \times \text{Collateral Value})_{i,t} + \varepsilon_{i,t} \quad (19)
 \end{aligned}$$

where, again, the collateral value of sovereign debt, measured as the ratio of private debts issued by domestic banks to their holdings of domestic sovereign debt, is instrumented by creditor rights. I assume that the variation in total debt-to-GDP is exogenous, as in [Aizenman et al. \(2013\)](#).<sup>19</sup> As in equation (18), the coefficient  $\alpha_i$  represents country-fixed effects, the coefficient  $\nu_t$  captures time-fixed effects. As in the previous section, I include the vector  $X'_{i,t}$  as controls, which contains inflation, current account balance-to-GDP ratio and real GDP growth. The error term,  $\varepsilon_{i,t}$ , is assumed to be AR(1).

Prediction 3 predicts  $\beta_2 < 0$ , and prediction 4 predicts  $\beta_3 < 0$ . Regression results shown in table 4 are consistent with these predictions. As expected by prediction 3, the coefficient for collateral value,  $\beta_2$ , is negative and significant at 10% level. When collateral value and total debt-to-GDP are both included (column(3)), a one unit increase in the collateral value

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<sup>19</sup>Equation (19) can be viewed as estimating the first-order approximation of equation (11) with respect to total debt  $T$  and collateral value  $\lambda$ , which are both assumed to be exogenous in the model.

is associated with a 4 percentage points decrease in the share of domestically-held debt. The coefficient for debt-to-GDP ratio,  $\beta_1$ , is positive and significant at 1% level. A one percentage point increase in debt-to-GDP ratio is associated with a 0.129 percentage point increase in the share of domestically-held debt. Interestingly, when only total debt-to-GDP or collateral value is included (column (1) and (2)), the corresponding  $R^2$  is, respectively, 0.16 and 0.11. When both variables are included, the  $R^2$  increases by more than 50% to 0.24. This result is also consistent with the theory, which argues that both collateral value and total debt are necessary to jointly explain the variation in debt-ownership.

When the interaction term between total debt and collateral value,  $(\text{Total Debt-to-GDP} \times \text{Collateral Value})_{i,t}$ , is included (column (4)), both the magnitude and significance of  $\beta_1$  increase. More importantly, as expected by prediction 4, the regression coefficient for the interaction term,  $\beta_3$ , is negative and significant at the 10% level. This implies the marginal effect of changes in total debt on share of domestically-held debt is declining as the collateral value of sovereign debt increases. When the collateral value is zero, one percent increase in debt-to-GDP ratio is associated with 0.18 percent increase in domestic debts. When the collateral value increases by one percent, however, the marginal effect reduces by 0.09 percent. In other words, if the collateral value is larger than 2, the marginal effect of changes in debt-to-GDP ratio becomes negative. The average collateral value for GIIPS (excluding Ireland) and non-GIIPS countries between 2007 and 2014 are, respectively, 1.80 and 11.35. This explains figure 1, where we observe that the share of domestically held-debt increases in GIIPS countries but not in non-GIIPS countries.

## 6 Conclusion

Given that major developed countries have experienced a significant run-up in public debts after the onset of the global financial crisis in 2008, what explains the cross-country difference in sovereign debt ownership? This paper argues that, consistent with financial repression,



domestic debt is a commitment device for debt repayments. Therefore, domestically-held debts should be positively related to the government's incentive to default. The key variables that affect this incentive are: 1) the collateral value of government debt and 2) the level of public debt. In particular, the share of debt held by domestic banks is strictly increasing in total debts only in highly-indebted countries whose debts have low collateral value. Empirical evidence is then provided for these model predictions.

As [Diamond \(1965\)](#) suggests, changes in debt-ownership have important implications for the real economy. Therefore, it is crucial to understand the determinants of debt ownership.<sup>20</sup> This paper relates debt ownership to the level of public debt, the collateral value of public debt, and sovereign default risk in a unified dynamic equilibrium model. An important policy implication from the model is that the government should pay close attention to changes in debt-ownership as it conducts fiscal policy. In particular, I argue that when debts are “moving back home”, as observed in the GIIPS countries, the level of public debt is suboptimally excessive. Empirically, this paper provides evidence that changes in domestically-held debts and externally-held debts have different impacts on the default component of sovereign debt prices.

Finally, this paper is concerned mainly about the observed time-series paths of debt ownership and total public debt in major developed countries in the European Monetary Union (except the U.K. and the U.S.), so it is reasonable to simplify the model by omitting inflation and monetary policy.<sup>21</sup> Nonetheless, for countries with independent currency and monetary policy, raising the inflation rate could be, and perhaps a more attractive alternative to outright default. To the best of my knowledge, no one has yet established, either theoretically or empirically, any connection between monetary policy and debt ownership. A potentially fruitful extension that allows the government to influence inflation through monetary policy is left for future research.

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<sup>20</sup>See, for example, [Forslund et al. \(2011\)](#) and [Guscina \(2008\)](#)

<sup>21</sup>The empirical result of this paper is robust to exclusion of these two countries in the sample.

