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ABSTRACT

Sovereign Default, Domestic Banks and Financial Institutions*

We build a model where sovereign defaults weaken banks' balance sheets because banks hold sovereign bonds, causing private credit to decline. Stronger financial institutions boost default costs by amplifying these balance-sheet effects. This yields a novel complementarity between public debt and domestic credit markets, where the latter sustain the former by increasing the costs of default. We document three novel empirical facts that are consistent with our model's predictions: public defaults are followed by large private credit contractions; these contractions are stronger in countries where banks hold more public debt and financial institutions are stronger; in these same countries default is less likely.

JEL Classification: F34, F36, G15 and H63

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1 Introduction

Recent sovereign debt crises highlight a close link between government default and financial sector turmoil where banks often take centre stage. In the Russian default of 1998 the government's suspension of debt payments triggered large losses on the balance sheets of Russian banks, who had heavily invested in public bonds. These events, further exacerbated by the devaluation of the Ruble, allegedly contributed to cause a financial sector meltdown and a credit crunch. Although particularly severe, the Russian episode is by no means exceptional. During the years 1998-2002, the same link between government default, bank bond-holdings and banks' balance sheets appear to have played a key role in Ecuador, Pakistan, Ukraine and Argentina (IMF, 2002).

The current debt crisis in Europe also illustrates the link between government default and financial fragility. The downgrading of Greek public bonds in April 2010 raised concerns about the solvency of Greek and other European banks precisely because of their exposure to Greek bonds. Similar concerns arose with respect to banks exposed to other European states facing distressed public finances such as Portugal and Spain. In this context, market participants viewed the €750 billion package committed by the E.U. to avoid public defaults as a way to sustain the continent's banking sector, whose exposure to the bonds of the financially distressed states is estimated to be in the order of one trillion Euros (The Economist, 2010).¹

These events strike at the very heart of the notion that governments can always default on their debts in a fully discriminatory manner, or perfectly engineer post-default bailouts, so as to avoid hurting domestic agents. In reality, banks appear to suffer severe losses on public bondholdings when their government defaults, suggesting that there may be large domestic costs of public default that extend beyond international penalties and loss of reputation (Sturzenegger and Zettelmeyer, 2006). Avoiding these domestic costs may be a prominent reason why governments repay their debts. Crucially, these events also point to the importance of financial institutions such as investor rights and corporate governance. By shaping the extent to which public default hurts banks and credit, these institutions may shape the cost of default and thus the governments' incentive to repay in the first place. Some evidence suggests that public default risk is indeed lower in more developed financial systems (Reinhart et al. 2003, Kraay and Nehru 2006), but the specific mechanisms for

¹Before the E.U.package, Dexia, Société Générale and Crédit Agricole, who were estimated to have large exposures to Greek bonds of 14% to 35% of their Net Asset Values, had cumulative average excess returns of -9.5% in the 10-day window around the downgrade by Moody's and Standard&Poor's of Greek bonds in April 2010. By contrast, large banks (BBVA, Santander, BPE, Barclays, RBS, and Lloyds) who were estimated to have a small exposure had an excess return of -1.7%. [Authors' computations using the Standard & Poor's 350 Europe].

why this is the case remain to be understood.

This paper studies this link between public default, domestic financial markets and debt sustainability, both theoretically and empirically. We build a simple model of public borrowing in which the government is opportunistic and can default on its debts. In the spirit of Broner and Ventura (2010), it is assumed that default is non-discriminatory. In this model, domestic banks choose to hold public bonds as a store of liquidity (Holmström and Tirole 1993), implying that the government's decision to default involves a trade-off. On the one hand, default beneficially increases total domestic resources for consumption, as some public bonds are held abroad. On the other hand – and in line with the aforementioned debt crises – a default hurts domestic banks holding the other public bonds, thereby hampering credit, investment, and output.²

In this setup we find that better financial institutions increase the government's cost of default via two main effects. First, better institutions boost the leverage of banks. Higher leverage allows banks to finance a higher level of real investment, but - most important - it amplifies the impact of an adverse shock to the banks' balance sheets. That is, a government default will disrupt more real activity and generate a larger social cost in countries where better financial institutions allow banks to be more leveraged. Second, for a given amount of public debt, better financial institutions allow the country's private sector to attract more foreign financing. Larger capital inflows to the country's private sector in turn increase the cost (and reduce the benefit) of default for the government by allowing: i) domestic banks to boost leverage, enhancing credit and investment and, ii) domestic agents to hold more public debt, reducing the share of such debt that is externally held.

If financial institutions are sufficiently good, these two effects are so strong that they discipline the government into repaying its debt. The key insight of the model is that financial institutions generate a complementarity between public borrowing, private credit markets and private inflows. By attracting private inflows, strong institutions reduce the government's incentive to default, facilitating public borrowing. By contrast, the inability of institutionally weak countries to attract or retain private capital boosts public default risk, reducing credit and output. As we discuss in Section 3.3, this complementarity, which is absent from existing sovereign risk models where no distinction is made between public and private capital flows, can shed light on the synchronization of booms and busts in the private and public financial sectors (Reinhart and Rogoff 2010).

²The government may try to default and bail out domestic banks, *de facto* restoring discrimination. Section 6.1.6 however shows that this option may not be feasible due to the very foundation for non-discrimination in our setup: the presence of secondary markets (Broner et al. 2010). There are of course many other reasons (such as the government's imperfect information on the quality of banks) that limit the effectiveness of bailouts in reality.

In Section 4 we document the link between government default and domestic financial markets, on which there is to date little systematic evidence.³ We build a large panel of emerging and developed countries over the years from 1980 to 2005. We measure the quality of financial institutions by using the “creditor rights” score of La Porta et al. (1998), which is the leading institutional predictor of credit markets development around the world (Djankov et al. 2007). Among other things, our data allows us to control for country fixed effects – that is, for all time invariant differences among countries that may be spuriously associated with financial institutions – as well as for major domestic and external economic shocks. We first document that, in line with anecdotal evidence, public defaults are followed by large and systematic drops of aggregate financial activity in the defaulting country. Crucially then, we find strong and robust correlations that are consistent with the following subtler predictions of our model: the post-default credit crunch is stronger in countries where banks hold more public debt, and where financial institutions are stronger.

The data also show that, consistent with our model: i) the probability of public default is lower in countries where financial institutions are stronger and intermediaries hold more public debt; and ii) improvements in financial institutions allow greater government borrowing.⁴

We extend the work on sovereign debt by stressing the role of domestic financial markets in reducing the government’s temptation to default. Most existing models of sovereign debt build on Eaton and Gersovitz’s (1981) insight that repayment is enforced by the threat of market exclusion [see Eaton and Fernandez (1995) for a review]. By calibrating a reputational model, Arellano (2008) finds that loss of market access is not sufficient to account for the observed low frequency of defaults: a large domestic output cost is also needed. Our paper provides a micro-foundation for such an output cost. To highlight our theory, we study a finite horizon setting where reputational concerns are absent.

Our approach is related to studies of sovereign debt repayment under the assumption of non-discriminatory default. Guembel and Sussman (2009) consider a political economy mechanism, Brutti (2009) studies a model where default destroys firms’ ability to insure against idiosyncratic shocks. The paper closest to our approach is Basu (2009), who built – independently from us –

³Borensztein and Panizza (2008) show that public defaults are associated with banking crises; Brutti (2009) shows that after default more financially dependent sectors tend to grow relatively less; Arteta and Hale (2008) use firm level data to show that syndicated lending by foreign banks to domestic firms declines after default; and Reinhart and Rogoff (2010) document the co-occurrence of private and public financial crises. To the best of our knowledge, we are the first to look at the impact of default on aggregate measures of financial intermediation and to study how such effect depends on a country’s financial institutions and banks’ bondholdings.

⁴We also find that public default risk is lower, and sovereign borrowing larger, in countries whose private sector receives larger capital inflows, which is consistent with the idea of complementarity.

a model where the government trades off the consumption gain arising from default with the cost of destroying banks' capital; in Basu's model, however, banks' public bondholdings are forced by the government rather than being optimally chosen. More broadly, our key theoretical innovation with respect to these works is to study the role of financial institutions and private capital flows. Our paper is also related to Sandleris (2009), who builds a model in which public defaults lead to output losses because they send a negative signal regarding the state of the economy.

Finally, several papers study the effect of private contracting frictions on capital flows [Gertler and Rogoff (1990), Caballero and Krishnamurthy (2001), Matsuyama (2004), Aoki et al. (2009)]. These works show that financial institutions shape a country's borrowing by affecting the share of output that domestic residents can pledge to foreigners, but they do not consider public debt and default. In our model the government can instead expand total borrowing from foreigners because the adverse impact of public default on domestic markets effectively allows the government to commit to repay. In the language of Caballero and Krishnamurthy (2001), we endogenize a country's external collateral constraint as a function of its domestic collateral constraint.

2 The Basic Model

2.1 Setup

2.1.1 Preferences and Technology

There is a small open economy (Home) that lasts for three periods $t = 0, 1, 2$. The economy is populated by a measure one of agents and by a benevolent government. There is an international financial market that is able and willing to lend or borrow any amount at an expected return equal to the (gross) interest rate r_t^* . We assume initially that $r_t^* = 1$ for all $t = 0, 1, 2$.

Residents of Home ("domestic residents") are risk neutral and indifferent between consumption in the three dates. A fraction β of them consists of "banks" or "bankers," denoted by B , while the remaining fraction $(1 - \beta)$ consists of "savers", denoted by S . All domestic residents receive an endowment from the economy's "traditional sector" equal to $\omega_0 < 1$ at $t = 0$ and to $\omega_{1j} > 1$ at $t = 1$, for $j \in \{S, B\}$. We assume that $\omega_{1B} > \omega_{1S}$ and use $\omega_1 = \beta \cdot \omega_{1B} + (1 - \beta) \cdot \omega_{1S} > 1$ to denote the total endowment of Home at $t = 1$.

Besides receiving their endowments, domestic residents have access to a linear investment project at $t = 1$ in the economy's "modern sector." This project yields A_j units of the consumption good at $t = 2$ per unit invested at $t = 1$, for $j \in \{S, B\}$. Bankers are more productive than savers, i.e.

$A_B \geq 1 = A_S$ (for simplicity, only banks generate a social surplus). This difference in productivity, which could be due to a greater ability of banks in monitoring projects (e.g. Diamond 1984), creates a benefit for savers to lend resources to bankers so that they can be productively invested. Productivity A_B is stochastic and becomes known at the beginning of $t = 1$, taking value $A_H > 1$ with probability $p \in (0, 1)$ and $A_L = 1$ with probability $(1 - p)$. This allows us to study the cyclical properties of public default. We use $\pi \in \{H, L\}$ to index the state of productivity.

At $t = 0$ there is an indivisible investment of size 1 that the government wants to undertake. To finance this investment, the government taxes domestic residents lump-sum. Since $\omega_0 < 1$, however, the public investment requires borrowing from foreigners at $t = 0$.

2.1.2 Financial Markets

To finance the public project at $t = 0$ and investment at $t = 1$, the government and bankers need to borrow. They do so by issuing one-period, non-contingent financial claims. We refer to claims issued by banks as deposits (d) and to claims issued by the government as public bonds (b). We use b_j and d_{jt} to respectively denote the holdings, by agents of type $j \in \{S, B\}$, of public bonds and of deposits originated at time $t \in \{0, 1\}$: when $d_{jt} < 0$, agents of type j are issuers of deposits. We denote by r_b the (gross) contractual interest rate promised by public bonds, by r_{dt} the (gross) contractual interest rate promised by deposits originated at t . Since public bonds are only issued at $t = 0$, none of the variables associated to them require a time subscript.

Although all claims in our economy are in principle non-contingent, they are subject to enforcement frictions that effectively make them contingent on full or partial default. Crucially, these frictions are different for deposits and public bonds. Public bonds are subject to public default risk. That is, the government opportunistically decides which fraction of its maturing bonds to repay in each period. Since the government is benevolent, its repayment decision seeks to maximize the welfare of domestic residents. By contrast, private deposits are subject to imperfect court enforcement: if a bank defaults, only a share α of its revenues is seizeable by depositors. If $\alpha = 1$, the bank can pledge all of its revenues to depositors and financial frictions are non-existent. These frictions rise as α falls below 1. The level of α captures the quality of financial institutions and, in particular, the strength of investor protection at home.⁵

⁵The structure of enforcement frictions here departs from the traditional sovereign risk literature, which either focuses only on public debt (e.g. Eaton and Gersovitz 1981) or it assumes that the enforcement of private contracts is *entirely* dependent on a strategic decision by the government (e.g. Broner and Ventura 2010). Our assumption captures an intuitive pecking order where it is easier for governments to default on public debt rather than to disrupt

Under these enforcement frictions, the payments delivered by public bonds and deposits originated at $t = 0$ may be ex-post contingent on the state of productivity $\pi \in \{H, L\}$. Taking this into account, and letting $\rho^\pi \leq 1$ denote the share of its contractual obligations that the government decides to repay in state $\pi \in \{H, L\}$, we denote by $r_b^\pi = \rho^\pi \cdot r_b$ the (gross) ex-post return of government bonds. Likewise, we denote by $r_{d0}^\pi(\rho^\pi) \leq r_{d0}$ the ex-post return of bank deposits originated at time $t = 0$, where we take into account that this ex-post return may also be affected by public default. As for deposits originated at $t = 1$, they are not subject to any uncertainty and hence there is no difference between their ex-ante and ex-post returns, both of which we denote by r_{d1}^π . Finally, we use $r_0 = E_0(r_{d0}^\pi)$ to denote the expected return of deposits originated at $t = 0$. Note that all of these returns are specified independently of the identity of the assets' holder. This is because, despite being subject to different enforcement frictions, both public bonds and deposits are enforced in a non-discriminatory fashion. The timing of the model is described below.

1. $t = 0$: Domestic residents receive ω_0 . Financial markets open. Public bonds are issued and banks accept deposits from savers. Given the respective contractual interest rates r_b , r_{d0} and r^* on government bonds, deposits and foreign bonds, agents optimally determine their portfolio. If possible, the public investment is undertaken.
2. $t = 1$: The state of productivity $\pi \in \{H, L\}$ is revealed. Domestic residents receive ω_{1j} , $j \in \{B, S\}$. All promises issued at $t = 0$ mature. The government chooses what share $\rho^\pi \in [0, 1]$ of its outstanding obligations $r_b \cdot b$ to repay, where b denotes the total amount of bonds issued by the government. Repayment is financed via lump-sum taxation τ , where

$$\tau(b, \rho^\pi) = \rho^\pi \cdot r_b \cdot b, \tag{1}$$

so that a default ($\rho^\pi < 1$) is associated to a lower taxation of domestic residents. Financial markets open, promises are issued and modern-sector investment is determined.

