Domestic and External Sovereign Debt

JOB MARKET PAPER

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link to the latest version and the online appendix here

Abstract

We develop a theory of sovereign debt in the presence of limited enforcement, by analysing both domestic and external debt. In a financially repressed economy, a government that exploits its market power in the domestic asset market can increase its debt capacity in the international asset market. The reason is the additional endogenous default cost: a government in default loses the gains from trading across these segmented asset markets. We can account for the empirically observed composition of sovereign debt for developing countries. We obtain a higher share of external debt over domestic debt and higher default incentives in recessions than in booms. We also find a run up in external debt before default. After re-entering the markets, the external debt increases rapidly. Finally, the level of financial development determines the long-run levels and composition of debt. Economies with low (high) financial development have high (low) average total debt and high (low) shares of external debt.

Key words: sovereign debt, domestic, external, default, financial repression, financial development, capital controls.

JEL Codes: E21, E44, F30, F34, G10, H63, O16.

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1 Introduction

Sovereign debt is characterized by limited enforcement. Why is it nonetheless so plentiful? Previous theoretical research has established that, even in the absence of legal enforcement, the government may repay its debt because of the consequences of default. However, it has been difficult to reconcile most of these theoretical studies with the qualitative features of the evidence. Moreover, it has proven difficult to rationalize the magnitude of debt levels observed in the data in quantitative sovereign debt models.

We provide an additional reason for the existence of sovereign debt, that is quantitatively relevant. In underdeveloped economies the government can financially repress the domestic market by restricting outward capital flows. The sovereign benefits from partitioning its debt market into domestic and external segments, even though the government lacks commitment in each market. As long as the incentives to default in the two debt markets are connected, the gains from the domestic financial repression transmit to the government’s willingness to repay also the debt issued in the international financial market.

Recent datasets\(^1\) have revealed that the history of sovereign domestic debt and defaults is as long as the history of external debt and defaults. Sovereign debt is a risky asset, no matter to whom it is issued. At the same time, as highlighted by Obstfeld (1993), Dooley (1995), Aizenman (2004) and Kirkegaard et al. (2011), governments have tried to use financial repression\(^2\) jointly with capital controls to reduce the domestic debt burden. In fact, governments have been able to drive a wedge between domestic and international yields on similar financial instruments. Even in recent decades, developing countries have been still characterized by various forms of capital restrictions,\(^3\) notwithstanding policy suggestions for more financial liberalization.\(^4\)

Our theory can account for the empirically observed composition of sovereign debt across the business cycle for many developing countries. Moreover, we can reproduce the cross-country relationship between total government debt and its domestic and external components. The data on non-developed countries show the following relationships between default incentives and the com-

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\(^2\)We use the following definition for financial repression provided by Kirkegaard et al. (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 nonmarketable.

\(^3\)The normalized index of financial liberalization constructed by Abiad et al. (2008) for the period 1973-2005 is equal to 0.42 for non-advanced economies, in contrast to 0.69 for advanced economies. Aizenman and Pasricha (2013) document that significant restrictions to capital flows are still in place with a dataset for the period 2001-2010. Fernández et al. (2013) 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.

\(^4\)In light of the recent financial crisis and consequent high volatility of capital flows, economists and financial institutions have instead started arguing in favour of capital controls under specific conditions. The IMF has changed its institutional view on the use of capital controls, as discussed in IMF (2012) and Krugman (2012). In particular, the benefits of capital controls are said to be large for countries with low levels of financial development.
position of debt:

**FACT 1.** Default episodes happen mostly in "bad times", as reported in Tomz and Wright (2013), among others.

**FACT 2.** The ratio of domestic debt over external debt is procyclical for most of the non-developed countries. Figure 1 shows that the correlation between detrended GDP and the domestic-to-external debt ratio is positive for 76 percent of the countries considered (94 out of 123 countries).\(^5\)

**FACT 3.** Countries with low levels of average total debt over GDP feature a balanced composition of domestic and external shares. Countries with high average total debt over GDP are more biased towards external debt, as reported in Figure 2.

![Figure 1: Source: own calculations based on Ugo Panizza’s dataset described in Panizza (2008).](image)

The first two stylized facts imply that the share of domestic over external debt is lower in periods when the government is more likely to default. The third fact implies that countries with higher average total debt over GDP have higher shares of external debt.

Our model builds on the seminal paper by Eaton and Gersovitz (1981), that examined the case of poor countries borrowing in the international financial market. In their model sovereign borrowing is possible, because of the threat of exclusion from the international market after default. The quantitative properties of their model have been explored in a dynamic general equilibrium framework

\(^5\)We thank Ugo Panizza for providing us with the updated version of his dataset, described in Appendix E. 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. In our model domestic debt is meant as debt issued to domestic bondholders and external debt is meant as debt issued to foreign bondholders. For a more detailed analysis on the cyclicity of the debts and their ratio, see Appendix E.
by Aguiar and Gopinath (2006) and Arellano (2008). We propose an extension of these papers by introducing the domestic financial market. Acknowledging that poor countries are usually characterized by an underdeveloped financial market - in the sense of not being able to supply enough saving instruments - we focus our attention on how domestic market conditions affect domestic and external sovereign debt issuance and default decisions.

The model has three main ingredients. First, the government lacks commitment and can default indiscriminately on both types of debt. Reinhart and Rogoff (2011) report that defaults happen both on domestic and external sovereign debt. The empirical studies on discriminatory defaults provide inconclusive evidence on whether governments discriminate and which bondholder is favoured, as reported in Tomz and Wright (2013). This comes at no surprise. 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. Second, markets are incomplete. The government can issue one-period non-contingent bonds to domestic and external investors. This feature, together with lack of commitment and endowment uncertainty, gives rise to default in equilibrium. Third, the domestic economy can be financially repressed, as a result of financial underdevelopment and capital controls. This allows the government to act as a price discriminator across domestic and external markets. In fact, BIS (2007) explains that the narrowness of the domestic investor base for local bond markets of emerging economies is partly
due to captive market arrangements and other distortions. Evidence of a positive gap between international and domestic interest rates on government debt of developing countries is reported by Guidotti and Kumar (1991), Giovannini and de Melo (1993) and Gordon and Li (2003). More recently, Du and Schreger (2013) report evidence of lower credit spreads in local-currency debt than foreign-currency debt for emerging markets, mostly due to liquidity factors.