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## A Proofs

### A.1 Proof of proposition 1

Government in country R defaults if and only if  $U_{\text{Default}} \geq U_{\text{No Default}}$ , i.e.

$$\begin{aligned}
 & (1-c)y_1 + w_R \underbrace{\tilde{A}f((1-c)y_{1R})}_{I_{\text{Default}}} \\
 & \geq y_{1R} + b_F + b_{RR} - T_R + w_R \underbrace{\tilde{A}f(y_{1R} + \lambda b_D)}_{I_{\text{No Default}}} \\
 \Rightarrow \quad & \tilde{A} \leq \frac{(T - b_D) - cy_1}{w(f(y_1 + \lambda b_D) - f((1-c)y_1))}
 \end{aligned}$$

Define  $a^*$  such that the above inequality holds. Hence, government defaults if and only if the realized productivity shock is less than  $a^*$ . Moreover, it is clear that  $a^*$  is strictly decreasing in  $b_{RR}$ ,  $c$ , and  $\lambda_R$ .  $a^*$  is strictly increasing in  $T_R$  and, if  $f(\cdot)$  is strictly concave, also in  $b_F$ .

### A.2 Proof of Proposition 2

Recall that  $T = b_F + b_D$ . Note that  $\Pi(a^*) = a^*$ . From equation (8) and (6), the market clearing conditions,

$$\begin{aligned}
 & 1 - a^* + \frac{w\lambda(1-\gamma)((\mu + \sigma)^2 - (a^*)^2)}{2} = \frac{g}{T} \\
 \Rightarrow & -\left(\frac{w\lambda(1-\gamma)}{2}\right)(a^*)^2 - a^* + \left(\frac{1}{2\sigma} + \frac{w\lambda(1-\gamma)^2}{2} - \frac{g}{T}\right) = 0
 \end{aligned}$$

Suppose the quadratic equation above have a solution in  $[0, 1]$ . Then

$$\Pi(a^*) = \left(\frac{1}{w\lambda(1-\gamma)}\right) \times \left[\sqrt{(1 + w\lambda(1-\gamma))^2 - w\lambda(1-\gamma)\frac{2g}{T}} - 1\right]$$

where the positive root is discarded because  $\Pi(a^*) > 0$ . A solution exists if  $T$  is sufficiently large. Specifically,  $T \in [\frac{g}{2(1+0.5x)}, \infty)$  implies  $\Pi(a^*) \in [0, 1)$ . In addition,

$$\frac{\partial \Pi(a^*)}{\partial T} = \frac{g}{T^2(1 + a^*w\lambda(1 - \gamma))} > 0 \quad (20)$$

And it is also clear that  $\frac{d^2 \Pi(a^*)}{dT d\lambda} < 0$ .

### A.3 Proof of Proposition 3

Given the level of total debts issued by country R,  $T$ , the equilibrium solution  $\mathbf{x} = (a^*, p_{R0}, b_D, b_F)$  must satisfy equation (5), (6), (7), (8). This gives a system of four non-linear equations, one can obtain

$$b_D = \frac{T - cy_1(1 + a^*w)}{1 + a^*w\lambda} \quad (21)$$

$$b_F = T - b_D \quad (22)$$

$$a^* = \frac{1}{w\lambda(1 - \gamma)} \left[ \sqrt{(1 + w\lambda(1 - \gamma))^2 - w\lambda(1 - \gamma)\frac{2g}{T}} - 1 \right] \quad (23)$$

$$p_{R0} = \frac{g}{T} \quad (24)$$

Also, from equation (10),

$$\frac{\partial a^*}{\partial T} = \frac{g}{T^2(1 + a^*w\lambda)} > 0 \quad (25)$$

$$\frac{\partial a^*}{\partial \lambda} = \frac{(a^* - a_L)}{\lambda(1 + a^*w\lambda)} > 0 \quad (26)$$

It follows that  $b_D/T$  is strictly decreasing in  $\lambda$  and  $c$ .

## A.4 Proof of Proposition 4

Assume, without loss of generality, that  $\gamma = 0$ . Note that  $\frac{b_D}{T} = \frac{1}{1+w\lambda} > 0$  as  $T \rightarrow \infty$ .