3. $t = 2$: Output is realized and promises issued at $t = 1$ mature.

legal institutions. The ability of governments to directly intervene in private contracts appears to be quite limited. For instance, during the 2002 default the Argentine government tried to interfere with private contracts by forcing the “pesification” (at non-market exchange rates) of all dollar denominated private sector assets and liabilities. Many creditors, however, took legal action against the government, which was forced to “redollarize” the assets (Sturzenegger and Zettelmeyer 2005). Of course, in particularly severe crises the government *could* be tempted to alter domestic institutions, rendering this pecking order irrelevant.

t=0	t=1	t=2
ω_0 realized	A_B becomes known ω_1 realized	Output realized
	Asset payments made GOVERNMENT REPAYMENT / TAXATION	Asset payments made
Asset Markets Open	Asset Markets Open	
Public investment	Private investment	

Figure 1

The main feature of our timing is that when the government decides whether or not to repay its debt banks have not yet issued new deposits. Hence, there is scope for the government's repayment decision to affect financial markets and investment, which lies at the heart of our story. Equation (1) captures the key assumption of nondiscriminatory public policy (with respect to both default and taxation). Section 6.1.6 formally shows how such non-discrimination naturally arises in the presence of secondary markets.

We now analyze the equilibrium of our economy. We first consider a financially closed economy, in which the government can sell bonds to foreign and domestic residents but the latter cannot borrow or lend internationally. This provides a benchmark that enables us to isolate the effects of private capital flows, which we introduce in Section 3.

A competitive equilibrium of our economy is a set of portfolio decisions by agents, a government repayment decision and a set of expected and ex-post returns on assets such that (i) given asset returns, portfolio decisions are optimal; (ii) asset markets clear; (iii) returns on government bonds are consistent with government optimization, and; (iv) returns on deposits are consistent with imperfect enforcement. We focus on symmetric equilibria, in which all agents of the same type hold the same portfolio.

2.2 Equilibrium in deposit markets

We first characterize the equilibrium in deposit markets, without reference to the government's repayment decision, starting with the market at $t = 1$ and then working our way back to study the market at $t = 0$. We then consider the government's default decision.

2.2.1 Equilibrium in the deposit market at $t = 1$

Let W_j^π be the wealth of an individual of type $j \in \{B, S\}$ when financial markets open at $t = 1$ and the state is π ; this includes the individual's endowment plus any payments obtained/made from assets purchased/issued at $t = 0$. Upon learning A_π at $t = 1$, a bank entering the period chooses its level of deposits d_{B1} by solving:

$$\max_{d_{B1}} A_\pi \cdot (-d_{B1} + W_B^\pi) + r_{d1} \cdot d_{B1} \quad \text{subject to,} \quad (2)$$

$$-d_{B1} \cdot r_{d1}^\pi \leq \alpha \cdot A_\pi \cdot (-d_{B1} + W_B^\pi) \quad \text{for } d_{B1} < 0, \quad (3)$$

for $\pi \in \{H, L\}$, where Equation (3) represents the bank's credit constraint. The equilibrium interest rate on deposits must be lower than the productivity of investment, i.e. $r_{d1}^\pi \leq A_\pi$, since otherwise banks would not want to attract any deposits. It must also be true that $r_{d1}^\pi > \alpha \cdot A_\pi$, since otherwise a bank could attract an infinite amount of deposits. Under these conditions, the banking system's demand of funds at $t = 1$ is given by

$$\beta \cdot \frac{\alpha \cdot A_\pi}{r_{d1}^\pi - \alpha \cdot A_\pi} \cdot W_B^\pi, \quad (4)$$

and aggregate investment by the banking system is in turn given by,

$$I^\pi(W_B^\pi) = \beta \cdot \frac{r_{d1}^\pi}{r_{d1}^\pi - \alpha \cdot A_\pi} \cdot W_B^\pi. \quad (5)$$

Equations (5) and (4) show that greater investor protection α enhances the ability of banks to leverage their wealth, attracting more deposits and expanding their investments at $t = 1$.

The supply of funds at $t = 1$ depends on the wealth of savers. If $r_{d1}^\pi > 1$, savers are willing to lend all of their wealth $(1 - \beta) \cdot W_S^\pi$ to banks. If $r_{d1}^\pi = 1$, savers are indifferent between lending and not lending and their supply of funds is given by the interval $[0, (1 - \beta) W_S^\pi]$.

There are two types of equilibria in the deposit market at $t = 1$. In the first type, deposits at $t = 1$ are constrained by banks' ability to absorb savings: in such an equilibrium, $r_{d1}^\pi = 1$ and the demand for funds in Equation (4) falls short of the supply. Modern-sector investment is constrained by banks' wealth, yielding a social surplus of

$$(A_\pi - 1) \cdot \beta \cdot \frac{1}{1 - \alpha \cdot A_\pi} \cdot W_B^\pi. \quad (6)$$

This type of equilibrium arises when $\alpha \leq \alpha^{\max}$, where α^{\max} is defined as

$$\alpha^{\max}(\beta; \pi) = \frac{(1 - \beta) \cdot W_S^\pi}{A_\pi \cdot [\beta \cdot W_B^\pi + (1 - \beta) \cdot W_S^\pi]}. \quad (7)$$

The second type of equilibrium corresponds instead to the case in which investor protection is very strong, i.e. $\alpha > \alpha^{\max}(\beta; \pi)$, and banks are capable of absorbing all domestic wealth to invest it in the modern sector. Now the social surplus of this investment equals

$$(A_\pi - 1) \cdot [\beta \cdot W_B^\pi + (1 - \beta) \cdot W_S^\pi]. \quad (8)$$

Inspection of Equations (6) and (8) shows that social surplus is positive only if $\pi = H$ and $A_B = A_H > 1$, and it also allows us to establish the following preliminary result:

Lemma 1 *If $\alpha \leq \alpha^{\max}$, investment is constrained by banks' wealth. In this case, modern sector surplus is increasing in banks' wealth W_B^π and in investor protection α . If $\alpha > \alpha^{\max}$, modern sector surplus is constrained only by total domestic wealth, and it is independent of α .*

The key point here is that if $\alpha \leq \alpha^{\max}$, investment is limited by banks' ability to borrow. In this range, higher bank capital, better investor protection and a larger banking sector reduce the severity of financial frictions, expanding investment and surplus. Crucially, the wealth of banks and savers, as well as the need for intermediation at $t = 1$, depends on the equilibrium portfolios at $t = 0$ and on the government's repayment decision. We study these below.

2.2.2 Equilibrium in the deposit market at $t = 0$

At $t = 0$, any deposits raised by banks can only be invested in public bonds. Since these bonds must be attractive to the international financial market, their expected return must satisfy $E_0(r_b^\pi) = r^* = 1$. If the expected interest rate on deposits also equals one, i.e. $r_0 = 1$, savers are indifferent between holding public bonds and bank deposits; if instead $r_0 > 1$, savers deposit all of their initial endowment $(1 - \beta) \cdot \omega_0$ in banks.

Consider now a bank that raises $-d_{b0} = (b_B - \omega_0)$ in the deposit market at $t = 0$ to purchase a total of b_B public bonds. Due to enforcement frictions, any such bank must satisfy:

$$r_0 \cdot (b_B - \omega_0) \leq \alpha \cdot (\omega_{1B} + b_B), \quad (9)$$

where we have taken into account the fact that $E_0(r_b^\pi) = 1$. By constraint (9), expected payments on deposits cannot exceed a share α of the bank's expected revenues at $t = 1$. If a bank demands the maximum amount of bonds allowed by Equation (9), its bondholdings are equal to:

$$b_B = \min \left\{ \frac{\omega_0 + \alpha \cdot \omega_{1B}}{1 - \alpha}, \frac{\omega_0}{\beta} \right\}. \quad (10)$$

The first term in brackets captures bondholdings when deposits are constrained by (9): in this case, banks cannot purchase all domestically held public bonds; as a result, $r_0 = 1$ and the amount $(\omega_0 - \beta \cdot b_B)$ of public debt is held by savers.⁶ Formally, this case arises if

$$\alpha \leq \alpha_0(\beta) \equiv \frac{(1 - \beta) \cdot \omega_0}{\omega_0 + \beta \cdot \omega_{1B}}. \quad (11)$$

When instead $\alpha > \alpha_0(\beta)$, savers deposit their whole endowment in banks. In this case $r_0 > 1$ and banks use all domestic resources to purchase public bonds, so that $\beta \cdot b_B = \omega_0$ as shown by the second term in brackets in Equation (10).

Equation (10) holds only if banks actually want to hold as many bonds as possible, i.e. if constraint (9) is binding. This is the case in equilibrium if the government is expected (i) to repay its debt if productivity is high (i.e. $A_B = A_H$), but (ii) to fully default otherwise. In the next section, we show that this strategy is indeed optimal for the government if it is ever to repay.⁷ Since $E_0(r_b^\pi) = 1$ then, the ex-post return on public bonds when productivity is high must compensate investors for the probability of default, i.e. $r_b^H = 1/p$. Thus, by borrowing from savers to buy one government bond, a bank increases its revenues by $(1/p - 1) > 0$ units in state $\pi = H$ and decreases them by 1 unit in state $\pi = L$. That is, banks are eager to buy public bonds because these bonds enable them to transfer resources from the unproductive to the productive state of nature, in which they earn rents from investment equal to $A_H - r_{d1}^H$.

This idea is reminiscent of Holmström and Tirole's (1993) notion that public debt provides liquidity, expanding firms' ability to invest. In their model, firms need liquidity when they suffer a negative shock that requires them to invest, and public bonds provide such liquidity. In our model,

⁶See Section 6.1.1 in the Appendix for a more detailed derivation of domestic bondholdings. Throughout, we assume that whenever domestic residents are indifferent between investing in government bonds and not doing so, they invest all of their available resources in government bonds. In a sense, then, we determine the weakest possible conditions under which government debt is sustainable in equilibrium.

⁷As is usually the case in this class of economies, there is also a pessimistic equilibrium in which the government is expected to fully default on its debt regardless of realized productivity at $t = 1$. In such an equilibrium, no bonds are issued because there is no demand for them. Consequently, the government does not make any decisions regarding repayment on the equilibrium path, beliefs are not proven wrong and they are therefore consistent with equilibrium.

banks need liquidity when the economy is productive and investment opportunities abound: public bonds, with their procyclical returns, are good at providing such liquidity. Because of this, banks choose to hold bonds in equilibrium. We consider this to be an attractive feature of our model. At the same time, there are many other reasons, most notably government regulation, for why banks may want to hold public bonds in reality. Our mechanism for debt repayment, however, does not hinge upon any particular reason behind banks' holdings of public debt. Besides, as we show in Section 4, banks' holdings of public debt in emerging markets often exceed regulatory constraints, implying that regulation is probably not the whole story.

2.3 Government default

We now analyze the government's repayment decision. Only if the government can commit to repay bondholders at $t = 1$ can the public project be financed. After productivity $\pi \in \{H, L\}$ is realized at $t = 1$, the government chooses what share $\rho^\pi \in [0, 1]$ of its debt to repay. To understand the government's incentives, note that debt repayment affects the domestic distribution of wealth. The wealth of an agent of type $j \in \{B, S\}$ at $t = 1$ is given by,

$$W_j^\pi = \omega_{1j} + r_b \cdot \rho^\pi \cdot [b_j - b] + r_{d0}^\pi(\rho^\pi) \cdot d_{j0}, \quad (12)$$

where we have used the government's budget constraint and the fact that $r_b^\pi = \rho^\pi \cdot r_b$.

Equation (12) shows that the impact of government repayment ρ^π on the wealth of type- j individuals depends on their holdings of public bonds. If $b_j \geq b$, the wealth of these individuals is increasing in ρ^π , because the share of the debt they own exceeds their share of the tax burden required to service the debt. Thus, for this type of agents, the benefit of government repayment is larger than the cost. The opposite is true when $b_j < b$.

Keeping this in mind, the government chooses ρ^π at $t = 1$ to maximize social welfare:

$$[\beta \cdot W_B^\pi + (1 - \beta) \cdot W_S^\pi] + (A_\pi - 1) \cdot I^\pi(W_B^\pi), \quad (13)$$

for $\pi \in \{H, L\}$, which is the sum of total domestic wealth (the first term in brackets) plus the surplus generated by modern sector investment. The government's trade-off is straightforward. On the one hand, as long as foreigners hold some debt, default beneficially boosts the total wealth of domestic agents, i.e. the first term in Equation (13). On the other hand, if banks hold a sufficiently large amount of government bonds, default hurts the wealth of the banking system, reducing modern-

sector investment and lowering the second term of Equation (13). By redistributing wealth away from banks, default may ultimately reduce investment and output.

Of course, for this redistribution to be costly it must be that investment is productive. As a result, repayment never occurs in the low productivity state when $A_B = A_L = 1$, i.e. $\rho^L = 0$. If the government is ever to repay, it only does so when productivity is high, i.e. when $A_B = A_H > 1$, implying that in such state the government must pay an interest rate $r_g^H = 1/p$.⁸ Since public defaults can only affect social surplus if $\pi = H$, we now focus on this state, denoting by $\alpha^{\max}(\beta)$ the level $\alpha^{\max}(\beta; H)$ of investor protection beyond which in $\pi = H$ all domestic wealth is invested.

2.3.1 Default, Sustainable Debt and Financial Institutions

Suppose now that productivity is high at $t = 1$, i.e. $A_B = A_H > 1$. Focus first on the case where $\alpha \leq \alpha^{\max}(\beta)$, so that $r_{d1}^H = 1$ and investment is constrained by banks' wealth. Public debt here is sustainable when the government finds it optimal to repay, setting $\rho^H = 1$. By using the definition of W_B^H from Equation (12), it can be shown that – as long as $\alpha \leq \alpha_0$ and some bonds are in the hands of savers – this is the case if:

$$(\omega_0 - 1) + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot (\omega_0 + \alpha \cdot \omega_{1B} - 1) \geq 0, \quad (14)$$

where $\omega_0 + \alpha \cdot \omega_{1B}$ reflects the bondholdings of banks b_B from Equation (10).⁹ The first term in Equation (14) is negative and it captures the decline in total domestic resources caused by repayment. The second term instead captures the impact of repayment on the after-tax revenue of banks and thus on investment, and it is positive as long as bondholdings are high enough and $\omega_0 + \alpha \cdot \omega_{1B} > 1$. Public debt is only sustainable if $\omega_0 + \alpha \cdot \omega_{1B} > 1$, so that the capital of banks increases in repayment ρ^H . When this is the case, then, incentives to repay are increasing in investor protection α . There are two reasons for this.

First, for a given amount of banks' bondholdings, higher levels of α enable banks to increase their leverage to expand modern-sector investment. Consequently, balance-sheet effects become stronger and the adverse impact of default on investment increases in α , as captured by the multiplier $1/(1 - \alpha \cdot A_H)$ above. This is the key effect of the model, for balance-sheet effects hinder financing precisely through leverage. Second, higher α enhances debt sustainability by increasing

⁸In order for lump-sum taxation to be feasible, we assume throughout that $\omega_0 + \omega_{1S} > 1/p$.