Our model features a government that is benevolent only towards domestic consumers and acts as an insurance provider for them. External government debt represents an insurance instrument. Instead, domestic government debt embodies a dual role: insurance for the government and saving instrument for captive domestic investors. Due to the presence of capital controls, the government can manipulate the supply of saving instruments in the domestic asset market. Hence, the government possesses market power in the domestic asset market. Default entails benefits and costs. Default counteracts adverse shocks to domestic consumers, but hinders the access to the two segmented debt markets. The former effect is common to standard sovereign debt models. The latter effect is an endogenous cost that originates from the market power in the domestic economy. In a nutshell, the novelty of the paper is that the incentives for the government to repudiate its debt are lowered by the gains from trading in segmented debt markets that are connected through the default risk.

In the first part of our paper we describe default incentives and the composition of debt across the business cycle. As in the standard sovereign debt models, default is more likely in recessions than in booms. The insurance role of default implies that the government has a stronger incentive to default during recessions. With respect to the borrowing behaviour of the government we obtain a procyclical ratio of domestic over external debt. Hence, our model jointly reproduces the first two stylized facts. The government issues more external than domestic debt in recessions, because it needs to borrow large amounts and affects the price of its debt less in the external market. However, during those periods the government debt is more risky. This composition of debt is sustainable in equilibrium, because the large amount of debt issued in recessions can be decumulated in booms with the highly valuable domestic debt. The two types of debt have a different role, that is reflected in their prices. The same amount of total debt has a different value if it is mostly domestic rather than mostly external.

In our model the government can issue more external debt in recessions than in booms. This is in contrast to standard models of external sovereign debt, where the government uses more debt in booms than in recessions. In these models default is a more attractive insurance instrument than debt. In our case default is not only beneficial. By repudiating the debt, the government

\[6\]In the model by Aguiar and Gopinath (2006) with transitory output shocks the government’s discount factor regulates the use of debt as a tool for insurance rather than default. When the government is extremely patient, debt is used as a form of insurance more often than default. When the government is relatively impatient, debt is dominated by default as a tool for insurance and leads the government to issue more debt during booms than during recessions. The latter is the case in Aguiar and Gopinath (2006) when they calibrate their model with a low discount factor. Arellano (2008) uses asymmetric default output costs, instead of proportional default output costs used by Aguiar and Gopinath (2006), punishing the government less in recessions than in booms. This makes debt an inferior insurance instrument compared to default, irrespectively of the discount factor. This leads to higher government borrowing during booms than during recessions. Our model features proportional output costs as in Aguiar and Gopinath (2006), but the behaviour of the
loses the market power in the domestic economy and the gains from trading in the two segmented
debt markets. This lowers default incentives and fosters the use of debt. For the same reason we
obtain higher average debt levels than standard sovereign debt models. In fact, our model can be
reduced to the standard case if the government does not take advantage of the domestic financial
development.\textsuperscript{7} Hence, we show how standard sovereign debt models are able to reproduce realistic
debt levels, once financial repression in the domestic market increases the government’s willingness
to repay its debt also in the external market.

We obtain lower volatility for domestic debt over output rather than external debt over output
across the business cycle. This feature is consistent with data on the two types of debt for non-
developed economies. Interest rate spreads and trade balance are higher in recessions rather than
in booms, in line with the evidence reported by Neumeyer and Perri (2005). Even though the gov-
ernment can issue more external debt in recessions than in booms, we can still obtain countercyclical
interest rate spreads and trade balance as the standard sovereign debt models. In fact, during reces-
sions the government issues high levels of external debt and pays high risk premia for the default
risk, leading to a net-saving position with respect to the rest of the world.

We investigate the behaviour of the model around default events. Before defaulting, the output
of the economy decreases, while total debt over output increases. Interest rate spreads soar up in
the periods before the default event. After defaulting, consumption picks up faster than output.
The government is able to issue large amounts of external debt over output starting fresh, because
the cost for defaulting is high. The behaviour of external debt over output before and after default is
consistent with cross-country evidence around default events reported in Mendoza and Yue (2012).

In the second part of our paper we analyse the role of the financial development on the long-
run composition of debt. We vary the level of domestic financial development and compare the
stationary distributions. We find that economies with low levels of financial development tend to
issue mostly external debt in the long run. Higher levels of financial development coincide with a
more balanced composition of total debt. Economies with higher total debt are the ones that tend to
have mostly external debt. Thus, we obtain the third stylized fact. Looking at the data through the
lenses of our model suggests the following interpretation. The least financially developed countries
are the ones who can sustain higher total debt levels, with an unbalanced composition. It is the
level of financial development to determine the composition of debt and therefore the levels of total
debt that are sustainable. Our results follow from the fact that the endogenous cost from defaulting
is higher when the level of financial development is lower. In the empirical part of our paper
we investigate whether there is any evidence that the level of financial development is associated
with the long-run composition of debt. The results hint towards a similar relationship as the one
predicted by the model for developing countries.

The use of capital controls in our model can be welfare improving for the government, due to

\textsuperscript{7}Our model without capital controls corresponds to the first model proposed in Aguiar and Gopinath (2006), allowing
only for transitory shocks to the output process.
the lack of commitment and the domestic financial underdevelopment. We compare the welfare of the government with and without capital controls and conclude that the benefits from capital restrictions are large and decreasing in the level of financial development. This is not only due to the access to a market that can be financially repressed, but also to the access to a perfect asset market connected to it through the default risk. This result is consistent with the empirical research reviewed in Kose et al. (2010), stating that there are benefits from financial liberalization only if some level of domestic financial development has been achieved.

