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Sovereign Default, Enforcement and the Private Cost of Capital

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Abstract

This paper develops a signaling model for a small open economy in which the sovereign debt repayment decision of the government provides new information to lenders regarding the government's willingness to enforce contracts. Lenders care about contract enforcement because it affects the expected repayment of loans. Therefore, if foreign lenders receive negative information from the sovereign default on the government's willingness to enforce contracts they worsen the financial conditions offered to local firms triggering a sharp reduction in credit and investment. The model can rationalize the worsened financial conditions in capital markets for the private sector observed after default episodes and that cannot be explained by weakened fundamentals, banking crises or currency crises.

Key words: Sovereign debt, Sovereign default, Reputation, Signaling, Interest rate

JEL Codes: E62, F30, F34, G15

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1 Introduction

Emerging market economies face recurrent and costly sovereign defaults that have pernicious effects on investment, consumption and growth. The ensuing worsening of private firms' financial conditions presents one key channel through which sovereign default affects economic activity.[1] In effect, recent empirical studies find a significant and economically relevant worsening of financial conditions for the private sector after sovereign defaults with a consequent reduction in private credit (Arteta and Hale 2008, Brutti 2011, Eichengreen and Moody 2000, Trebesch et al. 2009, Trebesch 2010 and Zymek 2012). In particular, Arteta and Hale (2008) find a negative effect of default on private credit of over 20 percent of the country-specific average and that lasts for over 2 years. A priori, a negative effect of sovereign default on private credit could be explained by the weakened fundamentals, banking crises and currency crises that usually coincide with sovereign defaults. However, what remains interesting is that the negative effect on private credit is significant even after controlling for all these factors.

What triggers this additional worsening of financial conditions for the private sector after sovereign defaults? This paper develops a signaling model in which the additional negative effect on private credit is triggered by the new and negative information that the sovereign default reveals to the financial markets regarding the government's willingness to enforce contracts.

The willingness to enforce contracts of the government is closely related to the institutional quality in the country. In fact, the effective institutional quality in a country is determined both by i) the laws and regulations; and ii) the willingness of the government to enforce those laws and regulations. While the first aspect is very transparent and there is a lot of public information about it, the second aspect is more obscure and harder to evaluate since it is typically related to the preferences of the government in office. Therefore, throughout the paper I focus on the second aspect.

The model developed in this paper considers a small open economy that lasts for two periods. The economy is composed of a benevolent government and a continuum of identical entrepreneurs that have access to credit. In the initial period the government, which has

[1] The recent Euro zone crisis has evidenced that developed countries have also become potential victims of sovereign defaults; adding to the relevance of a better understanding of the phenomenon studied in this paper.

private information regarding its willingness to enforce contracts, inherits an exogenous amount of sovereign debt and decides whether to repay or default. After the government repays or defaults, the entrepreneurs are allowed to borrow in the financial market. The interest rate of the entrepreneurs' borrowing depends on the new information about the government's willingness to enforce contracts revealed by the repayment/default decision. Finally, in the last period, the entrepreneurs decide whether to repay or default on their loans and consume.

The model can rationalize the worsened financial conditions for the private sector observed after default episodes and that cannot be explained by fundamentals, banking crises or currency crises. The key mechanism is the "updating effect" that the repayment decision generates over the expected contract enforcement in the country. After a sovereign default, this mechanism triggers a discrete increase on the private interest rate and a sharp reduction in credit and investment.

There are two crucial features that combine to generate the updating effect. The first feature is that lenders worsen the financial conditions they offer to the private sector if they receive negative information about the enforcement of contracts. This happens because a lower expected contract enforcement reduces the expected repayment of loans. The second feature is that the willingness to enforce contracts also affects the repayment decision of the government making the sovereign default informative. This happens through two main channels. Firstly, poor enforcement of contracts increases tax evasion, tax elusion and corruption negatively affecting tax revenues. Lower tax revenues make it more difficult for the government to raise the funds needed to repay sovereign debt, therefore increasing the probabilities of default. Secondly, the government's enforcement of its own debt contracts during a sovereign debt crisis is also revealing of its willingness to enforce private debt contracts (Trebesch 2009 and 2010). Then, if lenders observe a sovereign default they infer that there is a high probability that the government has a low willingness to enforce contracts in general.

Besides the updating effect, there is a second effect of the sovereign repayment decision over the private credit market: the "risk-transfer effect". This second effect is an indirect transfer of risk from the sovereign to the private sector that takes place through the taxes that the government needs to levy in order to repay the sovereign debt. These taxes indirectly affect the repayment ability of the private sector. Then, as long as the government chooses

to repay, the private interest rate grows with the level of sovereign debt. This effect is consistent with the empirical evidence found by Celasun and Ağca (2012) that "a higher level of sovereign debt is associated with significantly higher corporate borrowing costs in emerging market economies".

I conduct the analysis in a two period framework in order to highlight the mechanisms generating the results while keeping the model tractable. In this framework, in spite of the finite horizon setting and the absence of direct penalties, governments have incentives to repay their debt to avoid the negative consequences that sovereign defaults have over the financial conditions faced by the private sector. Nevertheless, higher levels of sovereign debt and lower willingness to enforce contracts of the government reduce these incentives increasing the risk of sovereign default (Reinhart et al. 2003 and Kraay and Nehru 2006).

In an extension to the model I allow for the level of sovereign debt to be determined endogenously. This allows me to characterize the sovereign interest rate in equilibrium. Consistent with empirical evidence, the resulting sovereign interest rate is increasing on the level of sovereign debt until a critical threshold where credit rationing occurs.

This paper contributes to the debate on the negative effects of sovereign defaults on the domestic economy, specifically focusing on the private credit channel. Most of the literature that analyzes the effects on the domestic economy concentrates on the negative effect that sovereign defaults have over the balance sheets of domestic agents that hold sovereign debt (Broner et al. 2010, Gennaioli et al. 2013, and Guembel and Sussman 2009). In particular, Gennaioli et al. (2013) analyze how domestic credit is affected by the negative balance sheet effect that sovereign default has on domestic banks that held sovereign bonds. While the relevance of this mechanism to explain the negative effect of sovereign default over domestic credit is very intuitive, it seems unrealistic to assume that negative effects on the balance sheet of the lenders can also explain the reduction in foreign credit since foreign lenders are typically more diversified than domestic banks.

In contrast, the model developed in this paper does not need to assume that domestic agents hold sovereign debt. Nevertheless, the domestic economy is still harmed by the default due to the negative information that it reveals to financial markets. This information story links the paper with the reputational spillovers of Cole et al. (1995) and Cole and Kehoe (1998), the signaling model of Sandleris (2008, 2010) and with the default traps of Catao et al. (2009). In particular, the signaling mechanism I adopt here is closer to the formulations

in Sandleris (2008, 2010). However, my paper is applicable to a wider set of sovereign default cases and is more thorough on its account of the phenomenon under study. Firstly, in my paper I can explain the effect of sovereign default over the private interest rate which is absent in the work of Sandleris. Secondly, the mechanism at work in my paper captures both the negative effects of sovereign default and debt over private interest rates while also providing a formal justification for the private information of the government. Finally, the fact that the transmission in the work of Sandleris depends on the economy being credit constrained limits the applicability of his papers to developing economies making it irrelevant to explain the negative effect over private credit of the recent sovereign debt crises in the Euro zone.

The remainder of the paper is organized as follows: Section 2 presents the environment and describes the model; Section 3 characterizes the possible equilibria and discusses the main results; Section 4 characterizes the sovereign interest rate in equilibrium by endogeneizing the decision on the level of sovereign debt; and Section 5 concludes.

