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Domestic and External Sovereign Debt*

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Abstract

Why do countries tend to repay their domestic and external debt, even though the legal enforcement of the sovereign debt contract is limited? Contrary to conventional wisdom, we argue that temporary market exclusion after default is costly. When the domestic financial market is characterized by a scarcity of private saving instruments, a government can partition its debt market into domestic and external segments, by restricting capital flows, to exploit its market power. The government's market power mitigates the problem of limited commitment, by making default a more costly option. Consequently, it extends the government's external debt capacity. We replicate the domestic and external sovereign debt for non-advanced economies, by unveiling their link to financial repression.

Keywords: sovereign debt, sovereign default, financial repression, financial development, capital controls.

JEL codes: E21, E44, E60, F34, F38, G15, G18, H63, O16.

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Sovereign debt is characterized by limited legal enforcement. As a consequence, countries have defaulted on their domestic and external debt throughout their history, as shown in Reinhart and Rogoff (2011).[1] However, sovereign defaults are rare and the domestic and external sovereign debt are substantial. In Figure 1 we utilize an updated version of Panizza (2008)'s dataset of government debt. The dataset distinguishes domestic and external debt according to the place of issuance and the legal jurisdiction. Reinhart and Rogoff (2011) mention that in most countries, for most of their history, the jurisdiction has coincided with the currency of the debt and the identity of the bondholders.[2] We classify the non-advanced economies according to the World bank Income Group they belong to and plot the average domestic and external debt against the average total debt for the period 1970-2010. The average total debt ranges from 52 percent to 79 percent. The average external debt decreases with the level of economic development, whereas the average domestic debt increases with the level of economic development.

What can explain these debt levels under limited enforcement of sovereign debt contracts? Previous research has argued that, even in the absence of legal enforcement, the government may repay its debt because of the consequences of default. A prominent consequence of default is the loss of reputation, that leads to financial market exclusion (Eaton and Gersovitz, 1981). Empirically, market exclusion after default is temporary. Quantitatively, financial market exclusion alone is an insufficient punishment after default to rationalize the observable sovereign debt levels. Aguiar and Gopinath (2006) illustrate, in calculations à la Lucas (1985), that the welfare benefits from smoothing the business cycle are too low to justify the government's repayment choice, when the only punishment after default is financial market exclusion. Therefore, it has not been possible to reconcile the following two regularities that characterize the sovereign debt of non-advanced economies.

- *Fact 1: Substantial domestic and external debt levels and low sovereign default frequency.*
- *Fact 2: Short-lived market exclusion after default.*

We show that these features are consistent with a model of sovereign debt in which the

[1]The authors report evidence that outright defaults on domestic debt did happen, despite the common belief that domestic debt would only be inflated away. *"Why would a government refuse to pay its domestic public debt in full when it can simply inflate the problem away? One answer, of course, is that inflation causes distortions, especially to the banking system and the financial sector. Sometimes, the government may view repudiation as the lesser evil,"* (Reinhart and Rogoff, 2011, pag. 326-327). The limited role for inflation is also confirmed by the findings in Forslund, Lima and Panizza (2011), who fail to find a significant correlation between the inflation history and the sovereign debt composition for non-advanced economies.

[2]The choice of using the updated version of Panizza (2008)'s dataset is due to the statistical distinction used for domestic and external sovereign debt and the extensive country-time dimension. As mentioned in Panizza (2008), this is the most accurate way to distinguish domestic from external debt, because it is possible to find correct information on the legal jurisdiction. Similar accuracy cannot be achieved for the identity of the bondholders and the currency of the debt.

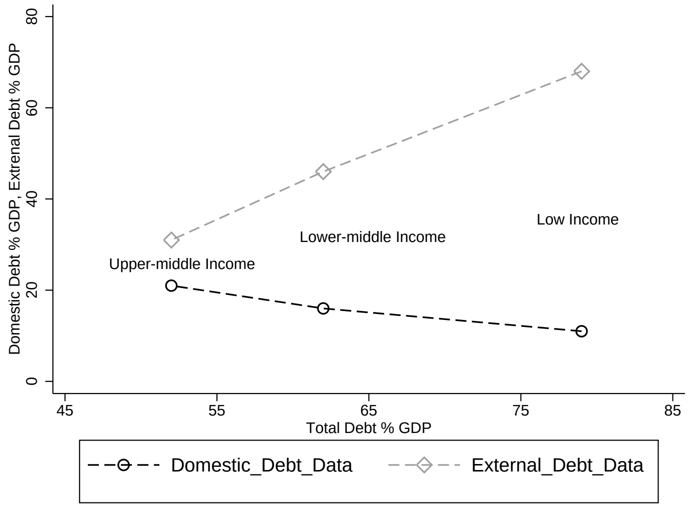


Figure 1: Average domestic and external sovereign debt as percentage of GDP for non-advanced economies during 1970-2010. The data include 38 Low income countries, 46 Lower-Middle income countries and 35 Upper-Middle income countries (list of countries in appendix A).
Source: Own calculations based on Ugo Panizza's dataset described in Panizza (2008). *Description:* With hollow circle we represent the average domestic debt as percentage of GDP for each income group. With hollow diamond we represent the average external debt as percentage of GDP for each income group

government lacks commitment to repay its debt and the economy is characterized by financial underdevelopment, that takes the form of a scarcity of private savings instruments. A central idea is that the government exploits the market power in its own economy in order to mitigate the lack of commitment. Consequently, it also alleviates the scarcity of savings instruments. Due to the government's market power, financial autarky during default is costly. The government exercises its market power by imposing capital controls,[3] so that part of the population is subject to financial repression.[4] We find support for our mechanism in Escolano, Shabunina and Woo (2016), who show that, on average, non-advanced economies paid a negative real interest rate on their debt (minus 6 percent for the period

[3]The normalized index of financial liberalization constructed by Abiad, Detragiache and Tressel (2008) for the period 1973-2005 is equal to 0.42 for non-advanced economies, in contrast to 0.69 for advanced economies. Fernández, Rebucci and Uribe (2015) report the average index of capital controls for various economies for the period 1995-2011. The average value for developed economies is 0.07, versus 0.35 for emerging economies and 0.54 for low-income countries. Moreover, they find that capital controls are acyclical.

[4]We use the following definition for financial repression provided by Kirkegaard, Reinhart and Sbrancia (2011). Financial repression includes directed lending to the government by captive domestic audiences (such as pension funds or domestic banks), explicit or implicit caps on interest rates, regulation of cross-border capital movements, and (generally) a tighter connection between government and banks, either explicitly through public ownership of some of the banks or through heavy "moral suasion". Financial repression is also sometimes associated with relatively high reserve requirements (or liquidity requirements), securities, transaction taxes, prohibition of gold purchases (as in the US from 1933 to 1974), or the placement of significant amounts of government debt that is non-marketable.

1966-2010), as a result of financial repression. As highlighted by Obstfeld (1993), Dooley (1995), Aizenman (2004) and Kirkegaard, Reinhart and Sbrancia (2011), governments have tried to use financial repression through capital controls to reduce the domestic debt burden throughout history. However, what has remained unexplored is how financial repression is linked to external debt and default.

We extend Eaton and Gersovitz (1981)'s framework along two dimensions, in order to link external debt and default with domestic debt. First, we introduce a domestic financial market that is less developed compared to the international financial market. More specifically, the domestic financial market is characterized by a scarcity of savings instruments. This modelling choice allows us to introduce domestic debt in a straightforward way. Second, we introduce an additional type of agents, that are savers. As in Eaton and Gersovitz (1981), the government cares about the welfare of the agents that would like to smooth consumption fluctuations due to endowment uncertainty. Hence, the welfare of the savers is not in the government's objective function. The savers are subject to financial repression. At the heart of the model is the interaction between consumption smoothing under limited commitment and market power.

Our contribution is twofold. First, we resolve the quantitative disconnect between short-lived market exclusion and sovereign debt levels. Seminal quantitative models of external debt, such as Aguiar and Gopinath (2006), Arellano (2008) and the subsequent literature, absent any other cost of default (such as endogenous or exogenous output costs), would predict insignificant debt levels. Thus, creating a stunning puzzle: the disconnect between market exclusion and sovereign debt levels. A reason behind this failure is that the welfare gains from smoothing shocks are small, as already pointed out by Aguiar and Gopinath (2006). Contrary to that, we claim that financial market exclusion is a costly punishment after default. The reason is that the government can benefit from segmenting its debt market. Importantly, the domestic debt market is a source of cheap funding for the government, because it can be subject to financial repression. We illustrate in a quantitative manner that temporary exclusion from segmented debt markets is a sufficient punishment after default to rationalize the observable sovereign debt levels and the composition of debt. We calibrate the model to three countries (Argentina, Mexico and Russia) that defaulted jointly on their domestic and external debt and used financial repression policies in the past decades. Consistently across the three countries, the model predicts short-lived market exclusion in order to account for the evidence on domestic and external sovereign debt.

The optimal behavior from the model is mostly determined by the interaction of the government's motive to smooth consumption in the presence of limited commitment and its market power in the domestic economy. The market power makes default a worse alternative compared to debt. Therefore, even a seemingly mild punishment after default, such as temporary financial market exclusion, is enough for our model to replicate realistic debt levels. The issue that remains open is whether the market power should be stronger in booms or recessions. If we want to describe the behavior of non-advanced economies, we need the market power to be relatively stronger in booms.[5] Thus, across the cycle, the scarcity of savings instruments is more pronounced in booms. Then, default incentives are stronger in recessions, which make default more likely in those times, in line with the evidence. Domestic debt is relatively more valuable than external debt in booms, due to the procyclical market power. Given the tension between smoothing fluctuations through debt issuance and procyclical market power, external debt may be higher or lower in booms, depending on the government's patience, the volatility and the persistence of the output process. For the three countries studied, the optimal behavior prescribes that, conditional on debt to be repaid, in bad times the domestic debt share is lower and defaults are more likely. Hence, without an a priori preference for domestic bondholders, the government tends to have lower domestic debt when default incentives are higher.

The second contribution of our paper is a unified explanation for the evidence on sovereign debt for non-advanced economies, as presented in Figure 1; it is a tale of financial repression. We obtain a negative real interest rate on government debt of similar magnitude as the one calculated by Escolano, Shabunina and Woo (2016) for non-advanced economies. Through the lens of our model, the Low Income group is able to sustain more sovereign debt than the Lower-middle Income and the Upper-middle Income groups, because the scarcity of private savings instruments is more pronounced. That implies that the government's market power for the Low Income group is higher than for the other two groups. Domestic debt is more valuable when the market power is higher. However, high market power implies that the marginal benefit from the additional debt issuance decreases faster. These two effects imply that the Low Income group can sustain higher total debt levels, mostly as external debt. The other two groups feature a more balanced composition of debt and lower total debt levels, because limited commitment is more prevalent.