**Related Literature.** Our model spans different literatures. First, it is related to the papers that study why sovereign debt exists. Second, it is related to the quantitative literature on external sovereign debt and default. Third, it is related to the papers that study financial repression and capital controls.

The literature on the existence of sovereign debt has evolved in three main strands, identified by the type of consequence for default. First, direct punishment by creditors have been considered, in the form of sanctions imposed on the defaulting economy. Second, it may be that the financial markets the government faces are not perfect and they provide worse conditions after a default event. Third, the default may imply an internal cost, in the sense of affecting the behaviour and the information available to other agents in relation to the government. The papers that are closer to ours are the ones dealing with the internal cost of default. In particular, we focus on the ones that have considered the role of domestic financial development together with domestic and external government debt are Brutti (2011), Mengus (2013) and Gennaioli et al. (2014). The focus of these papers is the effect of default on domestic bondholders, once the government cares about them but cannot discriminate across creditors at the repayment stage. Our paper shows how sovereign debt can be sustained even if the government does not assign an exogenous preference to domestic bondholders. In fact, the gains from trading in the two segmented debt markets drive the government’s willingness to repay its debt. The government trades in the domestic financially repressed market and the international frictionless market, while the two markets are connected through the default risk.

Other papers that consider both types of government debt are Vasishtha (2010) and D’Erasmo and Mendoza (2014). The former paper introduces the domestic debt as an instrument to reduce the burden from distortionary taxation. The latter paper focuses on the use of default for redistributive purposes.

There is a large literature on external sovereign debt and default, started with the seminal paper by Eaton and Gersovitz (1981). The aim of their paper was to understand how poor countries can borrow internationally, even if the enforcement of the sovereign debt contract is limited. The incentive to repay the debt lies in the fear of financial autarky that follows a default. The first papers to assess the quantitative implications of this model are Aguiar and Gopinath (2006) and Arellano (2008). These papers emphasize the positive role of default in terms of insurance benefits. The punishment for defaulting consists of loss of output and temporary autarky. Other papers have

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8See Panizza et al. (2009) for a literature review on this topic.
expanded the set of possibilities for the government, but remained focused on external debt and default. Our model builds on the basic framework in the sovereign debt literature, but models explicitly the domestic side of the economy. Thus, we investigate the connection between composition of debt and default incentives. We contribute to this literature by showing how domestic debt levels are interconnected to external debt levels.

The key feature of our model is the connection between the domestic financial repression and the gains from segmenting the two debt markets. A paper that is related to ours is Gordon and Li (2003). Motivated by the restrictions in the Chinese financial market, that lead domestic interest rates below the level of international interest rates, they provide a model to rationalize the behaviour of the Chinese government. 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. Our model goes one step further, by modelling the government’s choices in a dynamic general equilibrium model, where we also account for the government’s limited commitment.

Finally, some papers have analysed the benefits of capital controls in the presence of debt repudiation risk. Jeske (2006) uses a complete markets setting to show that capital controls and centralized borrowing can attain the constrained efficient level of borrowing. Dovis (2012) uses an incomplete market setting to show that the optimal Ramsey policy for a small open economy with lack of commitment prescribes capital controls. Moreover, capital controls do not vanish over time when the government is more impatient than external investors. In our case capital controls are welfare improving for the government, because they allow the government to realize the gains from financial repression by trading in the domestic and international debt markets.

Outline. The paper continues as follows. Section 2 describes the model environment and the recursive equilibrium. Section 3 offers an intuition of the main mechanism driving default incentives and the composition of debt with a simpler version of the model. Section 4 presents the quantitative results across the business cycle. Section 5 shows how the levels of financial development determine the composition of debt and the welfare for the government. Section 6 discusses the role of the default punishment and section 7 presents the empirical analysis between the composition of debt and the level of financial development in the long run. Section 8 concludes.

2 Model

The 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 sovereign debt and

The small open economy is populated by domestic consumers and a government that provides insurance for them against endowment shocks. It does so by issuing one-period non-contingent bonds. Moreover, the small open economy is populated by domestic investors with a pro-cyclical inelastic demand for assets. There is a limited supply of private risk-free assets in the domestic market. The rest of the world is populated by external investors, who have access to the frictionless and perfectly competitive international financial market. The government is able to restrict outward capital flows between the domestic and the international asset market. Given that the domestic financial market is underdeveloped, financial repression is obtained in the the domestic market. The government is the only agent that is able to trade freely across asset markets. Both domestic and external government bonds represent an insurance instrument for the government - domestic consumers. However, domestic government bonds represent a saving instrument for domestic investors. When issuing bonds, the government can target bondholders, but cannot commit to repay. Default arises in equilibrium in our model. The loss of credit worthiness in one market implies the same loss in the other market. The government faces the same punishment for defaulting in one market or the other, hence only non-selective default is optimal in equilibrium.

We continue by describing the agents that populate the economy, the recursive equilibrium and its solution.

2.1 Agents

2.1.1 Domestic Consumers

There is a mass λ of identical, infinitely lived consumers. They are risk-averse and maximize their utility from consumption. Every period they receive an endowment that is stochastic and not storable. We consider the case where the endowment follows a Markov process.10 The domestic consumers do not have access to any financial market.11 Therefore, the only instrument the consumers can use to insure against the endowment risk is a transfer from the government. The representative consumer solves the problem

\[
\max_{\{c_t\}_{t=0}^\infty} E_0 \sum_{t=0}^\infty \beta^t u(c_t) \tag{1a}
\]

subject to

\[
c_t = y_t + \tau_t, \tag{1b}
\]

10 The Markov process for the endowment will allow us to rewrite the problem in a recursive form later on.
11 A rationale for this assumption is that their transaction costs are very high, so borrowing or lending is prohibitive for them.
where $0 < \beta < 1$ is the discount factor, $c_t$ is consumption, $y_t$ is the endowment, $\tau_t$ are the government transfers and $u(\cdot)$ is increasing and strictly concave.