2 Environment

Consider a small open economy that lasts for two periods, $t = 0, 1$. The economy is composed of a government and a continuum of entrepreneurs that have access to the financial market, which is composed of a continuum of identical lenders.

The government is benevolent and inherits an exogenous amount of sovereign debt S_0. In line with most of the sovereign debt literature, S_0 is neither collateralized nor subject to external enforcement. As a result, in the event of a sovereign default, lenders do not recover anything. The government has private information regarding its own willingness to enforce contracts, which is given by the parameter θ_i with $i = \{H, L\}$ and $1 \geq \theta_H > \theta_L \geq 0$.

At the beginning of $t = 0$, the government must decide whether to repay or default on its sovereign debt, z_0=$\{0$ (default), 1 (repayment)$\}$. If the government chooses to repay, it can exercise its taxation power over the entrepreneurs' assets. Nevertheless, the tax revenue is affected by the government's willingness to enforce contracts, θ_i since lower contract enforcement increases the level of corruption and tax evasion in the economy. This feature is incorporated in the model by assuming that for each dollar of tax revenue, a proportion $(1 - \theta_i)$ gets lost or stolen. Then, for each dollar of financing needs, the government must collect $\frac{1}{\theta_i}$ dollars in tax revenues from the entrepreneurs.

The representative entrepreneur is risk neutral. He values private consumption, C, in $t = 1$, and his preferences are given by:

$$U = C_1.$$

The representative entrepreneur owns a risky productive technology that allows him to get $A(s)I_0^{\alpha}$ units of consumption in $t = 1$ by investing I_0 units of capital in $t = 0$. $A(s)$, with $s = h, l$, is an idiosyncratic shock realized at the beginning of $t = 1$ that takes the value $A(h) = A > 0$ with probability $p(h) = p$, and $A(l) = 0$, with probability $p(l) = 1 - p$. Capital can be converted into consumption goods at a one-to-one rate but it depreciates at the rate $(1 - \delta)$, with $\delta > 0$, from period to period. α, $p(s)$ and $A(s)$ are public information.

At $t = 0$, the entrepreneur receives an endowment e_0, which he can use to invest in the risky technology and to pay taxes. Additionally, right after the repayment/default decision of the government, the entrepreneur gains access to the financial markets and can borrow from the lenders at the interest rate R_{E0}. The financial contract available to the entrepreneur is collateralized by his assets and its enforcement depends on the willingness to enforce contracts of the government. In particular if the entrepreneur defaults, the lender can only seize a share θ_i of the entrepreneur's assets and the rest is lost. I choose to use only one parameter to represent the two aspects of enforcement of contracts relevant for the model just for tractability and notational convenience. However, in order for the main mechanism to work, I only need a much weaker assumption: the effect of the willingness of the government to enforce contracts on both aspects should be correlated.

Lenders face perfect competition and are risk-neutral. Therefore, the representative lender is willing to lend any amount of money to the representative entrepreneur as long as he breaks even and recovers, in expected terms, the opportunity cost of his funds, which is equal to R_W.

Lenders are restricted by the information they observe. In terms of the parameters of the economy, they observe everything except from the government's willingness to enforce contracts but they know the parameters that determine its probability distribution: $\{\theta_H, \theta_L\}$ and $\pi(\theta_H) \in (0, 1)$, which is the probability that $\theta_i = \theta_H$. In terms of the actions, lenders can observe the actions of the government, which is a big player on the market but they cannot observe the actions of the anonymous and atomistic entrepreneurs. In order to compensate

for the informational restrictions, lenders use all their knowledge about the economy and any kind of inference that they can make from the behavior of the local agents to determine the interest rate, R_{E0}, that maximizes their profits.

2.1 Timing

The timing of events in this economy is as follows. At $t = 0$ the entrepreneurs receive their endowments, e_0, and the government, who has private information regarding its willingness to enforce contracts, θ_i, receives the exogenous amount of sovereign debt, S_0. Given its private information, the government decides whether to repay or default on the sovereign debt, z_0, and sets the level of taxes, T_0. After observing the repayment/default decision of the government, the lenders determine the interest rate at which they are willing to lend to the entrepreneurs, R_{E0}. Given R_{E0}, the entrepreneurs decide how much they want to invest, I_0, and borrow, D_0. In the last period, $t = 1$, the entrepreneurs decide to repay or default on their private loans and consume whatever resources they have left. Figure 1 below shows the timing in a more schematic way.

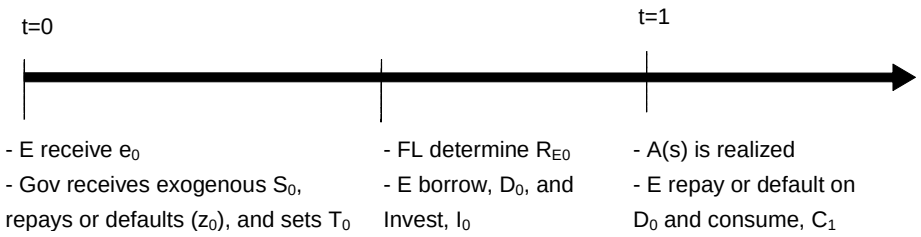

Figure 1: Timing of main events in the economy

Where: Gov = Government; E = Entrepreneurs; FL = Lenders

3 Equilibrium

Definition 1 *Given the level of sovereign debt, S_0, a Perfect Bayesian Equilibrium (PBE) in pure strategies for this economy is:*

- a strategy profile: $\{z_0(\theta_i), T_0(\theta_i), D_0(\pi(\theta_H/z_0), \theta_i), I_0(\pi(\theta_H/z_0)), R_{E0}(\pi(\theta_H/z_0))\}^*$;

- and a belief pattern $\pi(\theta_H/z_0)$; *such that:*

i) $(D_0(\pi(\theta_H/z_0),\theta_i),\ I_0(\pi(\theta_H/z_0)))^*$ *is a solution to the problem of the entrepreneurs given* $R^*_{E0}(\pi(\theta_H/z_0))$.

ii) $(z_0(\theta_i),\ T_0(\theta_i))^*$ *is a solution to the problem of the government given* θ_i *and* $R^*_{E0}(\pi(\theta_H/z_0))$.

iii) $R^*_{E0}(\pi(\theta_H/z_0))$ *satisfies in expected terms the zero profit condition of the lenders given* $\pi(\theta_H/z_0)$ *and* $(z_0(\theta_i),\ T_0(\theta_i),\ D_0(\pi(\theta_H/z_0),\theta_i),\ I_0(\pi(\theta_H/z_0))^*$.

iv) In equilibrium, beliefs, $\pi(\theta_H/z_0)$*, are updated with Bayes rule, while out of equilibrium they are specified following the intuitive criterion.*

Given the timing of events in the economy, the equilibrium needs to be solved by backward induction. First, I solve the problem of the representative entrepreneur since he is the last agent to make decisions in the economy: given the interest rate, he chooses how much to invest and borrow and whether to repay or default on his debt. Second, I solve the problem of the lenders that, after observing the government's repayment decision, decide on the interest rate at which they lend to the entrepreneurs. Finally, I solve the problem of the government that chooses whether to repay or default on the sovereign debt. After solving all these maximizations, I characterize the equilibrium for all the possible values of sovereign debt. The representative entrepreneur maximizes his expected consumption by deciding how much to invest and borrow at $t = 0$ and whether to repay or default on his debt at $t = 1$. Then the entrepreneur's optimization problem for a given R_{E0} is:

$$\max_{I_0,D_0} E_0\left[C_1(s)\right]$$

subject to

$$t = 0 : I_0 = e_0 - T_0 + D_0, \text{ and} \tag{1}$$

$$t = 1 : C_1(s) = \max\left\{A(s)I_0^{\alpha} + \delta I_0 - D_0 R_{E0}, 0\right\}. \tag{2}$$