⁹The appendix also considers the case where $\alpha > \alpha_0$ and $b_B = \frac{\omega_0}{\beta}$.

banks' ability to raise deposits to buy public bonds at $t = 0$, thus increasing banks' exposure to a public default. This second effect is not necessary for our results, it just makes them stronger. When these effects are jointly considered, Equation (14) defines a minimum level of investor protection $\alpha^{\min}(\beta)$ that is necessary for public debt to be sustainable. The shaded area in the following figure depicts the combinations (α, β) for which $\alpha > \alpha^{\min}(\beta)$:

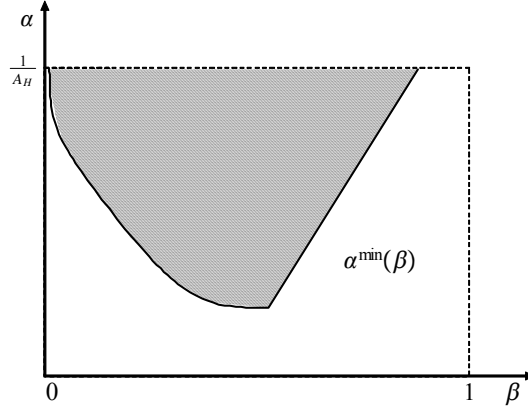


Figure 2

Note that $\alpha^{\min}(\beta)$ is non-monotonic in the share of bankers β . If $\beta \rightarrow 0$, incentives for repayment are only provided if α is high so that the few existing banks i) hold a disproportionately high share of public bonds and ii) are highly leveraged. If instead there are many banks ($\beta \rightarrow 1$) there is not much need for intermediation and a public default is necessarily beneficial. Public debt sustainability requires bank intermediation to be sizeable.

Consider now the other relevant case $\alpha > \alpha^{\max}(\beta)$, in which investment is constrained not by banks' wealth but by total domestic wealth. Now the government's first order condition becomes

$$A_H \cdot (\omega_0 - 1) < 0, \quad (15)$$

which is always negative because some of the public bonds are held abroad. Thus, when $\alpha > \alpha^{\max}(\beta)$, the government never has an incentive to repay in full and so the optimal level of public debt $b = 1$ is not sustainable. Intuitively, even if default hurts the balance sheets of banks, it also increases total domestic wealth by $(1 - \omega_0)$. If the domestic financial system is efficient enough to channel all of these resources to the modern sector, a public default boosts investment even though it hurts banks. Figure 3 below summarizes our discussion by shading the combinations (α, β) for which the optimal level of debt is sustainable:

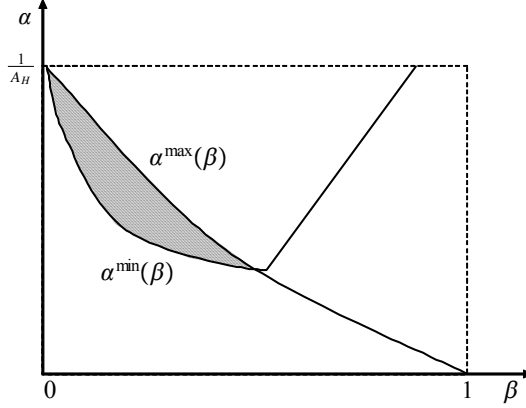


Figure 3

The Proposition below states the conditions for debt sustainability in the closed economy:

Proposition 1 *In the closed economy, the government can finance the public project if and only if (α, β) is such that $\alpha \in [\alpha^{\min}(\beta), \alpha^{\max}(\beta)]$. In this case, the government borrows at a contractual rate equal to $r_b = 1/p$, and it repays if and only if $A_B = A_H$. The set of combinations (α, β) fulfilling the previous condition is non empty if $p > p^*$, where p^* is a given threshold.*

Proof. See Appendix. ■

2.4 Discussion

As in recent sovereign debt crises, in our model public default hurts domestic banks because they hold public bonds in equilibrium. Because of non-discriminatory enforcement, the government is unable to avoid the costs of default by repaying only those bonds in the hands of the banking system while defaulting on the rest. Because of non-discriminatory taxation, the government is unable to avoid the costs of default by bailing out the banking system through direct subsidies. Section 6.1.6 in the Appendix argues that one way to theoretically justify both of these assumptions is through the presence of secondary markets for public bonds (Broner et al. 2010), which enable agents to effectively circumvent any attempt to discriminate by the government.¹⁰ Regardless of the particular reason that is ultimately invoked to limit the government's ability to discriminate, our mechanism relies on the existence of such limits, which make it impossible to fully avoid the costs associated to public defaults.

¹⁰ Another natural reason for which the effectiveness of bailouts might be limited is the presence of asymmetric information, which might require the government to transfer resources to productive and unproductive banks alike in an attempt to mitigate the adverse effects of a default.

In our setting, these costs of default – and thus the government’s ability to commit to repay ex-ante – are strongly affected by domestic financial institutions via two conflicting effects. On the one hand, higher levels of α strengthen the cost of default by enhancing the impact of adverse balance-sheet effects on investment. In institutionally more developed countries banks are more leveraged, which enhances financial fragility. On the other hand, if financial institutions are very good then banks become more resilient and, even though they suffer from a public default, they may still be able to intermediate all domestic wealth to investment.

Although it provides a useful conceptual benchmark, this second effect seems unlikely to be important in reality. First, the levels of α required for it to play a role may be implausibly high since, as recent events have shown, balance-sheet effects are important even in the most developed financial systems. More importantly, we point to another reason why this effect may not be relevant in reality: the presence of private capital flows. To see this, we extend our model to the more realistic case of an open economy and use it to derive our main empirical predictions.

3 The open economy: private and public capital flows

Suppose that the capital account of our economy opens up, allowing private agents to borrow from and lend to the international financial market at $t = 0$ and $t = 1$. The effects of private capital flows are best analyzed by considering two cases. In the first case, $r^* = 1$ and the domestic economy is (weakly) an importer of private capital. In the second case, $r^* > 1$ and the domestic economy may (but need not) become an exporter of private capital.

3.1 The Case of Capital Importers

If the world interest rate is equal to one at all dates ($r_0^* = r_1^* = 1$), opening up to private flows relaxes the domestic resource constraint at $t = 0$ and at $t = 1$. Both of these effects, we now argue, enhance the sustainability of public debt.

At $t = 1$, private inflows enable domestic banks to boost leverage by attracting deposits also from the international financial markets. Investment is no longer constrained by the total domestic wealth. Formally, this implies that investment is monotonically increasing in α , which eliminates the constraint represented by $\alpha^{\max}(\beta)$. From the viewpoint of $t = 0$, private inflows enable bankers and savers to expand their holdings of public bonds by borrowing abroad, as the domestic private sector can intermediate between its government and foreigners. This boosts the government’s

incentive to repay ex-post, shifting down the constraint represented by $\alpha^{\min}(\beta)$.

Formally, the condition for debt sustainability in the open economy when $r^* = 1$ is equal to:

$$(\omega_0 + \alpha \cdot \omega_1 - 1) + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot (\omega_0 + \alpha \cdot \omega_{1B} - 1) \geq 0. \quad (16)$$

In comparison to Equation (14), the first term above reflects the fact that domestic holdings of public bonds can now exceed ω_0 , because domestic residents can borrow against their future endowment ω_1 to purchase them. Likewise, the expression in parentheses in the second term reflects the fact that a bank's bondholdings now equal its pledgeable endowment $\omega_0 + \alpha \cdot \omega_{1B}$. Trivially, public debt is always sustainable once α is large enough to satisfy $\alpha \cdot \omega_1 \geq 1 - \omega_0$ because now foreign borrowing allows domestic residents to purchase all public bonds and sustainability is guaranteed. Equation (16) implies that:

Proposition 2 *When $r_0^* = r_1^* = 1$, there exists a threshold $\alpha_{open}^{\min}(\beta) < \alpha^{\min}(\beta)$ such that the government can finance the public project for all combinations (α, β) for which $\alpha \geq \alpha_{open}^{\min}(\beta)$.*

Proof. See Appendix. ■

Besides their direct effect on private investment, capital inflows are also beneficial for public debt sustainability. By expanding investment at $t = 1$ and domestic holdings of public bonds at $t = 0$, these inflows make default more costly. The darker area below shows how allowing for private inflows expands the set of economies for which the public project is financed:

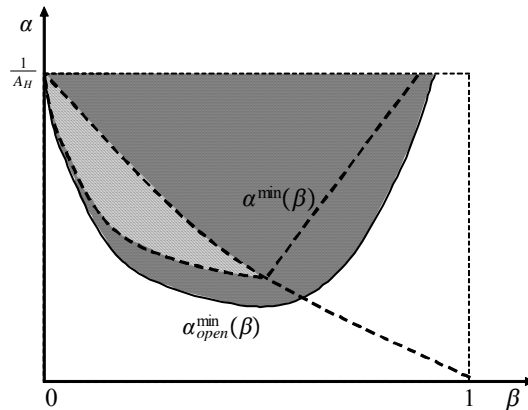


Figure 4

3.2 The Case of Capital Exporters

Consider now the case of a capital exporter, for which the autarky interest rate lies below r^* . We keep matters simple by assuming that $r_0^* = 1$ but $r_1^* \in (1, A_H)$.¹¹ In equilibrium, it is still true that $E_0(r_b^\pi) = E_0(r_{d0}^\pi) = 1$ but now the domestic interest rate at $t = 1$ equals r_1^* . As before, the ability of banks to attract deposits from the foreigners at $t = 1$ eliminates the constraint represented by $\alpha^{\max}(\beta)$ and the condition for debt sustainability becomes:

$$(\omega_0 + \alpha \cdot \omega_1 - 1) + \frac{A_H - r_1^*}{r_1^* - \alpha \cdot A_H} \cdot \beta \cdot (\omega_0 + \alpha \cdot \omega_{1B} - 1) \geq 0. \quad (17)$$

As in Equation (16), all domestic residents can now increase their total purchases of public bonds at $t = 0$ by borrowing abroad, which enhances debt sustainability. However, insofar as it leads to an increase in the equilibrium interest rate at $t = 1$, financial liberalization also induces capital outflows and reduces investment. This reduces the leverage of domestic banks and, consequently, the negative effects of public defaults on investment. Through this last effect, financial liberalization may decrease debt sustainability. Formally:

Proposition 3 *Let $\alpha_{open}^{\min}(\beta, r_1^*)$ be defined as the smallest level of α satisfying Equation (17), for $\beta \in (0, 1)$. There exists a threshold $\underline{r} \in (1, A_H)$ such that $\alpha_{open}^{\min}(\beta, r_1^*) > \alpha^{\min}(\beta)$ whenever $r_1^* > \underline{r}$.*

Proof. See Appendix. ■

Proposition 3 is most interesting when it is applied to economies where $\alpha \in [\alpha^{\min}(\beta), \alpha^{\max}(\beta)]$. These are economies whose α is sufficiently low that in the absence of financial liberalization $r_{d1}^H = 1$. Provided the international interest rate r_1^* is sufficiently high, financial liberalization reduces debt sustainability in these economies, as shown below:

¹¹We want to assess the effects of liberalization when the international interest rate is higher than the one prevailing at Home under autarky. In our model, that cannot happen at $t = 0$ because the government sells bonds to domestic residents and to foreigners in a unified market.

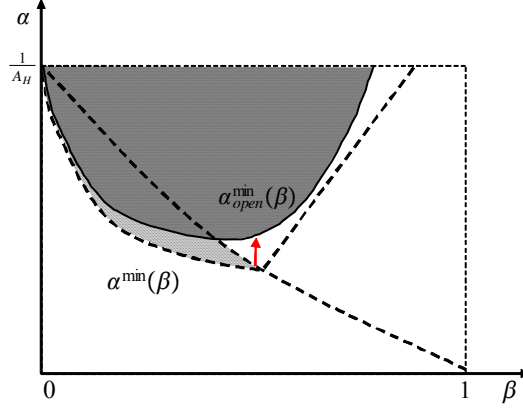


Figure 5

Liberalization lowers the cost of default in countries with low autarky interest rate by inducing private capital outflows from these countries. This possibility increase the minimum level of institutional quality $\alpha_{open}^{\min}(\beta)$ at which public debt is sustainable. As a result, the government of a capital-exporting economy may benefit from imposing controls to prevent the outflow of capital: beyond yielding a direct benefit when the return to domestic investment is higher than the international interest rate ($A_B > r_1^*$), such controls indirectly enhance public debt sustainability.

3.3 Discussion of the main results

In our model, private capital inflows boost the government's ability to borrow while capital outflows may do the reverse, so that private and public borrowing are complements.¹² Complementarity arises because public defaults cause costly disruptions in private financial markets that increase in the size and efficiency of the latter. It is precisely by boosting, via domestic intermediation and capital inflows, the size of domestic markets that good institutions reduce public default risk.

This idea of complementarity highlights a two-way interaction between public default and domestic financial markets. In our model, not only does default disrupt these markets, but any shock independently affecting the latter affects the government's incentive to default as well. We already saw an instance of this channel: in our model default is counter-cyclical precisely because when banks' productivity A_B is low, governments have less of an incentive to repay in order to preserve banks' balance sheets. But government incentives can be undermined by other shocks to banks. For example, a reduction in β could be used to represent a banking crisis at $t = 1$, capturing those

¹²This result differs from existing international finance models in which capital flows to the public and private sectors are substitutes. In models with full commitment and complete markets, substitutability stems from Ricardian equivalence. In models of sovereign risk, the government decides whether to enforce all of the country's external debt, so that substitutability arises because such enforcement decision depends on the total amount of payments.

states of nature in which a fraction of the original banks are revealed to be funding unproductive projects. It is easy to see in Equation (14) that this kind of shock to banks also reduces the government’s incentives to repay. Another shock hurting domestic markets and boosting public default risk is an increase in the international interest rate, for $\alpha_{open}^{\min}(\beta, r_1^*)$ is increasing in r_1^* [see Equation (30) in the appendix]. Intuitively, higher levels of r_1^* lead to capital outflows, reduce the size of domestic markets, hindering public debt sustainability. In these cases, higher degrees of institutional quality and thus of leverage are required in order to avoid public defaults.

This two-way link between public default and private markets is consistent with the evidence of Reinhart and Rogoff (2010) that during periods of “bonanza” there is a run up in both private and public debt that gives way, as financial markets unexpectedly deteriorate, to a co-occurrence of public default, banking crises and financial sector collapse.^{13,14} Besides rationalizing these cycles, complementarity can shed light on why, during temporary private sector crises, governments in emerging economies often find it difficult to borrow and provide domestic liquidity support.

Although both directions of this two-way link play an important role in reality, in this paper we primarily focus on the adverse impact of public defaults on domestic markets. The reason is that both directions ultimately require that public defaults disrupt domestic financial markets. To empirically test for this channel, we summarize our main predictions in the following corollaries, which are based on the results of Propositions 1-3. First, denote by PC_1 private credit at $t = 1$, which is equal to the volume of bank deposits in Equation (4). By using the definition of banks’ wealth in Equation (12), we obtain our most immediate prediction:

Corollary 1 *Public default should reduce private credit:*

$$\frac{\partial PC_1}{\partial \rho^\pi} = \beta \cdot \frac{\alpha \cdot A_\pi}{r_1^* - \alpha \cdot A_\pi} (b_B - 1) > 0. \quad (18)$$

Comparing two otherwise identical economies, the one in which the government defaults ($\rho^\pi < 1$) should have lower private credit than the one where the government fully repays its debt ($\rho^\pi = 1$).¹⁵ It is easy to see that Equation (18) yields two subtler predictions:

¹³We wish to stress that ours is a positive analysis, focusing on why public and private financial markets may move in the same direction. Reinhart and Rogoff (2010), raise also normative questions as to whether complementarity beneficially allows a country to relax its financing constraints or whether it amplifies deeper, not necessarily benign, forces such as investors’ misperceptions of risks. We leave these normative questions to future research.

¹⁴Of course, this might not be the only channel through which economic activity affects the likelihood of public default. An alternative explanation is that these shocks have fiscal implications that directly affect the cost of repayment for the government (see Arellano and Kocherlakota 2008).