Related literature. Our model builds on the seminal model of external sovereign debt in Eaton and Gersovitz (1981), and its quantitative implementation in Arellano (2008), Aguiar and Gopinath (2006). There is a vast literature that departed from there and developed in different directions (see Aguiar et al. (2016), D'Erasmo, Mendoza and Zhang (2016) for recent literature reviews). Our contribution to the sovereign debt literature is that we make financial market exclusion quantitatively relevant punishment after default. We are closer

[5] For the curious reader, this is mainly achieved by assuming that the same endowment shock hits the different types of agents in the small open economy. In addition, we assume that capital controls are acyclical, in line with the evidence in Fernández, Rebucci and Uribe (2015).

to the papers that introduced domestic debt, such as Mallucci (2015), Perez (2015) and D'Erasmo and Mendoza (2016), who also assume non-discriminatory default for domestic and external debt. Mallucci (2015) and Perez (2015) include a domestic financial sector and focus on the negative effect of the sovereign default on domestic banks. Their mechanism is based on the theoretical contribution in Gennaioli, Martin and Rossi (2014), who show how the development of domestic financial institutions affect the governemnt's default incentives, due to the effect of default on the level of credit in the domestic economy. D'Erasmo and Mendoza (2016) build on the idea that default can be used by the government to redistribute resources among the domestic agents, by assuming that the households enter the government's utility with a weight given by their wealth. Hence, all these papers focus on some form of internal cost of default and assume that the government has a preference for domestic bondholders. Instead, our results do not rely on internal costs and an a priori preference for domestic bondholders. They follow from the interaction between the government's market power and its consumption smoothing motive. Our model is consistent with the evidence on financial repression in non-advanced economies.

To the best of our knowledge, our model is the first one to integrate the study of domestic and external debt and default with the issue of financial repression, in the form of market segmentation, and to show the quantitative implications of this setting. Two recent non-quantitative papers have addressed the connection between financial repression and debt, Acharya and Rajan (2013) and Chari, Dovis and Kehoe (2016). However, financial repression in these papers takes the form of taxation that incentivizes banks to hold domestic debt, which means that it is not based on market segmentation. Guidotti and Kumar (1991) and Giovannini and de Melo (1993) report evidence of a positive gap between international and domestic interest rates on government debt of developing countries for the 70's and 80's. More recently, Du and Schreger (2016) find a positive gap between the spread of local currency debt and foreign currency debt of emerging economies. Given this evidence on price discrimination, connecting financial repression and market segmentation appears more relevant. In Acharya and Rajan (2013) the existence of external debt is due to the non-discriminatory default causing a loss of resources to redistribute internally for the (populist) government. Instead, in Chari, Dovis and Kehoe (2016) the assumption of complete markets rules out default in equilibrium, hence the mechanism allowing for debt in equilibrium is different from ours.

Outside the sovereign debt literature, a macro-finance paper that has implemented the idea of government's market power and segmented financial market is Gordon and Li (2003). They show that once the government has market power in the domestic market and domestic investors' demand for assets is less elastic than external investors' demand for assets, segmenting the market is the optimal choice. We contribute to the macro-finance literature by arguing that the government's market power can alleviate the limited commitment problem that characterizes government debt.

Outline. The paper continues as follows. Section 1 describes the model environment and the recursive equilibrium. Section 2 shows the quantitative relevance of financial market exclusion. In section 3 we unveil the link between financial repression and sovereign debt for non-advanced economies. Section 4 discusses the role of the model's key assumptions and section 5 concludes.

1 Model

The world economy consists of a small open endowment economy and the rest of the world. The time of the model is discrete and the horizon is infinite. We enrich the standard external sovereign debt and default model - á la Aguiar and Gopinath (2006) and Arellano (2008) - with a domestic financial market that is less financially developed than the international financial market. For insurance purposes, the government is allowed to issue domestic debt in addition to external debt and default on it. In contrast to the above mentioned models, the only punishment after default is short-lived market exclusion.

The small open economy is populated by two types of agents: risk-averse domestic consumers and risk-neutral domestic bondholders. Both types of agents face the same endowment uncertainty. A government provides insurance to the risk-averse consumers against endowment shocks. It does so by issuing one-period non-contingent domestic and external bonds. Domestic bondholders have a pro-cyclical inelastic demand for assets (government and private bonds). In addition, the supply of domestic private saving instruments is limited. The government possesses market power in its own economy, because it can affect the supply of savings instruments. Instead, the rest of the world is populated by risk-neutral agents that have access to a frictionless competitive financial market. The government restricts the access of domestic bondholders to the international financial market in order to exploit its market power. Thus, domestic bondholders are financially repressed in favor of domestic consumers.[6] The government issues domestic debt that is less costly compared to the external debt. The fact that the government has market power in the domestic economy compared to not having market power in the international financial market implies that both types of debt are being traded in equilibrium. Due to the assumption of incom-

[6]In our model the government is not a benevolent social planner for the whole population. This view of the government is in line with studies from political science, such as Menaldo (2016). The author argues that in countries with weak state capacity, where it is difficult to collect taxes, governments use financial repression to distort the market. In this way, they can raise revenues for their fiscal needs and to support coalitions to maintain power.

plete markets, default arises as an equilibrium outcome. The government faces the same punishment for defaulting in one market or the other (temporary financial autarky), hence only non-selective default is optimal in equilibrium. Our assumption is that by damaging the credit relationship in one debt market, the government damages its credit relationship also in the other debt market. These spillovers effects are similar to Cole and Kehoe (1998). If the government discriminates against external bondholders, it may violate international regulations or norms, thus entailing harsh punishment. External bondholders can retaliate in various ways against the defaulting economy in case of differential treatment. In our model we require that selective sovereign defaults on external debt are too costly for the government. Therefore, we focus on non-selective defaults.[7]

We proceed by describing the agents that populate the economy and the recursive equilibrium.

1.1 Agents

1.1.1 Domestic Consumers - Government

There is a mass λ of identical, infinitely lived consumers, who are risk averse. Every period, each domestic consumer receives an endowment y that is stochastic and not storable. We consider the case where the endowment follows a Markov process. Domestic consumers trade across the financial markets through the government. The government taxes their endowment in lump-sum fashion and provides insurance to the domestic consumers by issuing one-period non-contingent domestic and external government bonds. It can ex-ante identify the bondholders, but it cannot commit to repay the debt back to any of them. We model the lack of commitment through the strategic default choice. Formally, the problem of the government is

$$V(Y^G, B) = \max\{V^d(Y^G), V^{nd}(Y^G, B)\}, \tag{1}$$

where $Y^G = \lambda y$ denotes the government's endowment and B the total debt to be repaid. In each period the government chooses whether to default or issue domestic and external debt by comparing the value of default, $V^d(Y^G)$, and the value of not defaulting, $V^{nd}(Y^G, B)$. The state variables of the problem are the current endowment and the total amount of debt to be repaid, because the punishment after default is independent of the identify of the bondholder. The value of defaulting $V^d(Y^G)$ is defined as

[7]in Section 4 we discuss the role of this assumption. The main mechanism of the model, that relies on market power and limited commitment, would still hold with discriminatory default.

$$V^d(Y^G) = u(Y^G) + \beta \mathbb{E}\left[\theta V(Y'^G, 0) + (1-\theta) V^d(Y'^G)\right]. \quad (2)$$

If the government defaults in the current period, it receives the utility associated with the endowment shock. During the next period, with probability θ it re-enters the financial markets with zero past debt. With probability $1-\theta$ it remains in financial autarky. The probability θ is time-invariant. In case that the government does not default, it obtains the value from trading across markets $V^{nd}(Y^G, B)$, which is defined as

$$V^{nd}(Y^G, B) = \max_{B'^D, B'^E} \{u(Y^G - B + q^D(B', B'^D, Y^G)B'^D + q^E(B', Y^G)B'^E) + \beta \mathbb{E} V(Y'^G, B')\} \quad \text{(3a)}$$

subject to

$$B' = B'^D + B'^E, \quad \text{(3b)}$$

where B'^D and B'^E are the quantities of the domestic and external bonds that mature in the next period and $q^D(B', B'^D, Y^G)B'^D$, $q^E(B', Y^G)B'^E$ are the revenues from the domestic and external debt issuance, respectively. Positive values of B'^D and B'^E indicate borrowing. In each period the government repays its past debt B and issues new domestic and external debt, affecting both the current utility and the continuation value.

1.1.2 Domestic Bondholders

We aim to generate a scarcity of private savings instruments in the domestic economy. On the supply side, we assume a fixed amount of private savings instruments. On the demand side, we create a procyclical inelastic demand for savings instruments, by adopting a two-period overlapping generations modelling structure.[8]

There is a mass $1-\lambda$ of risk-neutral domestic bondholders who live for two periods: in the first period they are young, in the next period they are old. They receive a stochastic non-storable endowment y when young, but they cannot consume it. When young, they use their endowment to buy domestic government bonds b'^D and domestic private bonds l'. When old, they consume the expected return from their portfolio. Formally, the problem

[8]A similar modelling choice to generate a scarcity of savings instruments is presented in Farhi and Tirole (2012). The use of overlapping generations does not imply that a period in the model represents 25 years. A similar use of overlapping generations inside a macroeconomic model with infinite horizon households is offered by Clerc et al. (2015). It is beyond the scope of the paper to provide a microfounded framework in which the inelastic demand for assets emerges.

of the domestic bondholder is

$$V^D(Y^G, B', B'^D) = \max_{b'^D, l'} \{\delta(B', Y^G)l' + (1 - \delta(B', Y^G))(l' + b'^D)\} \tag{4a}$$

subject to

$$y = q^D(B', B'^D, Y^G)b'^D + q^l(B', B'^D, Y^G)l'. \tag{4b}$$

The domestic bondholder maximizes the next period's expected consumption $\delta(B', Y^G)l' + (1 - \delta(B', Y^G))(l' + b'^D)$, by taking the probability of sovereign default, $\delta(B', Y^G)$, as given. Each domestic bondholder is infinitesimally small and does not internalize how her demand for bonds influences the price of domestic government bonds $q^D(B', B'^D, Y^G)$ and the price of domestic private bonds $q^l(B', B'^D, Y^G)$. While the domestic consumers' endowment can be directly taxed by the government and used as collateral to issue debt, the domestic bondholders' endowment cannot be directly taxed. Financial repression is a form of indirect taxation.