Since the representative entrepreneur cannot hide resources and all his assets are liquidated if he defaults, he always prefers to repay his debt as long as it is feasible. Furthermore, the entrepreneur would never choose a level of debt so high that it would force him to default in all states, s, since this would imply zero consumption, an alternative that is weakly inferior to just not contracting any debt at all. Nevertheless, depending on the value of the parameters, the entrepreneur can prefer one of two possible situations:

i) $\{I_0, D_0\}$ are set such that the entrepreneur has enough resources to repay independently of s. In this case the entrepreneur's expected consumption and optimum level of investment are given by:

$$t = 1 : E_0 [C_1(s)] = pAI_0^{\alpha}(R_{E0}) + \delta I_0(R_{E0}) - R_{E0}D_0, \text{ and} \tag{3}$$

$$I_0(R_{E0}) = \min \left\{ \left[\frac{pA\alpha}{R_{E0}-\delta} \right]^{\frac{1}{1-\alpha}}, \frac{R_{E0}}{R_{E0}-\delta} (e_0 - T_0) \right\}; \tag{4}$$

where the second element of (4) follows from the feasibility constraint when $s = l$.

ii) $\{I_0, D_0\}$ are set such that the entrepreneur can only repay if $s = h$. In this case, the entrepreneur's expected consumption and optimum level of investment are given by:

$$t = 1 : E_0 [C_1(s)] = p [AI_0^{\alpha}(R_{E0}) + \delta I_0(R_{E0}) - R_{E0}D_0], \text{ and} \tag{5}$$

$$I_0(R_{E0}) = \left[\frac{A\alpha}{R_{E0}-\delta} \right]^{\frac{1}{1-\alpha}}. \tag{6}$$

In order to focus only in the case where private lending is risky, from now on I assume: A1: $A > \frac{(R_W - p\delta)^{\alpha}}{p^2\alpha} (R_W e_0)^{1-\alpha}$. Intuitively, this assumption implies that the returns of the private investment are so high that the representative entrepreneur prefers to borrow even if this implies the risk of having zero consumption when the bad shock is realized.

The next problem that needs to be analyzed is the decision of the representative lender over the interest rate at which he is going to lend to the entrepreneur, R_{E0}. Since the representative lender faces perfect competition, in equilibrium, R_{E0} must be such that he breaks even by recovering in expected terms his opportunity cost R_W.

Given A1, the lender knows that the entrepreneur only repays his debt if he receives the good productivity shock and defaults otherwise. In this last case, the assets of the entrepreneur, which are equal to his depreciated capital, are liquidated and distributed equally among his creditors. Then, from each dollar lent to the representative entrepreneur, the lender recovers $\theta_i * \delta I_0(R_{E0})/D_0(R_{E0})$.

Nevertheless, since the lender cannot observe neither $I_0(R_{E0})$ nor $\theta_i/D_0(R_{E0})$; he tries to infer them indirectly. In the case of $I_0(R_{E0})$; since the lender knows all the relevant parameters that determine investment he can calculate it from (6) by anticipating the entrepreneur's behavior. On the other hand, further inspection of $\frac{\theta_i}{D_0(R_{E0})}$ shows that it depends on the unobservable θ_i not only directly but also indirectly. The indirect dependence is a

result of T_0, one of the determinants of $D_0(R_{E0})$, being a function of the enforcement of contracts, as it will be shown in the analysis of the government's problem. From now on, I write $D_0(R_{E0}, \theta_i)$ to make this dependence explicit. Then, to make any inference about $\theta_i / D_0(R_{E0}, \theta_i)$ the lender needs some beliefs regarding the unobservable θ_i. His initial unconditional beliefs are given by the probability that the government has a high willingness to enforce contracts: $\pi(\theta_H)$. However, after observing z_0, the lender updates these beliefs. In equilibrium, the inference process is governed by a belief pattern, $\pi(\theta_H / z_0)$, that specifies the updated probability that the lender assigns to the willingness to enforce contracts of being high for a given value of z_0 observed. Using $\pi(\theta_H / z_0)$, the lender calculates his conditional expectation on the recovery rate per dollar of depreciated capital in the following way:

$$E_0 \left[\frac{\theta_i}{D_0(R_{E0}, \theta_i)} / z_0 \right] = \pi(\theta_H / z_0) \frac{\theta_H}{D_0(R_{E0}, \theta_H)} + (1 - \pi(\theta_H / z_0)) \frac{\theta_L}{D_0(R_{E0}, \theta_L)}. \tag{7}$$

Given (7), the interest rate, R_{E0}, that allows the lender to break even in expected terms is such that:

$$R_W = pR_{E0} + (1-p)\delta I_0(R_{E0}) E_0 \left[\frac{\theta_i}{D_0(R_{E0}, \theta_i)} / z_0 \right]. \tag{8}$$

which cannot be solved for R_{E0} due to the non-linear dependence of investment in the interest rate. Nevertheless, by totally differentiating (8), it becomes evident that a higher updated belief that the enforcement of contracts is high $\pi(\theta_H / z_0)$, reduces the interest rate the lender charges to the representative entrepreneur. Then, it is possible to see that the equilibrium private interest rate is a function of the updated beliefs: i.e. $R^*_{E0}(\pi(\theta_H / z_0))$, which implies that also the level of investment and the credit demand in equilibrium are a function of $\pi(\theta_H / z_0)$, i.e. $I_0(R^*_{E0}(\pi(\theta_H / z_0))) = I^*_0(\pi(\theta_H / z_0))$ and $D_0(R^*_{E0}(\pi(\theta_H / z_0)), \theta_i) = D^*_0(\pi(\theta_H / z_0), \theta_i)$.

In order to be able to further characterize the private interest rate it is necessary to have more information on the behavior of $\pi(\theta_H / z_0)$ which depends on the repayment/default decision of the government in equilibrium. Then, in the next paragraphs I analyze the government's repayment decision at $t = 0$ and, in the next section, I characterize the equilibrium value of $\pi(\theta_H / z_0)$ for each possible level of S_0.

The objective of the government at $t = 0$ is to maximize the welfare of the representative entrepreneur by deciding whether to repay or default on the sovereign debt:[2]

$$\max_{z_0(\theta_i), T_0(\theta_i)} E_0 [W] = E_0 [C_1(s, \theta_i)],$$

subject to the following constraints in $t = 0$:

$$T_0(\theta_i) = \frac{z_0(\theta_i) S_0}{\theta_i}, \tag{9}$$

$$z_0 S_0 \leq e_0 \theta_i, \tag{10}$$

and in $t = 1$:

$$E_0 [C_1(s, \theta_i)] = p [A I_0^{*\alpha}(\pi(\theta_H / z_0)) + \delta I_0^*(\pi(\theta_H / z_0)) - R_{E0}^*(\pi(\theta_H / z_0)) D_0^*(\pi(\theta_H / z_0), \theta_i)]. \tag{11}$$

The optimum repayment decision, $z_0(\theta_i)$, depends on the comparison of the costs and benefits of repaying versus defaulting taking the belief pattern of the lenders as given. Repayment is costly because taxes absorb resources that the entrepreneur could use for investment. Besides, marginal repayment costs are higher the lower the enforcement of contracts since this implies that the tax burden on the entrepreneur needs to be higher for each dollar of sovereign debt. The different marginal costs associated with the different values of contract enforcement generate the single crossing property in the model. Additionally, lower contract enforcement implies that the feasibility constraint (10) binds for lower levels of sovereign debt, forcing the country to default at levels of indebtedness that would be sustainable with better contract enforcement.

