# Sovereign Debt Maturity Structure under Asymmetric Information

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Abstract. This paper studies the optimal choice of sovereign debt maturity when investors are unaware of the government's willingness to repay. Under a pooling equilibrium there is a wedge between the borrower's true default risk and the default risk priced in debt, and its size differs with the maturity of debt. Safe borrowers tilt their debt maturity towards short-term -relative to the optimal choice under perfect information- since long-term debt pools more default risk that is not inherent to them. Risky borrowers mimic their behavior of safe borrowers to preclude the market from identifying their type. In times of financial distress, spreads increase and the default risk wedge of long-term debt relative to short-term debt increases, which makes borrowers shorten their debt maturity. Data on bond issuances for a panel of countries show that, consistent with the model, maturities co-vary negatively with spreads and that this co-movement is stronger in those situations in which informational asymmetries are larger.

**Keywords:** Sovereign debt, maturity structure, asymmetric information.
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# 1. Introduction

Governments actively manage the maturity composition of their debt by issuing debt with multiple maturities. A recent strand of academic research argues that debt maturity management can constitute a relevant macro policy for preventing debt crises and smoothing debt payments. This literature studies optimal sovereign debt maturity under the assumption of perfect information among all contracting parts. However, in the case of sovereigns, debt contracts are non-enforceable and the repayment decisions depend on the benefits and costs of default perceived by the government in office. Often these subjective benefits and costs are not fully observable by investors and informational asymmetries emerge in the market of sovereign debt.

This paper analyzes the optimal choice of sovereign debt maturity in the presence of asymmetric information between the government and creditors regarding the government's willingness to repay debt. In the model investors are unaware of the repayment capacity of borrowers -that can exogenously choose to default on their debt- and extract information about it from the borrower's choices of debt allocations. The model thus features a signaling game in which debt is not only used to transfer consumption across time but also as a signal to reveal the type of the borrower. Bond prices -that compensate investors for the expected loss from default- are jointly determined in equilibrium with the maturity structure of debt and play a key role in determining the optimal choices of debt issuance and maturity profile.

The paper focuses on a pooling equilibrium in which both safe and risky borrowers choose the same levels of debt with the same maturity profile. Under this equilibrium safe borrowers issue lower levels of debt relative to the amount of debt they would issue if investors were aware of their type. They do so because debt prices are excessively low for them. Safe borrowers also choose a shorter maturity structure -relative to the optimal maturity structure they would choose if investors were aware of their type- since the price distortion stemming from the presence of asymmetric information is higher in long-term debt relative to short-term debt. Long-term debt is less attractive to safe borrowers since it pools more default risk that is not inherent to them.

Risky borrowers, on the other hand, issue low levels of debt with a short maturity structure to mimic the behavior of safe borrowers and thus preclude the market from identifying their type. This way borrowers can gain a positive misinformation value by accessing debt at higher prices than those they should access if debt were priced according to their true fundamentals.

Times of financial distress in this model are characterized by periods where the *ex-ante* expected repayment capacity of borrowers deteriorates. In these periods, prices of long and short term debt fall and spreads increase. The deterioration in the expected repayment capacity affects debt prices in an asymmetric way: long-term debt prices decay more than short term-debt prices as the former reflect default risk during a longer period of time. Given this asymmetric price effect, it becomes optimal for safe borrowers, and also for risky borrowers that gain from pooling with safe borrowers, to shorten the maturity composition of debt. Therefore, if the ex-ante expected repayment capacity of borrowers varies over the cycle the model predicts a negative co-movement between average maturities and spreads.

We show that the shortening of debt maturity is also the equilibrium response to a temporary deterioration of the expected repayment capacity. We also show that an important assumption behind our results is the presence of cross-default: when a government defaults it does so on all outstanding debt. We study a variant of our model in which default only applies to the debt that is maturing on that period and find that, under specific circumstances, our main result is not robust to this alternative environment. However, empirical studies suggest that the environment with cross-default is a better representation of current sovereign debt markets. Sovereign bonds often include cross-default clauses (see IMF (2002)) and post-default debt restructuring episodes typically embrace outstanding bonds of various maturities (see Sturzenegger and Zettelmeyer (2008)).

We then test the predictions of the model in the data. To study how the the choice of maturity structure of sovereign debt is related with movements in debt prices we construct and analyze a database of sovereign debt maturities of new bond issuances and country spreads -defined as the interest rate premium that bonds from a particular country pay in excess of the interest paid on the US Treasury- for a representative sample of 34 financially integrated emerging economies.

The analysis of the data indicates that the maturity of debt covaries negatively with spreads. We regress average debt maturities of a given country in a given month on average country spreads and country and month fixed effects, and find a negative and statistically significant relationship between these two variables. This finding is in line with the empirical facts previously documented in Arellano and Ramanarayanan (2012) and Broner et al. (2013) for a more reduced set of countries. The negative co-movement is a prediction that is also shared by other theories. The distinct feature of our theory is its reliance on the presence of asymmetric information between the government and investors.

We exploit this differential feature by testing whether the co-movement of maturities and spreads is stronger in contexts in which informational asymmetries are larger. To do so we construct two proxies of the degree of asymmetric information between the government and foreign investors and assess its effects on the co-movement between maturities and spreads. The first proxy for situations in which the degree of asymmetric information is higher is given by years of presidential elections or years that immediately follow one. In these years, in which the type of the new governments is presumably less revealed to foreign investors, the co-movement between spreads and debt maturity is also stronger. The second proxy is given by the volatility of credit ratings for a given country. We find that for those countries with more volatile credit ratings, indicative of more volatile government types and a more relevant role for asymmetric information, the co-movement between spreads and debt maturity is stronger.

*Related Literature*

This paper relates to a growing literature on debt maturity choice. The availability of debt with multiple maturities is relevant in an economy with non-state-contingent debt. As shown in early work by Kreps (1982) and Duffie and Huang (1985), and more recently by Angeletos (2002) and Buera and Nicolini (2004), a rich maturity structure of bonds can help replicating allocations of an Arrow-Debreu economy with complete markets. Additionally, in the context of an economy without stage-contingent securities, long-term debt has been shown to be helpful for hedging motives. Lustig et al. (2008) and Arellano and Ramanarayanan (2012) argue that long-term debt helps hedge against future shocks. These two features highlighted by previous literature are present in the model presented in this paper. The existence of both short and long-term debt is essential for completing markets and long-term debt helps to hedge shocks to the risk-free interest rate.

A large strand of the literature has studied the interaction between maturity choice and sovereign default. In models of endogenous default short-term debt issuance can make a government more prone to suffering a roll-over crisis in which creditors fail to roll-over existing debt in the presence of coordination problems (Cole and Kehoe (2000), Bocola and Dovis (2016)) or bad economic prospects (Fernandez and Martin (2015)). On the other hand, recent literature has shown that short-term debt is less subject to time inconsistency problems as, unlike long-term debt, its repayment -and thus its price- is not affected by future debt paths for which the government cannot commit (Arellano and Ramanarayanan (2012), Niepelt (2014), Dovis (2014) and Aguiar and Amador (2015)). Given that the price of long-term debt can be affected by future debt paths, recent studies have highlighted how long-term debt can be subject to a debt dilution problem (for example, Hatchondo et al. (2012), Chatterjee and Eyigungor (2012) and Chatterjee and Eyigungor (2013)). Other factors that can affect the choice of maturity can come from lender's conditions. Broner et al. (2013) argue that short-term debt may be more desirable to risk-averse creditors since they face more uncertainty when lending long-term. We abstract from these mechanisms in this paper, in order to focus on the role of maturity choice as a signal of private information.

The presence of asymmetric information has been used to study other topics related to sovereign debt. Sandleris (2008) analyzes how repayment decisions can serve as a signal of the fundamentals of the economy. Cole et al. (1995) study the role of asymmetric information in debt settlements after defaults. Catao et al. (2014) use asymmetric information to explain recent decoupling in sovereign yields in the Eurozone. The role of asymmetric information in determining optimal maturity debt structure has been previously explored in the corporate finance literature. The closest paper in this literature is Flannery (1986) which evaluates the extent to which a firm's choice of risky debt maturity can signal insiders' information about the firm's quality. Flannery studies a pooling equilibrium in which firms with good projects finance a fixed amount of borrowing by issuing only short-term debt and rolling it over, since it benefits from better roll-over prices.[1] In this paper the government cares about inter-temporal consumption smoothing and has a larger set of actions (maturity choice and level of debt) with which it can signal its type. The pooling equilibrium features an interior maturity choice that is shorter than that under full information. Here, the reason for the shortening of maturities is to engage in a consumption path that maximizes consumption in those periods in which the wedge between the value of consumption and the relative price of consumption is lower.

Finally, the negative co-movement between maturities and spreads was previously documented in Arellano and Ramanarayanan (2012) and Broner et al. (2013) for a more reduced set of countries. Additionally, this prediction is also shared by the theories in these two papers that are based on a hedging-incentives trade-off associated to debt maturity (Arellano and Ramanarayanan (2012)), and shocks to foreign investor's risk aversion (Broner et al. (2013)). The contribution of the empirical section relies on showing that this co-movement

[1]Other papers study the role of asymmetric information in the maturity structure of corporate debt. Kale and Noe (1990) show that Flannery's pooling equilibrium satisfies signaling equilibrium refinements. Diamond (1991) analyzes debt maturity choice as a trade-off between a borrower's preference for short-term debt due to private information about the future credit rating, and liquidity risk.

is stronger in periods in which informational asymmetries are larger, as captured by our empirical proxies for asymmetric information. This new result provides evidence in support of the presence of the mechanism proposed in our theory.

The remaining of the paper is organized as follows. Section 2 presents the theoretical model and analyzes equilibrium with asymmetric information and compares it to the equilibrium under the benchmark case of full information. Section 3 performs comparative statics analysis and assesses the robustness of the results to alternative model specifications. Section 4 presents empirical evidence on sovereign debt maturity choice and spreads for emerging markets governments and uses the data to test the implications of the theory. Finally, section 5 concludes.

## 2. A Model of Debt Maturity Choice

Consider a small open economy inhabited by a representative agent that lives for three periods. The government (henceforth, the borrower) chooses debt allocations to maximize lifetime expected utility of consumption of the representative agent. The borrower can exogenously opt to repay or default on its debt. His ability to repay debt depends on his type $\theta$.[2]

The borrower's preferences are time separable and are represented by

$$U(\theta) = E\left[\log(c_0(\theta)) + \beta\log(c_1(\theta)) + \beta\beta_1\log(c_2(\theta))\right] \tag{1}$$

where $\beta$ represents the discount factor between time periods 0 and 1, $\beta_1$ is a stochastic discount factor between time periods 1 and 2 that is realized in period 1.

The borrower is endowed with a deterministic income stream $(y_0, y_1, y_2)$ and faces two exogenous shocks. The first shock determines whether default occurs. Let $\lambda^\theta$ be the probability that a borrower $\theta$ defaults on its debt at any time period. The borrower can be safe ($\theta = S$) or risky ($\theta = R$). It is assumed without loss of generality that safe borrowers never default, i.e., $\lambda_t^S = 0$, whereas risky borrowers default with probability $\lambda_t^R = \lambda_t > 0$ for $t = 1, 2$. We allow default probabilities for the risky borrower to be time-dependent. Default occurs

[2]Several reasons can be thought for why governments can differ in their capacity for repaying debt. For example, Cole et al. (1995) argue that repayment may be more likely in governments that have higher likelihood of remaining in power since this can be translated in higher discount factors. Another plausible reason is that governments may differ in their outside option of defaulting. Additionally, different preferences of political parties depending if they are in office or are opposition may also serve as a reasonable explanation. For examples of the later case see Alesina and Tabellini (1990).

indiscriminately in both short and long-term outstanding debt (this assumption is relaxed later). If the borrower defaults he can no longer access credit markets for all subsequent periods and consumes $c = y_{def} > 0$.

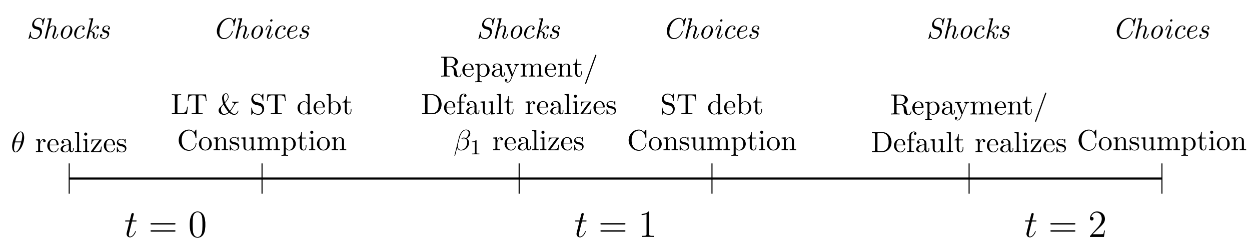
Borrowers also face an aggregate shock to the discount factor $\beta_1$ in $t = 1$. With probability $\pi \in (0, 1)$ the borrower is patient and faces a discount factor of $\beta^p$, and with probability $1-\pi$ the borrower is impatient and faces a discount factor of $\beta^i < \beta^p$. Without loss of generality, the shock to the discount factor is assumed to be mean preserving, i.e., $\pi\beta^p + (1-\pi)\beta^i = \beta$.