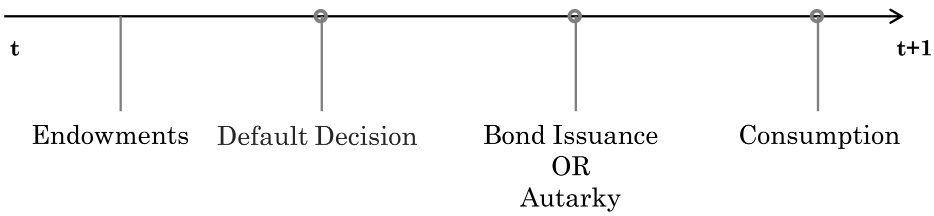
1.1.3 External Bondholders

We model the external bondholders as identical, infinitely lived, risk-neutral agents as in Eaton and Gersovitz (1981)'s framework and its subsequent quantitative implementations by Aguiar and Gopinath (2006) and Arellano (2008). They have access to a competitive international financial market where they can trade as much as needed of external risk-free assets. These assets pay one unit of good in the following period. The external investors can also trade external government bonds. They can observe the endowment of the small open economy when it is realized. The representative external investor buys external government bonds, b'^E, as long as their expected return, $1/q^E(B', Y^G)$, is equal to the return of the risk-free asset, r^z.

1.1.4 Financial Markets Development

The domestic financial market is assumed to be less developed than the international financial market in the sense that it cannot supply enough savings instruments. The supply of savings instruments (private bonds) is limited to an exogenous amount L. In both markets all participants take prices as given, except that in the domestic financial market the government has market power. Eventually, the government influences the effective supply of savings instruments in the domestic financial market. These features give rise to an endogenous interest rate in the domestic financial market. The interest rate in the external market is exogenous to the small open economy.

1.1.5 Timing



The endowment shock is realized. Every agent observes the realized endowment. Afterwards, the government decides whether to default or not on the amount borrowed in the past. If the government defaults on its debt, it is in autarky in the current period. On the other hand, if the government does not default, it has access to the segmented financial markets and chooses the amount of bonds to issue in the domestic and the external market. When financial markets open, domestic investors can trade domestic government bonds and domestic private bonds. External investors can trade external government bonds and external risk-free assets. At the end of the period agents consume.

1.2 Recursive Equilibrium

Following Chatterjee et al. (2007), we define two sets which characterize the government's optimal decision to repay or to default. The repayment set is the set of values of current endowment such that, given a value of total debt B, the government prefers repayment to default:

$$Rep(B) = \{Y^G \in \Psi : V^{nd}(Y^G, B) \geq V^d(Y^G)\}. \tag{5}$$

Its complement, the default set, is the set of values of current endowment such that, given a value of total debt B, the government prefers default to repayment:

$$D(B) = \{Y^G \in \Psi : V^d(Y^G) > V^{nd}(Y^G, B)\}. \tag{6}$$

These sets depend only on the total amount of debt to repay at the beginning of the period, because we have simplified the problem and reduced the number of state variables in an insightful way. A government would never default selectively, because the cost for defaulting is the same for any type of bondholder and amount of debt.[9] Finally, for the same reason we can define the unique endogenous default probability as the probability that, given the current endowment and the total amount of bonds issued B', the next period's endowment belongs to the default set

$$\delta(B', Y^G) = \int_{D(B')} f(Y'^G, Y^G) dY'^G. \tag{7}$$

We can now define the maximum level of borrowing at which the default probability is zero and the maximum level of borrowing where the default event is an almost-sure event. First, the no-default-risk borrowing limit is

$$B^{MIN} = \sup\{B : D(B) = \emptyset\}. \tag{8}$$

Below this level government bonds behave like risk-free assets. Second, the highest level of debt that the government can attain before the probability of default is one is defined as

$$B^{MAX} = \inf\{B : D(B) = \Psi\}. \tag{9}$$

Within these limits the set of values of total borrowing carry a default premium paid to domestic and external bondholders.[10]

1.2.1 Definition of Equilibrium

A recursive equilibrium is an initial condition B_0, pricing functions q^l, q^D,q^E, q^z, sets of value functions V, V^d, V^{nd} for the government, V^D for domestic bondholders; policy functions B'^D, B' for the government, $b^{D'}$, $b^{E'}$, l' for the bondholders; the repayment set $Rep(B)$ and default set $D(B)$ such that:

(a) Given the price functions q^D and q^E, B'^D, B', the repayment set $Rep(B)$ and the default set $D(B)$ satisfy the government's maximization problem (1) - (3).

(b) Given the price functions q^D and q^l and the government's policy functions, $b^{D'}$ and l' solve the maximization problem of the representative domestic bondholder (4a) - (4b).

(c) Given the price functions q^E and q^z and the government's policy functions, external

[9]Based on the evidence from Jeanneret and Souissi (2016), defaults on local currency debt are as likely as defaults on foreign currency debt. Thus, selective defaults appears to be of a second order importance.

[10]We also set a lower bound for the government's savings. This limit arises from the constraint on the consumption of domestic bondholders. We define this limit as $\underline{B}^D = -L$.

bondholders optimally choose $b^{E'}$.

(d) Bond markets clear, that is $\int_0^{\frac{1-\lambda}{2}} b^{D'} di = B'^{D}$ in case of domestic borrowing and $\int_0^1 b^{E'} di = B'^{E}$ in case of external borrowing. Domestic private bond markets clear, that is $\int_0^{\frac{1-\lambda}{2}} l' di = L$.

1.3 Pricing Functions

We derive the pricing functions from the optimization problems that we have defined in section 1.1. The price of the international risk-free bonds traded in the international financial markets is equal to the discount factor of the external bondholders, because the external financial market is competitive and the bondholders are risk neutral.

$$q^z = \beta^E. \tag{10}$$

The price of the risky asset - external government bond - is such that the expected profits from its purchase are equal to the profits from the purchase of the external risk-free asset. Thus, the price of the external government bonds is a function of the external risk-free interest rate and the default probability:

$$q^E(B', Y^G) = \beta^E(1 - \delta(B', Y^G)). \tag{11}$$

The probability of default $\delta(B', Y^G)$ defines the risk premium that the government has to pay to the investors to compensate them for the default risk. The higher the default probability, the lower is the price at which the government is able to sell bonds to the investors. The government affects this price only through the default risk.

Now we move to the problem of the domestic bondholders, expressed in (4a) - (4b). By using the no-arbitrage condition, we can define the price of domestic government bonds in terms of the price of the domestic private bond l as:

$$q^D(B', B'^D, Y^G) = (1 - \delta(B', Y^G))\, q^l(B', B'^D, Y^G).$$

As noted before, the price of domestic private bonds is not constant (as it was the case for the external bonds), but depends on the total amount of bonds issued by the government, the amount of domestic bonds and the endowment of the government (that is perfectly positively correlated to the domestic bondholders' endowment). By using the aggregate version of the budget constraint of the young domestic investors (4b) [11] and the market clearing conditions for the bond markets, we obtain an expression for the price of domestic private bonds:

$$q^l(B', B'^D, Y^G) = \frac{Y^D}{(1 - \delta(B', Y^G))B'^D + L}. \tag{12}$$

We can rewrite the price of domestic bonds as:

$$q^D(B', B'^D, Y^G) = \frac{(1 - \delta(B', Y^G))Y^D}{(1 - \delta(B', Y^G))B'^D + L}. \tag{13}$$

There are two channels through which the government affects the price of domestic private bonds (12) and domestic government bonds (13), due to its market power. On one hand, an increase in B'^D, everything else equal, affects negatively the price of all the assets in the domestic economy, because the government increases the effective supply of bonds in the domestic market. That implies lower prices for domestic government bonds and domestic private bonds. On the other hand, an increase in the default premium due to a marginal increase in risky government bonds (either B'^D or B'^E), everything else equal, affects positively the price of the domestic private bonds. This is a general equilibrium effect of the default risk premium: the effective total supply of domestic assets that bears no sovereign default risk decreases. The effect on the price of domestic bonds is more complex. In fact, the positive general equilibrium effect is counteracted by the negative effect coming from the additional risk premium to pay to bondholders. Although the net effect is negative, the domestic government bond price turns out to be less sensitive to the default premium. That can allow the government to indulge in more risky borrowing.[12] Focusing on the price of external government bonds (11) and the price of domestic government bonds (13), we notice that they are linked through the default risk premium. The default risk premium increases with the total amount of debt issued. This means that an increase

[11] The budget constraint of the young domestic bondholders in aggregate form becomes:

$$Y^D = (1 - \delta(B', Y^G))\, q^l(B', B'^D, Y^G)B'^D + q^l(B', B'^D, Y^G)L,$$

where $Y^D = \frac{1-\lambda}{2}y$. Since only young domestic bondholders receive an endowment, the part of the output of the economy that is under the control of the government is equal to $\frac{2\lambda}{1+\lambda}$. The part of the output that is under the control of the young domestic bondholders is equal to $\frac{1-\lambda}{1+\lambda}$.

[12] The risk of government bonds affects also the price of the domestic private bonds because of the government's market power. Gourinchas and Jeanne (2012) mention how this general equilibrium effect of the risk premium can explain the small decrease in the yield on US Treasury bill following the downgrading of the US in 2011.

in B'^D to a level where the default risk is positive, not only affects the price of domestic bonds, but also the price of external bonds. The reverse is true for an increase in B'^E.[13]

1.4 Counterfactual Domestic Private Bond Price

We define the counterfactual domestic private bond price, q_c^l, in order to understand how large is the government's market power and when it is stronger.

$$q_c^l = \frac{\frac{1-\lambda}{1+\lambda}GDP}{L} \tag{14}$$

This is the ratio of the domestic bondholders' endowment, Y^D, over the amount of private bonds, L. We call it a "counterfactual" private bond price, because it would be the prevailing price of private savings instruments in the domestic economy, if the government did not issue any domestic debt but still imposed capital controls. In equilibrium, the government issues domestic debt to take advantage of the high prices (low interest rates), but by doing so, it also decreases them (raises the rates) with each additional domestic bond. The higher is this counterfactual price, the more intense is the scarcity of private savings instruments. The difference between q_c^l and q^f gives a measure of the benefits of market segmentation.

The lower is the level of financial development in the domestic economy, i.e. L/GDP, or the smaller is the size of the government, λ, the more intense is the scarcity of private savings instruments. Indeed, the benefits from financially repressing domestic bondholders are larger when they represent a larger part of the population, $1 - \lambda$.

1.5 The Link between Debt Laffer Curves and the Composition of debt

In order to understand what drives the government's issuance decisions, we introduce the endogenous "debt Laffer curves". The debt Laffer curve explains how the government's revenues from issuing debt vary with the amount of debt issued. In order to simplify the exposition, we make three simplifying assumptions with respect to the model that we calibrate in the next section. First, the government's endowment shocks are i.i.d and the endowment for the domestic bondholders is fixed. Thus, the debt revenues, and hence the bond prices, depend only on the total amount of debt issued, B'. Second, the probability

[13] Even if we had a model of discriminatory default, this link would still be there as long as the probability of defaulting on one type of debt was positively correlated with the probability of defaulting on the other type of debt.