2.1.2 Government

The government is assumed to be benevolent towards domestic consumers and therefore maximizes their utility. The government does not take into account the utility of the domestic investors. As the government acts as an insurance provider in our model, it cares only about the agents who are risk averse, face endowment shocks and have no instrument available to insure against them. It has access to the domestic and the external financial market to issue one-period domestic and external bonds, respectively. The government can ex-ante identify the bondholders, but cannot commit to repay the debt back to any of them. We model the lack of commitment through the strategic default choice. At any time $t$ the government observes and taxes all the endowment of the consumers $Y_t$ and decides whether to repay the debt or not. In case of repayment it can issue one-period bonds; in case of no repayment (default) it may suffer from an output loss and it is in financial autarky for a temporary period, independently of the identity of the bondholders. During the exclusion from the market the government loses its ability to impose capital controls. Hence, domestic investors can save abroad. Following the same idea as Cole and Kehoe (1998), we assume that if a government is viewed as untrustworthy in the external market, the government is viewed as untrustworthy in the domestic market as well. Due to this assumption, discriminatory default is never an optimal choice. As mentioned at the beginning, we want to identify how the initial conditions in the domestic financial market affect the choice of domestic and external issuance and therefore we do not consider any exogenous preferences for one or the other type of investors.\textsuperscript{12}

The problem of the government is

$$\max \left\{ C_t, B_{D, t+1}^D - B_{E, t+1}^E \right\} \sum_{t=0}^{\infty} \beta^t u(C_t)$$

subject to

$$C_t - q_t^D B_{D, t+1}^D - q_t^E B_{E, t+1}^E = Y_t - B_{D, t}^D - B_{E, t}^E \quad \text{if} \quad d_t = 0,$$

and

$$C_t = Y_t \quad \text{if} \quad d_t = 1,$$

\textsuperscript{12}The government in our model does not maximize the utility of the domestic investors because it represses their ability to trade in the asset market. However, in section 4 we show that default incentives are stronger when the external-to-domestic debt ratio is higher. Our model produces an endogenous priority for domestic investors over external investors. The assumption of equal exogenous default cost could be relaxed and the model could be solved with selective defaults. We would probably obtain more external than domestic defaults. However, the qualitative results would be similar. The probability of defaulting in the two markets would be highly correlated and so the prices of the two types of debt would still be highly connected.
where $B_E^t$ and $B_D^t$ are external and domestic bonds that mature in the current period and $q_{t+1}^EB_{t+1}^E$, $q_{t+1}^DB_{t+1}^D$ are the values of the new domestic and external bonds that mature the next period. Positive values of $B_E^t$ and $B_D^t$ indicate borrowing, while negative values indicate saving. The variable $d_t \in \{0, 1\}$ represents the choice of default. The possibility of default gives rise to an endogenous borrowing constraint. The government can save by buying domestic private assets through the domestic investors or external risk-free assets through the external investors. $Y_t$ and $C_t^{13}$ represent, respectively, the aggregate endowment and consumption of the domestic consumers. The difference $T_t = q_{t+1}^DB_{t+1}^D + q_{t+1}^EB_{t+1}^E - B_D^t - B_E^t$ represents the total transfer from the government to the consumers. During default the government is assumed to lose a fraction of the endowment, hence $Y_{t}^{def} = (1 - \kappa) Y_t^{14}$.

### 2.1.3 Domestic Investors

We intend to create an inelastic demand for stores of value in the domestic economy. We do it in the most convenient way. There is a mass $1 - \lambda$ of risk-neutral domestic investors who live for two periods: in the first period they are young, in the second period they are old. They receive a non-storable endowment when young and consume only when old. The endowment is stochastic and perfectly correlated with the endowment of the domestic consumers. Domestic investors and consumers face the same endowment shocks. Domestic investors have access to two types of assets: domestic private assets and one-period government bonds (in case the government issues them). Domestic private assets pay one unit of good in the following period.

In case the government has not defaulted at time $t$, the problem of the representative domestic investor is

$$\max_{c_D^t, l_{t+1}^D, b_D^t} E_t c_D^t$$

subject to

$$q_{t}^l l_{t+1} + q_{t}^D b_{t+1}^D = y_D^t$$

Following Arellano (2008), the sovereign debt literature assumes an asymmetric cost during default. The relative loss in endowment declines with the endowment and is zero for low enough levels. This asymmetry in default cost is necessary to generate high default probability and high volatility of spreads, because default incentives are higher for lower endowments. Moreover, in equilibrium government borrowing is higher for higher endowments. The asymmetric default cost generates higher debt levels, because it reduces default incentives when the government has higher endowment, which enables the government to borrow more. Without the asymmetric default cost, higher - but still not very realistic - default rates can be generated only by assuming a very impatient borrower (e.g. $\beta = 0.41$ at annual frequency in Aguiar and Gopinath (2006)). For the moment we do not assume this ad-hoc asymmetry in default cost. In section 6 we discuss the effect of the punishment structure on our results.

It is reasonable to assume that the endowments of all the agents in the small open economy are highly positively correlated.

We can obtain the total endowment of the domestic investors as $Y_{t}^{D} = \int_0^\Lambda y_t \, dt = \lambda y_t$ and $C_t = \int_0^\Lambda c_t \, dt = \lambda c_t$.
\[ c_{t+1}^{D,t} = b_{t+1}^D + l_{t+1} \quad \text{if} \quad d_{t+1} = 0, \]  
(3c)

\[ c_{t+1}^{D,t} = l_{t+1} \quad \text{if} \quad d_{t+1} = 1, \]  
(3d)

where the \( q^D_t l_{t+1} \) and \( q^D_t b_{t+1}^D \) represent the investment of the endowment in the two assets. If the government had defaulted at time \( t \), the value of \( b_{t+1}^D \) is set to zero.