There are infinitely many risk neutral investors that are perfectly competitive. They face the same discount factor as the borrower in $t = 0$ and the same aggregate shock to the discount factor in $t = 1$. The presence of stochastic intertemporal preferences in investors introduces uncertainty in the risk free interest rate.[3]

The available debt instruments for borrower $\theta$ are short-term bonds $b_{t,1}(\theta)$ (zero coupon bonds issued at time $t$ payable at date $t+1$) and long-term bonds $b_{t,2}(\theta)$ (zero coupon bonds issued at time $t$ payable at date $t+2$). The prices of these bonds are denoted $q_{t,1}$ and $q_{t,2}$, respectively.

The timing of the shocks and decisions in the model is summarized in Figure 1.

FIGURE 1. Timing of Choices and Shocks




Borrower $\theta$ consumption stream in repayment states is then given by

$$c_0(\theta) = y_0 + b_{0,1}(\theta)q_{0,1} + b_{0,2}(\theta)q_{0,2} \tag{2}$$

$$c_1(s, \theta) = y_1 - b_{0,1}(\theta) + b_{1,1}(s, \theta)q_{1,1}(s) \tag{3}$$

$$c_2(s, \theta) = y_2 - b_{0,2}(\theta) - b_{1,1}(s, \theta) \tag{4}$$

where $s = \{p, i\}$ depending on whether at $t = 1$ agents are patient or impatient.

[3]The assumption that borrowers face the same shock to the discount factor as investors is without loss of generality and made mostly for tractability reasons. Main results remain robust to imposing different discount factors for borrowers and investors.

Note that in those states in which there is default the borrower is in autarky and makes no choices. In those states in which there is repayment, there are complete markets for borrowers given that the number of debt instruments matches the number of states where there is repayment. In the absence of uncertainty in the discount factor of $t = 1$ and any other source of uncertainty, there would be asset redundancy in the economy as the payoffs of long-term debt can be exactly replicated by issuing short-term debt and rolling it over in period 1.

The set of equilibria in this model depends on the assumption about the information sets of the agents. The equilibrium with full information is now analyzed as it serves as a benchmark for the equilibria with asymmetric information.

### 2.1. *Equilibrium under Full Information Benchmark*

In this specification investors have full information on the borrower's type.[4] Hence, a bond issued by borrower $S$ is a different security than a bond issued by borrower $R$, and can be priced differently. Equilibrium in this particular setting will be defined in the following way:

Definition **1.** *An equilibrium in the full information setting is a set debt allocations* $\{b_{0,1}(\theta), b_{0,2}(\theta), b_{1,1}(s,\theta)\}$ *and prices* $\{q_{0,1}(\theta), q_{0,2}(\theta), q_{1,1}(s,\theta)\}$ *for* $s = p, i$ *and* $\theta = \{S, R\}$*, such that:*

*(1) the borrower chooses debt allocations to maximize (1) subject to (2) - (4),*

*(2) prices are determined by the discounted expected repayments to investors.*

Given the inter-temporal preferences of investors and default probabilities of borrowers, the equilibrium prices of borrower's $\theta$ bonds are:

$$q_{0,1}(\theta) = \beta(1 - \lambda_1^\theta), \tag{5}$$

$$q_{0,2}(\theta) = \beta^2(1 - \lambda_1^\theta)(1 - \lambda_2^\theta), \tag{6}$$

$$q_{1,1}(s,\theta) = \beta^s(1 - \lambda_2^\theta), \tag{7}$$

for $s = \{p, i\}$ and $\theta = S, R$.

Using the fact that long-term debt price is equal to the product of the expected prices of short-term debt, i.e., $q_{0,2} = q_{0,1}\mathbb{E}_0[q_{1,1}]$, the solution to the borrower's problem is characterized by perfect consumption smoothing across time and states in which there is repayment

[4]This specification of the model builds on the three period setup in Arellano and Ramanarayanan (2012).

with

$$c_t^{FI}(s,\theta) = \frac{W(\theta)}{\delta(\theta)}, \tag{8}$$

for all $t, s$ and $\theta$, where $\delta(\theta) \equiv 1 + \beta(1 - \lambda_1^\theta) + \beta^2(1 - \lambda_1^\theta)(1 - \lambda_2^\theta)$ and $W(\theta) \equiv y_0 + q_{0,1}(\theta)y_1 + q_{0,2}(\theta)y_2$ is the market value of the borrower's wealth. The presence of complete markets allows the borrower to attain perfect consumption smoothing which turns out to be optimal given that borrowers are risk averse and that investors and borrowers face the same inter-temporal discount factor. There is a unique set of debt allocations that can attain the optimal level of consumption and is given by

$$b_{0,1}^{FI}(\theta) = y_1 - \frac{W(\theta)}{\delta(\theta)}, \tag{9}$$

$$b_{0,2}^{FI}(\theta) = y_2 - \frac{W(\theta)}{\delta(\theta)}, \tag{10}$$

$$b_{1,1}^{FI}(s,\theta) = 0. \tag{11}$$

The uniqueness of the equilibrium debt allocations comes from the existence of uncertainty in discount factors in $t = 1$. The existence of this uncertainty breaks down the possibility of replicating the payoffs of long-term debt by rolling-over short-term debt.

Due to the fact that borrowers and investors discount time at the same rate, the need for trading bonds comes only from the dispersion of endowments across time.[5] The borrower optimally chooses not to issue debt in $t = 1$ and issues short term debt to trade away period 1 endowment net of optimal consumption and long-term debt to trade away period 2 endowment net of the optimal level of consumption.

In order to ensure that the borrowers issue debt and do not save the following assumption is made.

Assumption 1.

$$y_1 \geq \frac{W(\theta)}{\delta(\theta)} \qquad \textit{and} \qquad y_2 \geq \frac{W(\theta)}{\delta(\theta)} \qquad \textit{for } \theta = S, R. \tag{A1}$$

Low enough values of $y_0$ relative to $y_1$ and $y_2$ ensures that optimal debt allocations are non-negative. By restricting primitives such that equilibrium debt allocations are non-negative we can analyze the model without taking a stance on what is the savings technology available for borrowers.[6]

[5]Note that when $y_0 = y_1 = y_2$ the borrower does not need to issue debt at all.

[6]In this setup given that default is exogenous, whether or not the government has access to a savings technology is not relevant. In models of endogenous default that rely on reputational costs, the access to a

2.2. *Equilibrium under Asymmetric Information*

In this specification the borrower is still aware of his type. However, investors cannot distinguish the borrower's type and only know the *ex-ante* distribution of borrowers in the economy which is given by $\Pr(\theta = R) = \alpha \in (0, 1)$. Under this setting the definition of equilibrium requires a specification of investors beliefs about the type of the agent.

Beliefs are formed in every time period and state and determine the probability that a borrower is of type $\theta = R$. Denote a history of debt allocations in $t = 0$ as the vector $b_0 = (b_{0,1}, b_{0,2})$, and the set of possible histories as $\mathbf{B}_0 = \mathbb{R}^2_+$. Beliefs in $t = 0$ are a mapping $\mu_0 : \mathbf{B}_0 \to [0, 1]$. Similarly, denote a history of debt allocations in $t = 1$ and state $s$, as the vector $b_1(s) = (b_{0,1}, b_{0,2}, b_{1,1}(s))$, and the set of possible histories as $\mathbf{B}_1(s) = \mathbb{R}^3_+$. Beliefs in $t = 1$, state $s$ are a mapping $\mu_1(s) : \mathbf{B}_1(s) \to [0, 1]$. Equilibrium is defined as follows.

Definition **2.** *In the asymmetric information setting a Perfect Bayesian Equilibrium (PBE) is a set of debt allocations* $\{b_{0,1}(\theta), b_{0,2}(\theta), b_{1,1}(s, \theta)\}$*, prices* $q_{0,t} : \mathbf{B}_0 \to \mathbb{R}$ *for* $t = 1, 2$ *and* $q_{1,1}(s) : \mathbf{B}_1(s) \to \mathbb{R}$*, and beliefs* $\mu_0 : \mathbf{B}_0 \to [0, 1]$ *and* $\mu_1(s) : \mathbf{B}_1(s) \to [0, 1]$*, for* $s = p, i$ *and* $\theta = \{S, R\}$*, such that:*

*(1) The borrower chooses debt allocations to maximize (1) subject to (2) - (4),*
*(2) prices are determined by the discounted expected repayments to investors given beliefs and*
*(3) where possible, beliefs are determined using Bayes rule, i.e.:*

$$\mu_0(b_0) = \frac{\Pr(\theta = R|b_0)}{\Pr(b_0)} \qquad \textit{and} \qquad \mu_1(s, b_1) = \frac{\Pr(\theta = R|s, b_1)}{\Pr(s, b_1)} \quad \textit{for } s = p, i.$$

To simplify notation we refer to a PBE as the triplet $\{b(\theta), q(b), \mu(b)\}$. Two types of equilibria may arise under this framework: a separating equilibrium, where different type of borrowers choose different allocations and thus investors can perfectly tell apart each borrower's type; and a pooling equilibrium, where both types of agents choose the same allocation and thus investors cannot distinguish their type.[7] A set of both pooling and separating equilibria exist in this game.

In order to restrict attention to a relevant notion of equilibrium we focus in this paper on a particular equilibrium: the one that gives the highest utility to the safe borrower. This

savings technology is relevant for the ability of the government to credibly issue positive debt (Bulow and Rogoff (1989)).

[7]A semi-separating equilibrium is a third type of equilibrium that may also emerge in this game. In this equilibrium borrowers randomize the choice of debt allocations over intersecting sets. These type of equilibria is not analyzed in this paper.

equilibrium selection seems a natural benchmark since it is the safe borrower the one that is prone to suffer the most from the presence of asymmetric information either by being pooled with a riskier borrower or by engaging in distortionary allocations to separate from the risky borrower.[8] Equilibrium selection is captured in the following definition.

Definition **3.** *In the asymmetric information setting a Best Perfect Bayesian Equilibrium for Safe Borrower (PBE-BS) is a triplet of debt allocations, prices and beliefs* $\{b(\theta), q(b), \mu(b)\}$ *such that:*

*(1)* $\{b(\theta), q(b), \mu(b)\}$ *is a PBE and*

*(2)* $\{b(\theta), q(b), \mu(b)\}$ *yields the highest payoffs to the safe borrower, i.e.:*

$$U(b(S); S) \geq U(\tilde{b}; S)$$

*for any other* $\tilde{b}$ *sustained under a PBE.*

To analyze the PBE-BS we first find the best PBE for the safe borrower among the set of pooling equilibria and then verify that this equilibrium is indeed the best PBE-BS among all possible equilibria under specific parametric assumptions.

Beforehand, note that on any PBE, whether pooling or separating, prices are determined by beliefs in the following way:

$$q^*_{0,1} = \beta(1 - \mu_0 + \mu_0(1 - \lambda_1)), \tag{12}$$

$$q^*_{0,2} = \beta^2(1 - \mu_0 + \mu_0(1 - \lambda_1)(1 - \lambda_2)), \tag{13}$$

$$q^*_{1,1}(s) = \beta^s(1 - \mu_1 + \mu_1(1 - \lambda_2)), \tag{14}$$

for $s = p, i$.

To find the pooling PBE-BS we first compute the on-equilibrium prices, then solve for the optimal debt allocations for borrower $S$ given those prices and finally construct beliefs that sustain those prices and allocations under a PBE.

[8]The criterion of analyzing a specific equilibrium that is characterized by yielding the highest -or lowest- payoffs to a particular agent has already been used in the existing literature. See, for example, Aguiar and Amador (2011).