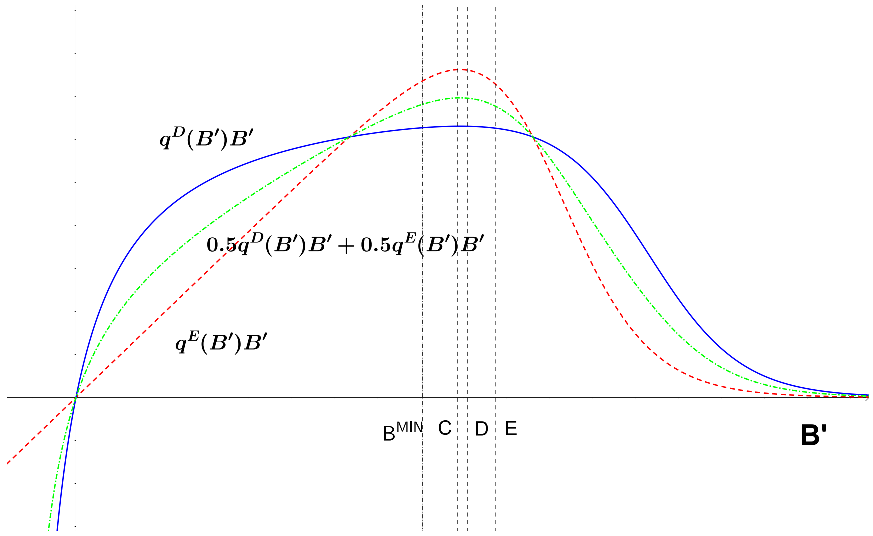


Figure 2: We plot the debt Laffer curve under three different cases: when only domestic debt is issued (blue solid line), only external debt is issued (red dashed line), or both are issued in equal share (green dash-dotted line).

of default is exogenous and follows a logistic function.[14] Third, the composition of debt is fixed exogenously. Under these three simplifications, we illustrate how the composition of debt affects the Laffer curve and how that differs from the standard sovereign debt models that only feature external debt.

We consider two polar cases, only external debt or only domestic debt issued, and an equal share of domestic and external debt, as shown in Figure 2.[15] The debt Laffer curve represents the increase in current consumption, hence the revenues, due to borrowing on the y-axis and the amount of borrowing on the x-axis. The value B^{MIN}, defined in (8), is the value of debt after which the probability of default is positive, hence the government has to pay a risk premium to sell its debt. The values C, D, E represent the maxima of the Laffer curve, as defined in (9), for external debt only, for the equal debt composition and for the domestic debt only, respectively. These are the levels of debt that maximize the government's revenues from issuing debt, for each type of debt composition. The interval between B^{MIN} and each maximizing value is the so-called "risky borrowing region", that

[14] Following Jeanneret and Souissi (2016), we have assumed that the marginal probability of default follows a logistic distribution. In particular, we have used:

$$Prob(def = 1) = \frac{1}{1 + exp(11 - x/2)}$$

Furthermore, we have assumed the external risk-free rate equal to 4 percent, the domestic bondholders' endowment equal to 15 and the amount of private bonds equal to 3. The choice of the parameter values is simply for better representation.

[15] To be precise, depending on the model parameters and the endowment shock that hits the economy, the debt Laffer curve for only domestic debt can be higher or lower than the one for the external debt. The current figure is just for exposition purposes.

is the region where there is borrowing with positive default probabilities, for each case of debt composition. We know that in equilibrium the government will never choose a level of borrowing above C, D, E, because it can attain the same level of consumption for a lower level of borrowing.

We start by describing the Laffer curve for the case of purely external debt. Until B^{MIN} the increase in current consumption is linear in B' because the probability of default is zero. The marginal gain from borrowing is positive and constant: each additional unit of borrowing adds $(1 + r^z)^{-1}$ unit of consumption. After that point the curve becomes concave, due to the risk premium to be paid to external bondholders. In the risky borrowing region the marginal gain from additional borrowing is positive but decreasing, because the default risk increases. After C the marginal gain from borrowing becomes negative: the risk premium more than offsets the additional utility of borrowing one more unit.

The Laffer curve for the case of solely domestic debt, instead, is never linear. Until B^{MIN} the curve is concave, even though the probability of default is zero. In fact, domestic market prices increase in B' because of the government's market power in the domestic financial market. This determines the positive but decreasing marginal gain from borrowing. In the risky borrowing region a positive probability of default exists. Here, the risky borrowing region is larger, as it ends at the value of debt equal to E. As we mentioned above, the probability of default has a dual role in affecting the price of domestic government bonds: a positive one and a negative one. The net effect on domestic bond prices is negative, but it is substantial only for high levels of default risk. Hence, the marginal gain from borrowing decreases slowly at the beginning of the risky borrowing region and more quickly later on.

The Laffer curve for an equal share of domestic and external debt lies between the other two curves. In general, we can infer that the higher is the ratio of domestic to total debt, the more concave is the Laffer curve and therefore the faster the marginal gain from borrowing decreases, even without default risk. At the same time, the risky borrowing region is larger, the higher is the ratio of domestic to total debt. The discussion of the debt Laffer curve highlights the importance of actually allowing the government to choose the composition of debt. In our model, when the government chooses the debt composition, it is not only choosing the size of its revenues, but also the size of the risky borrowing region, hence the elasticity of its revenues to the default risk. The concavity of the Laffer curve coming from the government's market power suggests that the total debt arising in equilibrium will be low when the domestic to total debt ratio is high. Moreover, the concavity of the risky borrowing region with domestic debt predicts a higher domestic debt share when the default risk is lower.

The risky borrowing region is the most crucial element of sovereign debt models. In their literature review, Aguiar and Amador (2014) argue that standard sovereign debt models have problems replicating realistic debt levels, because the price schedule of external government bonds is very elastic to the debt issued. In other words, the Laffer curve for solely external debt features a narrow risky borrowing region. Our model helps to expand Aguiar and Amador (2014)'s argument. The key feature of standard sovereign debt models is that the price of external debt is formed in a competitive financial market. Once we add a domestic financial market, where the government has market power and the default risk works as link to the external market, we are able to make the borrowing region larger. In fact, the price schedule becomes less elastic to the amount of debt issued. The optimal debt composition determines the "optimal" risky borrowing region. That explains why our model is able to reproduce realistic debt levels at low default frequencies even when the punishment from default is only short-lived market exclusion.

2 The Quantitative Relevance of Market Exclusion

Having described the trade-offs of the government's debt issuance choice under simplifying assumptions, we move back to the full model where both debt composition and default are endogenous. This section illustrates that our model resolves the disconnect between sovereign debt levels and financial market exclusion. We are able to reproduce the sovereign debt levels and the composition of debt at reasonable default frequencies, even if market exclusion is the only punishment after default.[16] Importantly, we do that by allowing for financial repression in the domestic economy. We calibrate the model to match the domestic debt levels, external debt levels and the domestic and external default frequency of Argentina, Mexico and Russia. We have chosen these three countries, because they have jointly defaulted on the domestic and external debt at some point throughout their recent history and have used the financial repression policies extensively in the period of interest.

2.1 Calibration

We calibrate the model at an annual frequency, due to the frequency of the dataset on government debt. The model is solved with value function iteration on a discrete grid.[17]

In Table 1 we report the parameters that are calibrated and in Table 2 the ones that are used to match debt and default statistics. The coefficient of risk aversion of the government

[16] By no means we imply that other costs from defaulting that have been considered in the literature to explain the sovereign debt levels are irrelevant. Our goal is to show the importance of financial market exclusion.

[17] The two-dimensional grid consists of 300 points for the debt and 61 points for the endowment. In Section 2.5, we show that our results are not sensitive to the number of points for the endowment grid, unlike the standard sovereign model for external debt.

Table 1: Parameters

Common		**Argentina**	**Mexico**	**Russia**
risk aversion: σ		2	2	2
risk-free rate: r^z		0.04	0.04	0.04
Country specific				
persistence (end.): ρ	log(gdp per capita)	0.72	0.82	0.77
st.dev (end.): σ_ϵ	log(gdp per capita)	0.053	0.034	0.057
private bonds : L	liquid liabilities % GDP	19	26	25

Note: Annual frequency. Data coverage: Argentina and Mexico (1970-2010), Russia (1992-2010). Source: The data on GDP per capita are from the International Macroeconomics Dataset belonging to md4stata datasets. The data on liquid liabilities as percentage of GDP are obtained from the financial development database 2016.

is set to 2. The world risk-free rate is set to 4 percent. The stochastic endowment process is estimated from data on GDP per capita for the period 1970-2010. In particular, we assume that the GDP per capita has a log-quadratic trend.After subtracting the log-quadratic trend, we obtain the cyclical component and we fit a log-normal AR(1) process with zero mean. We obtain that Argentina has the least persistent process among the three countries and Mexico has the most persistent one. In addition, Mexico's estimated stochastic process is the least volatile among the three. Argentina and Russia have volatile stochastic processes. The endowment shock process is discretized using the Tauchen and Hussey (1991) method. The parameter L that regulates the degree of financial development in the economy is set to capture the liquid liabilities as percentage of GDP, which is a measure of financial depth based on Čihák et al. (2012). The last three parameters, the government's discount factor, β, the size of the government, λ, and the probability of market re-entrance, θ, are chosen to target the domestic debt to GDP, external debt to GDP and the default frequency based on joint defaults on domestic and external debt.

The values of β we obtain are low and in line with the standard sovereign debt models (for example, Aguiar and Gopinath (2006)'s discount factor translated into annual frequency is equal to 0.4). The size of the government, λ, implies that domestic bondholders' savings represent 68 percent, 74 percent and 77 percent of the GDP for Argentina, Mexico and Russia, respectively. Independently of the country chosen, the calibration exercise shows that our model with only market exclusion after default can generate the relevant debt levels and a default frequency close to the empirical levels. Remarkably, it only requires the market exclusion to be between 1 and 1.5 years. This number is at the lower bound of the empirical estimates. Compared to a standard sovereign debt model, such as Aguiar and Gopinath (2006) and Arellano (2008), market exclusion is more costly in our

Table 2: Target moments

	Argentina		**Mexico**		**Russia**	
	Data	Model	Data	Model	Data	Model
External Debt %GDP	29	29	24	25	26	26
Domestic Debt %GDP	19	18	19	19	20	20
Default frequency (%)	2	1.1	1.5	1.1	2	1.4
Calibrated parameters						
discount factor: β	0.46		0.48		0.48	
government size: λ	0.19		0.15		0.13	
prob. market re-entrance: θ	1		0.82		0.85	

Note: Annual frequency. Data coverage: Argentina and Mexico (1970-2010), Russia (1992-2010). The parameters β, λ, θ are set to match the external debt, domestic debt and default frequency jointly.
Source: The data on government debt are an extended version of the dataset from Panizza (2008). The calculation of the default frequency is based on the data on joint default events on domestic and external debt reported in Reinhart and Rogoff (2009) for the period 1800-2010.

model, because it implies that the government loses access to segmented markets, one of which offers relatively cheap funding.