Differentiate  $b_d$  with respect to  $T$  yields

$$\frac{\partial b_D}{\partial T} = \frac{1}{(1+w\lambda a^*)^2} \times \left( (1+w\lambda a^*) - (T\lambda + cy_1(1-\lambda))wa_T^* \right)$$

To prove the first property, compute the second derivative of  $b_D$  with respect to  $T$ .

$$\begin{aligned} (1+w\lambda a^*)^4 \times \frac{\partial}{\partial T} \left( \frac{\partial b_D}{\partial T} \right) &= - (1+w\lambda a^*)^2 \left( T\lambda + cy_1(1-\lambda) \right) wa_{TT}^* \\ &\quad - 2(1+w\lambda a^*)wa_T^* \left( (1+w\lambda a^*) - (T\lambda + cy_1(1-\lambda))wa_T^* \right) \end{aligned}$$

Note that  $-a_{TT}^* = \frac{2}{T}a_T + \frac{a_T^2 w \lambda}{1+a^* w \lambda} > 0$ , from which it is clear that  $\frac{\partial b_D}{\partial T}$ . Hence, given  $\lambda \geq 0$ ,  $b_D(T)$  is a convex function of  $T$ . Define  $h(T) = b_D(T)/T$ . If  $T_0$  is a local extrema for  $h(T)$ , then  $h'(T_0) = 0$ . Next, we need to show that  $h''(T_0) > 0$ . Differentiate  $h'(T)$  with respect to  $T$  yields

$$\begin{aligned} T^2 h'(T) &= \frac{\partial b_D}{\partial T} T - b_D \\ \Rightarrow T^2 h''(T) + 2T h'(T) &= \frac{\partial^2 b_D}{\partial T^2} T \end{aligned}$$

Because  $h'(T_0) = 0$  and  $\frac{\partial^2 b_d}{\partial T^2} > 0$ ,  $h''(T_0)$  must also be strictly positive. It follows from the differentiability of  $h(\cdot)$  that there can at most be one  $T_0$  such that  $h'(T_0) = 0$ . Note that

$$\begin{aligned} T^2(1+w\lambda a^*)^2 \frac{\partial h}{\partial T} &= -a_T w \lambda T^2 + cy_1 a_T w T(\lambda - 1) \\ &\quad + cy_1(1+a^*w)(1+a^*w\lambda) \end{aligned}$$

If  $\lambda$  is small, then the first two terms are close to zero, implying  $\frac{\partial h}{\partial T}$  is positive, which proves property 2). Suppose  $c$  is small. Then, if  $\lambda$  is large and  $T$  is small, the last two terms are



close to zero, implying  $\frac{\partial h}{\partial T}$  is negative, which proves property 1). Take the limit as  $T \rightarrow \infty$ , property 4) immediately follows.

## A.5 Proof of proposition 5

Again, assume without loss of generality, that  $\gamma = 0$ . Applying the Envelope theorem to the government's problem (13) to obtain

$$\frac{dU(T, b_D)}{dT} = p_0 \left( \frac{b_D}{T} \right) - (1 - \Pi(a^*)) \quad (27)$$

where  $p_0$  satisfies equation (6) and  $b_D/T$  satisfies equation (11). Equation (14) immediately follows. Suppose  $(c - \gamma) > 0$ . Then  $b_D/T$  is strictly less than one when  $\lambda = 0$ , implying that  $\frac{dU(T, b_D)}{dT} < 0$ . Because  $b_D/T$  is a continuous function of  $\lambda$ , property 1 must be true.

Let  $h = b_D/T$  and suppose  $\frac{dU(T, b_D)}{dT} = 0$ . Then

$$\begin{aligned} \left( \frac{T^2}{g} \right) \frac{d^2U(T, b_D)}{dT^2} &= -h + Th_T + \frac{1}{1 + w\lambda a^*} \\ &= \frac{cy_1(1 + wa^*)}{T(1 + w\lambda a^*)} + Th_T \end{aligned} \quad (28)$$

From equation (11), we know that

$$Th_T = \frac{1 - cy_1wa_T - Thw\lambda a_T - (1 + w\lambda a^*)h}{1 + w\lambda a^*}$$

where  $a_T > 0$  satisfies equation (25). It follows that

$$\begin{aligned} (1 + w\lambda a^*) \times (28) &= \frac{2cy_1(1 + wa^*)}{T} - cy_1wa_T - Thw\lambda a_T \\ &= -cy_1wa_T \\ &< 0 \end{aligned}$$

The second equality is derived from the assumption that  $\frac{dU(T, b_D)}{dT} = 0$  and equation (11).

Therefore,  $\frac{dU(T, b_D)}{dT}|_{(T^*, b_D^*)} = 0$  implies that  $U(T^*, b_D^*)$  is a local maximum. Because  $U(T^*, b_D^*)$  is continuous with respect to  $T$ , the intermediate value theorem implies  $U(T^*, b_D^*)$  must also be the global maximum, which proves property 2.

To prove property 3, we know from equation (28) that  $U(T^*, b_D^*) = 0$  implies  $h_T < 0$ . Suppose  $(T', b'_D)$  satisfies (11) but  $\frac{\partial}{\partial T}(\frac{b_D}{T})|_{(T', b'_D)} > 0$ . Property 1 from proposition 4 implies  $T' > T^*$ . But then from property 2 of proposition 5,  $\frac{dU(T, b_D)}{dT}|_{(T', b'_D)} < 0$ .