Let $b^P = (b^P_{0,1}, b^P_{0,2}, b^P_{1,1}(s))$ be the equilibrium allocations under some pooling equilibrium. In any pooling equilibrium on-equilibrium beliefs are given by

$$\mu_0(b^P_0) = \alpha, \tag{15}$$

$$\mu_1(s, b^P_1) = \frac{\alpha(1-\lambda_1)}{1-\alpha\lambda_1}, \tag{16}$$

for any $s$. These on-equilibrium beliefs are consistent with Bayes rule. Note that the belief of being a risky borrower in $t = 1$ is lower than belief of being a risky borrower in $t = 0$. The reason is that in $t = 1$ on-equilibrium beliefs are given by the probability of being a risky borrower conditional on not having defaulted in that period. Since, by definition, the risky borrower defaults at $t = 1$ with some positive probability and the safe borrower never defaults, it follows that the on-equilibrium beliefs should be lower in that period. Using (12) - (16) we obtain on-equilibrium debt prices

$$q^*_{01}(b^P_{01}, b^P_{02}) = \beta(1-\alpha\lambda_1) \tag{17}$$

$$q^*_{02}(b^P_{01}, b^P_{02}) = \beta^2(1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)) \tag{18}$$

$$q^*_{11}(s, b^P_{11}) = \beta^s \frac{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)}{1-\alpha\lambda_1} \tag{19}$$

for $s = p, i$.

Now consider the following artificial problem of choosing debt allocations to:

$$\max_b U(b; S) \qquad s.t. \qquad U(b; R) \geq U^{FI}(R) \tag{20}$$

and also subject to (2) - (4) and prices given by (17) - (19). $U^{FI}(R)$ is the utility attained by borrower $R$ under the full information allocation. This problem yields the allocations that maximize borrower S utility such that borrower R finds it optimal to pool. Under certain parametric assumptions that are discussed later, borrower $R$ finds optimal to pool with the allocations that maximize the unrestricted problem for borrower $S$. It follows that the Lagrange multiplier associated to this restriction is zero. The optimal consumption rule for borrower $S$ is given by

$$c^P_0 = \frac{W^P}{\delta(S)} \tag{21}$$

$$c^P_1(s) = \tau^P_1 \frac{W^P}{\delta(S)} \tag{22}$$

$$c^P_2(s) = \tau^P_2 \frac{W^P}{\delta(S)} \tag{23}$$

for $s = p, i$, where $\delta(S)$ is defined as in the full information specification, $W^P \equiv y_0 + q_{0,1}y_1 + q_{0,2}y_2$ is a measure of the borrower's total wealth valued at the pooling prices, and

$$\tau_1^P = \frac{1}{1-\alpha\lambda_1} > 1 \qquad \text{and} \qquad \tau_2^P = \frac{1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)} > \tau_1^P.$$

These parameters reflect a measure of the distortion at time $t$ introduced by the presence of asymmetric information and the inability of investors to tell a borrower's type under a pooling equilibrium. The parameter $\tau_t^P$ is the ratio between the true probability of repayment of borrower $S$ at time $t$ -which was set to one at any time period without loss of generality- and the ex-ante probability of repayment that investors can infer at time $t$ with the set of information available to them.

The unique set of debt allocations that are consistent with the optimal consumption rule are given by

$$b_{0,1}^P = y_1 - \frac{\tau_1^P W^P}{\delta(S)}, \tag{24}$$

$$b_{0,2}^P = y_2 - \frac{\tau_2^P W^P}{\delta(S)}, \tag{25}$$

$$b_{1,1}^P(s) = 0. \tag{26}$$

for $s = p, i$. To ensure that borrowers issue non-negative debt allocations in all possible states and that borrower $R$ prefers to pool as opposed to separate, the following parametric assumptions are made. The implications of this assumption are discussed later.

Assumption 2.

$$y_1 \geq \frac{\tau_1^P W^P}{\delta(S)} \qquad \textit{and} \qquad y_2 \geq \frac{\tau_2^P W^P}{\delta(S)} \tag{A2.a}$$

$$\beta(1-\lambda_1)\log(\tau_1^P) + \beta^2(1-\lambda_1)(1-\lambda_2)\log(\tau_2^P) > \delta(R)\left(\log\left(\frac{W(R)}{\delta(R)}\right) - \log\left(\frac{W^P}{\delta(S)}\right)\right) \tag{A2.b}$$

Note that the solution to the maximization problem (20) does not necessarily provide equilibrium debt allocations. Now we need to prove that these allocations indeed constitute a PBE. For this purpose consider the following degenerate beliefs

$$\mu_0^P(b_0) = \begin{cases} \alpha & \text{if } (b_{01}, b_{02}) = (b_{01}^P, b_{02}^P) \\ 1 & \text{if } (b_{01}, b_{02}) \neq (b_{01}^P, b_{02}^P) \end{cases}$$

$$\mu_1^P(s, b_1) = \begin{cases} \frac{\alpha(1-\lambda)}{1-\alpha\lambda} & \text{if } b_1(s) = b_1^P(s) \\ 1 & \text{if } b_1(s) \neq b_1^P(s) \end{cases}$$

for any $s$.[9] Given these beliefs the pooling PBE-BS is characterized in the following Lemma.

LEMMA **1.** *Assume parameters satisfy (A2.a) and (A2.b), then debt allocations* $\{b^P_{0,1}, b^P_{0,2}, b^P_{1,1}(s)\}$ *for* $\theta = S, R$ *and* $s = p, i$*, prices* $\{q^*_{0,1}, q^*_{0,2}, q^*_{1,1}(s)\}$ *for* $s = p, i$ *and beliefs* $\{\mu^P_0, \mu^P_1\}$ *configure a unique pooling PBE-BS.*

All proofs can be found in Appendix A.

It is worth comparing the optimal consumption rules in non-default states for both agents under the full information benchmark and the pooling equilibrium to assess the effects of the introduction of asymmetric information under this type of equilibrium. Recall that the full information benchmark was characterized by consumption smoothing for safe and risky borrowers in states in which there is repayment. Under this specification the maturity structure of debt is determined by the income dispersion.

The presence of the pooling equilibrium in the asymmetric information setting leaves borrower $S$ worse off respect to the full information setting: the utility obtained in the pooling PBE is strictly less than the utility obtained in the equilibrium with full information. The reason is that the prices that the borrower faces for issuing debt are now lower due to the fact that they reflect an average default risk that pools his true default risk with that of the other borrower who is riskier. However, the price effect for long and short term debt is asymmetric. Long-term debt prices decay more than short-term debt prices -relative to full information prices- since they pool default risk for two periods instead of one. In other words, long term debt is less attractive than short term debt for safe borrowers since it pools more default risk that is not inherent to them. The safe borrower optimally reacts to this negative asymmetric effect on prices by lowering the amount of debt and shortening its maturity profile. These debt allocations entail an increasing consumption path across time.[10]

On the other hand, borrower $R$ sees himself benefited from the presence of asymmetric information. If this were not true, it would not be a pooling equilibrium, as borrower $R$ would prefer to separate and choose the full information optimal allocation. Given the

[9]These are not the unique beliefs that can sustain these debt allocations as a PBE.

[10]Interestingly, as in the full information benchmark, under the pooling equilibrium agents also attain state consumption smoothing in states in which there is repayment. Given the presence of complete markets, the fact that $q_{0,2} = q_{0,1}\mathbb{E}_0[q_{1,1}]$ and the fact that borrowers and investors share the same discount factors, the optimal consumption rule is characterized by perfect consumption smoothing across repayment states in $t = 1, 2$.

on-equilibrium pooling prices borrower $R$ would prefer to attain a decreasing path of consumption across time. However, by choosing that allocation he would reveal his type and this would not constitute an equilibrium. In order to preclude the market from identifying his type borrower $R$ mimics the behavior of borrower $S$. This way he can gain a positive misinformation value by accessing to cheaper debt than the one priced according to his true fundamentals.

The existence of this pooling equilibrium relies on Assumption 2.b, that ensures borrower $R$ prefers pooling and mimicking borrower $S$ by choosing the same debt allocations, to separating and choosing the full information optimal allocation. Borrower $R$ will only prefer to pool if the utility obtained from the price gain is higher than the disutility from issuing distorted debt allocations.

Now that the pooling PBE-BS has been fully characterized the next part shows that this equilibrium is indeed the PBE-BS among all the set of equilibria. For this it is necessary to characterize the PBE-BS among the set of separating equilibria which is done in the next lemma.

Let $\{b^S_{0,1}, b^S_{0,2}, b^S_{1,1}(s)\}$ be the debt allocations that solve the following problem

$$\max_b U(b;S) \qquad s.t. \qquad U(b;R) \leq U^{FI}(R)$$

and also subject to (2) - (4) and prices given by (5) - (7) for $\theta = S$. This problem yields the allocations that maximize borrower S expected utility subject to the constraint that borrower R prefers to separate and choose his full information allocations regardless of the fact that he will reveal his type by doing so.

Lemma **2.** *Debt allocations $\{b^S_{0,1}, b^S_{0,2}, b^S_{1,1}(s)\}$ for borrower $S$, debt allocations $\{b^{FI}_{0,1}, b^{FI}_{0,2}, b^{FI}_{1,1}(s)\}$ for borrower $R$, prices $\{q^*_{0,1}, q^*_{0,2}, q^*_{1,1}(s)\}$ for $s = p, i$ configure a unique separating PBE-BS sustained by degenerate beliefs*

$$\mu^S_0(b_0) = \begin{cases} 0 & \text{if } b_0 = b^S_0 \\ 1 & \text{otherwise} \end{cases}, \qquad \text{and} \qquad \mu^S_1(s, b_1) = \begin{cases} 0 & \text{if } b_1 = b^S_1 \\ 1 & \text{otherwise} \end{cases}$$

*for any $s$.*

The presence of the separating equilibrium in the asymmetric information setting leaves borrower $S$ worse off respect to the full information setting given that in order to separate from borrower $R$, borrower $S$ engages in some distortionary consumption path. He does so by consuming more in states in which his valuation of consumption is highest relative that of borrower $R$. Given that borrower $R$ defaults with positive probability in periods $t = 1, 2$ the highest consumption valuation of borrower $S$ relative to borrower $R$ occurs in late repayment states. Although for different reasons, the optimal consumption rule features an increasing consumption path across time, as in the previously analyzed pooling equilibrium. In order to attain this increasing consumption path borrower $S$ optimally chooses to issue low levels of debt with shorter maturities, relative to the optimal issuance under the full information benchmark.

Borrower $R$ is indifferent between separating and pooling and decides to separate by choosing the debt allocations that maximize his utility in the full information benchmark. In other words, he prefers to choose debt in order to optimally transfer resources across time regardless of the fact that he reveals his type by doing so. A more detailed analysis of the separating PBE-BS can be found in Appendix B.

Given the characterization of the separating PBE-BS we can now analyze when is the case that the PBE-BS is pooling which is done in the following proposition.

PROPOSITION **1.** *There exist some threshold ex-ante probability of being a risky borrower* $\tilde{\alpha} \in (0, 1]$ *such that for* $\alpha \leq \tilde{\alpha}$ *the pooling PBE* $\{b^P(\theta), q^*(b), \mu^P(b)\}$ *for* $\theta = S, R$ *is the PBE-BS.*

The utility attained by borrower $S$ in the separating equilibrium does not depend on the ex-ante probability of being a risky borrower since types are fully revealed in this type of equilibrium. On the other hand, the utility attained by borrower $S$ in the pooling equilibrium is decreasing in the ex-ante probability of being a risky borrower. The reason is that the higher the ex-ante probability of being a risky borrower, the more negative wealth effect borrower $S$ gets from being pooled with a risky borrower. It follows that for low values of $\alpha$ borrower $S$ benefits more from the pooling equilibrium.

## 3. Asymmetric Information and Debt Maturity: Comparative Statics

This section derives testable implications of the model that are obtained from pursuing a comparative statics analysis. We restrict attention to the set of parameters that are such that the PBE-BS is pooling and study how spreads and debt maturity change in response to a change in the ex-ante probability of being a risky borrower. We then analyze how results are affected in two different model extensions.

3.1. *Comparative Statics in Main Model*

We consider how variations in the ex-ante probability of being a risky borrower affect the debt allocations and prices of the pooling equilibrium that yields the highest utility to the safe borrower. We focus on the maturity structure of debt which we define as the ratio $\frac{q_{0,1}b_{0,1}}{q_{0,2}b_{0,2}}$.[11] The results are summarized in the following proposition.

PROPOSITION **2.** *Under the pooling PBE-BS the prices of both long and short-term debt decrease when the ex-ante probability of being a risky borrower increases:*

$$\frac{\partial q_{0,1}}{\partial \alpha} < 0 \quad \textit{and} \quad \frac{\partial q_{0,2}}{\partial \alpha} < 0.$$

*Additionally, there exists a small enough $y_0$ such that the optimal maturity composition shortens when the ex-ante probability of being a risky borrower increases:*

$$\frac{\partial (q_{0,1}b_{0,1}/q_{0,2}b_{0,2})}{\partial \alpha} < 0.$$

The intuition for the first result is straightforward. When a given borrower is more likely to be risky the prices at which investors are willing to buy his debt are lower because the ex-ante default risk is higher. Lower debt prices come hand in hand with higher spreads.