¹⁵Note that Equation (18) must hold in equilibrium, for if $b_B < 1$ public debt is not sustainable ex-ante.

Corollary 2 *The post-default contraction in private credit should be stronger in countries with: (i) better financial institutions, as $\partial^2 PC_1 / \partial \rho^\pi \partial \alpha > 0$, and; (ii) higher holdings of public debt by domestic banks, as $\partial^2 PC_1 / \partial \rho^\pi \partial b_B > 0$.*

Finally, consider the impact of institutions on ex-ante default risk. To see this, suppose that an indebted government faces an unexpected increase in the international interest rate r_1^* at $t = 1$. Such shock may or may not cause a default depending on whether, at the new interest rate, the government's first-order condition [i.e. either Equation (16) or (17)] is met. This implies that:

Corollary 3 *The frequency of default should be (weakly) lower in countries with: i) better financial institutions, i.e. higher α , and; (ii) higher holdings of public debt by domestic banks b_B .*

Intuitively, in these countries the cost of default is higher at any interest rate r_1 , as illustrated by the fact that the government's first order conditions are more likely to be slack.

This concludes the theoretical discussion of our model. Section 6.1.6 in the Appendix demonstrates formally that these predictions are robust to allowing the government to bail out domestic banks after default and also to other modification of our baseline setup.

4 Empirical Analysis

We now look for evidence on our three main predictions in Corollaries 1, 2 and 3. We also check if countries with better financial institutions can sustain more public debt (which is a straightforward prediction of our model) and if there are traces of complementarity, whereby countries whose *private* sectors attract more foreign capital sustain more public debt and default less often.

Our tests are based on a large panel of emerging and developed countries over the years from 1980 to 2005, which we constructed by combining data from the IMF's International Financial Statistics (IFS) and the World Bank's World Development Indicators (WDI) (see Table AI in the Appendix for a description of variables and sources).¹⁶ Section 4.1 deals with the ex-post tests of Corollaries 1 and 2, Section 4.2 with the ex-ante ones.¹⁷

¹⁶The countries included are Algeria, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Indonesia, Ireland, Israel, Italy, Japan, Kuwait, Malaysia, Mexico, Morocco, New Zealand, Norway, Panama, Philippines, Poland, Portugal, Romania, Saudi Arabia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, United States.

¹⁷Our theory has also predictions for the impact of default on modern sector investment that mirror the ones for credit. Here we focus only on credit because it is hard to identify in our aggregate data the relevant finance intensive modern sector. Using industry level data, Brutti (2009) finds that industries that are more financially dependent grow less in defaulting countries. See also Borensztein and Panizza (2008) for a similar analysis.

4.1 Default, Institutions and Domestic Intermediation

To test for the ex-post link between default and domestic financial markets, we use as our main dependent variable the change in the annual ratio of private credit provided by deposit money banks and other financial institutions to GDP, which is drawn from Beck, Demirgüç-Kunt, and Levine (2000). This widely used measure is an objective, continuous proxy for the size of domestic credit markets. We focus on private credit changes – rather than levels – to control for persistence in the level of private credit. One drawback of such proxy is that it may capture the impact of default on GDP, obscuring the link between default and credit. We thus perform our tests also by using the percent change in private credit as our dependent variable.

We follow the existing literature and proxy for sovereign default with a dummy variable based on Standard & Poor’s definition of default as the failure of a debtor (government) to meet a principal or interest payment on the due date (or within the specified grace period) contained in the original terms of the debt issue. A debt restructuring where the new debt contains less favorable terms than the original issue is also counted as default.¹⁸

We proxy for the quality of a country’s financial institutions with the creditor rights index of Djankov, McLiesh and Shleifer (2007), who compute it for 133 countries for every year between 1978 and 2003, extending the methodology first introduced by La Porta et al. (1998).¹⁹ This index is the leading “institutional” predictor of credit market development around the world and directly maps into the parameter α of our model. Consistent with existing work, in our sample the raw correlation between private credit to GDP and the creditor rights index is positive, large (24.9%) and statistically significant at the 1% level.

We proxy domestic banks’ holdings of public debt with financial institutions’ net claims to the government relative to their total assets, following Kumhof and Tanner (2008). Table AII in the

¹⁸As most of existing work, we focus on whether a default occurs and not on monetary measures of creditors’ recovery such as the loss given default, for two main reasons. First, estimates of creditors’ losses given defaults (“haircuts”) are heavily dependent on the assumptions one makes about counterfactuals (e.g. Sturzenegger and Zettelmeyer 2005). Second, it is widely accepted that sovereign defaults are very large and disruptive events. Moody’s (2007) estimates the average recovery rate on sovereign bonds as 55% on an issuer-weighted basis, and 29% on a volume-weighted basis. Sturzenegger and Zettelmeyer (2005) find that even under the most conservative assumptions, recovery rates range from a minimum of 13% to a maximum of 90% of the bonds’ par value.

¹⁹The creditor rights index measures four powers of secured lenders in bankruptcy: (1) whether there are restrictions, such as creditor consent, when a debtor files for reorganization; (2) whether secured creditors are able to seize their collateral after the petition for reorganization is approved, that is, whether there is no automatic stay or asset freeze imposed by the court; (3) whether secured creditors are paid first out of the proceeds of liquidating a bankrupt firm; and (4) whether an administrator, and not management, is responsible for running the business during the reorganization. A value of one is added to the index when a country’s laws and regulations provide each of these powers to secured lenders. The creditor rights index aggregates the scores and varies between 0 (poor creditor rights) and 4 (strong creditor rights).

Appendix clearly shows that in our data the debtholdings of banks are large and vary sharply across countries. In our model banks hold government bonds to store liquidity, but an alternative explanation is that governments “force” domestic banks to hold public debt, for example by granting public debt a preferential status for the purpose of meeting reserve requirements. Figure 6 plots reserve requirements, which include, but are not limited to, public debt, against domestic banks’ holdings of public debt (figures are country averages across 2001-2003, sources are O’Brien 2007 and Beck et al. 2000). Details on bank bondholdings, on reserve requirements and on their sources are reported in Table AII in the Appendix.

Figure 6 shows that banks’ debtholdings are well above reserve requirements for 12 out of the 17 countries for which these data are available. It thus appears that banks may often directly benefit from holding public debt, and are not just forced by the government to hold them, at least as far as mandatory reserve requirements are concerned.²⁰

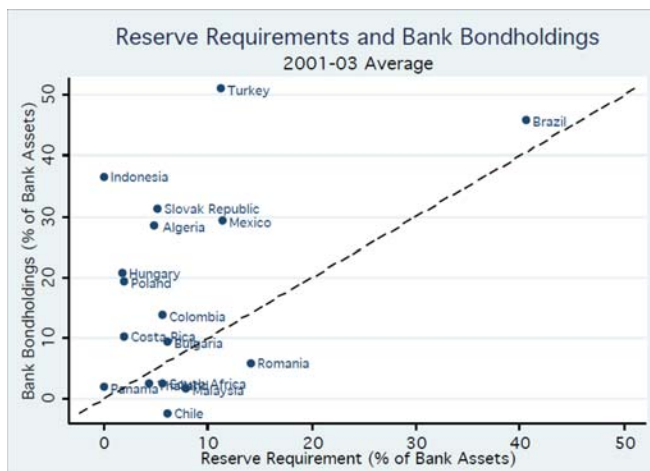


Figure 6

We evaluate the prediction of Corollary 1 on the negative impact of country i 's default at time

²⁰In our model, greater creditor rights enable banks to attract more savings and thus to purchase more public bonds. In the data, however, we find no significant relationship between bank bondholdings and creditor rights across countries (see Figure AI in the Appendix). One reason for this might be that, in financially developed economies, there is a greater private supply of liquid assets to compete with government bonds. In any case, our empirical finding differs from Kumhof and Tanner (2008), who document a negative relationship between banks’ holdings of public debt and an index of the quality of law. We believe that, for our purposes, the creditor rights index is a better indicator. This index directly measures the quality of financial institutions. Rule-of-law indices are instead survey based and tend to reflect broader differences in the level of development across countries. Moreover, data on creditor rights is available over a longer time series (1978-2003).

$t - 1$ on private credit in the same country at time t by running the pooled OLS regression:

$$(\text{Change in Private Credit})_{i,t} = \alpha_i + v_t + \beta_1 (\text{Sovereign Default})_{i,t-1} + X'_{i,t-1}\gamma + \epsilon_{i,t}, \quad (19)$$

where α_i and v_t are country and time effects, respectively, while $X'_{i,t-1}$ is a vector of lagged control variables. Our model predicts that in this regression $\beta_1 < 0$.

We then evaluate the predictions of Corollary 2 that the drop in private credit following a public default should be stronger in countries with better institutions and where domestic banks hold more public debt by running the regression:

$$\begin{aligned} (\text{Change in Private Credit})_{i,t} = & \alpha_i + v_t + X'_{i,t-1}\gamma + \beta_1 (\text{Sovereign Default})_{i,t-1} \\ & + \beta_2 (\text{Sovereign Default})_{i,t-1} \cdot (\text{Creditor Rights})_{i,t-1} \\ & + \beta_3 (\text{Sovereign Default})_{i,t-1} \cdot (\text{Bondholdings})_{i,t-1} + \epsilon_{i,t}, \end{aligned} \quad (20)$$

where, as before, α_i and v_t are country and time effects while $X'_{i,t-1}$ is a vector of control variables. Our model predicts that in this regression $\beta_2 < 0$ and $\beta_3 < 0$.²¹

An obvious concern for us is that an empirical association between sovereign default and a decline in credit flows may be due to endogeneity. There are two main possibilities. First, an economic shock may cause default and a decline in credit flows to occur jointly even if a direct link between them does not exist or it exists but it is different from the one stressed by our model. Second, some countries may be intrinsically more prone to both public *and* private debt crises than others, for instance because of country-specific historical or policy factors influencing both financial development and government default.

We address these concerns in two ways. First, we select appropriate control variables. To control for country-specific factors affecting both private credit flows and sovereign defaults, we include country fixed effects in our regressions. Fixed effects alone are not a panacea against omitted variables but capture all time-invariant differences across countries, such as those arising from long-run differences in the quality of economic policy. With respect to economic shocks, we control for those that are common across countries (e.g. changes in world interest rates) by

²¹As in all cross-country empirical studies, especially those involving emerging economies, data availability issues strongly affect sample size. For our study, this implies a sample period of 1980-2005 for regressions without creditor rights, and of 1980-2003 otherwise. Further data limitations related to the availability of control variables restrict the sample period to start in 1986 in some specifications. Below and in the next section we discuss in detail the sample composition in each and every test we perform.

including time dummies in our regressions.

After controlling for country and time fixed effects, the only remaining source of endogeneity potentially concerns country-specific shocks, particularly those that may trigger both a government default and a drop in private credit. We are not concerned by the possibility that these shocks may affect our measure of financial institutions. Unlike other measures of financial development, the creditor rights index is in fact remarkably persistent over time and it varies systematically in the cross section with the legal system transplanted by colonizers many centuries ago (La Porta et al. 1998, Djankov et al 2007).²² We thus identify proxies that the existing literature views as the main predictors of default and decline in credit. A worsening of a country’s domestic economy due to productivity or demand shocks may not only lead to a credit crunch but also to default (by reducing the government’s resources and incentive to repay). We thus control for GDP per capita growth and unemployment growth in our regressions. We also control for inflation, which is often associated with public debt crises and affects the (nominal) volume of credit. External shocks may also play a role. A speculative currency attack may trigger capital outflows, inducing credit crunch and default. We control for exchange rate depreciation to account for this and other channels whereby a currency’s instability can lead to private and public crises.

One particular concern in our analysis is the possibility that a prior, persistent financial sector weakening may induce public default. As discussed in Section 3.3 this channel is also consistent with our model, but here we wish to isolate the *direct* effect of default on credit markets. To address this issue, we control in our regressions for ex-ante default risk, a time-varying index computed by the International Country Risk Guide (ICRG), which proxies for the assessed risk of public default at $t - 1$. This measure combines several factors that make a country more prone to default *and* less attractive for foreign investors. Controlling for ex-ante default risk helps us purge our estimated coefficients from fluctuations in credit markets due to changes in investors’ prior expectations of public default including, but not limited to, those associated with anticipated shocks to banks and credit markets. As a result, we can be more confident of identifying our effects from relatively unanticipated default events. To address the impact of financial markets weakening on public

²²We directly illustrate this point by replicating the empirical tests of Corollary 2 and 3 by substituting the creditor rights index with its country average. More generally, one would ideally like to explicitly use the colonial origin of the country’s legal system as an instrument for creditor rights, as English common law countries have more developed financial markets than civil law countries, due not only to their superior creditor rights but also to other dimensions of their financial institutions such as shareholder rights and securities laws (see La Porta et al. 2008 for a review). However, the features of our data prevent us from using legal origin as an instrument, because all defaulting countries in our sample belong to the civil law legal origin. In other words, no country from the English common law legal origin has defaulted in our sample, perhaps because these countries are more financially developed.

default more thoroughly, we also control in our regressions for proxies of sudden stops and banking crises. As we later discuss, we report the results in table AIII in the appendix to save space. In table AIV in the appendix we also perform a system of equations estimation to control for potential correlations in the shocks causing default and credit crunches.^{23,24}

The second general strategy we use to address these and other residual endogeneity concerns is to use non-parametric propensity score matching methods. That is, we compare changes in private credit for country-year pairs that are matched along a set of important (time-varying) country characteristics that potentially affect a country’s propensity to default, and that only differ in whether a default actually occurred or not. This strategy also complements our earlier control for default risk, and increases our confidence that we are identifying the effects of relatively unanticipated default events. One advantage of non-parametric propensity score matching methods is that they allow to relax the assumption of linearity in the relationship between default and private credit. The results confirm our predictions and corroborate our earlier findings of pooled OLS regressions, and we report them in Table AV the Appendix to save space.

We now begin our ex-post analysis by presenting descriptive figures that provide a transparent and intuitive outlook on our main predictions, and then move to the regression results.

4.1.1 Default and Domestic Intermediation

Figure 7 below plots the average change in private credit to GDP following default and no default events (a similar figure obtains if we use medians). After a default in $t - 1$, the change in private credit from $t - 1$ to t is equal to -0.19 as a percent of GDP, as compared with 1.68 for country-years following no default. These differences, which go in the direction suggested by our model, are large in economic terms and statistically significant at the 1% level.

²³This empirical strategy is also valid to distinguish our mechanism from another potential channel, not present in our model, through which a weakening of the financial sector might generate a public default. We refer to this as the “bailout channel”: if the government is implicitly committed to bailing out the banking sector in the event of distress, a weakening of the sector might increase public liabilities enough to trigger a government default.

²⁴To avoid identifying our effects from outliers, throughout our analysis we perform a careful and thorough sensitivity analysis. We check for the presence of influential observations by computing the DFbetas from each regression in Table 1 and 2 (see, e.g., Belsley, Kuh and Welsch (1980, p. 28)). DFbetas measure, for each observation, how much a coefficient would change if that observation were dropped from the data. Consistent with Belsley et al. (1980), we define an observation as influential if its $|DFbeta| > 1$. We present the results obtained by excluding such observation. After each regression, we list the observations (if any) dropped according to this criterion.