## B Tables

**Table 1**  
**Summary Statistics for,  $\hat{\lambda}_R$ , the Collateral Value of Sovereign Debts**  
**(2007-2014)**

The proxy for the collateral value of sovereign debts,  $\hat{\lambda}_R$ , is defined as the ratio of private debts issued by domestic banks to their holdings of domestic sovereign debts. Private debts issued by domestic banks are obtained from Eurostat under the financial balance sheets of financial corporations (code: nasa\_10\_f\_bs). Holdings of domestic sovereign debts by domestic banks are obtained from [Merler and Pisani-Ferry \(2012\)](#). Data are all annual.

### GIIPS Countries

Country	Mean	Std. Dev.	Min	Max
Greece	0.102	0.063	0.041	0.206
Ireland	15.371	22.975	0.869	61.18
Italy	2.314	0.780	1.315	3.383
Portugal	2.359	1.255	1.100	3.740
Spain	1.958	0.759	0.99	3.06

### non-GIIPS Countries

Country	Mean	Std. Dev.	Min	Max
Belgium	0.653	0.161	0.463	0.882
Finland	46.549	23.594	19.098	77.915
France	5.304	0.598	4.53	6.077
Germany	3.385	0.423	2.661	3.900
Netherlands	15.605	3.866	10.613	22.389
United Kingdom	19.328	22.903	4.639	78.508

**Table 2**  
**Regressions of collateral value of sovereign debt on creditor rights.**

This table shows regressions of the collateral value of sovereign debt  $\hat{\lambda}$  on creditor rights. The collateral value of sovereign debt,  $\hat{\lambda}$ , is measured as the ratio of private debts issued by domestic banks to their holdings of domestic sovereign debts. Credit Rights is the strength of legal rights index from the World Bank's World Development Indicators. It ranges from 0 to 12, with higher scores indicating that these laws are better designed to expand access to credit. Standard errors are computed as indicated in the table. \*\*\*, \*\*, and \* indicates statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	Collateral Value	Collateral Value	Collateral Value	Collateral Value
Creditor Right	0.469*** (0.0751)	0.359** (0.171)	0.474*** (0.0784)	0.193*** (0.0681)
Constant	-1.513*** (0.506)	-2.173** (0.832)	-1.275 (0.771)	-0.0664 (0.198)
Country Fixed	No	Yes	No	Yes
Year Fixed	No	No	Yes	Yes
Error	Robust	Robust	Robust	AR(1)
R2	0.332	0.870	0.345	0.300
N	75	75	75	64

**Table 3**  
**Regressions debt ownership on collateral value of sovereign Debt and total debt-to-GDP ratio**

This table shows regressions of the collateral value of sovereign debt and total debt-to-GDP ratio on debt ownership. Credit Rights is a proxy for the collateral value. It is the strength of legal rights index from the World Bank's World Development Indicators. It ranges from 0 to 12, with higher scores indicating that these laws are better designed to expand access to credit. Standard errors are computed as indicated in the table. \*\*\*, \*\*, and \* indicates statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	Domestically-held Debt-to-GDP	Externally-held Debt-to-GDP	Domestically-held Debt-to-GDP	Externally-held Debt-to-GDP
Creditor Right	-1.247** (0.491)	1.319** (0.646)	-1.970** (0.979)	3.956*** (1.352)
Debt-to-GDP	0.174*** (0.0341)	0.672*** (0.0486)	0.121* (0.0719)	0.865*** (0.0986)
Creditor Rights × Debt-To-GDP			0.0107 (0.0126)	-0.0388** (0.0176)
Constant	6.762*** (2.360)	-18.44*** (2.744)	10.47*** (3.475)	-31.88*** (3.900)
Country Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
R2	0.399	0.770	0.408	0.789
N	71	71	71	71

**Table 4**  
**The Effect of Changes in Debt-to-GDP Ratio and the Collateral Value of**  
**Sovereign Debt on the Share of Domestically-held Debts.**

This table shows the effect changes in debt-to-GDP Ratio and the collateral value of sovereign debt on the share of domestically-held debt. The sample spans between 2007 and 2014 and covers Belgium, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal, Spain, the United Kingdom, and the United States. GIIPS is a dummy variable that equals 1 for Greece, Italy, Ireland, Portugal, and Spain. Debt-to-GDP ratio is instrumented by current account balance to GDP ratio. Real GDP growth is the annual-to-annual growth rate of nominal GDP divided by inflation. Collateral Value, measured as the ratio of private debts issued by domestic banks to their holdings of domestic sovereign debts, is instrumented by the strength of legal rights index from the World Bank's World Development Indicators. All independent variables except GIIPS and Collateral Value are expressed in percentage points. The dependent variable, 5-Yr CDS, is the 5-Year CDS spread obtained from Bloomberg, expressed in basis points. All columns include time and country fixed effects. Standard errors (in parentheses) are corrected for autocorrelation. \*\*\*, \*\*, and \* indicates statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Share of Domestically-held Debt	(2) Share of Domestically-held Debt	(3) Share of Domestically-held Debt	(4) Share of Domestically-held Debt
Debt-To-GDP	0.118*** (0.0429)		0.129*** (0.0406)	0.179*** (0.0469)
Collateral Value		-4.313* (2.432)	-4.071* (2.292)	
Debt-To-GDP $\times$ Collateral Value				-0.090* (0.0493)
Inflation	0.351* (0.210)	0.367 (0.226)	0.436* (0.226)	-0.0868 (0.364)
Real GDP growth	-0.000318 (0.0131)	-0.000870 (0.0141)	-0.00106 (0.0141)	0.00770 (0.0149)
Curr-To-GDP	0.810 (0.679)	1.431** (0.686)	0.769 (0.708)	-0.510 (0.986)
Constant	7.621*** (0.897)	21.04*** (0.737)	10.65*** (1.391)	10.04*** (1.395)
Country Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
R2	0.162	0.114	0.244	0.256
N	87	82	82	82