### 2.1.4 External Investors

We want the external investors to act in a frictionless environment. Therefore, we model them as identical, infinitely lived, risk-neutral agents. We maintain the risk neutrality assumption that external investors can diversify all their individual risk, as in Eaton and Gersovitz (1981). 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 solves the problem

\[
\max_{\{c_t^E, z_{t+1}, b_{t+1}^E\}} \mathbb{E}_0 \sum_{t=0}^{\infty} (\beta^E)^t c_t^E
\]

subject to

\[ c_t^E + q_t^E z_{t+1} + q_t^E b_{t+1}^E = z_t + b_t^E \quad \text{if} \quad d_t = 0, \]  
(4b)

\[ c_t^E + q_t^E z_{t+1} = z_t \quad \text{if} \quad d_t = 1, \]  
(4c)

where the \( q_t^E z_{t+1} \) and \( q_t^E b_{t+1}^E \) represent the investment in the two assets.

### 2.1.5 Asset Markets

The domestic and the external asset markets are competitive. The main difference is that domestic investors have a demand for stores of value and the supply of private assets in the domestic economy is limited to a constant amount \( L \). The government influences the effective supply of risk-free assets in the domestic financial market. These features give rise to an endogenous interest rate in the domestic market. In the external market the supply of risk-free assets is as much as needed (“unlimited”). The interest rate in the external market is exogenous to the small open economy.
2.1.6 Timing

The endowment shock in the domestic economy is realized. External investors observe the realized endowment. Afterwards, the government decides whether to default or not on the amount borrowed in the previous period. If the government defaults on its debt, it is in autarky for a temporary period and loses a fraction of its endowment. Asset markets open. Domestic young investors can trade domestic private assets and external investors can trade external risk-free assets. On the other hand, if the government does not default, it has access to the assets market and chooses the amount of bonds to issue in the domestic and the external market. When asset markets open, domestic investors can trade domestic government bonds and domestic private assets. External investors can trade external government bonds and external risk-free assets. Finally, agents consume.

2.2 Recursive equilibrium

We consider the recursive equilibrium. We first write the problem in a recursive form, then we define the equilibrium. Finally, we discuss the solution. The government’s problem contains three state variables: $Y, B^E, B^D$. If the government does not default, it can trade with domestic and external investors. If the government defaults, the punishment is independent of the amount not repaid and the identity of the bondholders. Therefore, in equilibrium the government will default on the total debt or not default at all. This implies that at the beginning of the period the only variable that matters, apart from the endowment of the domestic consumers, is the total amount of debt to repay. Hence, we notice that we can simplify the recursive formulation of the problem and use only one state variable representing the total debt maturing in the current period, no matter to whom it has to be paid.\footnote{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. This spillovers effects are similar to \textit{Cole and Kehoe (1998)}.} The two state variables $B^E, B^D$ can be replaced by one, $B = B^E + B^D$. The problem is greatly simplified because the value functions for the government contain only two
state variables: $Y$ and $B$. In this way we have managed to extend the standard sovereign debt model to account for the presence of domestic and external debt, without increasing the state space of the recursive problem. The value for the government when it has the option to decide whether to default or not, $V^o$, can be written

$$V^o(Y, B) = \max \{V^{\text{def}}(Y), V^c(Y, B)\}. \quad (5)$$

The government decides whether to default or repay and trade in the asset markets with domestic and external investors. The value of defaulting $V^{\text{def}}$ is

$$V^{\text{def}}(Y) = u((1 - \kappa)Y) + \beta \mathbb{E} \left[ \theta V^o(Y', 0) + (1 - \theta)V^{\text{def}}(Y') \right]. \quad (6)$$

In case of default the government is excluded from the market for the current period and loses a portion of its endowment. From the next period it can re-enter the market with probability $\theta$ without repaying any of the past debt.\(^{18}\) The assumption that the punishment for default is independent from the type of debt is the reason why we have only one value function of default. The continuation value of trading with domestic and external investors $V^c$ is

$$V^c(Y, B) = \max_{B'^{D}, B'^E} \left\{u(Y - B + q^{D}(B', B'^{D}, Y)B'^{D} + q^{E}(B', Y)B'^{E}) + \beta \mathbb{E}V^o(Y', B')\right\}$$

subject to

$$B' = B'^{D} + B'^{E}. \quad (7)$$

The government repays the total debt, issue new domestic and external bonds and gets the continuation value for the next period. We can rewrite the value $V^c$ in a more compact form, by substituting the constraint $B'^{E} = B' - B'^{D}$ into the objective function.

$$V^c(Y, B) = \max_{B', B'^{D}} \left\{u(Y - B + q^{D}(B', B'^{D}, Y)B'^{D} + q^{E}(B', Y)(B' - B'^{D})) + \beta \mathbb{E}V^o(Y', B')\right\}. \quad (8)$$

When the government has not defaulted, the representative domestic investor solves the problem

$$V^D(Y, B', B'^{D}) = \max_{b'^{D}, l'^{D}} \{\delta(B', Y)l' + (1 - \delta(B', Y))(l' + b'^{D})\} \quad (8a)$$

subject to

$$y'^{D} = q^{D}(B', B'^{D}, Y)b'^{D} + q^{E}(B', B'^{D}, Y)l', \quad (8b)$$

\(^{18}\)The use of a random variable for the re-entrance in the market allows us to write the value of default in a recursive way. This formulation is usual in standard sovereign debt models.
where $\delta(B^D, Y)$ is the probability that the government chooses default in the following period. The young domestic investors choose the optimal allocation of their endowment in domestic government bonds, $b^D'$, and domestic private assets, $l'$. The old domestic investors consume. If the government had defaulted in the previous period, the value of $b^D'$ is set to zero.

Now we turn to the problem of the representative external investor. The continuation value from trading with a non-defaulting government is

$$V^{End}(Y, b^E, z, B') = \max_{b^E', z'} \left\{ (z + b^E - q^E(B', Y)b^E - q^E z') + \beta^E(1 - \delta(B', Y))EV^{End}(Y', b^E', z', B'(Y', B')) + \beta^E \delta(B', Y)EV^{Ed}(Y', z') \right\},$$

(9)

where $\delta(B^D, Y)$ is the probability that the government chooses to default in the following period.