In terms of the benefits, if in equilibrium the observed repayment decision, z_0, has an effect over the welfare of the entrepreneur, then the government might have incentives to repay. The channel through which sovereign repayment can affect the welfare of the entrepreneur is the belief of the lenders about the government's willingness to enforce contracts. As previously argued better beliefs imply a lower private interest rate, $R_{E0}^*(\pi(\theta_H / z_0)$, higher

[2]The government internalizes all of the actions and is directly or indirectly making all the decisions. Therefore, it is also possible to analyze the equilibrium of the model writing directly the optimization problem of the government as a central planner, taking into account the constraints of the private agents (See Appendix 6.1).

investment and consumption for the representative entrepreneur. The specific effect of z_0 on $R^*_{E0}(\pi(\theta_H/z_0))$ in equilibrium is discussed in the next section for each possible level of S_0.

The trade-off between the costs and benefits of sovereign repayment is reflected in condition (12). The government prefers to repay as long as:

$$E_0\left[C_1(s,\theta_i)/z_0(\theta_i)=0\right] \leq E_0\left[C_1(s,\theta_i)/z_0(\theta_i)=1\right]. \tag{12}$$

From now on, I will refer to this as the incentive compatibility condition for repayment. Replacing the equilibrium levels of investment and interest rate under repayment and default; and rearranging we see that condition (12) holds for levels of S_0 lower than $\widetilde{S}$, where:

$$\widetilde{S} = \frac{\theta_i\left[A(1-\alpha)\left[I_0^{*\alpha}(\pi(\theta_H/1)) - I_0^{*\alpha}(\pi(\theta_H/0))\right] + e_0\left(R^*_{E0}(\pi(\theta_H/1)) - R^*_{E0}(\pi(\theta_H/0))\right)\right]}{R^*_{E0}(\pi\left(\theta_H/1\right))}. \tag{13}$$

The expression between brackets in (13) represents the net benefits from sovereign repayment as a function of the updated beliefs $\pi\left(\theta_H/z_0\right)$. For future notational convenience I use $\triangle\left(\pi\left(\theta_H/1\right),\pi\left(\theta_H/0\right)\right)$ to refer to this expression. Combining (13) with the feasibility constraint, (10), gives us the following necessary and sufficient condition for government repayment:

$$S_0 \leq \min\left\{e_0\theta_i, \tfrac{\theta_i}{R^*_{E0}(\pi(\theta_H/1))}\triangle\left(\pi\left(\theta_H/1\right),\pi\left(\theta_H/0\right)\right)\right\}. \tag{14}$$

The government repays as long as the level of sovereign debt is below the two debt thresholds specified. From this condition it becomes evident that the government's repayment decision changes with S_0 as higher levels of sovereign debt make it harder for this condition to hold by increasing the costs and reducing the net benefits of repayment. Additionally, since the two elements on the RHS of (14) depend on the government's willingness to enforce contracts, the decision of the government varies with θ_i providing the signaling value to the sovereign default.

3.1 Sovereign Repayment and Interest Rates

The previous definition of *PBE* allows for two types of equilibria depending on the information revealed by the repayment decision of the government: pooling and separating. Within the pooling equilibria the government always behaves in the same way independently of the willingness of the government to enforce contracts. Therefore the lenders cannot make any inference on the enforcement of contracts, from observing the equilibrium repayment decision. There are two possible types of pooling equilibria in this setting, either the government always repays or it always defaults. In contrast, within the separating equilibria, the repayment decision of the government changes depending on its willingness to enforce contracts allowing the lenders to learn from the observed repayment/default decision whether this willingness is high or low. There are also two possible types of separating equilibria in this setting, either the government repays when the willingness to enforce contracts is high and defaults otherwise, or vice versa. Only the first type constitutes an equilibrium in this economy.

For existence of equilibrium over the whole range of parameter values, I also need to allow for mixed strategies over the repayment decision in the previous definition of PBE. Within the mixed strategies equilibria the government has different repayment probabilities, $0 \leq \sigma(\theta_i) \leq 1$, depending on its willingness to enforce contracts. This allows the lenders to obtain partial or full information about θ_i from the observed z_0. In principle, there are many types of mixed strategies equilibria, but only one arises in this economy and only for certain combinations of parameters. In this specific mixed strategies equilibrium the government repays with certainty when the enforcement of contracts is high while it only repays with a probability, $\sigma(\theta_L)$, smaller than one when the enforcement of contracts is low.

In the next proposition, I characterize the type of equilibrium that arises for each possible value of sovereign debt, S_0.

Proposition 2 *Let's define the following thresholds:* $\overline{S}^P = \min\left\{e_0\theta_L, \frac{\theta_L \triangle(\pi(\theta_H),0)}{R^*_{E0}(\pi(\theta_H))}\right\}$; $\underline{S}^S = \min\left\{e_0\theta_L, \frac{\theta_L \triangle(1,0)}{R^*_{E0}(1)}\right\}$; *and* $\overline{S}^S = \min\left\{e_0\theta_H, \frac{\theta_H \triangle(1,0)}{R^*_{E0}(1)}\right\}$. *Then, for values of* S_0 *such that:*

i) $S_0 \in \left[0, \overline{S}^P\right]$; *there exists a first type of pooling equilibrium in which the government always repays*;

ii) $S_0 \in \left(\overline{S}^P, \underline{S}^S\right)$; *there exists a mixed strategies equilibrium in which the government repays with certainty when the enforcement of contracts is high while it only repays with a*

probability $\sigma(\theta_L) < 1$ *when the enforcement of contracts is low. This interval exists for values of* $e_0 > \overline{e_0} = \frac{A(1-\alpha)\left[I_0^{*\alpha}(\pi(\theta_H/1)) - I_0^{*\alpha}(\pi(\theta_H/0))\right]}{R^*_{E0}(\pi(\theta_H/0))}$.

iii) $S_0 \in \left(\underline{S}^S, \overline{S}^S\right]$; *there exists a separating equilibrium where the government only repays if the enforcement of contracts is high and defaults otherwise*;

iv) $S_0 > \overline{S}^S$; *there exists a second type of pooling equilibrium in which the government always defaults.*

Since $0 < \overline{S}^P \leq \underline{S}^S < \overline{S}^S$, *the pooling and the separating equilibria always exist and do not overlap while the mixed strategies equilibrium only arises if* $e_0 > \overline{e_0}$.

In all these equilibria: $R_W = pR^*_{E0}(\pi(\theta_H/z_0)) + (1-p)\delta I_0^*(\pi(\theta_H/z_0))E_0\left[\frac{\theta_i}{D_0^*(\pi(\theta_H/z_0),\theta_i)}/z_0\right]$.

Proof. *See Appendix 6.2.* ■

What triggers the worsening of financial conditions for the private sector after sovereign defaults? The new negative information revealed by the sovereign default triggers an increase in private interest rates ("updating effect"), which translates into a sharp reduction in credit and investment. Therefore, the signaling mechanism about the government's willingness to enforce contracts provides an explanation for the worsening of financial conditions to the private sector after default episodes. In particular, the amount of information revealed is increasing with the level of sovereign debt in the interval $\left[0, \underline{S}^S\right]$.