**Table 5**  
**Default Risk and Changes in Externally- and Domestically-  
held Debt-to-GDP Ratio**

This table shows the effect of total, externally- and domestically-held debt-to-GDP ratio on default risk between 2007 and 2014. The sample covers Belgium, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal, Spain, the United Kingdom, and the United States. GIIPS is a dummy variable that equals 1 for Greece, Italy, Ireland, Portugal, and Spain. Both externally-held and domestically-held debt-to-GDP ratio are instrumented jointly by the total debt-to-GDP ratio and the strength of legal rights index from the World Bank's World Development Indicators. Real GDP growth is the annual-to-annual growth rate of nominal GDP divided by inflation. Curr-To-GDP is the current account balance to GDP ratio. All independent variables except GIIPS are expressed in percentage points. The dependent variable, 5-Yr CDS, is the 5-Year CDS spread obtained from Bloomberg, expressed in basis points. All columns include time and country fixed effects. Standard errors (in parentheses) are corrected for autocorrelation. \*\*\*, \*\*, and \* indicates statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	5-Yr CDS	5-Yr CDS	5-Yr CDS	5-Yr CDS	5-Yr CDS	5-Yr CDS
Debt-To-GDP	4.815*** (0.766)		4.709*** (0.778)			
Externally-held Debt-to-GDP		10.90*** (2.209)		7.580*** (1.221)		10.85*** (2.101)
Domestically-held Debt-to-GDP		-11.62* (6.923)			15.30*** (4.402)	-12.23* (6.592)
Inflation			21.55*** (6.246)	22.11*** (6.363)	21.85*** (7.169)	22.63*** (6.337)
Real GDP growth			-0.282 (0.393)	-0.265 (0.401)	-0.341 (0.450)	-0.226 (0.399)
Curr-To-GDP			1.966 (15.56)	4.031 (15.79)	15.78 (18.22)	7.917 (15.56)
Constant	-242.4*** (37.33)	-160.0*** (33.18)	-279.8*** (36.50)	-220.6*** (32.19)	-123.2*** (35.59)	-196.0*** (33.92)
Country Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.345	0.401	0.434	0.464	0.287	0.493
N	88	83	87	82	82	82

**Table 6**  
**Default risk and changes in total debt-to-GDP Ratio**

This table shows the effect of total debt-to-GDP ratio on default risk between 2007 and 2014. The sample covers Belgium, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, Portugal, Spain, the United Kingdom, and the United States. GIIPS is a dummy variable that equals 1 for Greece, Italy, Ireland, Portugal, and Spain. Real GDP growth is the annual growth rate of nominal GDP divided by inflation. Curr-To-GDP is the current account balance to GDP ratio. Collateral Value, measured as the ratio of private debts issued by domestic banks to their holdings of domestic sovereign debts, is instrumented by the strength of legal rights index (Creditor Rights) from the World Bank's World Development Indicators. Therefore, Debt-to-GDP  $\times$  Collateral Value is instrumented by Debt-to-GDP  $\times$  Creditor Rights. All independent variables except GIIPS and Collateral Value are expressed in percentage points. The dependent variable, 5-Yr CDS, is the 5-Year CDS spread obtained from Bloomberg, expressed in basis points. All columns include time and country fixed effects. Standard errors (in parentheses) are corrected for autocorrelation. \*\*\*, \*\*, and \* indicates statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	5-Yr CDS	5-Yr CDS	5-Yr CDS	5-Yr CDS	5-Yr CDS	5-Yr CDS
Debt-To-GDP	4.028*** (0.908)	-0.797 (1.188)	5.729*** (1.214)	3.882*** (0.962)	-0.918 (1.280)	5.394*** (1.234)
Debt-To-GDP $\times$ GIIPS		5.568*** (1.037)			5.967*** (1.205)	
Debt-To-GDP $\times$ Collateral Value			-1.430** (0.710)			-1.414* (0.717)
Inflation				0.0550 (8.639)	4.078 (7.556)	-1.609 (8.774)
Real GDP growth				-0.242 (0.384)	-0.0872 (0.335)	-0.322 (0.381)
Curr-To-GDP				15.38 (9.598)	-6.104 (9.406)	20.33* (10.64)
Country Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.735	0.808	0.748	0.745	0.810	0.763
N	100	100	95	99	99	94