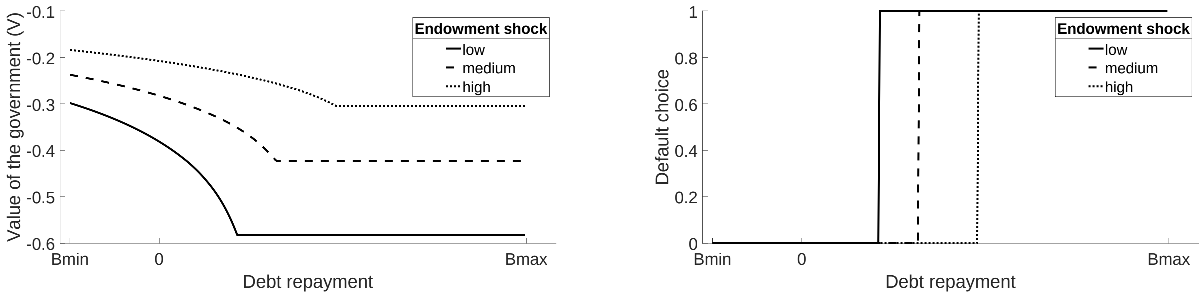
2.2 Policy Functions and Simulation

We analyze the optimal behavior of the government. First, we study the default incentives. Then, we discuss the pricing functions. Finally, we focus on the issuance decision in the domestic and external market.[18]

In this model the government has two ways of smoothing consumption: defaulting or issuing new debt (after repaying the past debt). Issuing new debt is beneficial for the current consumption, especially when the current endowment is low. But first the government has to repay the previous debt. The higher the past debt, the higher the incentives to default. In fact, defaulting is more appealing when roll over of debt is not possible. The weaker the market power of the government, the more likely it is that the benefits of inter-temporal risk sharing using government debt are outweighed by the benefits of defaulting. These are the trade-offs that the government faces in every period.

Figure 3a reports the value of the government when it has the option to default for high, medium and low endowment levels. The value function is higher for higher levels of endowment, reflecting the lower default incentives. Moreover, it is higher for smaller amounts of total debt to repay. Figure 3b shows the government's optimal defualt choice.

[18]For space reasons, we present the policy functions for Argentina. Qualitatively, the policy functions for Mexico and Russia are similar.



(a) Value of the government (b) Optimal Default Choice

Figure 3: On the left side we plot the value that maximizes the utility for the government by choosing among the utility from repaying, V^{nd}, and the utility from defaulting, V^{d} for low (black line), medium (dashed line) and high (dotted line) endowment. On the right side we plot the optimal default choice for the government for low (black line), medium (dashed line) and high (dotted line) endowment.

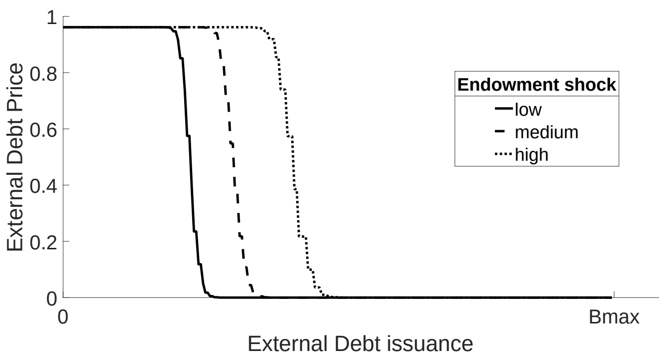
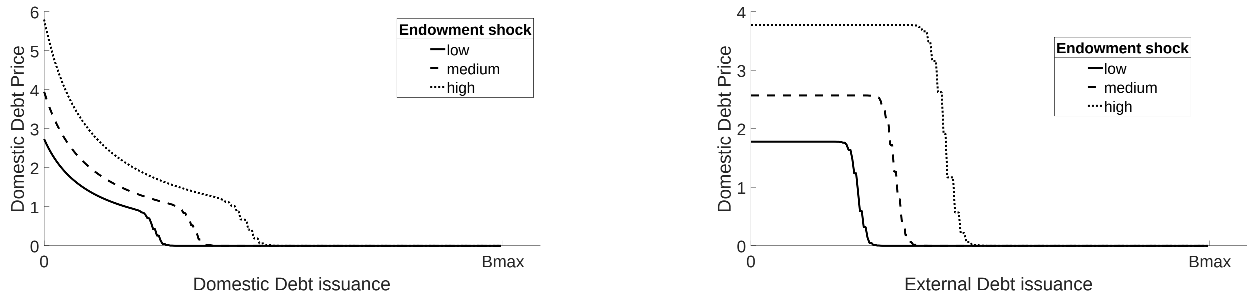


Figure 4: External debt price

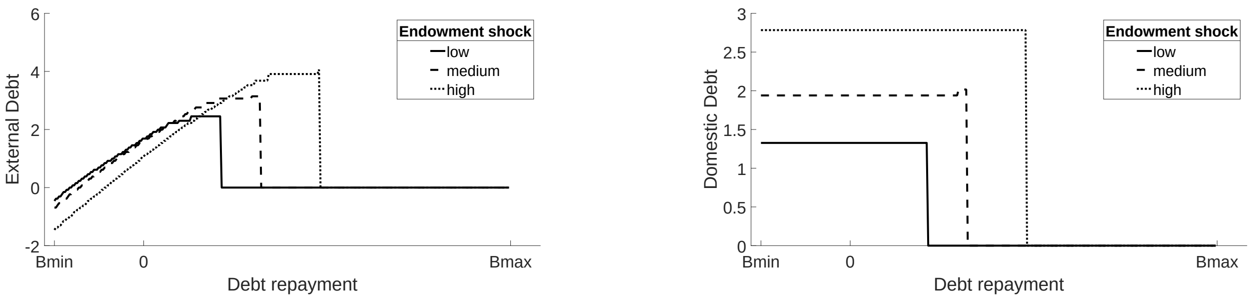
Figure 5: We plot how the price function for external bonds varies with the amount of external bonds issued, conditional on a fixed amount of domestic bonds issued, for low (black line), medium (dashed line) and high (dotted line) endowment.



(a) Domestic debt price conditional on no external debt issued

(b) Domestic debt price conditional on a fixed amount of domestic debt issued

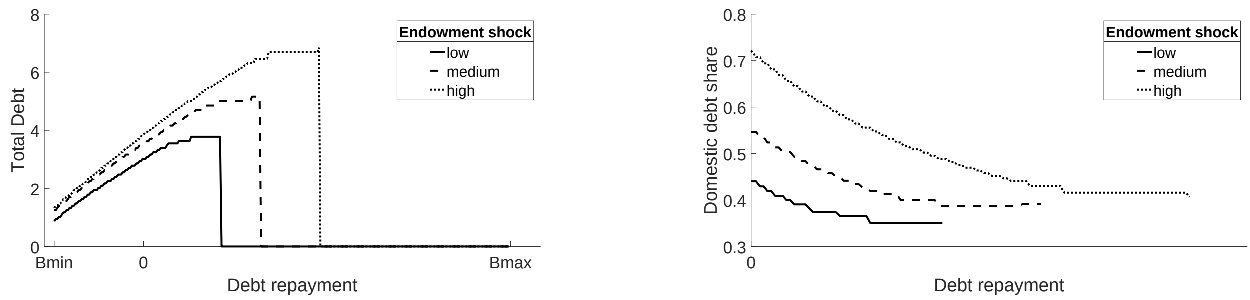
Figure 6: On the left side we plot how the price function for domestic bonds varies with the amount of domestic bonds issued, conditional on no external debt issued, for low (black line), medium (dashed line) and high (dotted line) endowment. On the right side we plot how the price function for domestic bonds varies with the amount of external bonds issued, conditional on a fixed amount of domestic debt issued, for low (black line), medium (dashed line) and high (dotted line) endowment.



(a) Optimal External Debt

(b) Optimal Domestic Debt

Figure 7: On the left side we plot the optimal choice of external debt for low (black line), medium (dashed line) and high (dotted line) endowment. On the right side we plot the optimal choice for domestic debt for low (black line), medium (dashed line) and high (dotted line) endowment.



(a) Optimal Total Debt

(b) Optimal Domestic Debt Share

Figure 8: On the left side we plot the optimal choice of total debt for low (black line), medium (dashed line) and high (dotted line) endowment. On the right side we plot the optimal choice of domestic debt share for low (black line), medium (dashed line) and high (dotted line) endowment.

The policy function features a monotonic relationship with respect to the state variables. Default incentives are stronger for lower endowment and higher debt to repay. This happens because the market power of the government is stronger with higher endowment, since the domestic demand for bonds is higher. Default is more coslty when the market power is stronger. The persistence of the shocks makes the default incentives even stronger in bad times, because the endowment is more likely to remain low in the following period, if it is low in the current period. Tomz and Wright (2013) report evidence that defaults happen mostly during recessions, hence this behavior is in line with the data.

In Figure 4 we plot the price function of external government bonds across external bond issuance, keeping the domestic debt issuance fixed. The pricing function is a straight line for low levels of debt because the default risk is zero and the external risk-free rate is taken as given by the small open economy. The function becomes convex when the risk premium becomes positive. The price falls to zero when the probability of default is one. This decrease in price is slower and starts later, the higher is the endowment level. This happens because default incentives are weaker for high endowment levels, as shown above. Figure 6a and 6b report the pricing function for domestic government bonds. Since the price of domestic debt depends both on the total amount of debt issued and on the domestic debt share, we fix one dimension per time. In Figure 6a we plot the price of domestic government bonds versus the domestic debt issuance, in case that only domestic debt is issued. As mentioned in the previous section, the pricing function is convex and the slope becomes steeper when the risk premium becomes positive. The price falls to zero when the probability of default is one. Moreover, the price is higher and decreases more slowly, the higher is the endowment level. Hence, the price of domestic debt is monotonic with respect to the endowment level. This happens for two reasons. First, the inelastic demand for assets from domestic bondholders is procyclical, implying that the price of all assets in the domestic economy is higher for higher endowment levels. Second, the probability of default is lower for higher endowment levels, thus making the general equilibrium effect of the risk premium stronger. Figure 6b reports the price of domestic bonds versus the external debt issuance, keeping the domestic issuance fixed. The pricing function is affected by the amount of external debt only through the default risk. Hence, we isolate the effect of the default risk on the pricing function q^D. The price is higher and decreases more slowly for higher endowment levels. Again we notice that the price function of domestic debt is monotonic in the endowment level, unlike the price function of external debt.