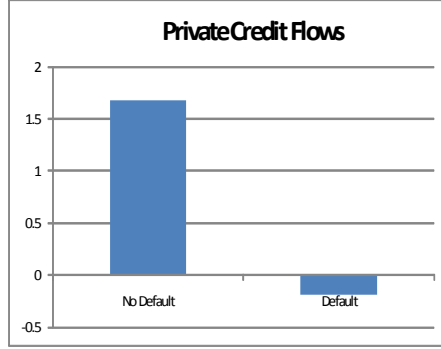


Figure 7

Table I below reports the results from estimating various specifications of Equation (19). In columns (1)-(3) the dependent variable is the annual change in private credit as a percent of GDP, in columns (4)-(6) it is the annual percent change in private credit. Country effects are treated as fixed in specifications (2) and (5), and as random in specifications (3) and (6). Standard errors are heteroskedasticity-consistent and clustered at the country level (the latter whenever the number of countries is large enough to allow reliance on asymptotics).

In our baseline regression of column (1), the coefficient on the sovereign default dummy is negative and significant, confirming the prediction of Corollary 1 that countries are more likely to experience a lower flow of private credit following a sovereign default. The results also indicate that private credit flows increase with GDP per capita growth and decrease with unemployment growth. In columns (2) and (3) we also include inflation, exchange rate depreciation and country effects (fixed in column (2), random in column (3)). The coefficient on the default dummy remains significant and its value is virtually unaffected by the inclusion of these additional controls. The Hausman test cannot reject the null of no difference in coefficients between the fixed effects and the random effects specification, implying that the random effects estimator is efficient.

Table I - Default and Private Financial Markets²⁵

	Private Credit Flows to GDP			Private Credit % Flows			Private Debt Flows to GDP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(Sovereign Default) _{t-1}	-0.028** (0.011)	-0.024* (0.014)	-0.028** (0.012)	-0.053* (0.028)	-0.086** (0.043)	-0.074** (0.036)	-0.007** (0.003)	-0.016*** (0.005)	-0.007* (0.004)
(GDP p.c. Growth) _{t-1}	0.326*** (0.117)	0.415*** (0.131)	0.353*** (0.119)	1.714*** (0.378)	0.393*** (0.079)	0.444*** (0.079)	0.143*** (0.032)	0.020 (0.012)	0.033*** (0.012)
(Unemployment Growth) _{t-1}	-0.058*** (0.013)	-0.046*** (0.012)	-0.055*** (0.012)	-0.067 (0.053)	-0.140*** (0.053)	-0.141*** (0.050)	0.003 (0.009)	-0.001 (0.006)	-0.002 (0.009)
(Default Risk) _{t-1}	0.003 (0.024)	-0.022 (0.041)	-0.002 (0.024)	-0.049 (0.073)	-0.173 (0.103)	-0.077 (0.072)	-0.009 (0.006)	-0.049*** (0.012)	-0.015** (0.006)
(Inflation) _{t-1}		0.000 (0.003)	0.000 (0.003)		-0.028* (0.016)	-0.028* (0.016)		-0.002** (0.001)	-0.002** (0.001)
(Exc. Rate Depreciation) _{t-1}		0.000 (0.002)	0.000 (0.002)		0.033*** (0.009)	0.034** (0.009)		0.001* (0.001)	0.002** (0.001)
Constant	0.021 (0.020)	-0.001 (0.034)	0.013 (0.028)	0.092 (0.056)	0.099 (0.085)	0.164** (0.069)	-0.009** (0.005)	-0.020*** (0.009)	-0.009* (0.005)
Time dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects?	No	. Fixed..	Random	No	. Fixed..	Random	No	. Fixed..	Random
Hausman χ^2			16.11			80.37***			69.4***
Clustered Std Errors?	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
No Observations	698	698	698	698	698	698	297	297	297
No Countries	46	46	46	46	46	46	22	22	22
No Defaults	46	46	46	46	46	46	43	43	43
Adjusted R ²	0.096	0.090	0.096	0.278	0.266	0.275	0.216	0.143	0.199

Columns (4), (5) and (6) show that the results are very similar when we use the percent change of private credit as a dependent variable. The coefficient in column (5) implies that private credit in year t is 8.6% lower than in year $t-1$ following a sovereign default, while the coefficient in column (2) implies that such decrease amounts to 2.4% of GDP, showing that public default indeed appears to exert a strong adverse impact on domestic credit markets.

Arteta and Hale (2008) document a negative effect of default on firms' access to foreign syndicated loans. To see whether a link between default and external capital is also present in the aggregate, columns (7), (8), and (9) estimate Equation (19) by using as independent variable the annual change in privately held external debt as a percent of GDP. We find that after public default

²⁵The table presents panel regressions for 46 countries over the 1980-2005 period. The dependent variable in columns 1 to 3 private credit flows to GDP is computed as (private credit to GDP in year t) - (private credit to GDP in year $t - 1$). The dependent variable in columns 4 to 6 private credit % flows is computed as (private credit in year t) - (private credit in year $t - 1$), as a percent of private credit in year $t - 1$. The dependent variable in columns 7 to 9 debt flows to GDP is computed as (private debt in year t) - (private debt in year $t - 1$). Sovereign default is a discrete variable that equals one if the sovereign is in default in year $t-1$, zero otherwise. Standard errors (in parentheses below the coefficient estimates) are adjusted for heteroskedasticity using the Huber (1967) and White (1980) correction, as well as for clustering at the country level using the Huber (1967) correction, wherever specified. *** indicates significance at the 1 percent level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

there is a significant reduction in *private* capital inflows, which may be due to the lower ability of domestic banks to borrow abroad – as suggested by our model – but it may also reflect other links between the domestic economy and foreign financing.

Overall, Table I provides systematic evidence that is strongly consistent with our prediction in Corollary 1 that government defaults are followed by large declines in credit. This finding provides an essential support to the relevance of our theory. Next, we focus on the subtler predictions of our model on the cross-country variation of post-default credit declines.

4.1.2 Institutions, Bondholdings and the Severity of the Credit Crunch

Corollary 2 predicts that the post-default drop in private credit should be stronger in countries with better institutions and where domestic banks hold more government debt. Figure 8 below shows that the raw change in private credit after a default is +0.63 as a percent of GDP in country-years with below-median creditor rights (i.e. creditor rights score of 0 or 1), as compared with -1.24 for country-years with above-median creditor rights (i.e. creditor rights score of 2, 3 or 4). The change in private credit after a default is -0.73 as a percent of GDP in country-years with below-median public debt-holdings, as compared with -1.68 for country-years with above-median public debt-holdings. These differences, which go in the directions predicted by our model, are large in economic terms and statistically significant at the 1% level.



Figure 8

Table II below reports the estimation of various specifications of Equation (20). Our baseline regressions take the specifications in columns 2 (and 5) of Table I, and add to them the interactive term of default with creditor rights in column (1), and the interactive term of default with domestic banks' debtholdings in column (2). Columns (3) and (4) report the results from the full specification

with both interactive terms, estimated with country fixed and random effects, respectively. Columns (5) to (8) repeat the analysis, with the percent change in private credit as our dependent variable.

Table II - Where is Default More Costly?²⁶

	Private Credit Flows to GDP				Private Credit % Flows			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(Sovereign Default) _{t-1}	-0.054***		-0.160**	-0.169***	-0.100**		-0.586*	-0.574*
*(Creditor Rights) _{t-1}	(0.010)		(0.061)	(0.061)	(0.039)		(0.332)	(0.326)
(Sovereign Default) _{t-1}		-0.066*	-0.151**	-0.153**		-0.406**	-0.723**	-0.562*
*(Bank Bondholdings) _{t-1}		(0.040)	(0.059)	(0.067)		(0.190)	(0.322)	(0.308)
(Creditor Rights) _{t-1}	0.027		0.030**	-0.001	0.053*		0.284**	-0.002
	(0.016)		(0.014)	(0.008)	(0.027)		(0.107)	(0.012)
(Bank Bondholdings) _{t-1}		-0.007	0.032	-0.017		-0.022	0.117	-0.048
		(0.043)	(0.043)	(0.044)		(0.259)	(0.282)	(0.110)
(Sovereign Default) _{t-1}	0.053**	-0.026	0.287**	0.304**	0.102	0.010	1.214	1.149*
	(0.020)	(0.020)	(0.127)	(0.127)	(0.065)	(0.109)	(0.724)	(0.685)
(GDP p. c. growth) _{t-1}	0.440***	0.596***	0.526***	0.550***	1.868***	1.929**	1.032	1.891*
	(0.141)	(0.161)	(0.195)	(0.178)	(0.449)	(0.893)	(1.190)	(0.989)
(Unemployment Growth) _{t-1}	-0.054***	-0.057**	-0.055***	-0.055**	-0.057	-0.143	-0.191*	-0.083
	(0.013)	(0.023)	(0.020)	(0.022)	(0.055)	(0.093)	(0.105)	(0.116)
(Default Risk) _{t-1}	-0.018	-0.009	-0.034	-0.008	-0.122	-0.184	-0.301	-0.095
	(0.050)	(0.026)	(0.036)	(0.030)	(0.081)	(0.160)	(0.218)	(0.114)
(Inflation) _{t-1}	-0.000	-0.033*	-0.006	-0.013	-0.006	-0.040	0.105	0.041
	(0.002)	(0.018)	(0.025)	(0.023)	(0.009)	(0.082)	(0.130)	(0.110)
(Exc. Rate Depreciation) _{t-1}	0.001	0.036*	0.000	0.006	0.016*	0.041	-0.139	-0.069
	(0.001)	(0.019)	(0.030)	(0.027)	(0.005)	(0.185)	(0.161)	(0.135)
Time dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects?	. Fixed..	. Fixed..	. Fixed..	Random	. Fixed..	. Fixed..	. Fixed..	Random
Hausman χ^2				2.53				11.57
Clustered Std Errors?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No Observations	608	271	197	197	608	270	197	197
No Countries	46	37	36	36	46	37	36	36
No Defaults	27	14	11	11	27	13	11	11
Adjusted R-squared	0.083	0.170	0.133	0.229	0.241	0.316	0.081	0.344

The negative coefficient on the interaction term between default and creditor rights in columns (1), (3), (4), (5), (7) and (8) is consistent with our prediction that public default is more disruptive of private financing in countries with better institutions.²⁷ The negative coefficient on the interaction

²⁶The table presents panel regressions for 46 countries over the 1986-2005 period. The dependent variable in columns 1 to 4 private credit flows to GDP is computed as private credit to GDP in year t – private credit to GDP in year $t - 1$. The dependent variable in columns 5 to 8 private credit % flows is computed as private credit in year t – private credit in year $t - 1$, as a percent of private credit in year $t - 1$. Sovereign default is a binary variable that equals one if the sovereign is in default in year $t-1$, zero otherwise. Standard errors (in parentheses below the coefficient estimates) are adjusted for heteroskedasticity using the Huber (1967) and White (1980) correction, as well as for clustering at the country level using the Huber (1967) correction. *** indicates significance at the 1 percent level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

²⁷Notice that this effect of institutions is not identified from changes in creditor rights during default years, excluding the possibility that it may reflect an endogenous adjustment of institutions during default episodes. In the sample

term between default and bank debtholdings in columns (2), (3), (4), (6), (7) and (8) is consistent with our prediction that default is more disruptive of private financing in countries where banks hold more public debt. Our interpretation is that higher debtholdings render banks' balance sheets more exposed to default, while better institutions render credit more sensitive to banks' balance sheet.²⁸ The economic magnitude of these effects is very large. A one standard deviation increase in banks' debtholdings in a defaulting country is associated with a 4.2% larger decrease in private credit (from column 8), which amounts to 1.1% of GDP (from column 4). An increase by one in the creditor rights score in a defaulting country (for example, moving from a score of 1, as in Argentina, to a score of 2, as in Chile) is associated with a more severe reduction of private credit by 5.7% (from column 8), which amounts to 1.7% of GDP (column 4).

This evidence on creditor rights is both novel and crucial, as it supports a novel and distinctive prediction of our model on the role of financial institutions. But the evidence on banks' bondholdings is very important, too. While it is arguably intuitive that a default should hurt more a banking sector holding more public debt, it should be noted that this finding is at odds with most existing models of public default that assume perfect discrimination, or perfect bailouts of domestic agents. Indeed, if benevolent governments could perfectly discriminate across agents, then domestic banks should have little to fear from a default to begin with, and certainly *irrespective* of their holdings of public debt. The role of banks' bondholding in the data confirms that in reality the domestic dislocations caused by default importantly depend on domestic holdings of government debt, supporting the link between public default and banks' fragility.

Interestingly, and in line with theoretical reasoning, our regressions suggest that the cross-country variation in institutions and bondholdings does not only explain the *severity* of post default credit drops, but also whether these declines occur at all. Indeed, after introducing the interactive terms the coefficient on lagged default turns from negative to positive, suggesting that in countries where financial institutions are weak and banks hold few public bonds, default may increase private credit. In particular, the coefficients in column (1) suggests that the effect of default on private credit is zero or slightly positive for countries having a creditor rights score of 0 or 1 and negative

used in Table II there is only one instance of institutional reform during default years (Indonesia 1998, in which the creditor rights score declined by one unit). More specifically, the results of Table 2 hold also if a country's creditor rights score at $t - 1$ is replaced by its time average, confirming the key role of average cross-sectional differences in financial development in identifying this effect. Similar considerations apply with respect to the regressions of Table III on the probability of default.

²⁸In Table II we find two influential observations in column (6) (Argentina in 2002 and Panama in 1997), and one in columns (2), (3), (4), (7), (8) (again Argentina in 2002). To be conservative, we present the results without these observations. Results are also robust to performing appropriate versions of weighted least squares.

for countries having a creditor rights score of 2, 3 and 4, confirming with formal regressions the pattern already evident from the raw data in Figure 8.

We perform a thorough robustness analysis to check for the possibility that our results may be driven by a sudden stop in capital flows or a banking crisis at $t - 1$. The fact that these events may precipitate public defaults and credit crunches is perfectly consistent with our model, although in our hypothesis default should exert an independent effect on domestic financial markets over and above the sudden stop or banking crisis. We re-estimate the specifications in Table I and II by adding as a control the banking crises dummy variable from Demirgüç-Kunt and Detragiache (1998) and a sudden stop dummy.²⁹ Our results are unaffected by these controls, and these tests are reported in Table AIII in the Appendix to save space. The most interesting feature of this analysis is that banking crises appear to predict future default and credit crunches, but even after this possibility is accounted for, default still exerts a strong independent negative impact on subsequent credit.³⁰ The system of equations estimation also confirms the findings of Tables I and II, and is reported in Table AIV in the Appendix.

Finally, we use a non-parametric propensity score matching method to compare changes in private credit for country-year pairs that are similar in terms of GDP per capita growth, creditor rights, banks' bondholdings, and likelihood of banking crises, and that only differ in whether a sovereign default actually occurred or not. The results (reported in Table AV in the Appendix) confirm our earlier findings that actual defaults are followed by a reduction in private credit, the more so in countries with strong creditor rights (country scores of 2, 3 and 4), and with above-median holdings of public debt by domestic banks. This evidence further strengthens the case for *unanticipated* defaults to drive our results, supporting the presence of a direct channel whereby public default causes financial sector turmoil.