The intuition for the second result is as follows. First note that prices of short and long-term debt do not react in the same way to increases in the ex-ante probability of being a risky borrower. Long-term debt prices drop more than short-term prices. The reason is that long-term debt prices are affected by the probability of the borrower defaulting in either period 1 or 2 and the ex-ante distribution of types affects the probabilities of both events. On the other hand, short-term debt prices are affected by the probability of default in the period that immediately follows its issuance and thus the ex-ante distribution of borrowers affects the price only through the likelihood of that single event. Given this asymmetric effect on prices, an increase in the ex-ante probability of being a risky borrower leads to consumption in period 2 becoming cheaper relative to consumption in period 0 and 1, and consumption in period 1 becoming cheaper relative to consumption in period 0. The safe borrower optimally responds to this change in relative prices by consuming more in period 2 relative to period 1 and consuming more in period 1 relative to period 0. This new consumption path is attained by reducing the overall level of debt issuance and shortening the maturity composition of debt.

[11]We measure the maturity structure measured at market value to make $b_{0,1}$ and $b_{0,2}$ comparable.

Risky borrowers still find optimal to mimic the behavior of safe borrower and preclude investors from identifying their type and thus face a positive wealth effect from being pooled with safe borrowers.

3.2. *Temporary Shocks*

The previous section examines the effect of an increase in the ex-ante probability of being risky that is permanent. In particular, the unconditional probability of being risky in period 1 also increases when $\alpha$ increases. This section analyzes the effect of a temporary shock to the ex-ante probability of being risky and shows that the same results hold even if the shock only affects the ex-ante default risk in period 1.

In order to analyze the effects of a temporary increase in ex-ante risk we consider a version of the model in which borrower $R$ faces a positive probability of changing to type $S$. In particular, denote the ex-ante probability of being risky $\Pr(\theta_0 = R) = \alpha + \varepsilon$ and the probability of borrower $R$ changing to type $S$, $\Pr(\theta_1 = S|\theta_0 = R) = \varepsilon/(\alpha + \varepsilon)$.[12] We maintain the assumption that the safe borrower does not change its type. In this new setup the unconditional probability of being risky in period 1 is $\Pr(\theta_1 = R) = \alpha$. Therefore we can interpret $\alpha$ as the permanent component and $\varepsilon$ as the temporary component as the ex-ante probability of being risky. We can then analyze the effects of a temporary increase in the ex-ante probability by performing comparative statics on $\varepsilon$. The results are summarized in the following proposition.

PROPOSITION **3.** *Under the pooling PBE-BS the prices of both long and short-term debt decrease in response to a temporary increase in the ex-ante probability of being a risky borrower:*

$$\frac{\partial q_{0,1}}{\partial \varepsilon} < 0 \quad and \quad \frac{\partial q_{0,2}}{\partial \varepsilon} < 0.$$

*Additionally, there exists a small enough $y_0$ such that the optimal maturity composition shortens in response to a temporary increase in the ex-ante probability of being a risky borrower:*

$$\frac{\partial (q_{0,1} b_{0,1} / q_{0,2} b_{0,2})}{\partial \varepsilon} < 0.$$

In this case given that the effect is temporary the absolute increase in default risk is the same for both short and long term debt. However, given that long-term debt prices carry more risk than short-term debt prices the relative effect on the former is higher than on the latter. Faced with an asymmetric relative effect on debt prices, the safe borrower optimally

[12]Here $\theta_t$ denotes the type of the government in period $t$.

responds by consuming more in period 2 relative to period 1 and consuming more in period 1 relative to period 0, which is achieved by a shortening of the debt maturity.

### 3.3. *Cross-Default*

This section analyzes the sensitivity of the model's results to relaxing the assumption that default occurs indiscriminately on all debt outstanding. We consider a modified version of the baseline model in which default occurs on the debt that is due in the period in which default happens and can potentially affect the repayment probability of debt that is due in the following period.

First we analyze the equilibrium in this setup and find that for the safe borrower, the presence of cross default makes the use long-term debt -as opposed to issuing short-term debt and rolling it over- a cheaper strategy to transfer resources from the last period to the first period. Second, we perform our comparative statics analysis and find the same baseline results when default probabilities in both periods are the same. However, more interestingly, we find that in the *joint* presence of cross-default and a decreasing path of default probabilities ($\lambda_1 > \lambda_2$), equilibrium average maturities may lengthen in response to an increase in the ex-ante probability of being a risky borrower.

We modify the baseline model in the following way. We maintain the assumption that borrower $S$ always repays. Additionally, as in the baseline model, if borrower $R$ defaults in $t = 2$ then he does not repay long-term debt $b_{02}$ nor short-term debt $b_{11}$ and consumes $c_2 = y_{def}$. If borrower $R$ defaults in $t = 1$ then he does not repay short-term debt $b_{01}$, is excluded from credit markets and consumes $c_1 = y_{def}$. However, now borrower $R$ can still repay its long-term debt in $t = 2$ and does so with probability $\lambda_2^D \in [\lambda_2, 1]$.[13] Therefore, $\lambda_2^D$ is the probability of borrower $R$ defaulting in $t = 2$ conditional on having defaulted in $t = 1$. Note that our baseline model corresponds to the particular case in which $\lambda_2^D = 1$. Additionally, the case of $\lambda_2^D = \lambda_2$ corresponds to the case in which a default is only on debt coming due and does not affect the probabilities of default on other outstanding debt. In

[13]In the state in which borrower $R$ repays long-term debt after having defaulted in $t = 1$ he will enjoy consumption $c_2 = y_2 - b_{02}$.

this setup, the on-equilibrium pooling prices are given by

$$q_{0,1}(b_{01}^P, b_{02}^P) = \beta(1-\alpha\lambda_1) \tag{27}$$

$$q_{0,2}(b_{01}^P, b_{02}^P) = \beta^2(1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)+\alpha\lambda_1(1-\lambda_2^D)) \tag{28}$$

$$q_{1,1}^*(s, b_{11}^P) = \beta^s \frac{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)}{1-\alpha\lambda_1} \tag{29}$$

for $s = p, i$. These prices imply that $q_{02} > \mathbb{E}\left[q_{01}q_{11}(s)\right]$ for $\lambda_2^D < 1$. For the perspective of borrower $S$ this implies that it is cheaper (in expected value) to transfer consumption from $t = 2$ to $t = 0$ using long-term debt rather than issuing short-term debt in $t = 0$ and rolling it over in $t = 1$. When the variance of $\beta^1$ is low enough, the above inequality holds for any state of the world. In this case, it can be shown that borrower $S$ will not use short term debt in either $t = 0$ ($b_{01} = 0$) or in $t = 1$ ($b_{11} = 0$). Which of the two non-negativity constraints bind will depend on the dispersion of incomes. Since we are interested in analyzing debt maturity structure we assume that income dispersion is such that we the equilibrium displays short- and long-term debt in the first period. The parametric assumptions that guarantees the existence of this equilibrium are stated in Appendix A. The following Lemma characterizes the equilibrium debt allocations in the case in which there are no shocks to the discount factor.

Lemma **3.** *Consider the model with time-varying default probabilities and cross-default. If parameters satisfy Assumption 3 (stated in the Appendix), the following debt allocations are sustained in the pooling PBE-BS*

$$b_{0,1} = y_1 - \frac{\beta}{q_{0,1}}\frac{W^P}{\delta(S)},$$

$$b_{0,2} = y_2 - \frac{\beta^2}{q_{0,2}}\frac{W^P}{\delta(S)},$$

$$b_{1,1}(s) = 0,$$

*for $s = p, i$.*

The allocations are have the same expression as in the baseline model with the difference that the equilibrium price of long-term debt is given by (28). We then use this equilibrium to characterize the responses of spreads and debt maturity to changes in the ex-ante probability of being risky.

Proposition **4.** *Consider the extended model with cross-default. Under the pooling PBE-BS the prices of both long and short-term debt decrease when the ex-ante probability of being* *a risky borrower increases:*

$$\frac{\partial q_{0,1}}{\partial \alpha} < 0 \quad and \quad \frac{\partial q_{0,2}}{\partial \alpha} < 0.$$

*Additionally, there exists a small enough $y_0$ such that:*

(1) *If $\lambda_2^D$ is sufficiently close to 1, the optimal maturity composition shortens when the ex-ante probability of being a risky borrower increases, $\frac{\partial(q_{0,1}b_{0,1}/q_{0,2}b_{0,2})}{\partial \alpha} < 0$.*
(2) *If $\lambda_1 > \lambda_2$ and $\lambda_2^D$ is sufficiently close to $\lambda_2$, the optimal maturity composition lengthens when the ex-ante probability of being a risky borrower increases, $\frac{\partial(q_{0,1}b_{0,1}/q_{0,2}b_{0,2})}{\partial \alpha} > 0$.*

The first case when $\lambda_2^D$ is sufficiently close to 1 converges to the model with no cross-default and in that case maturities shorten as shown in the previous subsection. The more interesting case is the second case in which a default in $t = 1$ does not affect the repayment probability of long-term debt. In that case the result on the behavior of maturities overturns if $\lambda_2 < \lambda_1$. For the perspective of the safe borrower whether short-term debt is more attractive long-term debt depends on whether the default probability in $t = 1$ is higher than that in $t = 2$. If it is, then an increase in the ex-ante probability of being a risky borrower decreases long-term debt prices more than short-term debt prices.

## 4. Sovereign Debt Maturity and Spreads: Empirical Evidence

This section test the implications of the model by analyzing empirical evidence on sovereign debt maturity structure and bond spreads. Data on sovereign bond issuance and spreads was collected for a comprehensive sample of emerging economies. The sample covers countries that are -or were once included- in J.P. Morgan's Emerging Markets Bond Index Global (EMBIG), subject to the constraint of having sufficient data availability. Being included in the EMBIG reflects both that the economy is emerging -and faces certain default risk- and that it is integrated to world capital markets. 34 countries met the sample criteria, namely, Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Dominican Republic, Ecuador, Egypt, El Salvador, Hungary, Indonesia, Ivory Coast, Kazakhstan, Lebanon, Lithuania, Malaysia, Mexico, Morocco, Nigeria, Panama, Peru, Philippines, Poland, Russia, South Africa, South Korea, Thailand, Tunisia, Turkey, Ukraine, Uruguay and Venezuela. Further details about the description of the data can be found in Appendix C.

Daily data for bond issuance was collected from Bloomberg and spreads data was obtained from Datastream. Our main analysis is carried out with data on bond issuance in all currencies. By doing so we include external public debt denominated in local currency, which has risen significantly in the past decade (see, for example, Du and Schreger (2015) and Ottonello and Perez (2016)). We also carry out a robustness analysis in which we only use bond issuances denominated in foreign currency. The time period ranges from January 1994 -when EMBIG spreads are initially available- until May 2012. However, data on particular countries may start later or end earlier, depending on the availability of data on each country spreads.[14]

A bond spread is the excess yield of the bond over the yield of a risk-free zero-coupon bond (i.e., a US Treasury) of the same maturity. A country's spread is a synthetic measure of the spreads of a representative basket of bonds issued by that country. It measures the implicit interest rate premium required by investors to be willing to invest in a defaultable bond of that particular country. A bond maturity is measured by the number of years until its maturity date.[15]

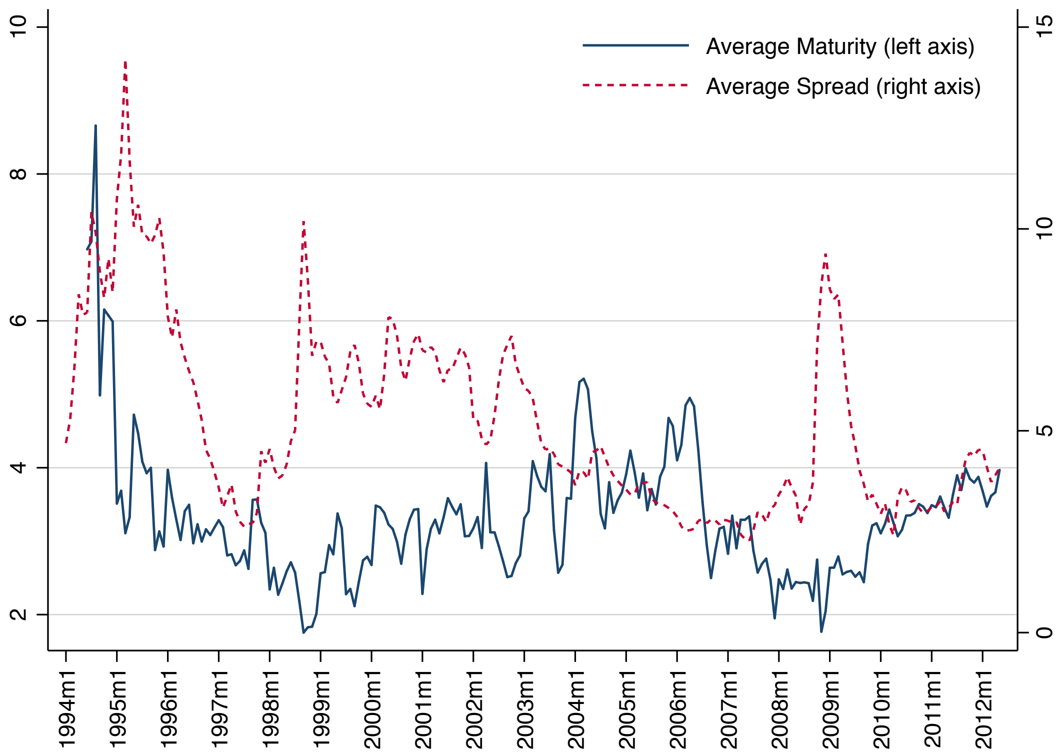
Monthly average spreads and average maturity were computed for each country in the sample. Maturities were weighted according to the face value of each bond. This weighting accounts for the fact that even though countries may issue bonds with different maturities at the same time, the economic relevance of each bond is given by the volume of debt associated to each bond. Summary statistics of the data are reported in Table C2 in Appendix C. As depicted in Figure 2, the maturity structure of debt of the average emerging economy tends to move in opposite directions with spreads. In periods of substantial increases in spreads like the Russian default in 1998, the Argentinean default in late 2001 and the 2007-09 global financial crisis, the maturity profile of debt issuances shortened considerably. This pattern

[14]Issuance during periods of default were excluded from the sample. In particular, the default periods of Dec-01 to Jun-05 for Argentina and Aug-98 to Sep-00 for Russia were not considered. Additionally, issuance under debt restructuring episodes identified in Cruces and Trebesch (2013) were also excluded from the analysis.