Figure 7a shows the policy function for the issuance of external debt. The amount of external debt issued does not feature a monotonic relationship with the endowment, conditional on the amount to be repaid. Actually, it is monotonic with respect to the endowment shock only when the amount to be repaid is sufficiently high. This is in line with what we found for the pricing function of external debt. Figure 7b reports the optimal borrowing decision for the government in the domestic market. The amount of debt issued does not vary significantly with the amount of debt to repay, except at the point where the government defaults and the debt goes to zero. In contrast to the external debt issuance, the domestic debt issuance is monotonic in the endowment level, as is its pricing function. The reason for this result is the tension between using debt for consumption smoothing in bad times while having more market power in good times.

Table 3: Business cycle statistics

	Argentina		**Mexico**		**Russia**	
	Data	Model	Data	Model	Data	Model
Mean						
External Spread (%)	15.2	1.1	3.4	1.1	7.1	1.6
Domestic Spread (%)	NA	0.6	NA	0.6	NA	0.9
Domestic debt share (%)	40	38	44	43	44	44
Standard deviation						
External Spread (%)	17.6	0.6	2.5	0.6	1.1	0.8
Domestic Spread (%)	NA	0.3	NA	0.4	NA	0.5
Correlation with GDPp.c.						
External Spread (%)	-0.3	-0.3	-0.4	-0.2	-0.4	-0.4
Domestic Spread (%)	NA	0	NA	0	NA	0
External debt % GDP	-0.7	-0.8	-0.2	0.7	-0.7	-0.1
Domestic debt % GDP	-0.6	-0.2	0.2	0.5	0.6	0.3
Trade balance % GDP	-0.4	-0.4	0.04	-0.3	NA	-0.5

Note: Annual frequency. Data coverage: Argentina and Mexico (1970-2010), Russia (1992-2010). Source: The data on government debt are an extended version of the dataset from Panizza (2008). The model is simulated for 5,000,000 periods. We extract 50 periods before a default event and calculate the business cycle statistics as the average of all 50-period business cycle statistics averages.
The data about external spreads are taken from Aguiar et al. (2016). The sample coverage is 1993-2014, due to the availability of EMBI data. The data about domestic spreads are not available for the period of interest.
The data about the trade balance are taken from Schmitt-Grohe and Uribe (2017). The sample coverage is 1980-2012, but the data for Russia are not available for a long enough time span at annual frequency.

Having presented the policy functions for domestic debt and external debt, we proceed with the policy function for the optimal domestic debt share. Figure 8b shows that, conditional on the debt to be repaid, the domestic debt share increases with the endowment.

This result comes from two driving forces. First, the market power of the government is higher, the higher is the endowment level. This is related to the assumption of procyclical inelastic demand for assets for domestic bondholders. In fact, we have discussed above that the price of domestic debt is monotonic in the endowment level. There is also a second importance force. When the endowment is low, the government has a greater need to issue debt for insurance purposes and issuing large amounts of debt affects the prices more in the domestic market than in the external market. This comes from the market power of the government in the domestic market and it is especially true when the risk of default is low or null.[19]

Hence, we obtain a higher domestic debt share when the endowment is higher, that is when default incentives are lower. Interestingly, we obtain this result without invoking any preference of the government for its domestic bondholders. It is simply due to the interaction of the government's market power and the consumption smoothing motive. In contrast, papers that focus on the internal costs of default, such as Mallucci (2015) and Perez (2015), rely on the government's preference for its domestic bondholders. Our mechanism is more relevant to explain the levels and the composition of debt for non-advanced economies, because it is in line with empirical evidence on the use of financial repression in these countries.

Having analyzed the optimal government's behavior, in Table 3 we look at some business cycle statistics. We show which features of the business cycle our model can capture, given that we have only allowed for market exclusion as default punishment and we have matched the debt levels. In terms of the average spread, the model accounts for a small fraction of the value in the data, although it is close to match the default frequency. This shortcoming of the model is common even among sovereign debt models that feature output costs during default and risk-neutral lenders. As explained in Schmitt-Grohe and Uribe (2017), these models cannot match the (external) default frequency and the external spread at the same time.[20] However, it is worth noting that our model is able to match the levels of debt, the default frequency and explain one fourth and one third of the external debt spread for Russia and Mexico, respectively.

Moreover, our model is consistent with the evidence, presented in Du and Schreger (2016), regarding the spreads of local currency and foreign currency debt for 10 emerging countries between 2005 and 2014. After extracting the currency risk from local currency

[19]In Section 4 we explain that the procyclical domestic debt share, conditional on the amount of debt to repay, is a feature of our model, independently from the assumption of procyclical domestic demand for assets.

[20]A solution proposed to match the average external spread was to allow the international bondholders to be risk-averse. However, Schmitt-Grohe and Uribe (2017) show that risk aversion under reasonable assumptions and parametrization does not solve the problem.

bond prices, the authors are able to compare the default risk premia of domestic and external bonds and find that the average domestic spread is lower than the average external spread.Du and Schreger (2016) mention sovereign debt market segmentation as potential cause for the gap between the local currency debt and the external currency debt. We obtain this regularity, even if the default in our model is not discriminatory. That is a consequence of the government's market power in the domestic economy. Even if the default probability is the same, since in the domestic economy the government affects the price of the domestic private bonds, L, we obtain different spreads across the two markets. The model's performance is relatively weak compared to the data when we look at the standard deviation of the spreads. Indeed, the difficulty of matching the volatility of the spread is typical of sovereign debt models that do not assume asymmetric output costs during the default period, as mentioned in Aguiar et al. (2016).[21] Taking into account that, it is worth noting that our results are not that far from the data, as long as Mexico and Russia are concerned. On the other hand, the model captures particularly well the correlations of these variables with respect to GDP.

2.3 Segmented versus Integrated Debt Markets - Model Performance

To highlight the importance of incorporating the government's market power in a sovereign debt model, in Table 4 we compare our model's performance with an economy where the government does not exploit its market power. This model is essentially similar to the one studied by Aguiar and Gopinath (2006) and Arellano (2008). Thus, we consider the standard external sovereign debt model and assume that the only punishment after default is the short-lived market exclusion that was obtained in the calibration in section 2.1. Under this assumption, an economy with integrated financial markets can sustain approximately zero debt in equilibrium. Instead, once we allow for the government to take advantage of its market power in the domestic economy, we can match the sovereign debt levels as we have seen in the previous section. Thus, the study of external sovereign debt is linked to the study of domestic sovereign debt and a relevant punishment after default, such as market exclusion, when it entails losing the benefits from domestic marker power.

[21] It was believed that asymmetric default costs during default were sufficient for the model to match the volatility of the external debt spreads in the data. However, Aguiar et al. (2016) show that an additional assumption is needed: a volatile endowment process. In fact, when they calibrate the model to Mexico, that features a less volatile output than Argentina, they are not able to match the volatility of the spread.

Table 4: Segmented and Non segmented debt markets.

		Model	
	Data	*Segmented*	*Non segmented*
Mean			
External Debt % GDP	29	29	approx. 0
External Spread (%)	15.2	1.1	approx. 0

Note: Annual frequency. Data coverage: Argentina (1970-2010).
Source: The data on external govenrment debt are an extended version of the dataset from Panizza (2008).

2.4 Default Events - Output

We study the behavior of the economy around default events. In particular, we are interested in the behavior of output around the Argentinian default, because it has been studied extensively in the sovereign debt literature. The model predicts that a default happens at the end of the output contraction, consistently with the evidence (Schmitt-Grohe and Uribe, 2017). In addition, the size of the fall in output at the point of default is within the relevant empirical estimates. On average, in our calibration, during the year of default output falls by 13%, as it is shown in Figure 9. In the data GDP per capita fell by 20% (our own calculation). We conclude that defaults in our model happen at the end of a sharp fall in output. That is important, because the model abstracts from mechanisms that induce a fall in output during default in an exogenous or endogenous manner. This result verifies that market exclusion becomes a relevant punishment, when the government loses access to segmented debt markets.

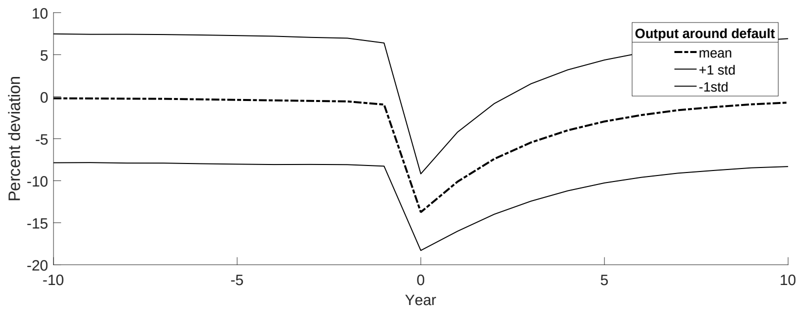


Figure 9: Output around default events, 10 years before and 10 years after. The model with Argentinean calibration is simulated 5,000,000 periods, then we extract 10 periods before and after a default event and calculate the mean and the standard deviation across default episodes.

Table 5: Sensitivity analysis

	Baseline	β		λ		θ	Ygrid
		$\beta_l = 0.41$	$\beta_h = 0.51$	$\lambda_l = 0.14$	$\lambda_h = 0.24$	$\theta_l = 0.8$	$n_y = 200$
Default frequency (%)	1.1	1.1	0.9	0.8	1.6	1.0	1.1
Mean							
External Debt (%)	29	34	25	59	13	41	29
Domestic Debt (%)	18	18	18	20	16	18	18
External Spread (%)	1.1	1.2	1.0	0.9	1.8	1.0	1.2
Domestic Spread (%)	0.6	0.6	0.5	0.4	1.0	0.5	0.6
Domestic debt share (%)	38	34	42	25	56	30	38
Standard deviation							
External Spread (%)	0.6	0.6	0.7	0.4	1.2	0.5	0.6
Domestic Spread (%)	0.3	0.3	0.3	0.2	0.7	0.3	0.3
Correlation with GDPp.c.							
External Spread (%)	-0.3	-0.1	-0.3	-0.2	-0.3	-0.3	-0.3
Domestic Spread (%)	0	0	0	0	0	0	0
External debt % GDP	-0.8	-0.9	-0.7	-0.9	0	-0.9	-0.8
Domestic debt % GDP	-0.2	0.1	-0.1	-0.3	0.1	0.1	0.1
Trade balance % GDP	-0.4	-0.4	-0.3	-0.4	-0.3	-0.4	-0.4

Note: The model is simulated for 5,000,000 periods. We extract 50 periods before a default event and calculate the business cycle statistics as the average of all 50-period business cycle statistics averages. In the baseline case we use $\beta = 0.46$, $\lambda = 0.19$, $\theta = 1$ and $n_y = 61$.