The external investors decide the amount of external government bonds, $b^E'$, and external risk-free assets, $z'$, to purchase. If the government chooses not to default in the next period, they get the continuation value from trading with a non-defaulting government; otherwise, they get the continuation value from not trading with the government because of the default event. If the government defaults, the continuation value for the representative external investor is

$$V^{Ed}(Y, z) = \max_{z'} \left\{ (z - q^E z') + \beta^E EV^{End}(Y', 0, z', B'(Y', 0)) + (1 - \theta) EV^{Ed}(Y', z') \right\}.$$  

(10)

The investors only trade external risk-free assets in the current period. In the following period they can trade again with the government with probability $\theta$.

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:

$$Rep(B) = \{ Y \in \Psi : V^c(Y, B) \geq V^{def}(Y) \}. $$

(11)

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:

$$D(B) = \{ Y \in \Psi : V^{def}(Y) > V^c(Y, B) \}. $$

(12)

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. The identity of the bondholders does not affect the choice of default and therefore the default and repayment sets do not depend on $B^D$ and $B^E$.

Now we can define the endogenous default probability as the probability that, given the current
endowment and amount of bonds issued, the next period’s endowment belongs to the default set

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

(13)

Even if the government can discriminate ex-ante between the two types of debt, selective default is not optimal because the cost of defaulting is the same for any type and amount of debt. Ex-post discrimination is not optimal. This implies a unique default probability that depends only on the aggregate endowment of the consumers and the total debt to be repaid.

2.2.1 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 $V^c$, $V^{deff}$, $V^\nu$ for the government, $V^D$, $V^{End}$, $V^{Ed}$ for the domestic and external investors respectively; policy functions $B'^D$, $B'$ for the government, $b'^D$, $b^E$, $l'$, $z'$ for the investors; 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 (5) - (7).

(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 investor (8a) - (8b).

(c) Given the price functions $q^E$ and $q^z$ and the government’s policy functions, $b^E$ and $z'$ solve the maximization problem of the representative external investor (9) - (10).

(d) Bond markets clear, that is $\int_{0}^{1-\lambda} b'^D di = B'^D$ in case of domestic borrowing and $\int_{0}^{1} b'^E di = (B' - B'^D)$ in case of external borrowing. Domestic asset markets clear, that is $\int_{0}^{1-\lambda} l' di = L.$

2.3 Solution

In this model the government acts first. In case it does not default, it has to decide the amount of bonds to issue for the next period. The price of bonds depends on the amount borrowed and the government internalizes the effect of its choice. The price is taken as given by the investors. We start solving the problem of the external investors, expressed in (9) - (10). After using the Benveniste-Scheinkman Theorem, the first order condition for $b^E$ reads:

$$q^E(B', Y) = \beta^E (1 - \delta(B', Y)),$$
while the first order condition for $z'$ reads:

$$q^z = \beta^E. \quad (14)$$

Here we can see the role of the assumption of risk-neutrality: 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. We can rewrite the price of risk-free assets $z$ in terms of the interest rate they bear, $r^z$, so that the first order conditions for $z'$ is

$$\frac{1}{1 + r^z} = \beta^E. \quad (15)$$

Using the expression above, we can derive the price of the external government bonds only as function of the external risk-free interest rate and the default probability:

$$q^E(B', Y) = \frac{1 - \delta(B', Y)}{1 + r^z}. \quad (16)$$

The probability of default $\delta(B', Y)$ defines the risk premium that the government pays to the investors. The higher is 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. At equilibrium the quantity demanded and the quantity offered of government bonds are equalized, so that $\int_0^{1 - \lambda_2} b^E \, di = (B' - B'^D)$.

Now we move to the problem of the domestic investors, expressed in (8a) - (8b). We can use the no-arbitrage condition to derive the price of domestic government bonds in term of the price of the domestic private asset $l$:

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

As noted before, the price of domestic private assets is not constant, but depends on the total amount of bonds issued by the government, the amount of domestic bonds and the aggregate endowment of the consumers. Also in this case the expected return from the risky asset is equal to the return on the private asset. At equilibrium markets clear, so $\int_0^{1 - \lambda_2} b^D \, di = B'^D$ and $\int_0^{1 - \lambda_1} l' \, di = L$. We can use the aggregate version of the budget constraint of the young domestic investors (8b) to get an expression for the price of domestic private assets:

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

that becomes

$$q^l(B', B'^D, Y) = \frac{Y^D}{(1 - \delta(B', Y)) B'^D + L}. \quad (17)$$
We can rewrite the price of domestic bonds as:

\[ q^D (B', B'^D, Y) = \frac{(1 - \delta(B', Y))Y^D}{(1 - \delta(B', Y))B'^D + L}. \] (18)

The relationship between \( q^D \) and \( q^l \) is similar to the relationship between \( q^E \) and \( q^z \). The prices of domestic government bonds (18) and domestic private assets (17) coincide as long as the default probability is not strictly positive. When the default probability becomes strictly positive, the price of government bonds is lower than the price of domestic private assets because of the risk premium.