In the next paragraphs, I illustrate the equilibrium properties of the government's repayment decision, and the private interest rates that emerge from the equilibrium characterization for both $e_0 \gtrless \overline{e_0}$. I begin by analyzing the government's repayment decision as a function of S_0.

Starting from very low levels of S_0, i.e. $S_0 \leq \overline{S}^P$, the government always prefers to repay its sovereign debt and has the necessary resources to do it. Nevertheless, as S_0 becomes larger repayment costs increase and these increments depend on the government's willingness to enforce contracts. Eventually, as S_0 crosses some critical thresholds, repayment becomes too costly either in terms of incentives or resources and the government changes its optimal decision to default. When the enforcement of contracts is low, this change happens at $\underline{S}^S$ if $e_0 \leq \overline{e_0}$, or more gradually throughout $\left(\overline{S}^P, \underline{S}^S\right)$ if $e_0 > \overline{e_0}$. When the enforcement of contracts is high the change happens at $\overline{S}^S$, the upper limit of the separating equilibrium. The ex-post result of the repayment behavior of the government is an increasing level of information revelation to the lenders in the interval $\left[0, \underline{S}^S\right]$. Figures 2 and 3 present the

behavior of the government as a function of S_0.

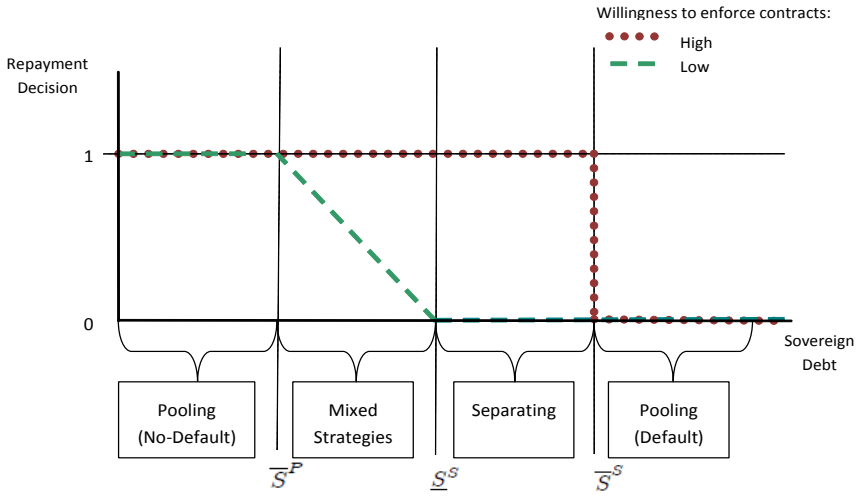

Figure 2: Repayment decision as a function of sovereign debt ($e_0 > \overline{e_0}$)

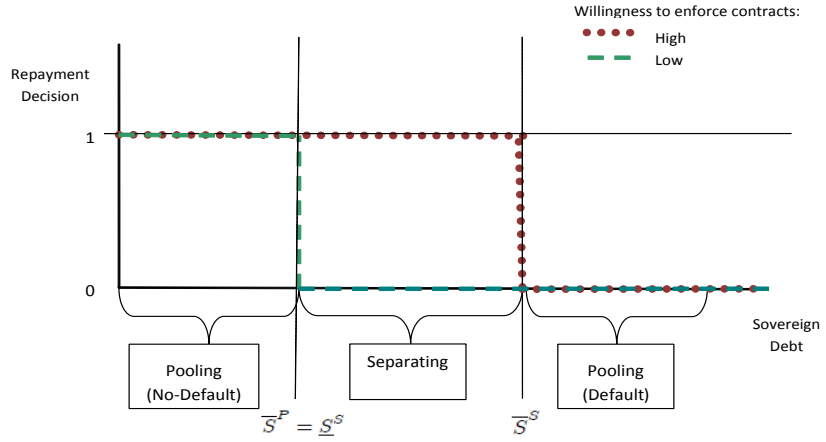

Figure 3: Repayment decision as a function of sovereign debt ($e_0 \leq \overline{e_0}$)

The repayment behavior of the government affects private interest rates through two effects an "updating effect" and a "risk-transfer effect". The key effect is the updating effect which depends on the information released by the repayment decision of the government. This information is used by the lenders to update their perception over the government's willingness to enforce contracts. If the new information is negative, as it happens after a sovereign default, it triggers a discrete increase on the private interest rate and a sharp

reduction in credit and investment. Thus the updating effect rationalizes the worsening of the financial conditions for the private sector observed after sovereign defaults.

There are two crucial features that combine to generate the updating effect. The first one is that lenders worsen the financial conditions they offer to the private sector if they receive negative information about the enforcement of contracts, since this affects their expected repayment of loans. The second feature is that government's willingness to enforce contracts affects the repayment decision of the government making the sovereign default informative. This happens through two main channels. Firstly, low enforcement of contracts negatively affects tax revenues making it more difficult for the government to raise the funds needed to repay sovereign debt and therefore increasing the probabilities of default. Secondly, the government's enforcement of its own (sovereign) debt contracts during a sovereign debt crisis is also revealing of its willingness to enforce private debt contracts (Trebesch 2009 and 2010). Then, if lenders observe a sovereign default they infer that there is a high probability that the government's willingness to enforce contracts is low.

There is also a second effect that affects interest rates, credit and investment: the risk-transfer effect. This second effect is an indirect transfer of risk from the sovereign to the private sector that takes place through the taxes that the government needs to levy in order to repay the sovereign debt. Higher taxes indirectly increase the leverage and reduce the repayment ability of the entrepreneurs when they receive the negative shock. The risk-transfer effect is more important the lower the willingness to enforce contracts since this implies a higher tax burden for each dollar of sovereign debt repayment. This second effect generates a monotonic increase of the private interest rate on the level of sovereign debt within each repayment equilibria.

The risk-transfer effect is consistent with the empirical evidence found by Celasun and Ağca (2012) that "a higher level of sovereign debt is associated with significantly higher corporate borrowing costs in emerging market economies" and with the findings of Borensztein, Cowan, and Valenzuela (2007) who show that corporate credit ratings decline in response to a higher level of public debt. Furthermore, the fact that the magnitude of the risk-transfer effect depends on the enforcement of contracts is also backed by the empirical findings of Celasun and Ağca (2012) since their estimates are significantly stronger in economies where creditor protection is weak. It is worth noting that sovereign defaults shut down the risk-transfer effect.

Figure 4 illustrates the private interest rate as a function of sovereign debt for each type of government for the case of $e_0 > \overline{e_0}$, I omit the other case since the only difference is that the mixed strategies interval disappears. Within the pooling equilibrium there is no information revelation from the sovereign repayment and $R^*_{E0}(\pi(\theta_H))$ is the same independently of the government's willingness to enforce contracts. Nevertheless, $R^*_{E0}(\pi(\theta_H))$ is increasing in S_0 due to the risk-transfer effect. In contrast with the pooling equilibrium, in the separating equilibrium the government's willingness to enforce contracts is fully revealed affecting the private interest rate as credit is now perfectly priced (updating effect). The interest rate in the repaying country increases with S_0 throughout the interval for the same reasons explained in the first type of pooling. But now the rate at which the interest rate grows is lower since the enforcement of contracts in the repaying country is better than when the average of the two countries is considered. In the defaulting country, the updating and risk-transfer effects have opposing signs but the updating effect is always dominating triggering an increase in the private interest rate.[3] Finally, the case with mixed strategies reveals partial information under repayment and full information under default. In terms of the interest rates this means that the interest rate after default is the same as the default interest rate in the separating equilibrium, while the interest rate after repayment decreases with the level of sovereign debt and lies between the lowest interest rate of the separating case and the highest interest rate after repayment of the pooling case. The decreasing pattern of the interest rate under the mixed strategies equilibrium is a consequence of the updating effect being stronger than the risk-transfer effect throughout the interval.