More broadly, the evidence in this section is strongly consistent with our prediction that sovereign defaults disrupt financial markets, the more so in countries with better institutions, and

²⁹The literature is not unanimous in empirically defining sudden stop in the data. As a result, we try different approaches. Following Calvo et al (2003), we define sudden stops as a reduction in current account deficit by more than 5% that is associated with an output contraction in the same year. We also adopt other approaches, such as trying different threshold, or using the (continuous) change in current account deficit, based on the work of Guidotti et al. (2004) and others, and our results are unaffected. Interestingly, in our sample the correlation between these sudden stop dummies and sovereign defaults is always between 5% and 12% depending on the definition of sudden stop. Many sudden stops in our sample, such as for example the so-called Tequila crisis in Mexico in the mid 1990s, were not associated with sovereign defaults.

³⁰One story consistent with these findings is that the expectation of a public default may trigger a banking panic and become self-fulfilling. There some evidence of this mechanism. Levy-Yeyati et al. (2009) analyze the behavior of depositors in the presence of macroeconomic risk, finding that sovereign risk increases the likelihood of bank panics.

where banks hold more public debt.

4.2 Ex-Ante Tests

We now test the ex-ante predictions of Corollary 3 that better financial institutions should allow countries to default less often and borrow more. We first study the determinants of default by running the probit regression:

$$\Pr(\text{Public Default})_{i,t} = v_t + \beta_1 (\text{Creditor Rights})_{i,t-1} + \beta_2 (\text{Bank Debtholdings})_{i,t-1} + X'_{i,t-1}\gamma + \epsilon_{i,t}, \quad (21)$$

Our model predicts that $\beta_1 > 0$. Additionally, it is interesting to see if greater bank debtholdings reduce the probability of default, namely $\beta_2 < 0$, which is also consistent with our model.

To focus on defaults that are unexpected as of $t - 1$, we control for the lagged value of default risk. Furthermore, in line with the empirical literature on public defaults (Kraay and Nehru 2006, Reinhart and Rogoff 2010) we control for lagged GDP per capita growth, the amount of short-term debt as a proportion of GDP, banking crises, and foreign reserves as a percent of GDP. Unless specified otherwise, our data sources are the WDI and IFS databases. We also control for the lagged change in the ratio of private external debt to GDP. A positive coefficient would provide some evidence consistent with the hypothesis of complementarity, whereby an ex-ante boost in private borrowing should reduce the probability of default.

We then turn to study the determinants of public borrowing by running the pooled regression:

$$(\text{Public Debt})_{i,t} = \alpha_i + v_t + \beta_3 (\text{Creditor Rights})_{i,t-1} + X'_{i,t-1}\gamma + \epsilon_{i,t}, \quad (22)$$

where the dependent variable is the level of government debt over GDP. Our model predicts that $\beta_3 > 0$. Since in this regression the dependent variable is the *stock* of public debt, the explanatory variables are expressed in levels.

We control for log GDP per capita, unemployment and inflation, which all capture long run factors affecting the demand (and supply) of public goods as well as short run factors affecting the accumulation of deficits and debts. By controlling for ex-ante default risk, we indirectly control for additional factors affecting the government's ability to accumulate or roll over its debt. We also include the lagged level of private external debt in our regression to test for complementarity between private and public borrowing, which implies a positive coefficient on this variable.

The use of country fixed effects in regression (22) implies that β_3 identifies the effect of reforms in

creditor rights on government debt.³¹ Finally, it is worth noting that limitations in data availability severely restrict our sample size when studying government debt. In particular, when studying the correlation of government debt and private debt our sample is restricted to 15 emerging countries³² from 1990 to 2003. It is also well known that available public debt data face issues of comparability because they are often constructed under different assumptions in different countries on what constitutes a government liability. These concerns thus provide yet another reason for focusing on within country variation. More generally, they suggest that our debt regressions should be interpreted with caution.

4.2.1 Institutions, Default and Government Borrowing

Table III below reports the results of the estimation of Equation (21). Column (1) shows a negative correlation between the probability of default and creditor rights, consistent with our prediction that better institutions render public debt more sustainable. Column (2) of Table IV shows a negative association between capital flows to the private sector and the probability of government default, which is consistent with the idea of complementarity, and in particular with our prediction that more private inflows reduce the likelihood of default.

The economic magnitude is extremely large. A standard deviation decrease in creditor rights makes a sovereign default more likely by 4.1 percent. A standard deviation decrease in the extent of private debt flows makes a sovereign default more likely by 7.2 percent. Control variables have the predicted sign, and are statistically significant.

By controlling for banks' debtholdings, column (4) shows that these are negatively associated with the probability of default, which is also consistent with our model.³³ When the bondholdings variable is introduced, though, sample size decreases by one half, and the coefficients on creditor rights and private debt flows become smaller in magnitude. The latter remains statistically significant, the one on creditor rights ends up with a p-value of 11%. We interpret these findings as suggesting that the mechanisms suggested by our model are at play in the data.

³¹It is interesting to note that there is a strong and negative association between creditor rights and public debt across countries. Intuitively, countries with better creditor rights tend to be more developed and less interventionist, which both reduce the role of the public sector in financial and other markets. To control for these large differences in development, a more appropriate way to test our predictions on ex ante borrowing is therefore to focus on the within-country variation, as we do here.

³²These are Algeria, China, Colombia, Costa Rica, Hungary, India, Indonesia, Mexico, Morocco, Philippines, Poland, Slovak Republic, South Africa, Thailand, Ukraine.

³³In Table III we find three influential observations in column (5) (Mexico in 1987, 1988 and 1989). Again, we present the results without these observations.

Table III - Determinants of Sovereign Defaults³⁴

	(1)	(2)	(3)	(4)	(5)	(6)
(Creditor Rights) _{t-1}	-0.036** (0.048)		-0.035** (0.028)	-0.001 (0.110)	-0.040*** (0.010)	-5.8(e ⁻⁶)** (0.015)
(Private Debt Flows) _{t-1}		-2.52** (0.046)	-2.95** (0.034)	-0.185* (0.074)	-2.51** (0.050)	-0.0006* (0.080)
(Bank Bondholdings) _{t-1}				-0.021* (0.060)		-8(e ⁻⁵)** (0.012)
(Banking Crisis) _{t-1}					0.102** (0.027)	0.008*** (0.000)
(GDP p.c. growth) _{t-1}	-0.146 (0.290)	-0.144 (0.199)	-0.213* (0.090)	-0.023** (0.039)	-0.156 (0.175)	-0.000 (0.119)
(Default Risk) _{t-1}	0.153 (0.194)	0.160* (0.081)	0.058 (0.600)	0.048*** (0.002)	0.032 (0.104)	0.0002*** (0.005)
(Short-Term Debt) _{t-1}	6.5(e ⁻¹²)*** (0.000)	4.8(e ⁻¹²)*** (0.000)	6.2(e ⁻¹²)*** (0.000)	1.9(e ⁻¹²)*** (0.000)	5.5(e ⁻¹²)*** (0.001)	7.4(e ⁻¹²)*** (0.000)
(Foreign Reserves) _{t-1}	-0.006 (0.146)	-0.007** (0.048)	-0.007* (0.096)	0.002*** (0.001)	-0.008** (0.044)	6.8(e ⁻⁶)*** (0.005)
Time dummies?	Yes	Yes	Yes	Yes	Yes	Yes
No Observations	257	278	257	133	257	133
No Countries	21	21	21	16	21	16
Defaults	46	47	46	25	46	25
Pseudo R ²	0.240	0.279	0.284	0.530	0.300	0.622

In columns (5) and (6) we control for banking crises and find that they are positively and significantly associated with the likelihood of a sovereign debt crisis. Still, the effects of creditor rights, private debt flows and bondholdings remain negative and significant. Broadly speaking, the results of column (5) and those in Table AIII confirm that sovereign defaults and banking crises are important causes of financial turmoil that often occur together, consistent with our model's predictions and with the evidence presented in Reinhart and Rogoff (2010).³⁵ More specifically, even after controlling explicitly for the channel whereby banking crises induce default, the strong and

³⁴The table presents probit regressions for 21 countries over the 1986-2003 period. The dependent variable is the probability that the country is in default in year t . The reported coefficients are estimates of the effect of a marginal change in the corresponding regressor on the probability of sovereign default, computed at the average of the dependent variable. Creditor rights is a discrete index ranging from zero to four aggregating creditor rights, following La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998). Private debt flows to GDP is computed as (private debt in year t - (private debt in year $t-1$)). Regressions include year fixed effects; standard errors are adjusted for heteroskedasticity using the Huber (1967) and White (1980) correction. P-values are reported in parentheses below the coefficient estimates. *** indicates significance at the 1% level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

³⁵The results of column (5) also hold if a country's creditor right score at $t-1$ is replaced by its time average. As a result, the negative impact of creditor rights on the probability of default is also not due to changes in creditor rights occurring in defaulting countries. Finally, we also replicate in our sample the methodology of Reinhart and Rogoff (2010) to estimate jointly a system of dynamic equations for the probabilities of default and of banking crises where lagged default and lagged banking crises are included as regressors in both equations. Our results show that in our sample sovereign defaults help predict the likelihood of banking crises, while the reverse is not true, confirming the presence of a direct link going from default from banking crises. The results are available upon request.

robust correlations we uncover are consistent with the presence of a channel whereby public default independently hurts domestic financial markets, the more so the higher the banks' bondholdings and the stronger the country's financial institutions.³⁶

Table IV - Determinants of Government Debt³⁷

	(1)	(2)	(3)
(Creditor Rights) _{t-1}	0.205** (.100)		0.270** (.101)
(Private Debt) _{t-1}		0.811** (0.326)	0.817** (.373)
(GDP per capita) _{t-1}	-0.075 (.099)	0.109 (.185)	0.265 (.187)
(Default Risk) _{t-1}	0.100 (.150)	0.368* (.192)	0.504** (.224)
(Inflation) _{t-1}	0.028 (.197)	-0.290 (.239)	-0.002 (.311)
(Unemployment) _{t-1}	0.152*** (.040)	0.039 (.076)	0.173** (.079)
Time dummies?	Yes	Yes	Yes
Country fixed effects?	Yes	Yes	Yes
Clustered SE?	Yes	No	No
No Observations	207	77	64
No Countries	38	15	15
R ²	0.009	0.121	0.177

Table IV presents the results of the estimation of Equation (22). Column (1) shows a strong and positive correlation between the level of government debt to GDP and the creditor rights index, consistent with our prediction that better creditor rights should allow the issuance of more public debt. Column (2) shows a strong and positive correlation between the level of government debt to GDP and the level of private debt to GDP, consistent with our hypothesis of complementarity. Column (3) confirms these findings in the full specification.³⁸ The economic magnitude is very

³⁶The evidence that the probability of default falls in banks' bondholding is another piece of evidence in support of this latter channel. Under the assumption that banking crises or financial crises cause default, but not the other way around, bank bondholdings should if anything be positively associated with the probability of default. This is because the expectations of a bank run and thus of the ensuing public default would become self-fulfilling if banks held many government bonds. A similar reasoning would apply to the "bailout channel" discussed in Footnote 23.

³⁷The table presents panel regressions for 46 countries over the 1986-2005 period. The dependent variable is government debt to GDP. Sovereign default is a binary variable that equals one if the sovereign is in default in year $t-1$, zero otherwise. Standard errors (in parentheses below the coefficient estimates) are adjusted for heteroskedasticity using the Huber (1967) and White (1980) correction. *** indicates significance at the 1 percent level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

³⁸One might be concerned that the correlations in this table may be endogenous, as (some) countries may reduce both creditor rights and the level of public debt in response to a shock leading them to default (as occurred in Indonesia in 1998). To control for this possibility, we add to the specification in column (3) sovereign default at $t-1$.

large. A reform increasing the creditor rights index by one point is associated with an increase in government debt by 20% of GDP. An increase in private debt to GDP by 1% translates into an increase in government debt to GDP by 0.8%.

Overall, this evidence shows that, consistent with our model's predictions, better institutions and higher private capital flows reduce default risk and allow the issuance of more public debt.

5 Concluding Remarks

We have studied, both theoretically and empirically, the link between public credit markets where government bonds are issued and traded, and private credit markets where banks intermediate savings to investment projects. The general lesson of our analysis is that the ability of government to borrow and repay, as well as the severity of default episodes, depends on the development of private financial markets, and in particular on the financial sector's ability to attract foreign capital. This is the idea of complementarity: countries with strong financial institutions will attract private sector borrowing and, as a consequence, facilitate public borrowing by disciplining the government.

This idea lines up with recent empirical evidence on the effects of financial globalization (see Kose et al. 2006) which stresses that the main benefits of successful financial integration are catalytic and indirect. In other words, these benefits are not simply, or even primarily, the result of enhanced access to foreign financing, but they are also the result of increased discipline on macroeconomic policies and on public governance more generally. Our model sheds light on these findings in the context of a specific government policy, the decision of whether or not to default on public debt, and finds that the "disciplining" effect of international financial markets obtains only in countries with good market institutions.

This suggests, at a broader level, a general mechanism whereby domestic markets and institutions may shape the impact of financial integration on a variety of public policies. As for government defaults, policies such as opportunistic devaluations or hyper-inflations will not only affect the returns obtained by foreigners on their investments, but are also likely to have other macroeconomic consequences potentially inflicting losses on some classes of domestic residents. Crucially from our standpoint, the magnitude of these losses, and hence the governments' incentives to misbehave in the first place, are likely to importantly depend on the quality and development of domestic

We find that the coefficient on sovereign default is small and statistically insignificant, and the coefficient on creditor rights is still positive and significant.

markets. Our current analysis hints at the possibility that the government may be able to commit not to pursue these policies by building on domestic market institutions, broadening the scope of complementarity between well functioning private markets and good government behavior. At the current stage, though, a more thorough understanding of these interactions remains an exciting topic for future research.