Comparing (16) and (18) we can notice that the debt issued by the government affects the price of domestic government bonds in the following ways. The common channel is due to the effect of \( B' \) on the risk premium. The government has to compensate the domestic investors with a premium for holding risky domestic government bonds. The risk premium increases with the total amount issued and affects the price of domestic bonds negatively. Given our assumption of limited supply of assets, the government is able to affect the amount of assets in the domestic asset market. This implies two other channels through which the government affects the price of domestic government bonds. On one hand, an increase in \( B'^D \), everything else equal, affects negatively the price of all the assets in the domestic economy. This happens because the government increases the amount of assets in the domestic market. The market clearing condition implies lower prices. On the other hand, an increase in risky government bonds (either \( B'^D \) or \( B'^E \)), everything else equal, affects positively the price of all the assets in the domestic economy. When the risk of government bonds increases, the portion of domestic assets that bears no risk decreases. The market clearing condition implies lower prices. This last effect is a general equilibrium effect. The risk of government bonds affects also the price of the domestic private asset because of the inelastic demand for assets from the domestic investors.\(^{19}\)

The possibility of issuing two bonds that can be defaulted upon at the same time introduces a close link between the prices of the two debt instruments. The prices \( q^D \) and \( q^E \) are connected through the default probability. As explained above, different channels can affect these prices. Formulas (16) and (18) show that without default risk the marginal value of the external debt is constant, while the marginal value of the domestic debt is decreasing in \( B'^D \). With positive default risk the marginal value of the domestic debt decreases slower if the risk is small and \( B'^D \) is large, rather than if they are both small. The different behaviour of the pricing functions is crucial to understand when the government finds it optimal to issue more domestic or more external debt.

It is worth mentioning the role of the available private assets in the domestic economy. Formulas (17) and (18) show that the parameter \( L \) affects the price of domestic private assets and domestic bonds. Everything else equal, both prices are higher, the lower is \( L \). This happens because the assets that bear no risk in the economy are few. The price adjusts through market clearing. A second

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\(^{19}\)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. However, they take this risk as given. Instead, we model the default choice endogenously and show the power of this general equilibrium effect.
important effect is on the elasticity of both prices to the amount of debt issued by the government. The more the availability of domestic private assets, the lower is the elasticity of domestic asset prices to $B'^D$ and $B'$, as long as there is no risk of default. On the other hand, the elasticity of prices to $B'^D$ and $B'$ decreases with $L$ when the risk of default is positive. This is the effect of the government’s market power.

Having described the role of the default probability on the price of government bonds, we can define the highest level of borrowing at which the default premium does not play a role. The no-default-risk borrowing limit is

$$B^{MIN} = \sup \{ B : D(B) = \emptyset \}. \quad (19)$$

This is the highest level of debt the government can attain before the default probability is strictly positive. Below this level the government bonds behave as the other assets. There exists a level of borrowing where the default event is an almost sure event and therefore the price of government bonds is reduced to zero. The no-default borrowing limit for the government is

$$B^{MAX} = \inf \{ B : D(B) = \Psi \}. \quad (20)$$

This is the highest level of debt the government can attain before the probability of default is one. These limits define the set of values of total borrowing that the government can issue only by paying a risk premium to the investors. These two limits are particularly useful when we discuss the debt Laffer curve later in our analysis. Finally, we can define the lower bound for the government’s domestic issuance. This limit arises from the constraint on the consumption of domestic investors. We define this limit:

$$B^D = -L. \quad (21)$$

We can turn to the main theoretical results. The next proposition is an extension to our model of the correlative proposition proved in the literature.\(^{21}\)

**Proposition 1.** For any given $Y$, the default set for total past debt $B^1$ is a subset of the default set for total past debt $B^2$, where $B^2 \geq B^1$.

**PROOF:**

See Appendix A.

Regardless of the composition of domestic and external debt, the value function of repaying the debt is decreasing in the amount to repay. On the other hand, the value of default is independent from the amount not repaid. If the government prefers default to repaying some specific amount, it

\(^{20}\)We can define the no-default-borrowing limit as in Zhang (1997) because our model satisfies the conditions of Proposition 1 in his paper.

\(^{21}\)For similar propositions refer to Eaton and Gersovitz (1981), Arellano (2008) and Chatterjee et al. (2007).
will prefer default to repaying any amount greater or equal than that. This ensures the monotonicity of the value of the government when it has the option to repay or not (and hence also the value of remaining in the contract) with respect to the amount of the debt to repay. The significance of the proposition is that the government always faces a trade-off when issuing domestic and external debt. The additional utility from issuing one more unit of bonds today is compared to the additional expected discounted loss in the continuation utility.\footnote{This effect cannot be seen with the use of derivatives, because our maximization problem is over a non-convex constraint set.}

Compared to the great majority of the models in the literature, our model allows the government to trade also in the domestic market. The choice of domestic and external debt for the government reflects the market conditions faced in each market. We obtain the following relationship between domestic to total debt ratio and prices of government bonds.

**Proposition 2.** Assume that $B'$ is the optimal total amount of debt given $(B, Y)$. If the government’s issuance of domestic debt is equal to $B'^D_2$, it implies that $q^D(B', B'^D_1, Y) > q^E(B', Y)$, where $B'^D_1 \in [0, B'^D_2)$.

**PROOF:** See Appendix A.

The proposition indicates that the government would never optimally choose the domestic to total debt ratio such that the unit price of domestic bonds is lower than the unit price of external bonds. Depending on the marginal effect of the issuance on domestic bond prices, the government may find it optimal to keep a positive wedge between domestic and external prices or it may find it optimal to drive them to be equal. Given our assumption that the penalty for default is the same, no matter the type of debt not repaid, the government chooses the ratio of domestic to total debt solely on the basis of the different level and elasticity of prices in domestic and external bond markets. This shows that the government has optimally decided to discriminate between domestic and external bondholders.

### 3 Understanding default incentives and issuance decisions: a special case

The aim of this section is to offer a preliminary understanding of how the default incentives are shaped and how the government makes the issuance decision in a simpler version of the model. We follow the simplifying assumptions in Arellano (2008)\footnote{See Section 2.A in the paper.} for the sake of comparison. We will show that default incentives work in a similar way, being stronger during recessions. On the other hand, the pricing functions are less elastic to the amount of debt issued when the government is risky. As explained in Aguiar and Amador (2013), 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. Our model features endogenous costs of default due to the government giving up the monopolistic role in the domestic asset market and the benefits from trading in segmented markets. Consequently, the risky borrowing region is large and allows the government to sustain more debt.