2.5 Sensitivity Analysis

In this section we show how sensitive are the results of our model to the value of key parameters. In Table 5 we show how the main moments we obtained for Argentina change when we vary the value of the government's discount factor, β, the size of the government, λ, and the probability of market re-entrance after default, θ. In Appendix B, we show also the sensitivity to the persistence of the output process, ρ, and the variance of the output shock, σ_ϵ.

Regarding the government's discount factor, a more impatient government would care less about the cost of default, hence default incentives are higher, everything else equal. Lower β should imply higher default probability. What happens to the level of debt is less clear. On one hand, higher default incentives mean that debt may be more expensive. On the other hand, a more impatient government would like to consume more today, hence has a stronger desire for debt. What we obtain from our exercise is indeed an increase in the default probability for higher β and a higher external debt level. The government is able to satisfy its desire for more debt.[22] A lower value for λ implies more domestic and

[22]In a similar sensitivity exercise, Schmitt-Grohe and Uribe (2017) obtain a lower debt level, in a model that contains also output costs during default. This comparison shows that the presence of two debt instruments,

external debt and lower default probability. In fact, this corresponds to the case of a larger share of captive domestic bondholders, hence the benefits from market power are larger for the government. When the cost from defaulting is higher, the level of debt that can be sustained is higher. A lower probability of re-entrance in the market after default, θ, means that default is more costly. This implies lower default incentives. In fact, we obtain lower default probability and higher external debt levels. This result shows how important is the market exclusion in our model. In standard sovereign debt models, the role of market exclusion is marginal, as described in Schmitt-Grohe and Uribe (2017). Instead, we obtain a remarkable difference (12% of total debt over GDP) just by increasing the average exclusion from the market from one year to one year and one quarter.

One additional test we perform is to increase the number of points for the endowment grid that is used to solve the model numerically. As first pointed out by Hatchondo, Martinez and Sapriza (2010) and more recently by Schmitt-Grohe and Uribe (2017), the number of grid points used for solving the model with a discrete state space technique matters for the results obtained with standard sovereign debt models. In particular, the average spread and the volatility of the spread are mostly affected. This is due to the sensitivity of the bond price function to the endowment shock, hence the size of the risky borrowing region. Our model is not subject to this problem. Increasing the number of endowment grid points from 61 to 200 does not have an impact on the business cycle statistics. Hence, this is another way to demonstrate that the risky borrowing region in our model is larger than in the standard sovereign debt models. In other words, we have made the bond price function less sensitive to the endowment shock.

3 Financial Repression and the Composition of Sovereign Debt

In this second part of the paper we turn the discussion to the role of financial repression in explaining the domestic and external sovereign debt of non-advanced economies. First, we conduct a calibration exercise in which the domestic and external debts unravel, by only targeting the total debt levels of non-advanced economies. Afterwards, we show that we can obtain negative real interest rates on sovereign debt that are close to the evidence for non-advanced economies during 1966-2010 (Escolano, Shabunina and Woo, 2016).

traded in segmented markets, allows the government to issue more debt when it is more impatient, like in models with full commitment.

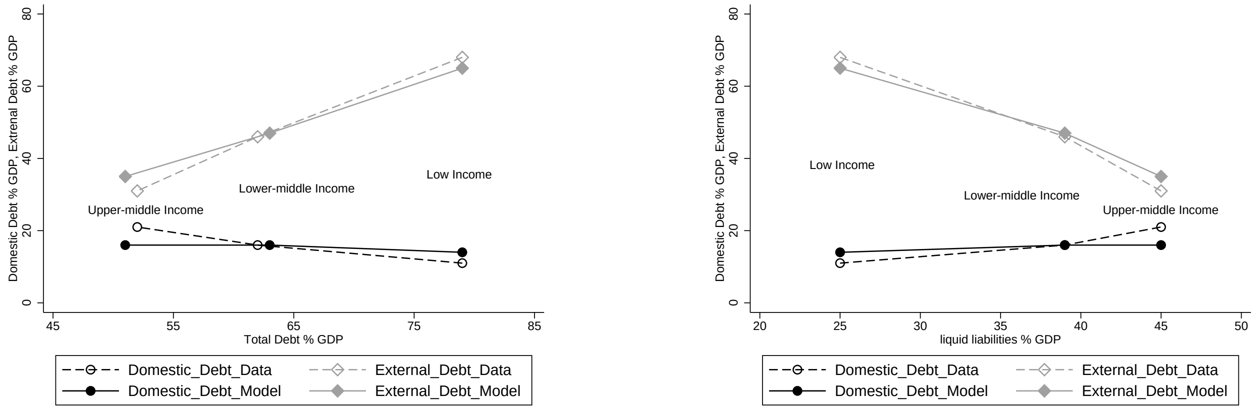
Table 6: Parameters for cross-group calibration

Common				
risk aversion: σ	standard	2		
risk-free rate: r^z	standard (RBC)	0.04		
discount factor: β	low default frequency	0.75		
persistence (end.): ρ	cross-country average	0.68		
st.dev (end.): σ_ϵ	cross-country average	0.042		
prob. market re-entrance: θ	Schmitt-Grohe and Uribe (2017)	0.08		
Group-specific: World Bank Income Group		LI	LMI	UMI
private bonds : L	liquid liabilities % GDP	25	39	45
Calibrated parameters		LI	LMI	UMI
government's size: λ	Target: Total debt % GDP	0.265	0.145	0.115

Note: Annual frequency. Data coverage: The data on annual quadratically detrended GDP per capita, liquid liabilities as percentage of GDP and total debt as percentage of GDP, cover the period 1970-2010 conditional on the country and the period belonging to the extended version of the dataset presented in Panizza (2008) and the availability of the data.
Source: The data on GDP per capita are from the International Macroeocnomics Dataset belonging to md4stata datasets. The data on liquid liabilities as percentage of GDP are obtained from the financial development database 2016 and the data on total debt as percentage of GDP are from an extended version of the dataset presented in Panizza (2008).

3.1 Across Income Groups Calibration

The calibration exercise is conducted in the following way. We split the countries according to the World Bank income group they belong to. All the parameters, except the amount of domestic private bonds and the government's size, are common across the groups (see table 6). The amount of domestic private bonds, L, is set to match the average level of financial development for each income group. The measure of financial development is liquid liabilities over GDP. Liquid liabilities as percentage of GDP is considered a measure of financial development related to financial institutions depth, based on the classification in Čihák et al. (2012). The parameter λ, that represent the government's size, is set to match the average total debt over GDP for each income group. Before proceeding with the calibration results, we explain how we set the other parameters that are common across income groups. The coefficient of risk aversion, σ, and the risk-free rate, r^z, are the same as in the previous calibration exercise. The choice of β is motivated by the fact that the average default frequency for the countries in our dataset is low. Based on our calculations from the cross-country data described in Reinhart and Rogoff (2009), we find that the frequency of joint defaults on domestic and external debt is around 0.3 percent. Thus, in order to target this low default frequency, β should be equal to 0.75. Then, we turn to to the parameters



(a) Total debt against domestic and external debt for Non-Advanced economies

(b) Liquid Liabilities against domestic and external debt for Non-Advanced economies

Figure 10: Domestic and External Sovereign Debt: Model vs Data

Source: Own calculations based on Ugo Panizza's dataset described in Panizza (2008) and the Financial Development dataset 2016.
Description: With hollow circle is the average domestic debt as percentage of GDP for each income group. With solid circle the value of domestic debt as percentage of GDP obtained in our model for each income group. With hollow diamond is the average external debt as percentage of GDP for each income group. With solid diamond the value of external debt as percentage of GDP obtained in our model for each income group.

that characterize the persistence and the standard deviation of the endowment process. We follow the same approach as in the individual country calibration. After obtaining the parameters for each country, we calculate the cross-country average. That implies a value of 0.68 for the persistence and 0.042 for the standard deviation. The probability of re-entrance to the market is set to 0.08. Based on Schmitt-Grohe and Uribe (2017), table 13.6, defaulted countries obtain partial re-access to the financial market after 9.8 years and full re-access to the financial market after 15.9. So we choose the market exclusion to be the average of the two, which is 13 years.

To match the data on total debt over GDP, the model requires more market power for the government for higher total debt levels. We can also derive the counterfactual domestic bond price for each income group, as defined in Formula 14. This measure decreases with the level of economic development: it goes from 2.32 for Low Income countries to 1.76 for Upper-Middle Income countries. In Figure 10 we plot the results from the two non-targeted moments of this calibration exercise, the average domestic and external debt. Remarkably, they closely resemble the data.

The Upper-middle Income group has a more balanced composition of debt compared to the other two groups. According to our model, the reason is that, given the smaller market power for the government for this income group, the benefits from financial repression are low. This implies that market segmentation is less beneficial, which yields a more balanced composition of government debt. On the other side, the Low Income group can sustain high levels of sovereign debt, because the benefits of financial repression are high, which implies that access to segmented debt markets is more valuable compared to the other two income groups. The strong government's market power implies that, everything else equal, one unit of domestic debt is more valuable than one unit of external debt. However, the additional net marginal benefit from domestic debt issuance decreases faster than the additional net marginal benefit from the external debt issuance. Thus, the government issues a small amount of domestic debt that is valuable and a larger amount of external debt.

3.2 Interest Rate Growth Differential

Reinhart and Sbrancia (2015) report that advanced economies reduced their government debt levels after World War II mostly by paying negative real interest rates. Recently, Escolano, Shabunina and Woo (2016) have calculated the interest rate growth differential for advanced and non-advanced economies for the period 1966-2010. The non-advanced economies paid on average -6.1 percent as real interest rate on their sovereign debt, adjusted for growth and currency valuations. Reinhart and Sbrancia (2015) and Escolano, Shabunina and Woo (2016) connect the low interest rates in these countries with the presence of financial repression. Our model of segmented debt markets serves as the best laboratory for explaining the evidence. There is no growth in our model. So, the interest rate growth differential from our model coincides with the real interest on the sovereign debt. Following Escolano, Shabunina and Woo (2016), the real interest rate on sovereign debt is a weighted average of the real interest rate paid on domestic debt and the real interest rate paid on external debt and the weight is given by their share:

$$R = dds * R^D + (1 - dds) * R^E. \tag{15}$$

R^D refers to the real interest paid on domestic debt, R^E refers to the real interest paid on external debt and dds is the domestic debt share. Then, taking a weighted average for the three income groups (the weight is given by the number of countries in each income group divided by the total number of countries), we obtain a real interest rate of -3.4 percent (Table 7).

Therefore, the model does not only replicate the levels and composition of debt, but is also consistent with the real interest rate paid on average by non-advanced economies, which is negative. That being said, it implies that the study of sovereign debt should not

Table 7: The real interest rate on sovereign debt

	Data	Model
Real Interest rate	-6.1%	-3.4%

The data on the real interest rate growth differential are based on Escolano, Shabunina and Woo (2016) for the period 1966-2010. The model counterpart is based on our calculations taking a weighted average across income groups. The weight is the fraction of countries belonging to one group out of the total countries that are part of the dataset on sovereign debt that is used in the paper.

refrain from the study of domestic debt for an additional reason. It cannot be consistent with the evidence on real interest rate on government debt, that is negative due to financial repression.