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6 Appendix

6.1 Theoretical Appendix

6.1.1 Bondholdings

To see why in our model banks strictly want to hold government bonds, consider the portfolio decision they face at time $t = 0$. The government is expected to repay fully if $A_B = A_H > 1$ and to default fully otherwise. If a bank purchases an amount b_B of bonds and holds an amount $-d_{B0}$ of deposits at $t = 0$ paying an expected gross interest rate of r_0 , his expected consumption at $t = 2$ is equal to:

$$p \cdot \left[\frac{(1 - \alpha) \cdot A_H \cdot r_{d1}^H}{r_{d1}^H - \alpha \cdot A_H} \cdot \left(\omega_{1B} + \frac{b_B}{p} + d_{0B} \cdot r_{d0}^H(1) - \frac{b}{p} \right) \right] + (1 - p) \cdot [\omega_{1B} + d_{0B} \cdot r_{d0}^L(0)], \quad (23)$$

where r_{d1}^H denotes the interest rate on deposits originated at $t = 1$ when $\pi = H$. The first term in Equation (23) reflects that with probability p productivity will be high and public debt is repaid. In this state, banks leverage their $t = 1$ wealth and borrow against their $t = 2$ modern-sector income to expand their investment. The second term in Equation (23) reflects that with probability $(1 - p)$ productivity is low and the government defaults. Note that Equation (23) makes explicit the fact that the ex-post rate of return on deposits, $r_{d0}^\pi(\cdot)$ for $\pi \in \{H, L\}$, is affected by the government's repayment decision. We initially restrict ourselves to the case in which $-d_{0B} \cdot r_{d0} \leq \alpha \cdot \omega_{1B}$: under this constraint, repayment by the bank to depositors is non-contingent and $r_{d0}^L(0) = r_{d0}^H(1) = r_0$. Since the maximum amount of bonds a bank can purchase is $\omega_0 - d_{0B}$, its optimal portfolio decision at $t = 0$ reduces to:

$$\begin{aligned} \max_{-d_{0B}} p \left[\frac{(1 - \alpha) \cdot A_H \cdot r_{d1}^H}{r_{d1}^H - \alpha \cdot A_H} \cdot \left(\omega_{1B} + \frac{\omega_0 - d_{0B}}{p} + d_{0B} \cdot r_{d0}^H(1) - \frac{b}{p} \right) \right] + (1 - p) \cdot [\omega_{1B} + d_{0B} \cdot r_{d0}^L(0)] \\ \text{s.t.} \quad -d_{0B} \leq \frac{\alpha \cdot \omega_{1B}}{r_0}, \end{aligned} \quad (24)$$

The objective in Equation (24) implies that, as long as

$$r_0 \leq \frac{(1 - \alpha) \cdot A_H \cdot r_{d1}^H}{(1 - p) \cdot (r_{d1}^H - \alpha \cdot A_H) + p \cdot (1 - \alpha) \cdot A_H \cdot r_{d1}^H},$$

a bank sets $-d_{0B} = \alpha \cdot \omega_{1B}/r_0$, taking the maximum amount of deposits allowed by the constraint in order to buy bonds. The intuition is simple: at $t = 0$, the most valuable assets for banks are those that promise to deliver at $t = 1$ in the event that investment is productive. The government bond has exactly this property, since it only repays in equilibrium if productivity is high. Besides their traditional sector output, banks can also pledge the proceeds of bonds themselves in order to further increase their bondholdings. This additional borrowing, though, will *de facto* be repaid only if the government repays its debt: otherwise, banks have only their traditional sector output and can only repay $\alpha \cdot \omega_{1B}$. In a sense, then, whenever banks pledge the proceeds of public bonds and use that to expand their bondholdings, they are borrowing funds that will have to be repaid fully in the productive state (at an effective contractual rate of r_0/p) and they are investing these funds in bonds that also pay only in that state (at a contractual rate of r_b/p). Hence, whenever $r_0 > 1$, banks are unwilling to pledge income beyond their traditional sector output and bondholdings are given by $\omega_0 + \alpha \cdot \omega_1/r_0$. If $r_0 = 1$, on the other hand, they are indifferent between expanding their bondholdings beyond $\omega_0 + \alpha \cdot \omega_1$ and not doing so: we assume that, in the event of such indifference, they expand their bondholdings as much as possible. The same assumption holds for savers throughout, since they are also indifferent between holding government bonds and not doing so if $r_0 = 1$. In a sense, then, we determine the weakest possible conditions under which government debt is sustainable in equilibrium.

In the case of the closed economy, equilibrium bondholdings will depend on whether α exceeds the threshold identified as α_0 in Equation (11). If $\alpha > \alpha_0$, then all of the economy's resources are allocated to productives at $t = 0$, and bondholdings will consequently be given by,

$$\begin{aligned} b_B &= \frac{\omega_0}{\beta} \\ b_S &= 0 \end{aligned} \tag{25}$$

If instead $\alpha < \alpha_0$, $r_0 = 1$ and bondholdings by savers are undetermined. Assuming that savers buy an equal amount of private bonds, bondholdings will be given by,

$$\begin{aligned} b_B &= \frac{\omega_0 + \alpha \cdot \omega_{1B}}{1 - \alpha} \\ b_S &= \frac{\omega_0(1 - \alpha - \beta) - \beta \cdot \alpha \cdot \omega_{1B}}{(1 - \beta)(1 - \alpha)} \end{aligned} \tag{26}$$

In the case of the open economy, since the constraint imposed by α_0 is irrelevant and we assume

throughout that $r_0 = 1$, bondholdings are simply given by

$$b_j = \frac{\omega_0 + \alpha \cdot \omega_{1j}}{1 - \alpha} \quad \text{for } j \in \{B, S\}. \quad (27)$$

6.1.2 Government repayment and debt sustainability

At $t = 1$, provided that $\pi = H$ and $r_{d1} = 1$, the government maximizes the following welfare function with respect to ρ^H :

$$[\beta \cdot W_B(\rho^H) + (1 - \beta) \cdot W_S(\rho^H)] + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot W_B(\rho^H).$$

The actual values of $W_j(\cdot)$ depends, of course, on equilibrium bondholdings. There are three cases to consider:

1. $\alpha \in (0, \alpha_0]$, where α_0 is as in Equation (11): in this case, banks pledge a fraction α of all their $t = 1$ revenues, including the proceeds from public bonds, and invest these in bonds at $t = 0$. Replacing these bondholdings in the welfare function, the government's first-order condition becomes

$$[\omega_0 - 1] + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot [\omega_0 + \alpha \cdot \omega_{1B} - 1] \geq 0.$$

2. $\alpha \geq \bar{\alpha}_0$, where $\bar{\alpha}_0 = \frac{\omega_0 \cdot (1 - \beta)}{\beta \cdot \omega_{1B}} > \alpha_0$: in this case, banks can borrow all domestic funds and use them to purchase government bonds only by pledging their traditional sector income. In this case, given their bondholdings the government's first-order condition becomes

$$[\omega_0 - 1] + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot \left[\frac{\omega_0}{\beta} - 1 \right] \geq 0.$$

3. $\alpha \in (\alpha_0, \bar{\alpha}_0)$: in this case, banks pledge some, but not all of their future proceeds from public bonds in order to acquire bonds at $t = 0$. This means that, unlike the previous cases, the marginal benefit of repayment is not constant for the government: whereas repayment of the first units of public debt (i.e., for $\rho^H \approx 0$) goes partly to the banks and partly to its creditors, repayment of the last units of public debt are appropriated fully by the banks (i.e.,

for $\rho^H \approx 1$). In this case, welfare as a function of ρ^H is given by

$$\left[\frac{(\omega_0 - 1)}{p} \cdot \rho^H + \omega_1 \right] + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot \left[\left(\frac{\omega_0}{\beta} - 1 \right) \frac{\rho^H}{p} + \omega_{1B} - \min \left\{ \alpha \left(\frac{\omega_0}{\beta \cdot p} \rho^H + \omega_{1B} \right), \frac{\omega_0(1 - \beta)}{\beta \cdot p} - \frac{(1 - p)}{p} \alpha \omega_{1B} \right\} \right],$$

where the last term $\min \{ \cdot, \cdot \}$ captures the fact that whether banks are able to repay their nominal debts in full or not depends on the government's decision to repay. Since this welfare function is convex in ρ^H , comparing its value under $\rho^H = 0$ and $\rho^H = 1$ yields the following necessary and sufficient condition for repayment,

$$\omega_0 - 1 + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot \left[\left(\frac{\omega_0}{\beta} - 1 \right) + p \cdot \omega_{1B} - \frac{\omega_0(1 - \beta)}{\beta} + (1 - p) \cdot \alpha \cdot \omega_{1B} - p \cdot \omega_{1B} \cdot (1 - \alpha) \right] \geq 0,$$

which reduces to the same condition as in case 1.

Therefore, all three cases can be summarized in the condition that

$$[\omega_0 - 1] + \frac{A_H - 1}{1 - \alpha \cdot A_H} \cdot \beta \cdot \left[\min \left\{ \omega_0 + \alpha \cdot \omega_{1B}, \frac{\omega_0}{\beta} \right\} - 1 \right] \geq 0,$$

which explains Equation (14) in the main body of the paper. From the previous analysis, we can obtain

$$\alpha^{\min}(\beta) = \max \left\{ \frac{1 + (A_H - 1) \cdot \beta}{A_H + \left[\frac{A_H - 1}{1 - \omega_0} \right] \cdot \beta \cdot \omega_{1B}}, \frac{(1 - \beta) + A_H \cdot (\beta - \omega_0)}{A_H \cdot (1 - \omega_0)} \right\}.$$

6.1.3 Proof of Proposition 1

The first part of the proposition follows directly from the discussion in the main body of the text. It remains to be shown that there exist values of β for which $\alpha^{\min}(\beta) < \alpha^{\max}(\beta)$, so that the optimal level of public debt is sustainable in equilibrium when $A_B = A_H$. Since $\alpha^{\min}(0) = \alpha^{\max}(0) = 1/A_H$, we proceed by analyzing the conditions under which

$$\left. \frac{\partial \alpha^{\min}(\beta)}{\partial \beta} \right|_{\beta=0} < \left. \frac{\partial \alpha^{\max}(\beta)}{\partial \beta} \right|_{\beta=0},$$

which would guarantee the sustainability of debt for low levels of β .

From Equation (14), we can obtain,

$$\alpha^{\min}(\beta) = \frac{1 + (A_H - 1) \cdot \beta}{A_H + \frac{(A_H - 1) \cdot \beta}{1 - \omega_0} \cdot \omega_{1B}}, \quad (28)$$

and

$$\left. \frac{\partial \alpha^{\min}(\beta)}{\partial \beta} \right|_{\beta=0} = \frac{(A_H - 1)}{A_H^2} \cdot \left[A_H - \frac{\omega_{1B}}{1 - \omega_0} \right]. \quad (29)$$

We assume throughout that $\left(A_H + \frac{\omega_{1B}}{\omega_{1S}} \right) \cdot (1 - \omega_0) < \omega_{1B}$, which in particular guarantees that Equation (29) is negative. On the other hand, Equation (7) yields,

$$\alpha^{\max}(\beta) = \frac{(1 - \beta) \cdot (\omega_0 - 1 + \omega_{1S} \cdot p)}{A_H \cdot (\omega_0 - 1 + p \cdot \omega_1) + (1 - p) \cdot \beta \cdot \omega_{1B}},$$

and

$$\left. \frac{\partial \alpha^{\max}(\beta)}{\partial \beta} \right|_{\beta=0} = \frac{1}{A_H} \cdot \left[-1 - \frac{A_H \cdot p \cdot (\omega_{1B} - \omega_{1S}) + (1 - p) \cdot \omega_{1B}}{A_H \cdot (\omega_0 - 1 + \omega_{1S} \cdot p)} \right].$$

Hence, a sufficient condition for debt to be sustainable for some combination (α, β) is that

$$A_H - 1 - \frac{\omega_{1B}}{1 - \omega_0} \cdot \frac{(A_H - 1)}{A_H} < -1 - \frac{A_H \cdot p \cdot (\omega_{1B} - \omega_{1S}) + (1 - p) \cdot \omega_{1B}}{A_H \cdot (\omega_0 - 1 + \omega_{1S} \cdot p)},$$

which reduces to

$$p > p^* = \frac{A_H \cdot (1 - \omega_0)}{\omega_{1S} \cdot (A_H - 1)} \cdot \left[\frac{\omega_{1B} - (1 - \omega_0) \cdot A_H}{\omega_{1B} - (1 - \omega_0) \cdot \left(A_H + \frac{\omega_{1B}}{\omega_{1S}} \right)} \right].$$

6.1.4 Proof of Proposition 2

From Equation (17) we obtain

$$\alpha_{open}^{\min}(\beta) = \frac{1 + (A_H - 1) \cdot \beta}{A_H - \left[\frac{A_H \cdot \alpha_{open}^{\min}(\beta) - 1}{1 - \omega_0} \right] \cdot \omega_1 + \left[\frac{A_H - 1}{1 - \omega_0} \right] \cdot \beta \cdot \omega_{1B}}, \quad (30)$$

which defines values of α above which public debt is sustainable in the open economy. Note that we have not fully solved for α in order to keep the expression simple. A comparison of Equations (28) and (30) reveals that, insofar as $\alpha < 1/A_H$, $\alpha_{open}^{\min}(\beta) < \alpha^{\min}(\beta)$.

6.1.5 Proof of Proposition 3

From Equation (17) we obtain

$$\alpha_{open}^{\min}(\beta, r_1^*) = \frac{r_1^* + (A_H - r_1^*) \cdot \beta}{A_H - \left[\frac{A_H \cdot \alpha_{open}^{\min}(\beta, r_1^*) - r_1^*}{1 - \omega_0} \right] \cdot \omega_1 + \left[\frac{A_H - r_1^*}{1 - \omega_0} \right] \cdot \beta \cdot \omega_{1B}}, \quad (31)$$

from which it can be verified that $\alpha_{open}^{\min}(\beta, r_1^*)$ is increasing in r_1^* . In particular, when $r_1^* \rightarrow 1$, $\alpha_{open}^{\min}(\beta, r_1^*) < \alpha^{\min}(\beta)$: this follows from comparing Equations (31) and (28) and noting that, in the closed economy, $r_{d1} \geq 1$. When $r_1^* \rightarrow A_H$, on the other hand, Equation (31) implies that $\alpha_{open}^{\min}(\beta, r_1^*) \rightarrow 1$ so that it is necessarily higher than $\alpha^{\min}(\beta)$. Therefore, there exists a value $r^* \in (1, A_H)$ for which $\alpha_{open}^{\min}(\beta, r^*) = \alpha^{\min}(\beta)$.

6.1.6 Theoretical Robustness

Since our main results have been derived in a stylized setting, it is natural to explore some extensions and alternative specifications. Here we discuss how these results are affected when some of our main assumptions are relaxed.

Non-discriminatory enforcement, taxation and bailouts. A central assumption behind our analysis is that both government repayment and taxation are fully non-discriminatory. Non-discrimination in repayment seems to fare well with empirical evidence: Sturzenegger and Zettelmeyer (2005), for example, study a large sample of recent defaults and find no evidence of systematic discrimination in the treatment of domestic and foreign creditors. But it can also be theoretically justified by the fact that, in recent years, most sovereign borrowing is undertaken through decentralized bond markets and is thus subject to active trading in secondary markets. Broner et al. (2010) show theoretically that, in this case, it may be difficult for a government to discriminate among different types of bondholders. To see the logic of this argument, we add two features to our baseline model. First, we obviously assume that public bonds can be traded in secondary markets at any point before they are redeemed: these markets are competitive and that they are not subject to interference by the government. Second, we assume that the government makes its enforcement and taxation decisions at $t = 1$ before asset payments and taxation take place, so that there is a lag between the adoption of an enforcement/taxation policy and its execution.

Suppose that, under these assumptions, the government tries to enforce payments in a dis-

criminatory fashion. In particular, imagine that it decides to repay bonds that are in the hands of domestic residents while defaulting on bonds that are in the hands of foreigners. In this case, foreigners that hold domestic bonds have an incentive to sell them in the secondary market at any positive price, since they will not collect anything from the government at the time of repayment: thus, the supply of bonds in the secondary market is inelastic and equals $1 - \omega_0$. Who demands these bonds? Clearly, domestic residents do; since they expect to be fully repaid by the government, they are willing to pay up to $\frac{1}{p}$ per bond. Assume for simplicity that $\min\{\beta \cdot \omega_{1B}, (1 - \beta) \cdot \omega_{1S}\} > \frac{1}{p}$. If the government announces a discriminatory enforcement policy, the only possible equilibrium is one in which – before asset payments are made – foreigners sell all of their bonds to domestic residents in the secondary market at a unit price of $\frac{1}{p}$. In this case, foreigners are *de facto* repaid by domestic residents through the secondary market, and the government is thus unable to discriminate. The only way in which it can avoid making payments to foreigners is to default on all bonds, as we have assumed that it does in the main body of the paper.