[3]The existence of the separating equilibrium (See Appendix 6.2) implies that the risk transfer effect is always dominated by the updating effect. If this were not the case, the separating equilibrium would not exist since the only reason why the government with good institutional quality prefers to repay is precisely the fact that the private interest rate is lower under repayment.

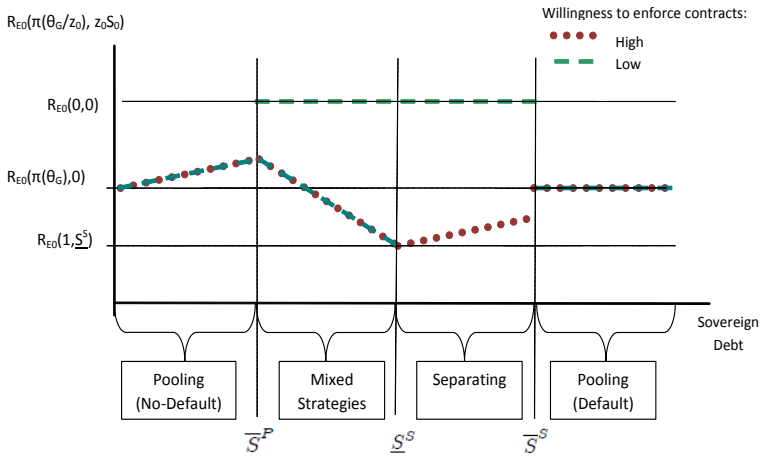

Figure 4: Private interest rates as a function of sovereign debt ($e_0 > \overline{e_0}$)

As it is possible to observe from Figure 6, independently of the level of information revelation, for all possible equilibria: $R^*_{E0}(\pi(\theta_H/1)) \leq R^*_{E0}(\pi(\theta_H/0))$. Combining this result with the optimum levels of investment and credit chosen by the entrepreneurs, it is possible to see that higher interest rates charged by the lenders imply lower investment and credit in the domestic economy: $\frac{\partial I^*_0(R^*_{E0}(\pi(\theta_H/z_0)))}{\partial R^*_{E0}(\pi(\theta_H/z_0))} < 0$ and $\frac{\partial D^*_{0i}(R^*_{E0}(\pi(\theta_H/z_0)),\theta_i)}{\partial R^*_{E0}(\pi(\theta_H/z_0))} < 0$ creating a link between the default/repayment decision of the government and the real economy. These effects provide incentives for sovereign debt repayment even in this finite horizon setting.[4]

4 Sovereign Interest Rate

In this section I endogenize the sovereign debt decision in order to explore the implications of the model in terms of the sovereign interest rate. I modify the benchmark case in two ways to allow the sovereign debt to be determined endogenously. First of all, I incorporate an additional period in the beginning of the model when the decision over the optimum level of sovereign debt is made. Then, I include a positive valuation for public good consumption on the preferences of the entrepreneurs so as to motivate public borrowing. The new timing is represented in Figure 5 below.

[4]In order to take this model to a repeated game framework it is necessary to reflect the fact that the government's willingness to enforce contracts varies with different governments by allowing θ_i to change over time. Then, a series of separating and pooling equilibria could alternate depending on the realizations of θ_i. However, once the θ_i of a particular government is revealed, the country will be stuck with the separating equilibrium until a new government gets into office.

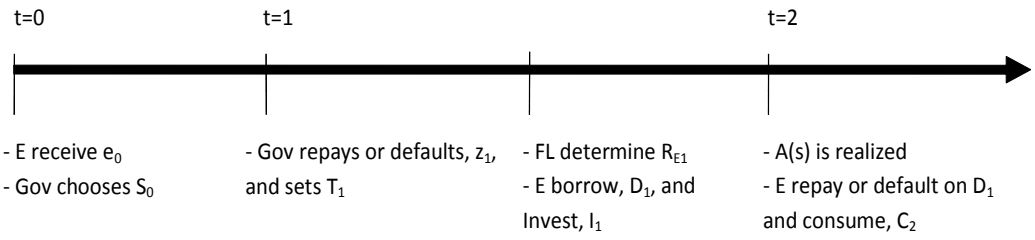

Figure 5: Timing of main events in the economy with endogenous sovereign debt

The benchmark case analyzed in Section 3 also determines the equilibrium continuation values implied by each level of sovereign debt from $t = 1$ onwards for this case: $\{z_1(\theta_i), T_1(\theta_i), R_{E1}(\pi(\theta_H/z_0)),\ D_1(\pi(\theta_H/z_1), \theta_i),\ I_1(\pi(\theta_H/z_1)),\ E_1\left[C_2(s, \theta_i)\right]\}^*$, where I have modified the time indexes to take into account the new period.[5] Then, the only pending decision to solve is the one of the government at $t = 0$ taking into account these continuation values:

$$\max_{S_0} E_0\left[W\right] = v(G_1) + E_1\left[C_2^*(s, \theta_i)\right],$$

subject to

$$\begin{aligned} t &= 0 : G_1 = \tfrac{S_0}{R^*_{S0}(S_0)}, \\ t &= 1 : T_1^*(\theta_i) = \tfrac{z_1^*(\theta_i) S_0}{\theta_i}, \text{ and} \end{aligned}$$

$$t = 2 : E_1\left[C_2^*(s, \theta_i)\right] = p\left[A I_0^{*\alpha}(\pi(\theta_H/z_0)) + \delta I_0^*(\pi(\theta_H/z_0)) - R^*_{E0}(\pi(\theta_H/z_0)) D_0^*(\pi(\theta_H/z_0), \theta_i)\right].$$

Notice that now the government knows its type when it has to contract the sovereign debt. However, the government chooses not to signal it through the level of sovereign debt since this would collapse sovereign lending to zero. This happens because the only reason for sovereign repayment in this framework is the signaling mechanism. Therefore if the government were to signal its type through the level of sovereign debt, even if it had a high willingness to enforce contracts, it would have no incentives to repay in the next period.

The optimum level of sovereign debt is determined by the trade-off between public consumption and the costs of sovereign repayment or the potential negative effects of default

[5] The problem of the representative entrepreneur can be generalized by allowing him to borrow, invest and consume in both periods without affecting the main results. Nevertheless, since these extensions obscure the main mechanism without having any value added in terms of the question of interest, I abstain from including them.

through the repayment signaling mechanism. Both sides of the trade-off present discontinuities at specific thresholds of S_0 making it difficult to determine the optimum value of S_0 without making further assumptions on the parameters However, the endogenization of S_0 does allow me to characterize the sovereign interest rate R_{S0} as part of the results of the model.