[15]An alternative, more precise measure of a bond's maturity is a bond's duration, defined in as the weighted average of the number of years until each of the bond's coupon payments. Due to poor data availability on bonds cash flow schedules, this measure cannot be computed for all bonds in all countries. However, as Arellano and Ramanarayanan (2012) document, the standard measure of maturity is a good substitute of the later.

is present in most of the countries in our sample (see last two columns of Table C2 that compute the conditional average maturity in times of high and low spreads).

FIGURE 2. Sovereign Spreads and Debt Maturity in Emerging Economies




*Notes*: All variables are calculated as simple averages of the countries in the sample. Spreads are measured percentage points. Debt maturity is the average maturity measured in years of all bonds issued in the last 6 months weighted by the face value of each bond.

To further illustrate this fact, a set of panel data regressions were estimated. The regressions estimate the relationship between debt maturity and country spreads. An observation of debt maturity is the weighted average maturity of all the bond issuances of a given country in a given month. The monthly average maturity was regressed against the prevailing monthly average country spread. The estimation results are reported in the first two columns of Table 1. The first column shows the estimates of the regression that includes country fixed effects and the second column the regression that includes country and month fixed effects. Results indicate that the choice of sovereign debt maturity is affected by country spreads. The coefficient on spreads is negative and significant at the 1% level in both specifications and the point estimate is similar. An increase in 100 basis points in a country's spread would have associated a reduction of 1 month in the average maturity structure of bonds.[16]

TABLE 1. Panel Regressions of Sovereign Debt Maturity

| | (1) Maturity | (2) Maturity | (3) Maturity | (4) Maturity | (5) Maturity | (6) Maturity |
|---|---|---|---|---|---|---|
| Spread | -0.069*** | -0.068*** | -0.054** | -0.049* | 0.038 | 0.044 |
| | (0.021) | (0.026) | (0.023) | (0.027) | (0.039) | (0.042) |
| Spread×Elections | | | -0.070*** | -0.086*** | | |
| | | | (0.023) | (0.024) | | |
| Spread×$\sigma^{Rating}$ | | | | | -0.056*** | -0.058*** |
| | | | | | (0.017) | (0.017) |
| $N$ | 4042 | 4042 | 3998 | 3998 | 4034 | 4034 |
| $R^2$ | 0.113 | 0.172 | 0.112 | 0.167 | 0.116 | 0.175 |
| Time FE | No | Yes | No | Yes | No | Yes |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes*: The dependent variable is the average maturity of bond issuances of a given country in a given month, weighted by the face value of each bond. The estimation method is OLS. Columns (1) and (2) include spreads ("Spread") as a regressor, which are measured in percentage points. Columns (3) and (4) include spreads and its interaction with a dummy if there was a presidential election that year or in the previous year ("Spread×Elections"). Columns (5) and (6) include spreads and its interaction with country volatility of credit ratings ("Spread×$\sigma^{Rating}$"). "Time FE" are month dummy variables. "Country FE" are country dummy variables. $*$, $**$, and $***$ represent statistical significance at the 10%, 5%, and 1% level, respectively.

These results are consistent with the testable implications of our model. However, as noted in section 1, this is a prediction that is shared by other models. The distinct feature of our theory is its reliance on the presence of asymmetric information between the government and investors about the willingness to repay of the former. If our proposed mechanism plays a role in determining the observed co-movement between maturity and spreads, then we

[16] As a benchmark, spreads for emerging markets increased by more than 500 basis points during the 2007-09 global financial crisis.

would expect this co-movement to be stronger in those situations in which informational asymmetries are larger.

We test this empirically by constructing a proxy for situations in which the degree of asymmetric information between governments and investors is expected to be larger or more relevant. The proxy is given by the years of presidential elections or those that immediately follow one. In those years the type of the government is presumably less revealed to foreign investors and the degree of asymmetric information is larger. We then estimate our baseline regressions including an additional regressor given by the level of spreads interacted with a dummy variable that is one in the year of a presidential election or the year that follows a presidential election.[17] Results are shown in the third and fourth column of Table 1. The coefficient on spreads interacted with the presidential elections dummy is negative and significant at the 1% level in both the specifications with and without month fixed effects. The point estimate is also economically relevant. An increase in 100 basis points in a country's spread in years of elections or years that follow elections, lead to an additional reduction of 1 month in the average maturity structure of bonds over and above the reduction in years of no elections.

As a robustness analysis we construct a second proxy for those countries in which the degree of asymmetric information is more relevant, which is given by the historical volatility of each country's credit ratings.[18] In countries with more volatile credit ratings, government types are expected to be less predictable by foreign investors. We estimate the baseline regressions with spreads interacted with the historical standard deviation of credit ratings of a given country, as an additional regressor. Results are shown in the last two columns of Table 1. The coefficient on spreads interacted with the volatility of country-credit ratings is negative and significant at the 1% level in both specifications.

Finally, we compute robustness checks that dwell with the estimation method and the use of data on bond issuance. We estimate the same set of regressions using the Heckman estimation method that accounts for the incidental truncation of the data. This two-step estimation considers the fact that periods of no issuance (and thus of no observed maturities)

[17]Data on presidential elections by country was obtained from Elections Results Archive and Psephos.

[18]Data on credit ratings for sovereign debt was obtained from Bloomberg. We used ratings from S&P 500 for foreign currency long-term debt. Ratings were transformed to a linear numerical scale and we computed the standard deviation of the historical time series of ratings for every country.

can also provide useful information.[19] Results, shown in the first six columns of Table C3, are in line with our baseline results in all the regressions with country and month fixed effects. We also perform an additional robustness check in which we estimate the same set of regressions with maturities computed with data on bond issuance on foreign currency only. The results are shown in the last six columns of Table C3. In this case the estimates are in line with our baseline results in the case of the regressions of maturities on spreads and in the specification that includes spreads interacted our preferred proxy of asymmetric information (the elections dummy).

## 5. Conclusion

The contribution of this paper is the analysis of the optimal choice of sovereign debt maturity structure under the assumption that investors are unaware of the governments' willingness to repay debt. Under a pooling equilibrium there is a wedge between the borrower's true default risk and the default risk priced in debt, and the size of this wedge differs with the maturity of debt. Long-term debt becomes less attractive for safe borrowers since it pools more default risk that is not inherent to them. Safe borrowers optimally react to this negative asymmetric effect on prices by shortening its maturity profile and risky borrowers mimic this behavior.

The relationship between maturity choice of sovereign debt and bond prices is introduced using a comparative statics analysis. In periods in which the ex-ante expected repayment capacity of borrowers deteriorates prices of both long and short term debt fall. Long-term debt prices decay more than short term-debt prices as the former reflect default risk during a longer period of time. Given this asymmetric price effect, it becomes optimal for safe borrowers, and also for risky borrowers that gain from pooling with safe borrowers, to shorten the maturity composition of debt.

The predictions of the model are shown to be consistent with the observed co-movement of spreads and debt maturities. Using data for a sample of 34 emerging economies, this paper analyzed the relationship between the sovereign debt maturity structure and country spreads. Results of panel data regressions indicate that the maturity of debt covaries negatively with

[19]Given that maturities are only available when countries decide to issue debt, the econometrician would tend to miss observations of maturities when countries decide not to issue debt which coincides with times of high spreads. The Heckman model takes into account this selection truncation by estimating a selection equation that estimates the decision of countries to issue debt and estimate the main equation of the maturity choice taking into account the selection model.

country spreads. Additionally, consistent with this particular theory, this co-movement is stronger in situations in which informational asymmetries between the government and foreign investors are expected to be higher.

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## Appendix A. Proofs

This appendix provides the proofs of all Lemmas and Propositions, and states the additional assumptions for the characterization of the equilibrium in the model without cross-default.

*Proof of Lemma 1.* It suffices to show that $\{b^P, q^*, \mu^P\}$ configures a pooling PBE. The fact that it will be the pooling PBE-BS follows by construction given that the debt allocations $b^P$ attain the maximum utility for borrower $S$ given on-equilibrium pooling prices.

Since it was already shown that beliefs $\mu^P$ are consistent with Bayes rule on equilibrium and that prices $q^*$ are determined by the discounted expected repayment given beliefs, it only remains to be proven that both borrowers find it optimal to choose allocations $b^P$ to show that $\{b^P, q^*, \mu^P\}$ indeed configures a pooling PBE.

Note that borrower $S$ prefers to chose allocation $b^P$ since, by definition it yields higher utility than any other allocation with pooling prices, and thus also yields higher utility than any allocation with prices set by beliefs $\mu_t = 1$ -since these are lower than pooling prices-.

Borrower $R$ prefers allocation $b^P$ if the maximum utility attained with prices set by beliefs $\mu_t = 1$ for all $t$ is lower than the utility obtained by choosing $b^P$. The debt allocations that yield the highest utility to borrower $R$ are given by (9)-(11) for $\theta = R$. The utility obtained from choosing these allocations is

$$U(b^{FI}, R) = \delta(R) \log\left(\frac{W(R)}{\delta(R)}\right) + \big(\beta\lambda_1 + \beta^2(1-(1-\lambda_1)(1-\lambda_2))\big)\log(y_{def})$$

On the other hand, the utility attained from choosing $b^P$ is

$$\begin{aligned} U(b^P, R) \quad = \quad & \log\left(\frac{W^P}{\delta(S)}\right) + \beta(1-\lambda_1)\log\left(\frac{\tau_1^P W^P}{\delta(S)}\right) + \beta^2(1-\lambda_1)(1-\lambda_2)\log\left(\frac{\tau_2^P W^P}{\delta(S)}\right) \\ & + \big(\beta\lambda + \beta^2(1-(1-\lambda)^2)\big)\log(y_{def}) \end{aligned}$$

Borrower $R$ will prefer to choose $b^P$ as long as $U(b^P, R) > U(b^{FI}, R)$ which is precisely what is stated in Assumption (A2.b).

Finally, uniqueness of the pooling PBE-BS comes from the fact that allocations $b^P$ are the unique maximizers of the utility of borrower $S$ given on-equilibrium pooling prices.

$\square$

*Proof of Lemma 2.* Again it suffices to show that $\{b^S(S), b^{FI}(R), q^*, \mu^S\}$ configures a PBE. The fact that it is the separating PBE-BS follows by definition of $b^S(S)$ and the fact that $b^S(S) \neq b^{FI}(R)$.

Note that beliefs $\mu_t^S(s, b_t)$ are consistent with Bayes rule on equilibrium since $\mu_t^S(s, b^S(S)) = 0$ and $\mu_t^S(s, b^{FI}(R)) = 1$ for all $t$. Additionally, prices $q^*$ are determined by the discounted expected repayment given beliefs. It only remains to be shown that borrower $R$ finds optimal to choose $b^{FI}(R)$ and borrower $S$ prefers to choose allocations $b^S(S)$ given prices $q^*(b)$.