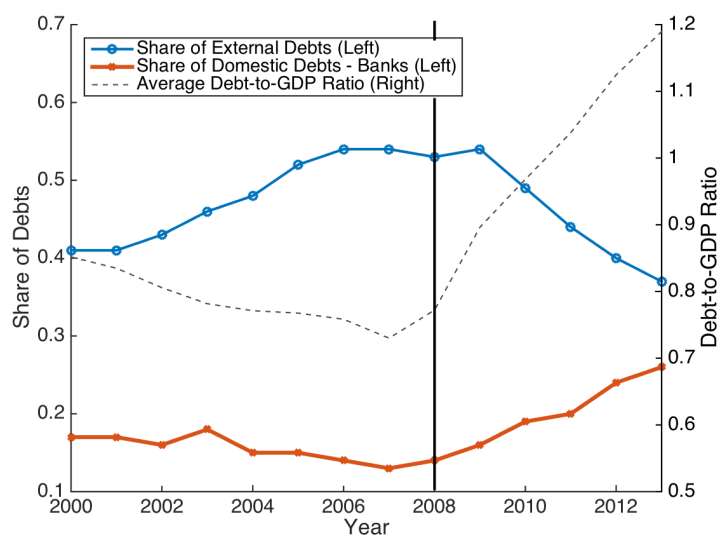


## C Figures

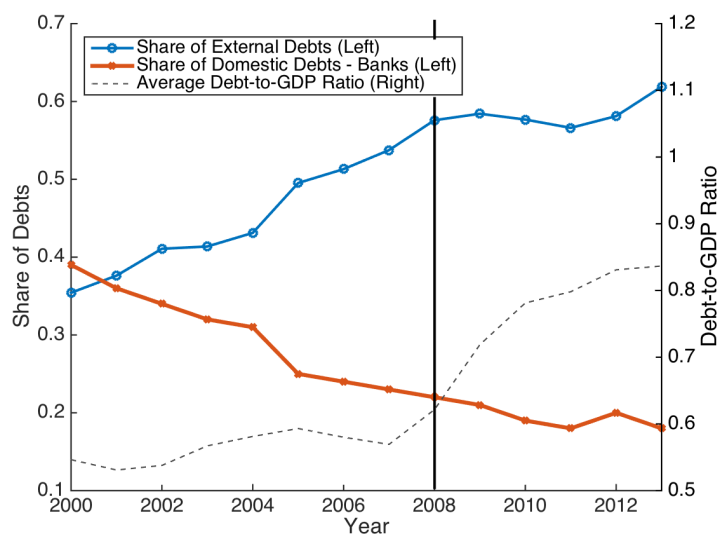
Figure 1

Shares of sovereign debt held by foreign investors and domestic banks (left axis) and Debt-to-GDP ratio (right axis)

GIIPS countries include Greece, Ireland, Italy, Portugal, and Spain. Non-GIIPS countries include Belgium, Finland, France, Germany, Netherlands, the United Kingdom, and the United States. Central bank holdings in issuing countries and debts held by domestic household, pension, and insurance companies are excluded. All series weighted by nominal GDP.



(a) GIIPS Countries



(b) Non-GIIPS Countries

Figure 2

Government Default Policy,  $a^*$  as a function of domestically-held debts,  $b_D$ , for a given debt level  $T$ .