At $t = 0$, lenders anticipate that the sovereign repayment decision depends on the level of sovereign debt and on the government's willingness to enforce contracts. But since they do not observe θ_i they can only set the interest rate as a function of S_0, by taking into account the expected repayment for each level of sovereign debt: $E[z_1/S_0]$. Since lenders face perfect competition, in equilibrium, $R^*_{S0}(S_0)$ must be such that they break even by recovering in expected terms their opportunity cost R_W:

$$R_W = R^*_{S0}(S_0)E[z_1/S_0]. \tag{15}$$

Figure 6 illustrates $R^*_{S0}(S_0)$ as a function of S_0 for the case when e_0 is larger than $\overline{e_0}$ (I omit the other case since the only difference is that the mixed strategies interval does not exist). The characterization of $R^*_{S0}(S_0)$ that results from the model is consistent with two main stylized facts of sovereign debt markets: as the level of sovereign debt of a country increases, creditors ask for a higher interest rate to compensate for the increased default risk (Arellano 2008). However, above a certain critical debt level no premium can compensate investors for the default risk, and credit rationing occurs (Eaton and Gersovitz 1981 and Zoli 2004).

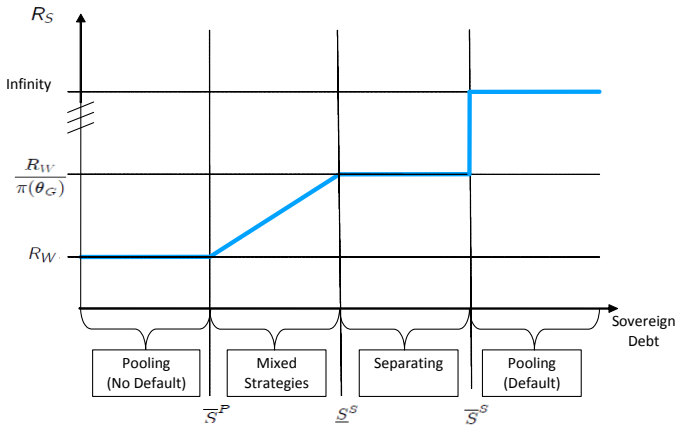

Figure 6: Sovereign interest rate as a function of sovereign debt ($e_1 > \overline{e_1}$)

5 Concluding Remarks

This paper represents a step towards a better understanding of the costs of sovereign debt crises. My model is motivated by evidence that sovereign defaults trigger a systematic worsening of financial constraints for the private sector that cannot be explained by weakened fundamentals, banking crises and currency crises. This paper provides a tractable framework to justify this worsening through a signaling mechanism that offers a new perspective on the links between the government's willingness to enforce contracts, sovereign default, and the access to credit of private firms in the country.

In the model, the repayment decision of the government releases new information to the lenders. With this new information, lenders update their perception over the government's willingness to enforce contracts. If the new information is negative, as it happens after a sovereign default, it triggers a discrete increase on the private interest rate and a sharp reduction in credit and investment. There is also a second effect through which sovereign debt affects interest rates, credit and investment: the risk-transfer effect. This second effect is an indirect transfer of risk from the sovereign to the private sector that takes place through the taxes that the government needs to levy in order to repay the sovereign debt.

The findings of this paper characterize a specific channel through which sovereign defaults affect the private sector. While some empirical work has been done on this regard, this paper provides new testable implications on which further work would be useful. Although beyond the scope of this paper, a potential extension for this framework would be to enrich the model to an infinite horizon environment and calibrate it in order to quantify the main results.

6 Appendix

6.1 Central Planner Optimization Problem

$$\max_{I_0(\theta_i), z_0(\theta_i), T_0(\theta_i)} E_0[W] = E_1[C_1(s, \theta_i)],$$

subject to a series of constraints in $t = 0$:

$$\begin{aligned} I_0 &= e_0 - T_0 + D_0, \\ T_0(\theta_i) &= \tfrac{z_0(\theta_i) S_0}{\theta_i}, \\ z_0 S_0 &\leq e_0 \theta_i, \\ R_W &= pR_{E0} + (1-p)\delta I_0(R_{E0}) E_0\left[\tfrac{\theta_i}{D_0(R_{E0}, \theta_i)} / z_0\right], \end{aligned}$$

where:

$$E_0\left[\tfrac{\theta_i}{D_0(R_{E0}, \theta_i)} / z_0\right] = \pi(\theta_H / z_0) \tfrac{\theta_H}{D_0(R_{E0}, \theta_H)} + (1 - \pi(\theta_H / z_0)) \tfrac{\theta_L}{D_0(R_{E0}, \theta_L)},$$

and another group of constraints in $t = 1$:

$$\begin{aligned} C_1(s, \theta_i) &= \max\{A(s) I_0^{\alpha} + \delta I_0 - D_0 R_{E0}, 0\} \\ E_1[C_1(s, \theta_i)] &= pC_1(h, \theta_i) + (1-p) C_1(l, \theta_i). \end{aligned}$$

6.2 Proof of Proposition 1

Let's begin by assuming that the first type of pooling equilibrium, where the government always repays its sovereign debt, does exist. Within this equilibrium, since the government always behaves in the same way there is no information revelation and the lenders' updated beliefs after observing the repayment decision just equals the unconditional beliefs, i.e. $\pi(\theta_H / 1) = \pi(\theta_H)$. This implies that the after-repayment private interest rate and investment are $R^*_{E0}(\pi(\theta_H))$ and $I^*_0(R_{E0}(\pi(\theta_H)))$, respectively. In the off-equilibrium event of default, I assume that the lenders believe that the enforcement of contracts is low, that is $\pi(\theta_H / 0) = 0$.

If this pooling equilibrium exists, the maximum level of sovereign debt that it can sustain is such that the government is able and willing to repay even if its willingness to enforce

contracts is low. According to (14), that means that S_0 should be lower or equal than $\overline{S}^P = \min\left\{e_0\theta_L, \frac{\theta_L \triangle(\pi(\theta_H),0)}{R^*_{E0}(\pi(\theta_H))}\right\}$. A sufficient condition for the interval $\left[0, \overline{S}^P\right]$ to be non empty is to prove that $\triangle(\pi(\theta_H), 0) > 0$. Recall that, for all S_0, $\triangle\left(\pi\left(\theta_H/1\right), \pi\left(\theta_H/0\right)\right)$ can be rewritten as the difference between the expressions: $AI_0^{*\alpha}(R^*_{E0}(\pi(\theta_H/z_0))) + I^*_0(R^*_{E0}(\pi(\theta_H/z_0))) - R^*_{E0}(\pi(\theta_H/z_0))\left(I^*_0(R^*_{E0}(\pi(\theta_H/z_0))) - e_0\right)$ for $z_0 = 0,\ 1$. The derivative of each of these expressions with respect to the updated beliefs $\pi(\theta_H/z_0)$ is given by:

$$\frac{\partial\left[AI_0^{*\alpha}(R^*_{E0}(\pi(\theta_H/z_0))) + \delta I^*_0(R^*_{E0}(\pi(\theta_H/z_0))) - R^*_{E0}(\pi(\theta_H/z_0))\left(I^*_0(R^*_{E0}(\pi(\theta_H/z_0))) - e_0\right)\right]}{\partial R^*_{E0}(\pi(\theta_H/z_0))} \frac{dR^*_{E0}(\pi(\theta_H/z_0))}{d\pi(\theta_H/z_0)},$$

which is positive since the first term equals $-I^*_0(R^*_{E0}(\pi(\theta_H/z_0))) + e_0 < 0$; and the last term, $\frac{dR_{E0}}{d\pi(\theta_H/z_0)}$, is equal to:

$$-\frac{I_0(R_{E0})\left[\frac{\theta_H}{D_0(T_0(\theta_H))} - \frac{\theta_L}{D_0(T_0(\theta_L))}\right]}{\frac{p}{(1-p)} + \frac{1}{1-\alpha}\frac{I_0(R_{E0})}{R_{E0}-\delta}\left[\pi(\theta_H/z_0)\theta_H\frac{I_0(R_{E0})-D_0(T_0(\theta_H))}{D_0^2(T_0(\theta_H))} + \pi(\theta_L/z_0)\theta_L\frac{I_0(R_{E0})-D_0(T_0(\theta_L))}{D_0^2(T_0(\theta_L))}\right]}$$

which is also negative. Since, $\pi(\theta_H) > 0$, then $\triangle(\pi(\theta_H), 0) > 0$ implying that this type of pooling equilibrium always exist.