Recall that $b^S(S)$ solves the following problem

$$\max_b U(b; S) \qquad s.t. \qquad U(b; R) \leq U^{FI}(R)$$

and also subject to (2) - (4) and prices given by (5) - (7) for $\theta = S$. In Appendix B we show that this is a well-defined problem that has a unique solution.

By definition of $b^S(S)$, borrower $R$ is indifferent between $b^{FI}(R)$ and $b^S(S)$. Also by definition of $b^{FI}(R)$, borrower $R$ prefers it to any other allocation $b \neq b^S(S)$. It follows that borrower $R$ finds it optimal to choose $b^{FI}(R)$.

In Appendix B we show that borrower $S$ chooses the allocations $b^S(S)$ given prices $q^*(b)$. □

*Proof of Proposition 1.* Note first that the utility attained by borrower $S$ under the pooling PBE-BS is continuous and strictly decreasing in $\alpha$, whereas the utility attained by borrower $S$ under the separating PBE-BS does not depend on $\alpha$.

In the extreme case when $\alpha = 0$ then the pooling PBE-BS coincides with the full information equilibrium for borrower $S$ which yields borrower $S$ a higher utility than the separating PBE-BS.[20] Therefore, for $\alpha = 0$ the PBE-BS is the best pooling PBE.

For the other extreme case of $\alpha = 1$ we may have that the PBE-BS is either pooling or separating. In the first case given the monotonicity of $U(\cdot; S, \alpha)$ under the pooling PBE-BS it follows that the threshold $\tilde{\alpha} = 1$. In the second case again by monotonicity of $U(\cdot; S, \alpha)$ under the pooling PBE-BS it follows from Bolzano's Theorem that there exists some threshold $\tilde{\alpha} \in (0, 1)$ such that for $\alpha \leq \tilde{\alpha}$ the pooling PBE-BS is the PBE-BS. □

*Proof of Proposition 2.* The first result of the proposition follows directly from the on-equilibrium price expressions.

To show the second result we need to show that

$$\frac{\partial q_{0,1} b_{01}^P / q_{0,2} b_{02}^P}{\partial \alpha} > 0 \text{ for small } y_0.$$

[20]It will yield the same utility as the separating PBE-BS when the restriction $U\left(b^S(S); R\right) \leq U^{FI}(R)$ is not binding since in this case the separating PBE-BS will also coincide with the full information equilibrium.

It suffices to show:

$$\frac{\partial q_{0,1}/q_{0,2}}{\partial \alpha} > 0, \qquad \frac{\partial b_{01}^P}{\partial \alpha} > 0 \qquad \text{and} \qquad \frac{\partial b_{02}^P}{\partial \alpha} < 0.$$

Proving the first inequality holds is equivalent to showing:

$$\frac{\partial \log(q_{0,1})}{\partial \alpha} > \frac{\partial \log(q_{0,2})}{\partial \alpha},$$

which is true given that

$$\frac{\partial \log(q_{0,1})}{\partial \alpha} = -\frac{\lambda_1}{1-\alpha\lambda_1} > -\frac{(\lambda_1 + \lambda_2(1-\lambda_1))}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)} = \frac{\partial \log(q_{0,2})}{\partial \alpha}.$$

Proving the second inequality holds is equivalent to showing:

$$\frac{\partial \log(\tau_1^P)}{\partial \alpha} + \frac{\partial \log(W^P)}{\partial \alpha} < 0$$

These derivatives are given by:

$$\begin{aligned}
\frac{\partial \log(\tau_1^P)}{\partial \alpha} + \frac{\partial \log(W^P)}{\partial \alpha} &= \frac{\lambda_1}{1-\alpha\lambda_1} - \frac{\lambda_1\left(\beta y_1 + \beta^2\left(1+\frac{\lambda_2}{\lambda_1}(1-\lambda_1)\right)y_2\right)}{q_{01}y_1 + q_{02}y_2} \\
&= \frac{\lambda_1}{1-\alpha\lambda_1} - \frac{\lambda_1}{1-\alpha\lambda_1}\frac{(q_{01}y_1 + \beta^2\left(1+\frac{\lambda_2}{\lambda_1}(1-\lambda_1)\right)(1-\alpha\lambda_1)y_2)}{q_{01}y_1+q_{02}y_2} \\
&< \frac{\lambda}{1-\alpha\lambda} - \frac{\lambda}{1-\alpha\lambda}\frac{W^P}{W^P} \\
&= 0.
\end{aligned}$$

The first equality uses the fact that $y_0 = 0$, and the inequality uses the fact that

$$\beta^2\left(1+\frac{\lambda_2}{\lambda_1}(1-\lambda_1)\right)(1-\alpha\lambda_1) > \beta^2\left(1+\frac{\lambda_2}{\lambda_1}(1-\lambda_1)\right)(1-\alpha+\alpha(1-\lambda_1)(1-\lambda_1)) > q_{0,2}.$$

It remains to show the third inequality. Again proving the third inequality holds is equivalent to showing:

$$\frac{\partial \log(\tau_2^P)}{\partial \alpha} + \frac{\partial \log(W^P)}{\partial \alpha} > 0.$$

These derivatives are given by:

$$\begin{aligned}
\frac{\partial \log(\tau_2^P)}{\partial \alpha} + \frac{\partial \log(W^P)}{\partial \alpha} &= \frac{\lambda_1+\lambda_2(1-\lambda_1)}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)} - \frac{(\lambda_1+\lambda_2(1-\lambda_1))\left(\beta\lambda_1\left(\lambda_1+\lambda_2(1-\lambda_1)\right)^{-1}y_1 + \beta^2 y_2\right)}{q_{01}y_1+q_{02}y_2} \\
&= \frac{\lambda_1+\lambda_2(1-\lambda_1)}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)}\left(1 - \frac{\beta\frac{\lambda_1(1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2))}{\lambda_1+\lambda_2(1-\lambda_1)}y_1 + q_{02}y_2}{q_{01}y_1+q_{02}y_2}\right) \\
&> \frac{\lambda_1+\lambda_2(1-\lambda_1)}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)}\left(1-\frac{W^P}{W^P}\right) \\
&= 0.
\end{aligned}$$

Here, the first equality uses the fact that $y_0 = 0$, and the inequality uses the fact that

$$\beta\frac{\lambda_1(1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2))}{\lambda_1+\lambda_2(1-\lambda_1)} < \frac{\lambda_1 q_{0,1}}{\lambda_1+\lambda_2(1-\lambda_1)} < q_{0,1}. \tag{30}$$

□

*Proof of Proposition 3.* Before turning to the proof we characterize the pooling PBE-BS for the new version of the model in which borrower $R$ faces a positive probability changing to type $S$ in period 1. Note that given $\Pr(\theta_0 = R) = \alpha + \varepsilon$, the probability of changing types for borrower $R$ is chosen to be $\Pr(\theta_1 = S|\theta_0 = R) = \varepsilon/(\varepsilon + \alpha)$, so that the unconditional probability of being risky in period 1 is $\Pr(\theta_1 = R) = \alpha$. This way we can interpret $\alpha$ as the permanent component of ex-ante risk in period 0 and $\varepsilon$ as the temporary component of ex-ante risk in period 0.

Also note that the on-equilibrium pooling debt prices reflect the fact that ex-ante probabilities of being risky are different, and are given by

$$q_{01}(b_{01}^P, b_{02}^P) = \beta(1-(\alpha+\varepsilon)\lambda_1) \tag{31}$$

$$q_{02}(b_{01}^P, b_{02}^P) = \beta^2(1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1) \tag{32}$$

$$q_{11}^*(s, b_{11}^P) = \beta^s\frac{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} \tag{33}$$

for $s = p, i$. To solve for the pooling PBE-BS we need to solve for debt allocations that maximize the utility of safe borrower $S$ given the on-equilibrium pooling prices and then verify that is indeed optimal for borrower $R$ to pool. Given that from the perspective of borrower $S$ the only thing that changes with respect to the previous setup are the on equilibrium prices, the debt allocations that solve the maximization problem are given by

$$b_{01}^P = y_1 - \frac{\tilde{\tau}_1^P W^P}{\delta(S)} \tag{34}$$

$$b_{02}^P = y_2 - \frac{\tilde{\tau}_2^P W^P}{\delta(S)} \tag{35}$$

$$b_{11}^P(s) = 0 \tag{36}$$

where $W^P$ is the borrower's wealth valued at the new equilibrium pooling prices and

$$\tilde{\tau}_1^P = \frac{1}{1-(\alpha+\varepsilon)\lambda_1} \qquad \text{and} \qquad \tilde{\tau}_2^P = \frac{1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1}$$

It can be shown that for low values of $\alpha$ borrower $R$ prefers to pool rather than choose the debt allocations that maximize his utility when debt prices reflect his default probabilities.

Finally, in order to fully characterize the pooling PBE-BS we need to describe beliefs that sustain these allocations as a PBE which are given by[21]

$$\mu_0^P(b_{01}, b_{02}) = \begin{cases} \alpha + \varepsilon & \text{if } (b_{01}, b_{02}) = (b_{01}^P, b_{02}^P) \\ 1 & \text{if } (b_{01}, b_{02}) \neq (b_{01}^P, b_{02}^P) \end{cases}$$

$$\mu_1^P(b_{11}, s) = \begin{cases} \frac{\alpha(1-\lambda_1)}{1-(\alpha+\varepsilon)\lambda_1} & \text{if } b_{11}(s) = b_{11}^P(s) \\ 1 & \text{if } b_{11}(s) \neq b_{11}^P(s) \end{cases}$$

Now we prove the proposition. The first result of the proposition follows directly from the fact that on-equilibrium price expressions are decreasing in $\varepsilon$. To show the second result we follow the same steps as the previous proof. We need to show that

$$\frac{\partial q_{0,1} b_{01}^P / q_{0,2} b_{02}^P}{\partial \varepsilon} > 0 \text{ for small } y_0.$$

It suffices to show:

$$\frac{\partial q_{0,1}/q_{0,2}}{\partial \varepsilon} > 0, \qquad \frac{\partial b_{01}^P}{\partial \varepsilon} > 0 \qquad \text{and} \qquad \frac{\partial b_{02}^P}{\partial \varepsilon} < 0.$$

Proving the first inequality holds is equivalent to showing:

$$\frac{\partial \log(q_{0,1})}{\partial \varepsilon} > \frac{\partial \log(q_{0,2})}{\partial \varepsilon}$$

which is true given that

$$\frac{\partial \log(q_{0,1})}{\partial \varepsilon} = -\frac{\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} > -\frac{\lambda_1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1} = \frac{\partial \log(q_{0,2})}{\partial \alpha}.$$

Proving the second inequality holds is equivalent to showing:

$$\frac{\partial \log(\tilde{\tau}_1)}{\partial \varepsilon} + \frac{\partial \log(W^P)}{\partial \varepsilon} < 0.$$

The previous derivatives are:

$$\begin{aligned} \frac{\partial \log(\tilde{\tau}_1)}{\partial \varepsilon} + \frac{\partial \log(W^P)}{\partial \varepsilon} &= \frac{\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} - \frac{\lambda_1(\beta y_1 + \beta^2 y_2)}{q_{01} y_1 + q_{02} y_2} \\ &= \frac{\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} - \frac{\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} \frac{q_{01} y_1 + \beta^2(1-(\alpha+\varepsilon)\lambda_1) y_2}{q_{01} y_1 + q_{02} y_2} \\ &< \frac{\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} - \frac{\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} \frac{W^P}{W^P} \\ &= 0. \end{aligned}$$

[21]These are particular degenerate beliefs. As in the main setup, these are one of many beliefs that can sustain these allocations in equilibrium.

The first equality uses the fact that $y_0 = 0$, and the inequality uses the fact that $1-(\alpha+\varepsilon)\lambda_1 > 1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1$.