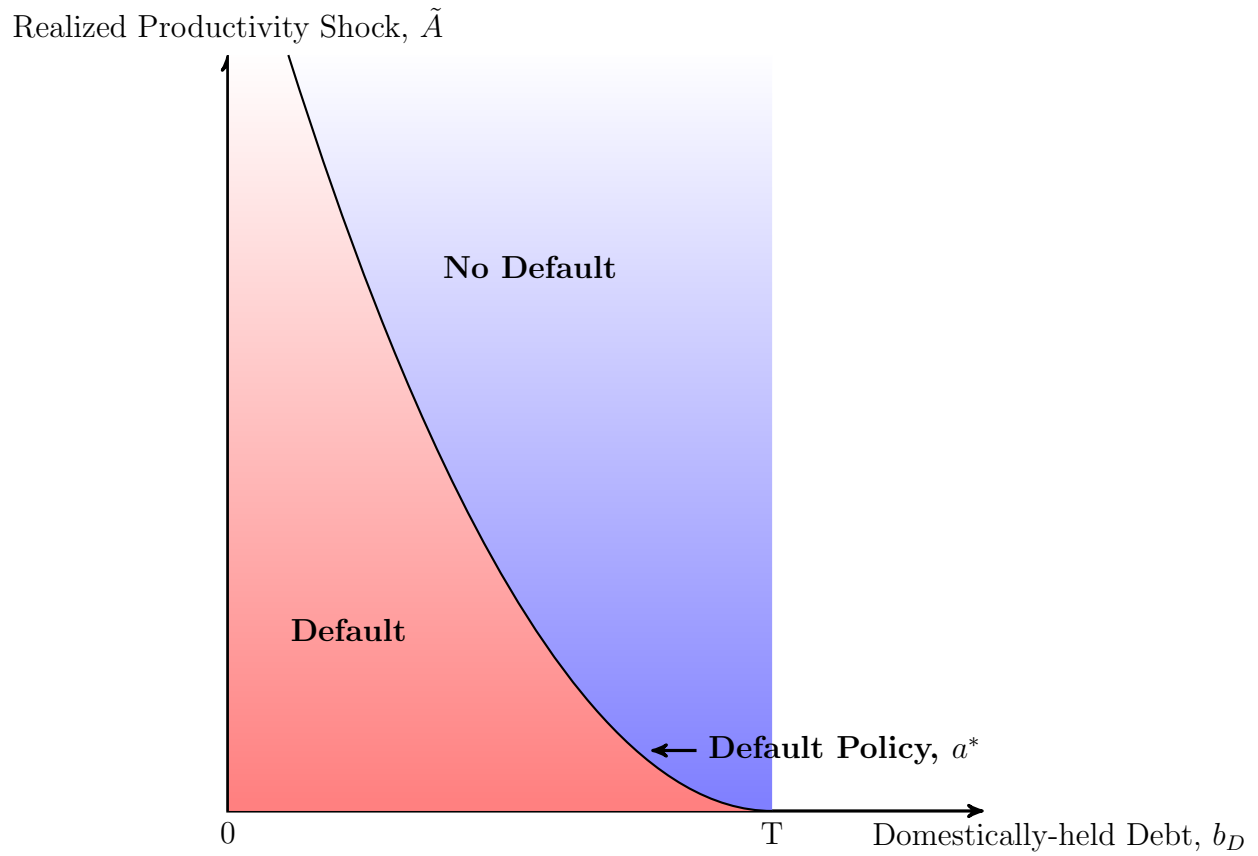
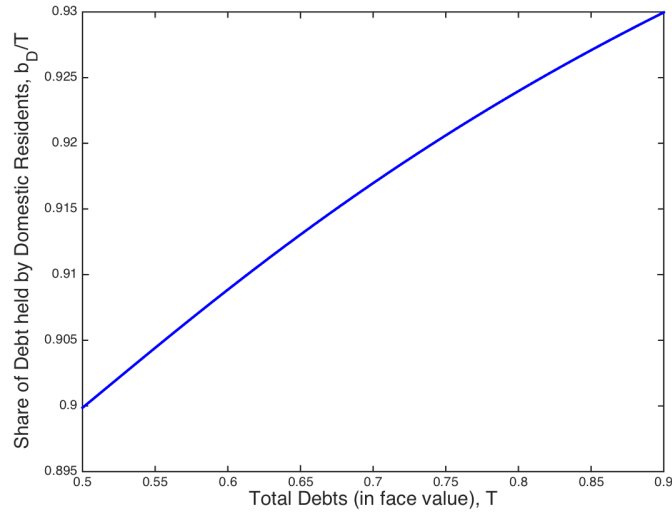
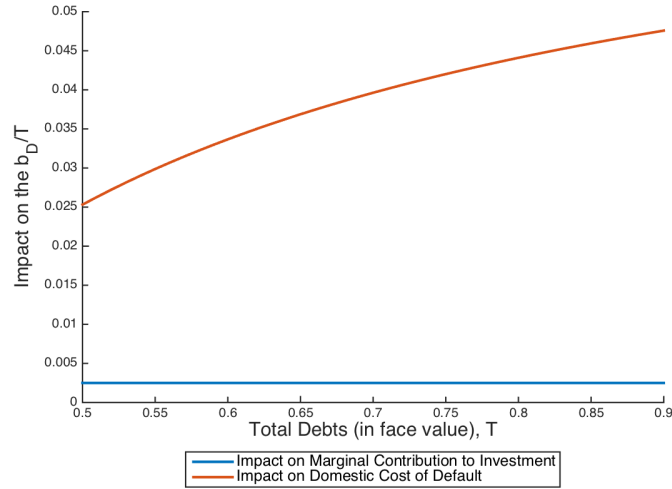


Figure 3

Share of Debt held by Domestic Banks  $b_D/T$  as a function of  $T$  for a country with low collateral value of sovereign debts,  $\lambda = 0.01$ .