However, this is not the only possible type of pooling equilibria that can exist. There can also exist a second type of pooling equilibria where the government always defaults independently of its willingness to enforce contracts. Therefore, there is no information revelation through the repayment decision z_0 and after observing the default the lender beliefs are again equal to the unconditional beliefs, what implies that the equilibrium interest rate and investment are just equal to the ones in the previous pooling equilibrium. A necessary and sufficient condition for the existence of this equilibrium is that the level of sovereign debt is so high that the government never has enough resources or incentives to repay even if it has a high willingness to enforce contracts.

Now, let's assume the existence of a separating equilibrium where the government repays when the willingness to enforce contracts is high and defaults otherwise. Then, in this equilibrium, lenders learn the exact value of θ_i from the repayment decision of the government, that is $\pi(\theta_H/1) = 1$ and $\pi(\theta_H/0) = 0$.

For this equilibrium to exist the level of sovereign debt has to be such that it makes it too costly for the government with low willingness to enforce contracts to repay S_0 while the

government with high willingness to enforce contracts is still able and willing to repay. The fact that it must be too costly for the government with low willingness to enforce contracts to repay provides a lower bound on S_0. In particular, from combining the repayment condition with the equilibrium values for investment and interest rate under separating, we get that S_0 must be higher than $\underline{S}^S = \min\left\{e_0\theta_L, \frac{\theta_L \triangle(1,0)}{R^*_{E0}(1)}\right\}$ for the government with low willingness to enforce contracts to default. On the other hand, the repayment condition of the government with the high willingness to enforce contracts provides an upper bound on S_0 equal to $\overline{S}^S = \min\left\{e_0\theta_H, \frac{\theta_H \triangle(1,0)}{R^*_{E0}(1)}\right\}$. Visual inspection of the limits of the separating equilibrium $\left(\underline{S}^S, \overline{S}^S\right]$ shows that $\underline{S}^S$ is always lower than $\overline{S}^S$ since $\theta_L < \theta_H$. Then, this equilibrium always exists.

From the comparison of $\overline{S}^P$ and $\underline{S}^S$, it is possible to see that these limits coincide when the feasibility constraint of the government with low willingness to enforce contracts is tighter than the incentive compatibility condition. In particular this happens when the level of endowment of the entrepreneurs is lower or equal than $\frac{A(1-\alpha)\left[I_0^{*\alpha}(\pi(\theta_H/1)) - I_0^{*\alpha}(\pi(\theta_H/0))\right]}{R^*_{E0}(\pi(\theta_H/0))}$. In this case: $\overline{S}^P = \underline{S}^S = e_0\theta_L$, since $\frac{\theta_L \triangle(\pi(\theta_H),0)}{R^*_{E0}(\pi(\theta_H))} < \frac{\theta_L \triangle(1,0)}{R^*_{E0}(1)}$. To prove this inequality, first of all, it is possible to observe that $R^*_{E0}(\pi(\theta_H)) \geq R^*_{E0}(1)$ since the expected loan recovery in the event of a bad shock is lower under pooling: Then, a sufficient condition for the interval to exist is to prove that $\triangle(\pi(\theta_H), 0) \leq \triangle(1, 0)$. Recalling (13) and simplifying, the sufficient condition becomes $\triangle(1, \pi(\theta_H)) \geq 0$, which is always true given the same argument used to prove the existence of the pooling equilibrium. Then when $\overline{S}^P = e_0\theta_L$, the upper limit of the pooling equilibrium coincides with the lower limit of the separating equilibrium.

However, when the incentive compatibility condition of the government with low willingness to enforce contracts is tighter than the feasibility constraint, then these limits do not coincide, i.e. $\overline{S}^P = \frac{\theta_L \triangle(\pi(\theta_H),0)}{R^*_{E0}(\pi(\theta_H))} \neq \underline{S}^S$. In this case, there exists a non-empty interval, $\left(\overline{S}^P, \underline{S}^S\right)$, between the pooling and the separating equilibria. Within this interval, the government is still able to repay but if its willingness to enforce contracts is low it does not have enough incentives to repay with certainty. Nevertheless, if the private interest rate after repayment is low enough it can still make sense for the government with low willingness to enforce contracts to repay with a positive probability lower than one giving rise to a mixed strategies equilibrium. A sufficient condition for this is that : $\theta_H - \theta_L \geq \left(e_0 - \left[\frac{A\alpha}{R_W - 1}\right]^{\frac{1}{1-\alpha}}\right)^{-1}$, which always holds since the LHS is negative given assumption A1. Then, there exists a mixed

strategies equilibrium in the interval $\left(\overline{S}^P, \underline{S}^S\right)$ where the government repays with certainty when its willingness to enforce contracts is high while it only repays with a probability smaller than one $\sigma(\theta_L)$ when its willingness to enforce contracts is low. This implies that after observing a default, the lenders are certain that the government has low willingness to enforce contracts , whereas after observing repayment their information is still incomplete, even though they are more informed than under the pooling equilibrium.

The fact that the incentive compatibility condition of the government with low willingness to enforce contracts binds:

$$\begin{aligned} A(1-\alpha)I_0^{\alpha}\left(\tfrac{\pi(\theta_H)}{\pi(\theta_H)+(1-\pi(\theta_H))\sigma(\theta_L)}\right) + R_{E0}\left(\tfrac{\pi(\theta_H)}{\pi(\theta_H)+(1-\pi(\theta_H))\sigma(\theta_L)}\right)\left(e_0 - \tfrac{S_0}{\theta_L}\right) \\ = A(1-\alpha)I_0^{\alpha}(0) + R_{E0}(0)e_0, \end{aligned} \tag{16}$$

implies that the incentive compatibility condition of the government with high willingness to enforce contracts is slack and that the respective repayment probabilities are $0 < \sigma(\theta_L) < 1$ and $\sigma(\theta_H) = 1$. Given these probabilities the updated beliefs of the lenders conditional on repayment and default become $\pi(\theta_H/1) = \frac{\pi(\theta_H)}{\pi(\theta_H)+(1-\pi(\theta_H))\sigma(\theta_L)}$ and $\pi(\theta_H/0) = 0$, which implies the following expected recovery rates per dollar of observed investment:

$$\begin{aligned} E\left[\tfrac{\theta_i}{D_0^*(\pi(\theta_H),\theta_i)}/1\right] &= \left[\pi(\theta_H/1)\tfrac{\theta_H}{D_0^*(\pi(\theta_H),\theta_H)} + (1-\pi(\theta_H/1))\tfrac{\theta_L}{D_0^*(\pi(\theta_H),\theta_L)}\right] I_0^*(\pi(\theta_H)) \\ E\left[\tfrac{\theta_i}{D_0^*(\pi(\theta_H),\theta_i)}/0\right] &= \tfrac{\theta_L}{D_0^*(1,\theta_L)} I_0^*(0) \end{aligned}$$

By totally differentiating (16) it is possible to observe that $\sigma(\theta_L)$ is always decreasing in S_0.

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