It remains to show the third inequality. Again proving the third inequality holds is equivalent to showing:

$$\frac{\partial \log(\tilde{\tau}_2^P)}{\partial \varepsilon} + \frac{\partial \log(W^P)}{\partial \varepsilon} > 0.$$

Calculating these derivatives yields:

$$\begin{aligned}
\frac{\partial \log(\tilde{\tau}_2^P)}{\partial \varepsilon} + \frac{\partial \log(W^P)}{\partial \varepsilon} &= \frac{\lambda_1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1} - \frac{\lambda_1(\beta y_1 + \beta^2 y_2)}{q_{01}y_1 + q_{02}y_2} \\
&= \frac{\lambda_1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1}\left(1 - \frac{\frac{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1}{1-(\alpha+\varepsilon)\lambda_1} q_{01}y_1 + q_{02}y_2}{q_{01}y_1 + q_{02}y_2}\right) \\
&> \frac{\lambda_1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1}\left(1 - \frac{W^P}{W^P}\right) \\
&= 0.
\end{aligned}$$

Here, the first equality uses the fact that $y_0 = 0$, and the inequality uses the fact that $1-(\alpha+\varepsilon)\lambda_1 > 1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)-\varepsilon\lambda_1$. □

Assumption 3 (Existence of pooling PBE-BS in model with cross-default.).

$$y_t \geq \frac{\hat{\tau}_t^P W^P}{\delta(S)} \qquad \textit{for } t = 1, 2, \tag{A3.a}$$

$$\beta(1-\lambda_1)\log(\hat{\tau}_1^P) + \beta^2(1-\lambda_1)(1-\lambda_2)\log(\hat{\tau}_2^P) > \delta(R)\left(\log\left(\frac{W(R)}{\delta(R)}\right) - \log\left(\frac{W^P}{\delta(S)}\right)\right) \tag{A3.b}$$

$$\left(\log\left(W^P\right) - \log\left(\tilde{W}^P\right)\right)\delta(S) \geq \log(q_{1,1}) + \log(q_{0,1}) - \log(q_{0,2}) \tag{A3.c}$$

$$\beta^i = \beta^p = \beta \tag{A3.d}$$

*where $W^P$ is evaluated at equilibrium prices* (27) - (29)*, $W(R), \delta(R), \delta(S)$ are defined as in the full-information model, $\tilde{W}^P = y_0 + \frac{q_{0,2}}{q_{1,1}(s)} y_1 + q_{0,2} y_2$,*

$$\hat{\tau}_1^P = \frac{1}{1-\alpha\lambda_1} \quad \textit{and} \quad \hat{\tau}_2^P = \frac{1}{1-\alpha+\alpha(1-\lambda_1)(1-\lambda_2)+\alpha\lambda_1(1-\lambda_2^D)}.$$

The first equation ensures positive debt allocations. The second ensures that borrower $R$ prefers to pool than separate. The third ensures that dispersion in income is such that it is optimal for borrower $S$ to set $b_{1,1} = 0$ (this assumption is satisfied if $y_1 = 0$, for example). Finally, the last assumption eliminates the source of uncertainty of interest rates which are not essential for our results in this part.

*Proof of Lemma 3.* We first show that the debt allocations solve the problem

$$\max_{b\in\mathbb{R}^3_+} U(b;S) \qquad s.t. \qquad U(b;R) \geq U^{FI}(R)$$

and also subject to (2) - (4) and prices given by (27) - (29). Note that with cross-default prices are such that $q_{0,2} > q_{0,1}q_{1,1}$. Therefore, the government always prefers to use long-term debt and the non-negativity constraint associated to $b_{0,1}$ and/or $b_{1,1}$ is binding.

Consider the case in which $b_{0,1} = 0$, the consumption allocations that solve this problem are

$$c_0 = \frac{\tilde{W}^P}{\delta(S)} \qquad c_1 = \frac{\beta q_{1,1}}{q_{0,2}}\frac{\tilde{W}^P}{\delta(S)} \qquad c_2 = \frac{\beta^2}{q_{0,2}}\frac{\tilde{W}^P}{\delta(S)}$$

where $\tilde{W}^P = y_0 + \frac{q_{0,2}}{q_{1,1}}y_1 + q_{0,2}y_2$. The utility associated to these allocations is $\tilde{U} = \log\left(\frac{\tilde{W}^P}{\delta(S)}\right)\delta(S) + \beta\log\left(\frac{\beta q_{1,1}}{q_{0,2}}\right) + \beta^2\log\left(\frac{\beta^2}{q_{0,2}}\right)$.

Now consider the case in which $b_{1,1} = 0$. the consumption allocations that solve this problem are

$$c_0 = \frac{W^P}{\delta(S)} \qquad c_1 = \frac{\beta}{q_{0,1}}\frac{W^P}{\delta(S)} \qquad c_2 = \frac{\beta^2}{q_{0,2}}\frac{W^P}{\delta(S)}$$

and the utility associated to these allocations is $U = \log\left(\frac{W^P}{\delta(S)}\right)\delta(S) + \beta\log\left(\frac{\beta}{q_{0,1}}\right) + \beta^2\log\left(\frac{\beta^2}{q_{0,2}}\right)$. It can be seen that $U > \tilde{U}$ given the parametric assumption (A3.c).

To finish showing that these allocations are part of a pooling PBE we first note that beliefs are consistent with Bayes rule and that given assumption (A3.b), borrower $R$ prefers to pool than separate to his best prefer deviation that yields him the utility associated to the full-information equilibrium. □

*Proof of Proposition 4.* The first result of the proposition follows directly from the on-equilibrium price expressions.

Then we have two cases, we first prove case 1. Note that when $\lambda_2^D \to 1$ we converge to the baseline model, and by Proposition 2, we know that $\frac{\partial(q_{0,1}b_{0,1}/q_{0,2}b_{0,2})}{\partial\alpha}|_{\lambda_2^D=1} < 0$. Hence, by continuity of equilibrium allocations we obtain our result.

We now prove our second result. It suffices to show that $\frac{\partial q_{0,1}b_{01}^P/q_{0,2}b_{02}^P}{\partial\alpha}|_{\lambda_2^D=\lambda_2} < 0$ for small $y_0$. It suffices to show:

$$\frac{\partial q_{0,1}/q_{0,2}}{\partial\alpha}|_{\lambda_2^D=\lambda_2} < 0, \qquad \frac{\partial b_{01}^P}{\partial\alpha}|_{\lambda_2^D=\lambda_2} < 0 \qquad \text{and} \qquad \frac{\partial b_{02}^P}{\partial\alpha}|_{\lambda_2^D=\lambda_2} > 0.$$

The first inequality holds since:

$$\frac{\partial \log(q_{0,1})}{\partial \alpha}|_{\lambda_2^D=\lambda_2} = -\frac{\lambda_1}{1-\alpha\lambda_1} < -\frac{\lambda_2}{1-\alpha\lambda_2} = \frac{\partial \log(q_{0,2})}{\partial \alpha}|_{\lambda_2^D=\lambda_2},$$

for $\lambda_1 > \lambda_2$. Proving the second inequality holds is equivalent to showing:

$$-\frac{\partial \log(q_{0,1})}{\partial \alpha}|_{\lambda_2^D=\lambda_2} + \frac{\partial \log(W^P)}{\partial \alpha}|_{\lambda_2^D=\lambda_2} > 0$$

These derivatives are given by:

$$\begin{aligned}
-\frac{\partial \log(q_{0,1})}{\partial \alpha}|_{\lambda_2^D=\lambda_2} + \frac{\partial \log(W^P)}{\partial \alpha}|_{\lambda_2^D=\lambda_2} &= \frac{\lambda_1}{1-\alpha\lambda_1} - \frac{\lambda_1\left(\beta y_1 + \beta^2 \frac{\lambda_2}{\lambda_1} y_2\right)}{q_{01}y_1 + q_{02}y_2} \\
&= \frac{\lambda_1}{1-\alpha\lambda_1} - \frac{\lambda_1}{1-\alpha\lambda_1}\frac{(q_{01}y_1 + \beta^2\frac{\lambda_2}{\lambda_1}(1-\alpha\lambda_1)y_2)}{q_{01}y_1 + q_{02}y_2} \\
&> \frac{\lambda}{1-\alpha\lambda} - \frac{\lambda}{1-\alpha\lambda}\frac{W^P}{W^P} \\
&= 0.
\end{aligned}$$

The first equality uses the fact that $y_0 = 0$, and the inequality uses the fact that

$$\frac{\lambda_2}{\lambda_1}(1-\alpha\lambda_1) < (1-\alpha\lambda_2).$$

It remains to show the third inequality. This is equivalent to showing:

$$-\frac{\partial \log(q_{0,2})}{\partial \alpha}|_{\lambda_2^D=\lambda_2} + \frac{\partial \log(W^P)}{\partial \alpha}|_{\lambda_2^D=\lambda_2} < 0$$

Calculating these derivatives yields:

$$\begin{aligned}
-\frac{\partial \log(q_{0,2})}{\partial \alpha}|_{\lambda_2^D=\lambda_2} + \frac{\partial \log(W^P)}{\partial \alpha}|_{\lambda_2^D=\lambda_2} &= \frac{\lambda_2}{1-\alpha\lambda_2} - \frac{\lambda_2\left(\beta \frac{\lambda_1}{\lambda_2} y_1 + \beta^2 y_2\right)}{q_{01}y_1 + q_{02}y_2} \\
&= \frac{\lambda_2}{1-\alpha\lambda_2} - \frac{\lambda_2}{1-\alpha\lambda_2}\frac{\left(\frac{\lambda_1}{\lambda_2}(1-\alpha\lambda_2)y_1 + \beta^2 q_{0,2}y_2\right)}{q_{01}y_1 + q_{02}y_2} \\
&< \frac{\lambda}{1-\alpha\lambda} - \frac{\lambda}{1-\alpha\lambda}\frac{W^P}{W^P} \\
&= 0.
\end{aligned}$$

Here, the first equality uses the fact that $y_0 = 0$, and the inequality uses the fact that

$$\frac{\lambda_1}{\lambda_2}(1-\alpha\lambda_2) < (1-\alpha\lambda_1).$$

$\square$

## Appendix B. Best Separating Equilibrium

This appendix characterizes the best separating equilibrium for borrower $S$.

To solve for the separating PBE-BS we will follow the same steps as in the pooling equilibrium: first solve for the optimal debt allocations for borrower $S$ given separating prices subject to the constraint of borrower $R$ preferring not to pool; and second construct beliefs that sustain those prices and allocations under a PBE.

Consider the following artificial problem that chooses debt allocations to:

$$\max_b U(b; S) \qquad s.t. \qquad U(b; R) \leq U^{FI}(R)$$

and also subject to (2) - (4) and prices given by (5) - (7) for $\theta = S$. This problem will yield the allocations that maximize borrower $S$ expected utility such that borrower $R$ finds it optimal to separate and choose his full information allocations regardless of the fact that he will reveal his type by doing so.

Let $\phi$ be the Lagrange multiplier associated to the separating restriction. Then the first order conditions associated to this problem are

$$\frac{\beta}{c_0} - \beta\left(\frac{p}{c_1(p)} + \frac{1-p}{c_1(i)}\right) = \phi\left(\frac{\beta}{c_0} - \beta(1-\lambda_1)\left(\frac{p}{c_1(p)} + \frac{1-p}{c_1(i)}\right)\right),$$

$$\frac{\beta^2}{c_0} - \beta\left(\frac{p\beta^p}{c_2(p)} + \frac{(1-p)\beta^i}{c_2(i)}\right) = \phi\left(\frac{\beta^2}{c_0} - \beta(1-\lambda_1)(1-\lambda_2)\left(\frac{p\beta^p}{c_2(p)} + \frac{(1-p)\beta^i}{c_2(i)}\right)\right),$$

$$\frac{\beta^s}{c_1(s)} - \frac{\beta^s}{c_2(s)} = \phi\left(\frac{\beta^s(1-\lambda_1)}{c_1(s)} - \frac{\beta^s(1-\lambda_1)(1-\lambda_2)}{c_2(s)}\right).$$

The optimal consumption stream that is implied by these first order conditions is

$$c_0^S = \frac{W(S)}{D^S}$$

$$c_1^S(s) = \frac{\tau_1^S W(S)}{D^S}$$

$$c_2^S(s) = \frac{\tau_2^S W(S)}{D^S}$$

for $s = p, i$, where $D^S = 1 + \beta\tau_1^S + \beta^2\tau_2^S$, $W(S)$ is the market value of wealth valued at safe borrower's debt prices and

$$\tau_1^S = \frac{1-\phi(1-\lambda_1)}{1-\phi} > 1 \qquad \text{and} \qquad \tau_2^S = \frac{1-\phi(1-\lambda_1)(1-\lambda_2)}{1-\phi} > \tau_1^S.$$

It is interesting to note the parallelism between to the solution to this problem and the optimal consumption stream in the pooling PBE-BS. As in the pooling PBE-BS the optimal consumption stream is to consume a distorted fraction of wealth, now valued at prices that reflect the true repayment capacity of the safe borrower. In this case the distortion is introduced via the parameters $\tau_1^S$ and $\tau_2^S$ that reflect the inter-temporal valuations of consumption of borrower $S$ relative to borrower $R$.