By the same logic, secondary markets also limit the government’s ability to bailout banks that are hurt by a public default. To see this, consider that – at the time of deciding its enforcement and taxation policy – the government defaults on all public bonds. It also decides to tax consumers in order to bailout the banking system, paying it a subsidy of $\frac{1}{p}$ per defaulted bond as a compensation for its losses. But this policy amounts to discriminatory enforcement, since banks are ultimately being repaid in excess of other bondholders. Once again, there are gains from trading bonds in the secondary markets. Before taxation takes place, all bondholders except banks have an incentive to sell their bonds in the secondary market at any positive price. Banks, in turn, are willing to pay up to $\frac{1}{p}$ per bond in order to collect the government compensation. In this manner, all bondholders different from banks are *de facto* repaid by banks through the secondary market, and the government is thus unable to discriminate through taxation.

Risk Aversion. We have simplified the model by assuming risk neutrality for all agents. Because of this assumption, bankers strictly prefer to hold government bonds rather than foreign bonds or deposits, while savers are indifferent between all existing assets. We have assumed throughout that, whenever indifferent, domestic residents hold as many bonds as they can purchase. Although the introduction of risk aversion would complicate the exposition along some dimension, there is also a sense in which it would make our results cleaner. In particular, risk aversion would decrease the bondholdings of savers relative to those of bankers, who would still value the positive correlation between the bond’s payoff and the productivity of investment.

Role of Public Investment. We assumed exogenously that the government always wants to undertake the public investment, without specifying the role that such investment plays. All of our results would go through if we assumed that the public investment served some productive purpose. It could be thought, for example, that it is the public investment at $t = 0$ that gives rise to the investment opportunities in the modern sector at $t = 1$. In this case, our analysis regarding the government's incentives to repay its debt would still go through: regardless of the reason for which the government borrows and invests, such incentives depend only on the size and distribution of domestic bondholdings. At the same time, our analysis regarding domestic demand for public bonds is also independent of the specific role of public investment. The only thing that would change relative to our current analysis is that it would need to be verified that it is optimal for the government to invest and develop the modern sector. Formally, this requires that

$$p \cdot (A_H - 1) \cdot I(\omega_0 + \omega_1 - 1) > 1.$$

6.2 Empirical Appendix

Table AI - Description of Variables Used in the Analysis

Private Credit to GDP	Ratio of credit from deposit taking financial institutions to the private sector (International Financial Statistics lines 22d and 42d) to GDP (International Financial Statistics line 99b), expressed as a percentage. Line 22d measures claims on the private sector by commercial banks and other financial institutions that accept transferable deposits such as demand deposits. Line 42d measures claims on the private sector given by other financial institutions that do not accept transferable deposits but that perform financial intermediation by accepting other types of deposits or close substitutes for deposits (e.g., savings and mortgage institutions, post office savings institutions, building and loan associations, certain finance companies, development banks, and offshore banking institutions). Source: International Monetary Fund, International Financial Statistics (September 2008).
Sovereign Default	Dummy variable that equals 1 if in year $t-1$ the sovereign issuer is in default. Sovereign default is defined as the failure to meet a principal or interest payment on the due date (or within the specified grace period) contained in the original terms of the debt issue. In particular, each issuer's debt is considered in default in any of the following circumstances: (i) For local and foreign currency bonds, notes and bills, when either scheduled debt service is not paid on the due date, or an exchange offer of new debt contains terms less favorable than the original issue; (ii) For central bank currency, when notes are converted into new currency of less than equivalent face value; (iii) For bank loans, when either scheduled debt service is not paid on the due date, or a rescheduling of principal and/or interest is agreed to by creditors at less favorable terms than the original loan. Such rescheduling agreements covering short and long term debt are considered defaults even where, for legal or regulatory reasons, creditors deem forced rollover of principal to be voluntary. Source: Standard & Poor's (2008).
Private Debt to GDP	Ratio of private, nonguaranteed external debt, which is an external obligation of a private debtor that is not guaranteed for repayment by a public entity. Source: World Development Indicators (September 2008).
Creditor Rights	An index aggregating creditor rights, following La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998). A score of one is assigned when each of the following rights of secured lenders are defined in laws and regulations: First, there are restrictions, such as creditor consent or minimum dividends, for a debtor to file for reorganization. Second, secured creditors are able to seize their collateral after the reorganization petition is approved, i.e., there is no automatic stay or asset freeze. Third, secured creditors are paid first out of the proceeds of liquidating a bankrupt firm, as opposed to other creditors such as government or workers. Finally, if management does not retain administration of its property pending the resolution of the reorganization. The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003.
Banks Bondholdings	Ratio of net claims to government, expressed as a percentage of financial institutions' net total assets. The numerator is the sum of all entries representing net credit to the public sector by deposit money banks, other banking institutions and nonbank financial institutions, minus all credit by the public sector to these institutions. The denominator is the sum of the net total assets of these three groups, after canceling out credit items between them, minus all credit by the public sector to these institutions. Source: International Financial Statistics (2008).
Government Debt to GDP	Ratio of public debt, which is an external obligation of a public debtor, including the national government, a political subdivision (or an agency of either), and autonomous public bodies, expressed as a percentage. Source: World Development Indicators (September 2008).
GDP per Capita	Logarithm of gross national product per capita (Atlas method) from 1980 to 2005. Source: World Development Indicators (September 2008).
Unemployment	Annual percentage unemployment. Source: World Development Indicators (September 2008).
Inflation	Annual percentage inflation, GDP deflator. Source: World Development Indicators (September 2008).
Default Risk	An index assigning risk points as a decreasing function of the estimated foreign debt service, which in turn is expressed as a percentage of the sum of the estimated total exports of goods and services. The index ranges from 0 (low risk) to 10 (high risk). Source: International Country Risk Guide (ICRG).
Exchange Rate Depreciation	

Table AII - Reserve Requirements and Eligible Assets

	<u>Bondholdings</u> Assets	Reserve Requirements	<u>Res. Requirement</u> Assets	Eligible Assets
	2001-03		2001-03	
Algeria	28.49	6.25% of demand and time deposits	4.90	
Brazil	45.90	60% of demand deposits, 30% of Advances on Export Contracts; 15% of time deposits; 20% of savings deposits	40.61	Cash, treasury bonds, deposits in central bank.
Bulgaria	9.39	8% - based on deposits' volume acquired	6.14	Cash on current account by BNB.
Chile	-2.33	9% for demand deposits; 3.6% for time deposits and an additional 10% for both	6.16	
Colombia	13.79	Cash reserve: "Fit into the Bank of the Republic on Checking accounts 13 %, Deposits of Saving 6 % and Certificates of deposit to Term 2.5 %."	5.62	
Costa Rica	10.32	5%	1.96	..N.A.: Assume all bank deposits eligible
Hungary	20.84	5% of all sources of funds	1.84	
Indonesia	36.66	No reserve requirement	0.00	
Malaysia	1.63	4% of eligible liabilities	7.87	Govt. bonds, T-Bills, Cagamas bonds, Central Bank securities, development bonds, other eligible securities
Mexico	29.27	20% of banks' liabilities	11.42	Cash in domestic and foreign currencies, T-Bills, bonds issued by the govt. or other countries.
Panama	1.96	No reserve requirement	0.00	
Poland	19.29	4.5%	1.82	..N.A.: Assume all bank deposits eligible
Romania	5.94	18% of ROL deposits. 25% of deposits in foreign exchange kept in USD, EUR.	14.11	Securities, bonds, cash, short term deposits.
Slovakia	31.30	3%-5%	5.15	Demand deposits in SKK; demand deposits in foreign currency; term deposits in SKK; term deposits in foreign currency; bills of exchange issued by bank for non-bank clients; bond issued by bank for non-bank clients; other obligations to the clients; intrabank deposits of foreign banks dealt with domestic commercial banks
South Africa	2.68	2.5% of adjusted liabilities as minimum reserve balance with the South African Reserve Bank; 5% of reduced liabilities as liquid assets.	5.60	Only domestic central government stock of any maturity
Thailand	2.46	6% of total deposits and total short-term foreign currency borrowing (< 1 year).	4.43	Govt. securities, bonds issued by the Central Bank, debentures, bonds, or promissory notes guaranteed by the Ministry of Finance; bonds or debt instruments guaranteed by other state corporations.
Turkey	51.13	6% of liabilities denominated in TRL and 11 % of liabilities denominated in foreign currencies. Also, 4 % of liabilities denominated in TRL and 1% of liabilities denominated in foreign currencies	11.19	Cash in vault, govt paper, free deposits at Central Bank

Table AIII - Controlling for Sudden Stops and Banking Crises ³⁹

	Private Credit Flows to GDP				Private Credit % Flows			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(Sovereign Default) _{t-1}			-0.104***	-0.107***			-0.620*	-0.559*
*(Creditor Rights) _{t-1}			(0.033)	(0.028)			(0.317)	(0.344)
(Sovereign Default) _{t-1}			-0.116**	-0.115**			-0.782**	-0.697*
*(Bank Bondholdings) _{t-1}			(0.045)	(0.045)			(0.331)	(0.366)
(Creditor Rights) _{t-1}			0.032*	0.031*			0.262**	0.281**
			(0.017)	(0.018)			(0.102)	(0.126)
(Bank Bondholdings) _{t-1}			0.035	0.042			0.136	0.145
			(0.043)	(0.038)			(0.282)	(0.275)
(Sovereign Default) _{t-1}	-0.027**	-0.016*	0.172**	0.193***	-0.087*	-0.062*	1.285*	1.217*
	(0.012)	(0.009)	(0.065)	(0.058)	(0.044)	(0.037)	(0.696)	(0.730)
(GDP p. c. growth) _{t-1}	0.320**	0.268***	0.569**	0.524***	0.421***	0.328***	1.496	0.886
	(0.157)	(0.103)	(0.233)	(0.186)	(0.083)	(0.077)	(1.301)	(1.134)
(Unemployment Growth) _{t-1}	-0.054***	-0.042***	-0.055***	-0.047**	-0.145***	-0.098*	-0.205*	-0.163
	(0.012)	(0.013)	(0.019)	(0.019)	(0.053)	(0.051)	(0.102)	(0.101)
(Default Risk) _{t-1}	-0.003	0.005	-0.044	-0.047	-0.173	-0.166*	-0.260	-0.323
	(0.026)	(0.020)	(0.031)	(0.030)	(0.103)	(0.095)	(0.208)	(0.238)
(Inflation) _{t-1}	0.000	-0.000	-0.018	-0.020	-0.029*	-0.025	0.174	0.088
	(0.003)	(0.002)	(0.018)	(0.018)	(0.016)	(0.016)	(0.136)	(0.137)
(Exc. Rate Depreciation) _{t-1}	0.000	0.001	0.016	0.017	0.034***	0.032***	-0.216	-0.125
	(0.002)	(0.001)	(0.020)	(0.019)	(0.009)	(0.009)	(0.167)	(0.167)
(Sudden Stop) _{t-1}	-0.019		-0.000		0.054		0.178**	
	(0.026)		(0.023)		(0.043)		(0.084)	
(Banking Crisis) _{t-1}		-0.043***		-0.023**		-0.110***		-0.090
		(0.010)		(0.010)		(0.030)		(0.082)
Country effects?	Random	Random	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Clustered SE and time dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No Observations	698	693	198	198	698	693	197	197
Adjusted R-squared	0.097	0.147	0.125	0.140	0.268	0.306	0.095	0.088

³⁹The table presents panel regressions for 46 countries over the 1980-2005 period. The dependent variable in columns 1 to 4 private credit flows to GDP is computed as private credit to GDP in year t – private credit to GDP in year $t - 1$. The dependent variable in columns 5 to 8 private credit % flows is computed as private credit in year t – private credit in year $t - 1$, as a percent of private credit in year $t - 1$. Sovereign default is a discrete variable that equals one if the sovereign is in default in year $t-1$, zero otherwise. Standard errors (in parentheses below the coefficient estimates) are adjusted for heteroskedasticity using the Huber (1967) and White (1980) correction, as well as for clustering at the country level using the Huber (1967) correction. *** indicates significance at the 1 percent level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

**Table AIV - Temporal Patterns of Sovereign Defaults and Credit Crunches: A
Simultaneous Equations Approach**

Dependent Variable:	(Private Credit Flows) _t
	(1)
(Sovereign Default) _{t-1}	-0.027** (0.013)
(GDP p.c. Growth) _{t-1}	0.489*** (0.099)
(Unemployment Growth) _{t-1}	-0.039** (0.019)
(Default Risk) _{t-1}	-0.023 (0.030)
(Inflation) _{t-1}	-0.002 (0.003)
(Exc. Rate Depreciation) _{t-1}	0.003 (0.003)
Constant	0.021 (0.033)
Time dummies?	Yes
Country effects?	. Fixed..
R ²	0.300
Dependent Variable:	(Sovereign Default) _t
(Private Credit Flows) _{t-1}	-0.627** (0.299)
(GDP p.c. growth) _{t-1}	0.005 (0.125)
(Default Risk) _{t-1}	0.334*** (0.100)
(Short-Term Debt) _{t-1}	4.3 (e ⁻¹²)*** (0.000)
(Foreign Reserves) _{t-1}	-0.001 (0.002)
Constant	0.590 (0.132)
Time dummies?	Yes
No Observations	239
No Countries	18
No Defaults	24
R ²	0.250

Table AV - Comparison of Matched Defaulting and Non-Defaulting Country-Years⁴⁰

	Not Matched		Matched by:			
	(1)	(2)	(3)	(4)	(5)	(5)
		GDP p.c. growth	Creditor Rights	Banks' Bondholdings	Banking Crises	All Variables
(Sovereign Default) _{t-1}	-0.019*** (0.007)	-0.017*** (0.006)	-0.018*** (0.005)	-0.026** (0.010)	-0.013** (0.006)	-0.020* (0.011)
No Observations	1,226	952	1,121	366	1,179	254
No Defaults	98	60	87	34	97	23

	Not Matched		Matched by All Variables	
	(1)	(2)	(3)	(4)
	Low Creditor Rights	High Creditor Rights	Low Creditor Rights	High Creditor Rights
(Sovereign Default) _{t-1}	-0.006 (0.007)	-0.031*** (0.012)	0.004 (0.013)	-0.040* (0.027)
No Observations	398	723	92	83
No Defaults	46	41	9	17

	Not Matched		Matched by All Variables	
	(1)	(2)	(3)	(4)
	Low Debtholdings	High Debtholdings	Low Debtholdings	High Debtholdings
(Sovereign Default) _{t-1}	-0.024 (0.018)	-0.030*** (0.010)	-0.025 (0.032)	-0.034** (0.015)
No Observations	196	201	92	98
No Defaults	15	21	9	17

⁴⁰The dependent variable private credit flows to GDP is computed as private credit to GDP in year t – private credit to GDP in year $t - 1$. The matching variable sovereign default is a discrete variable that equals one if the sovereign is in default in year $t-1$, zero otherwise. Average treatment effects on the treated are reported, with bootstrap standard errors. *** indicates significance at the 1 percent level; ** indicates significance at the 5% level; * indicates significance at the 10% level.

Figure AI - Bank Bondholdings and Creditor Rights