4 Discussion of Assumptions

In this section we discuss the role of two main assumptions. The first one is the procyclical inelastic demand for assets from the domestic bondholders. The second one is the non-discriminatory default.

The inelastic demand for assets from the domestic bondholders is procyclical, because their endowment is (perfectly) positively correlated to the government's endowment. It is reasonable to assume that the resources of all agents in the economy are positively correlated. The fact that they are perfectly correlated is a simplifying, but not crucial, assumption that allows us to carry on only one state variable for the endowment process. In the model, across different calibrations, we obtain a procyclical domestic debt share, conditional on the amount of debt to repay.[23] The procyclical demand for assets makes the market power of the government stronger in good times. Solving the model with a different assumption, either fixed endowment or countercyclical endowment for the domestic bondholders, that would imply acyclical or countercyclical market power, we can still obtain a procyclical domestic debt share, conditional on the amount of debt issued. Instead, the default incentives change, becoming stronger in good times. The reason is that the government's market power is not anymore stronger in good times, hence default is not anymore too costly in good times. We conclude that the main driver behind the procyclical domestic debt share is the higher demand for external debt in bad times, that is obtained depending on the calibration of the government's patience and the output process. Overall, given that

[23]However, the unconditional correlation between the output and the domestic debt share can be positive or negative.

the evidence shows that default happens mostly in bad times, we consider our assumption of procyclical demand for assets, and therefore stronger market power in good times, the appropriate one.

The model assumes non-discriminatory default. This assumption allows us to carry over only one state variable for total debt. Moreover, the evidence on whether and how default discrimination happens is inconclusive. As mentioned before, the key mechanism in our model is related to the fact that the government can segment its debt market and possesses market power in the domestic segment. The two debt markets are related through the default risk. Hence, what we really need for our mechanism to work is the default risk of one debt to be positively correlated to the default risk of the other debt. If we had to relax the assumption of non-discrimination, it would be possible to obtain this kind of positive correlation. Our assumption is, therefore, not too stringent.

5 Conclusion

We have provided a model to explain the domestic and external sovereign debt in the presence of limited legal enforcement of sovereign debt contracts. Our starting point is that non-advanced economies are not able to produce enough private savings instruments for "local savers". Hence, there is a role for domestic public debt, especially when the government restricts outward capital flows to exercise market power. The debt market is divided into domestic and external segments and the default risk links the debt instruments issued in the two markets. We have shown that a short-lived market exclusion after default, a previously thought mild default punishment, is enough to match the observable debt levels of Argentina, Mexico and Russia at realistic default frequencies. Moreover, we obtain a composition of debt that resembles the data. This renders the idea of allowing the government to segment its debt market quantitatively relevant.

An additional key result is the connection of domestic and external sovereign debt levels of non-advanced economies with financial repression, consistently with the evidence. We have conducted a quantitative exercise in which we have targeted the total sovereign debt level of the non-advanced economies, by varying the potential for financial repression in the economy. The exercise regards the non-advanced economies, split into the three World Bank income groups they belong to. The model predicts that the higher are the benefits of financial repression - hence the higher the government's market power - the higher are the sustainable debt levels. As a consequence of the differences in the market power across the three income groups, we predict that governments of poorer countries can sustain higher sovereign debt levels, mostly external debt, because the benefits from financially repressing part of the population are higher. Thus, financial repression is not only a tool to explain the domestic sovereign debt levels, as is usually argued, but, most importantly, to explain the external sovereign debt levels as well. Finally, our model rationalizes the average negative real interest rates paid by non-advanced economies on sovereign debt. Domestic and external sovereign debt are inherently linked in a model of financial repression.

In the model we have abstracted from other features of sovereign debt to be able to highlight the link between domestic and external debt. We leave the issue of the maturity structure, debt renegotiation, discriminatory default, currency composition for future research. In addition, it would be interesting to see how market exclusion from segmented debt markets compete with additional costs from defaulting, once we have shown that it is costlier than what was thought. These features would help to improve the model's performance in terms of business cycle statistics.

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A Data

Table 8 shows the countries included in the analysis, according to the World Bank Income group they belong to. With respect to Panizza (2008)'s dataset we have excluded Comoros, Montenegro, Serbia and Somalia for lack of data on domestic and total debt. We have excluded Iraq, Lithuania, Namibia, Syrian Arab Republic and United Arab Emirates for lack of data on the composition of sovereign debt. We have also excluded Sao Tome and Principe for limited length of data series and Saudi Arabia for lack of data.

Figure 11 reports the distribution of the correlation between the domestic-to-external debt ratio and the detrended GDP for the countries in the dataset.

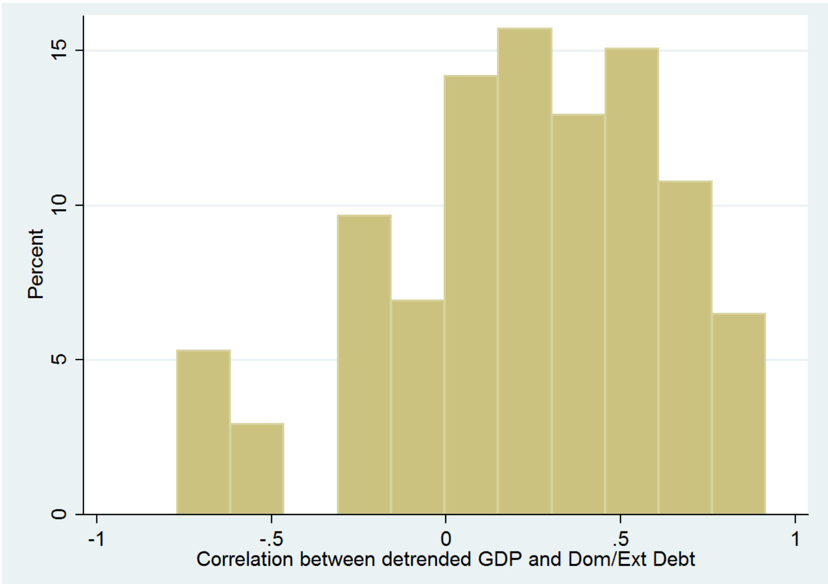

Figure 11: Distribution of correlation between detrended GDP and Domestic to External debt ratio for non-advanced economies.
Source: own calculations based on Ugo Panizza's dataset described in Panizza (2008).

B Additional Sensitivity Analysis

In this section we provide additional sensitivity analysis. We vary the variance of the output shock, σ_ϵ, and the persistence of the output process, ρ.

An increase in the variance of the output process implies that larger shocks hit the government's economy, increasing the incentives to default. On the other hand, the incentives for precautionaty savings increase, and should lead to lower debt issued in equilibrium. In line with these mechanisms and with Schmitt-Grohe and Uribe (2017), we obtain higher default probability, higher spreads and lower external debt when we increase σ_ϵ. The do-

Table 8: List of countries

Low Income	Lower-Middle Income	Upper-Middle income
Bangladesh	Albania	Algeria
Benin	Angola	Argentina
Burkina Faso	Armenia	Belarus
Burundi	Azerbaijan	Bosnia Herzegovina
Cambodia	Belize	Botswana
Central Africa	Bhutan	Brazil
Chad	Bolivia	Bulgaria
Eritrea	Cameroon	Chile
Ethiopia	Cape Verde	Colombia
Gambia	China	Costa Rica
Ghana	Congo Republic	Dominica
Guinea	Cote d'Ivoire	Dominican Republic
Guinea Bissau	Djibouti	Fiji
Haiti	Ecuador	Gabon
Kenya	Egypt	Grenada
Kyrgyz Republic	El Salvador	Jamaica
Laos	Georgia	Kazakhstan
Liberia	Guatemala	Latvia
Madagascar	Guyana	Lebanon
Malawi	Honduras	Macedonia
Mali	India	Malaysia
Mauritania	Indonesia	Mauritius
Mozambique	Iran	Mexico
Myanmar	Jordan	Panama
Nepal	Lesotho	Peru
Niger	Maldives	Poland
Rwanda	Moldova	Russia
Senegal	Mongolia	Seychelles
Sierra Leone	Morocco	South Africa
Tajikistan	Nicaragua	St Vincent Grens
Tanzania	Nigeria	StKitts and Nevis
Togo	Pakistan	StLucia
Uganda	Papua New Guinea	Turkey
Uzbekistan	Paraguay	Uruguay
Vietnam	Phillipines	Venezuela
Yemen	Samoa	
Zambia	Solomon Islands	
Zimbabwe	Sri Lanka	
	Sudan	
	Swaziland	
	Thailand	
	Tonga	
	Tunisia	
	Turkmenistan	
	Ukraine	
	Vanuatu	

Table 9: Sensitivity analysis - additional

	Baseline	ρ		σ_ϵ	
		$\rho_l = 0.67$	$\rho_h = 0.77$	$\sigma_\epsilon^l = 0.048$	$\sigma_\epsilon^h = 0.058$
Default frequency (%)	1.1	0.9	1.4	0.9	1.3
Mean					
External Debt (%)	29	33	27	32	26
Domestic Debt (%)	18	18	18	18	18
External Spread (%)	1.1	1.0	1.5	0.9	1.4
Domestic Spread (%)	0.6	0.5	0.8	0.5	0.7
Domestic debt share (%)	38	35	40	36	40
Standard deviation					
External Spread (%)	0.6	0.6	0.6	0.6	0.6
Domestic Spread (%)	0.3	0.3	0.3	0.3	0.3
Correlation with GDPp.c.					
External Spread (%)	-0.3	-0.2	-0.5	-0.2	-0.3
Domestic Spread (%)	0	0	0	0	0
External debt % GDP	-0.8	-0.9	-0.3	-0.8	-0.8
Domestic debt % GDP	-0.2	0	0	0	0.1
Trade balance % GDP	-0.4	-0.3	-0.4	-0.3	-0.4

The model is simulated for 5,000,000 periods. We extract 50 periods before a default event and calculate the business cycle statistics as the average of all 50-period business cycle statistics averages. In the benchmark case we use $\rho = 0.72$, $\sigma_\epsilon = 0.053$.

mestic debt is unaffected by the change in the parameter, because there are other forces at work in the domestic market, due to the market power of the government.

Increasing the persistence of the output process should lead to an increase in the default probability, because bad shocks to the economy are supposed to be followed more likely by more bad shocks. This increases the incentives to default and hence the default premia, making debt more costly. In fact, we obtain a higher default probability and higher spreads on the debt when we increase ρ, while external debt drops.

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