The value of the Lagrange multiplier is obtained by setting the separating restriction to bind, i.e. $\phi$ will be such that

$$\log\left(\frac{W(S)}{D^S}\right)+\beta(1-\lambda_1)\log\left(\tau_1^S\frac{W(S)}{D^S}\right)+\beta^2(1-\lambda_1)(1-\lambda_2)\log\left(\tau_2^S\frac{W(S)}{D^S}\right)=U^{FI}(R).$$

It can be shown that $\phi<1$. This result ensures that consumption will be non-negative and increasing across time. The unique optimal debt allocations associated with this consumption stream are given by

$$b_{01}^S=y_1-\frac{\tau_1^S W(S)}{D^S},$$
$$b_{02}^S=y_2-\frac{\tau_2^S W(S)}{D^S},$$
$$b_{11}^S(s)=0.$$

Finally, to complete the proof of Lemma 2 we now show that borrower $S$ will find optimal to choose $b^S(S)$ given prices $q^*$. This will be true when the utility of choosing $b^S(S)$ and revealing his type is higher than the utility of choosing the best allocation conditional on being believed to be a risky borrower. The allocations that yield the highest utility to borrower $S$ given debt priced with borrower $R$ default risk are given by:

$$b_{0,1}=y_1-\frac{W(R)}{(1-\lambda_1)\delta(S)}\qquad b_{0,2}=y_2-\frac{W(R)}{(1-\lambda_1)(1-\lambda_2)\delta(S)}\qquad b_{1,1}(s)=0.$$

It then follows that borrower $S$ will prefer allocations $b^S(S)$ if

$$\log\left(\frac{W(S)}{D^S}\right)\left(1+\beta+\beta^2\right)+\beta\log\left(\tau_1^S\right)+\beta^2\log\left(\tau_2^S\right)>$$
$$\log\left(\frac{W(R)}{\delta(S)}\right)\left(1+\beta+\beta^2\right)-\beta\log\left(1-\lambda_1\right)+\beta^2\log\left((1-\lambda_1)(1-\lambda_2)\right).$$

The presence of the separating equilibrium in the asymmetric information setting leaves borrower $S$ worse off respect to the full information setting given that in order to separate from borrower $R$, borrower $S$ engages in some distortionary consumption path. He does so by consuming more in states in which his valuation of consumption is highest relative that of borrower $R$. Given that borrower $R$ defaults with positive probability in periods $t=1,2$ the highest consumption valuation of borrower $S$ relative to borrower $R$ occurs in late repayment states. Although for different reasons, the optimal consumption rule features an increasing consumption path across time, as in the previously analyzed pooling equilibrium. In order to attain this increasing consumption path the safe borrower optimally chooses to issue low levels of debt with shorter maturities, relative to the optimal issuance under the full information benchmark.

In the pooling equilibrium distortions in the debt allocations of the safe borrower (with respect to the full information benchmark allocations) are introduced via prices whereas in the separating equilibrium prices correctly reflect the borrower's true repayment capacity but the safe borrower engages in similarly distorted allocations to prevent risky borrowers to mimic their choices.

Borrower $R$ is indifferent between separating and pooling and decides to separate by choosing the debt allocations that maximize his utility in the full information benchmark. In other words, he prefers to choose debt in order to optimally transfer resources across time regardless of the fact that he reveals his type by doing so.

## Appendix C. Data Description

This appendix discusses in further detail the data collected for the empirical analysis conducted in section 4 and presents additional calculations.

A country was included in the sample if it is included -or was once included- in J.P. Morgan's EMBI Global (EMBIG), subject to the constraint of having sufficient data availability. Being included in the EMBIG reflects that both that the economy is emerging -and faces certain default risk- and that it is integrated to world capital markets. To be included in the EMBIG index, countries have to satisfy one of the following criteria:

(1) Be classified as low or middle per capita income by the World Bank;
(2) Have restructured external or local debt in the past 10 years;
(3) Have restructured external or local debt outstanding.

For a given particular bond to be included in the index, it must have a face value of over 500 million dollars, maturity of more than two and a half years and verifiable daily prices and cash flows.

For all countries in the sample data on bond issuance and country spreads was collected. Daily data for bond issuance was collected from Bloomberg and spreads data was obtained from Datastream. Table C1 reports the 34 countries that were included in the sample with the number of bond issuance observations and the sample period for which there is data availability on spreads. The resulting sample of countries turned out to be balanced across regions: 34% of the countries in the sample are from Latin America, 21% from Emerging Asia, 24% from Emerging Europe and 21% from Middle East and Africa.

Table C1. Data and Sample Description

| Country | Obs. | Sample Period | Country | Obs. | Sample Period |
|---|---|---|---|---|---|
| Argentina | 853 | Jan/94 - May/12 | Lithuania | 802 | Dec/09 - May/12 |
| Brazil | 1379 | May/94 - May/12 | Malaysia | 1985 | Nov/96 - May/12 |
| Bulgaria | 225 | Aug/94 - May/12 | Mexico | 1291 | Jan/94 - May/12 |
| Chile | 3929 | Jun/99 - May/12 | Morocco | 917 | Jan/94 - Nov/06 |
| China | 1367 | Jan/94 - May/12 | Nigeria | 672 | Jan/94 - May/12 |
| Colombia | 687 | Mar/97 - May/12 | Panama | 143 | Aug/96 - May/12 |
| Croatia | 1638 | Sep/96 - May/12 | Peru | 715 | Apr/97 - May/12 |
| Dominican Rep. | 351 | Dec/01 - May/12 | Philippines | 2174 | Jan/98 - May/12 |
| Ecuador | 585 | Mar/95 - May/12 | Poland | 1144 | Nov/04 - May/12 |
| Egypt | 1622 | Aug/01 - May/12 | Russia | 344 | Sep/97 - May/12 |
| El Salvador | 189 | May/02 - May/12 | South Africa | 23 | Jan/95 - May/12 |
| Hungary | 1524 | Feb/99 - May/12 | Thailand | 3239 | Jun/97 - Mar/06 |
| Indonesia | 1185 | Jun/04 - May/12 | Tunisia | 74 | Jun/02 - Mar/11 |
| Ivory Coast | 14 | May/98 - May/12 | Turkey | 754 | Jul/96 - May/12 |
| Kazakhstan | 1058 | Jul/07 - May/12 | Ukraine | 1255 | Jun/00 - May/12 |
| Korea | 7249 | Jan-94 - Apr/04 | Uruguay | 5553 | Jul/01 - May/12 |
| Lebanon | 1918 | May/98 - May/12 | Venezuela | 2539 | Jan/94 - May/12 |

Note: The default periods of Dec/01 - Jun/05 for Argentina and Aug/98 - Sep/00 for Russia were excluded from the sample. The period of Jul/04 - Nov/09 for Croatia was also excluded due to lack of data on spreads. Issuance under debt restructuring episodes identified in Cruces and Trebesch (2013) were also excluded from the analysis.

Bond issuance data covers bonds issued in all currencies. On average, 17% of a country's issuance is denominated in foreign currency. Nevertheless, there is great variability of the share of foreign currency-denominated debt across countries. For example, all debt issuance from Ecuador is dollar-denominated, whereas for the case of Brazil only 4% of the issuance in the sample was denominated in foreign currency. It is thus relevant not to restrict the analysis by analyzing only foreign-currency denominated debt.

Table C2 displays a series of summary statistics on the data. Monthly average spreads and average maturity were computed for each country in the sample. Spreads are measured in percentage points and maturities are measured in years and are monthly country averages with each monthly observation given by the weighted average of all bond issuances, weighted according to the volume of debt raised with each bond.

Emerging economies pay a substantial positive premium over the US Treasury yield of an average of over 400 basis points. However, average spreads differ widely across countries, suggesting that the market poses different perceptions of default risk for different countries. The average maturity of debt is 3.2 years. Additionally, the average level of issuance and the weighted average bond maturity also differ across countries.

Average maturity for times of high (above the country sample median) and low (below the country sample median) spreads are also reported in Table C2. The weighted average maturity shortens in times of high spreads relative to times of low spreads in 20 countries.

Table C2. Bond Spreads and Maturities in Emerging Economies

| Country | Median Spread (in %) | Avg. Maturity (in years) | | |
|---|---|---|---|---|
| | | Unconditional | Low Spreads | High Spreads |
| Argentina | 6.81 | 3.61 | 3.73 | 3.48 |
| Brazil | 5.22 | 3.73 | 4.97 | 2.66 |
| Bulgaria | 3.58 | 2.91 | 2.77 | 3.14 |
| China | 1.05 | 4.84 | 3.41 | 6.60 |
| Chile | 1.40 | 1.27 | 0.44 | 1.79 |
| Colombia | 3.32 | 2.79 | 2.53 | 2.99 |
| Croatia | 2.75 | 1.54 | 1.63 | 1.50 |
| Dominican Rep. | 4.63 | 3.70 | 3.25 | 4.48 |
| Ecuador | 9.21 | 3.74 | 3.06 | 4.32 |
| Egypt | 1.51 | 0.93 | 1.21 | 0.77 |
| El Salvador | 2.95 | 2.66 | 4.24 | 2.04 |
| Hungary | 0.87 | 2.10 | 2.33 | 1.97 |
| Indonesia | 2.63 | 1.24 | 2.07 | 0.84 |
| Ivory Coast | 23.14 | 4.05 | 3.21 | 5.50 |
| Kazakhstan | 3.88 | 1.99 | 1.61 | 2.07 |
| Korea | 1.18 | 2.59 | 3.99 | 2.05 |
| Lebanon | 3.62 | 3.14 | 3.00 | 3.27 |
| Lithuania | 3.16 | 2.00 | 2.34 | 1.97 |
| Malaysia | 1.56 | 2.18 | 2.14 | 2.23 |
| Mexico | 3.02 | 2.23 | 2.24 | 2.22 |
| Morocco | 4.37 | 5.37 | 5.91 | 5.06 |
| Nigeria | 9.60 | 1.70 | 1.32 | 2.06 |
| Panama | 3.18 | 4.01 | 4.51 | 3.63 |
| Peru | 3.49 | 3.85 | 4.59 | 3.04 |
| Phillippines | 3.81 | 3.35 | 4.34 | 2.69 |
| Poland | 1.77 | 3.53 | 4.40 | 2.65 |
| Russia | 2.63 | 4.59 | 6.11 | 3.76 |
| South Africa | 2.03 | 11.37 | 13.12 | 9.95 |
| Thailand | 1.19 | 1.76 | 1.75 | 1.77 |
| Tunisia | 1.39 | 3.22 | 3.12 | 3.37 |
| Turkey | 3.29 | 2.62 | 2.86 | 2.42 |
| Ukraine | 4.83 | 2.52 | 3.63 | 2.04 |
| Uruguay | 2.97 | 3.09 | 2.98 | 3.14 |
| Venezuela | 9.07 | 3.16 | 3.95 | 2.36 |

TABLE C3. Regressions of Sovereign Debt Maturity: Robustness Analysis

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity | Maturity |
| Spread | -0.204$^{*}$ | -0.067$^{***}$ | -0.164$^{*}$ | -0.050$^{*}$ | -0.081 | 0.045 | -0.205$^{***}$ | -0.098 | -0.172$^{**}$ | -0.088 | -0.248$^{**}$ | -0.241$^{*}$ |
| | (0.121) | (0.025) | (0.094) | (0.027) | (0.154) | (0.040) | (0.061) | (0.077) | (0.067) | (0.081) | (0.117) | (0.132) |
| Spread×Elections | | | 0.002 | -0.086$^{***}$ | | | | | -0.161$^{**}$ | -0.127$^{*}$ | | |
| | | | (0.073) | (0.024) | | | | | (0.067) | (0.076) | | |
| Spread×$\sigma^{Rating}$ | | | | | -0.053 | -0.058$^{***}$ | | | | | 0.020 | 0.084 |
| | | | | | (0.043) | (0.016) | | | | | (0.053) | (0.060) |
| $N$ | 5446 | 5446 | 5287 | 5287 | 5299 | 5299 | 1126 | 1126 | 1104 | 1104 | 1118 | 1118 |
| $R^2$ | | | | | | | 0.231 | 0.392 | 0.238 | 0.395 | 0.230 | 0.392 |
| Time FE | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Specification | Heckman | Heckman | Heckman | Heckman | Heckman | Heckman | For. Cur. | For. Cur. | For. Cur. | For. Cur. | For. Cur. | For. Cur. |

*Notes:* The dependent variable is the average maturity of bond issuances of a given country in a given month, weighted by the face value of each bond. The estimation method is Heckman for the first six columns. The Heckman estimation output of the selection equation is omitted. Columns (1) and (2) include spreads ("Spread") as a regressor. Columns (3) and (4) include spreads and its interaction with a dummy if there was a presidential election that year or in the previous year ("Spread×Election"). Columns (5) and (6) include spreads and its interaction with country volatility of credit ratings ("Spread×$\sigma^{Rating}$"). Columns (7) - (12) repeat the same specifications with maturities computed with issuances in foreign currency. These columns are estimated with OLS. "Time FE" are month dummy variables. "Country FE" are country dummy variables. Columns $*$, $**$, and $***$ represent statistical significance at the 10%, 5%, and 1% level, respectively.