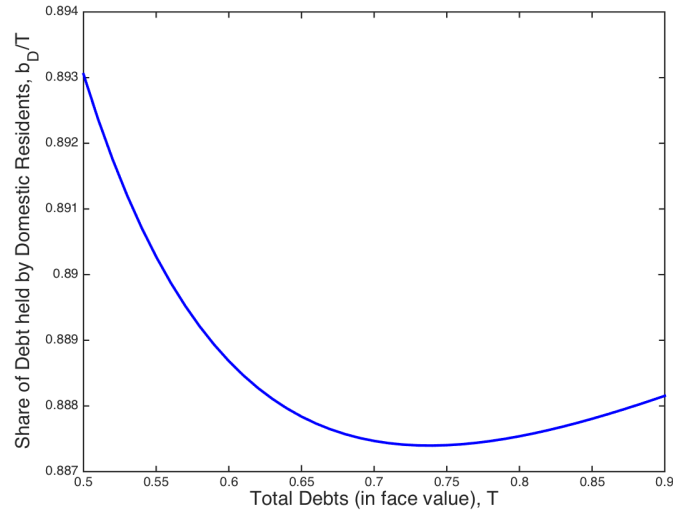
(a) Share of Debts held by Domestic Banks  $b_D/T$  as a function of  $T$



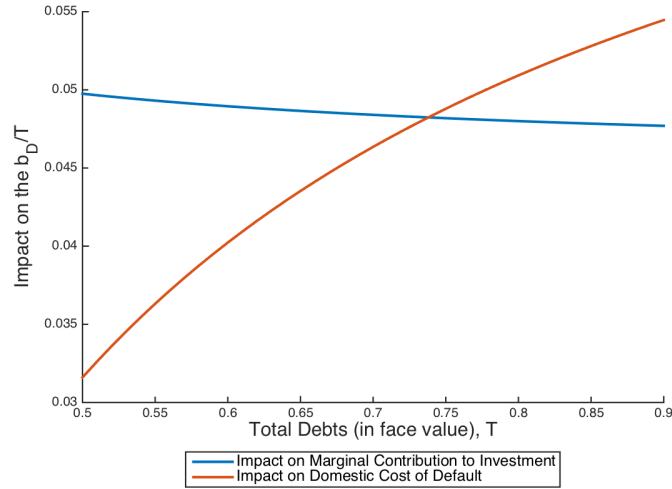
(b) Incentives that determine the Share of Debts held by Domestic Banks  $b_D/T$  as a function of  $T$

Figure 4

Share of Debt held by Domestic Banks  $b_D/T$  as a function of  $T$  for a country with low collateral value of sovereign debts,  $\lambda = 0.2$ .



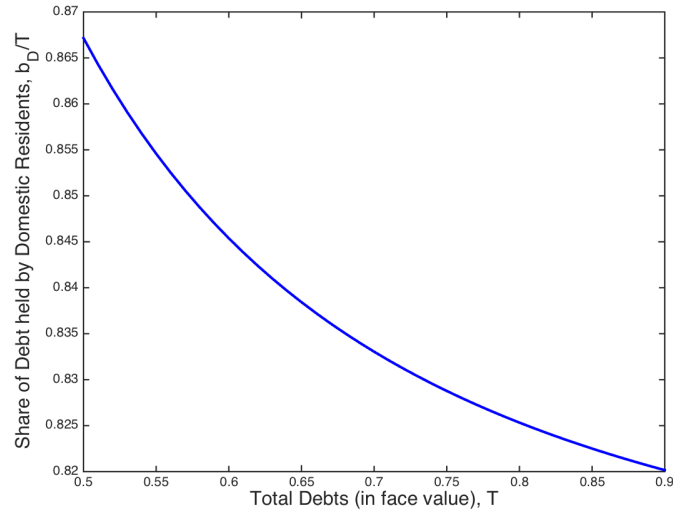
(a) Share of Debt held by Domestic Banks  $b_D/T$  as a function of  $T$



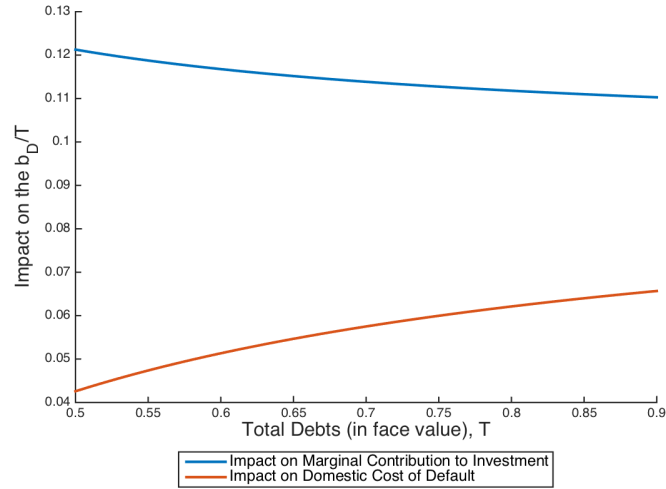
(b) Incentives that determine the Share of Debts held by Domestic Banks  $b_D/T$  as a function of  $T$

Figure 5

Share of Debt held by Domestic Banks  $b_D/T$  as a function of  $T$  for a country with low collateral value of sovereign debts,  $\lambda = 0.5$ .



(a) Share of Debt held by Domestic Banks  $b_D/T$  as a function of  $T$



(b) Incentives that determine the Share of Debt held by Domestic Banks  $b_D/T$  as a function of  $T$

Figure 6

Share of Debt held by Domestic Banks  $b_D/T$  for countries with high collateral values and different domestic cost of default  $c$ .