We assume i.i.d. shocks to the endowment of the consumers, permanent autarky in case of default ($\theta = 0$), no default output loss ($\kappa = 0$) and constant endowment for domestic investors ($Y_D = \tilde{Y}_D$). Due to the assumption of i.i.d. shocks, the distribution of the endowment shock for the next period does not depend on the current endowment shock. Therefore the default probability depends only on $B'$ and not on $Y$. The same holds for $q^E$: the market prices in the external market are the same for any endowment shock.

$$q^E(B') = \frac{1 - \delta(B')}{1 + r^z}.$$  

(22)

However, prices in the domestic market would still depend on $Y$ through $Y_D$. Once we assume a constant endowment for domestic investors, prices in the domestic economy depend only on $B'$ and $B'^D$:

$$q^I(B', B'^D) = \frac{Y_D}{(1 - \delta(B'))B'^D + L}.$$  

(23)

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

(24)

The default probability decreases the price of domestic and external government bonds, but the effect on the former ones is reduced. In fact, the default probability plays a dual role in the domestic market. On one hand, it represents the risk premium that the government has to pay to domestic investors with respect to the price of domestic private assets. This additional return reflects the fact that government bonds carry a default risk and decreases the price. On the other hand, the default probability decreases the amount of assets yielding a return with certainty and therefore it increases the price of domestic private assets and domestic bonds. This second effect is the endogenous leverage arising from the risky nature of government bonds and the limited supply of stores of value. Government’s decisions feed back into the price of all assets. The leverage effect is not present in the price of external government bonds, because the external asset market is frictionless.

The next two propositions are extensions of propositions proved in the aforementioned literature.

**Proposition 3.** If default is optimal for some debt level $B$, i.e. $D(B) \neq \emptyset$, there is no contract of external or domestic debt available such that the government can roll over the existing debt.
The intuition of the proposition follows from the fact that the model yields default in equilibrium. The default set is not empty when default is an optimal choice for some levels of endowment $Y$. Given our assumptions, the default probability depends only on the amount borrowed and not on the endowment level. If the government could roll over the debt for some $B$ where the default set is not empty, it means that the government would optimally choose to roll over and not to default. This would be possible for any endowment, thereby contradicting the assumption that default is optimal for some $B$ and some $Y$. Here we can see how the model differs from Cole and Kehoe (2000) and the related models that have self-fulfilling types of equilibria, where the government issues new debt to external investors before deciding whether to repay the past debt or to default. The lag between the issuance of new debt and the default decision makes the price of new debt dependent on the debt to repay as well. Multiple equilibria can arise in these settings. Some of these equilibria feature roll over of debt.

By using Proposition 3 we can show the following:

**Proposition 4.** Given total debt $B$, if the government finds it optimal to default with $Y_2$, it finds it optimal with $Y_1$, where $Y_1 \leq Y_2$.

**Proof:**

See Appendix A.

The proposition illustrates the monotonic relationship between endowment shocks and default incentives. The lower the endowment, the higher the marginal utility of consumption. The government has two ways of smoothing consumption: defaulting or issuing new debt (after repaying the past debt). Defaulting is more appealing when roll over of debt is not possible. The proposition shows that for low levels of endowment the benefits of risk sharing using government debt are outweighed by the benefits of risk sharing using the default option.

In order to understand what drives the government’s issuance decisions, we introduce the endogenous "Laffer curves". We analyse two polar cases. First, we describe the Laffer curve for the external market, conditional on no domestic debt issued. Afterwards, we describe the Laffer curve for the domestic market, assuming that no external debt is issued. Finally, we provide the intuition for how the Laffer curve looks like for all the combinations of the two debts. We start with the case of the external market and the curve is the same as in the benchmark model in Arellano (2008).[^24]

Figure 3 represents the increase in current consumption due to external borrowing on the $y$-axis and the amount of external borrowing on the $x$-axis. The value $B^*$ is the value of external borrowing that maximizes the current utility. The vertical red lines define the risky borrowing region, that is the

[^24]: There is a sign difference between our paper and Arellano (2008). Positive values of $B$ indicate borrowing instead of saving.
region where there is borrowing with positive default probabilities. We know that in equilibrium the government will never choose a level of borrowing above $B^*$ because it can attain the same level of consumption for a lower level of borrowing. In fact, here we are not representing the continuation utility from choosing $B^E$, but we know that it decreases in $B^E$. Until $B^{MIN}$ the increase in current consumption is linear in $B^E$ because the probability of default is zero. The marginal gain from borrowing is positive and constant: each additional unit of borrowing adds $\frac{1}{1+r}$ unit of consumption. After that point the curve becomes concave, due to the risk premium to be paid to external investors. In the risky borrowing region the marginal gain from additional borrowing is positive but decreasing because the default risk increases. After $B^*$ the marginal gain from borrowing becomes negative: the risk premium more than offsets the additional utility of borrowing one more unit.

Figure 4 represents the Laffer curve for the domestic market. Differently from before, the curve 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 $B^{ID}$ because the government increases the supply of assets in the economy. This determines the positive but decreasing marginal gain from borrowing. In the risky borrowing region a positive probability of default exists. As we mentioned above, the probability of default has a dual role in affecting the price of government bonds: a positive one and a negative one. The net effect on domestic bond prices is negative but it depends on the level of domestic debt issuance. Differently from the external market, the risky borrowing region can be larger if the domestic debt becomes risky at a higher level. The marginal gain from borrowing decreases more quickly because of the additional effect of the default risk. After $B^*$ the marginal gain from borrowing becomes negative: the risk premium more than offsets the additional utility of borrowing one more unit.
Figure 4: The Laffer curve for the domestic market, conditional on no external debt issued.

The Laffer curve for this model coincides with Figure 3 for $B' = B^E$ and with Figure 4 for $B' = B^D$. For any other composition of total debt the Laffer curve is a linear combination of the two. The higher is the ratio of domestic to total debt, the more concave is the curve and therefore the faster the marginal gain from borrowing decreases. We expect that the total debt arising in equilibrium is low when the domestic to total debt ratio is high. Moreover, the feature of $q^D$ predicts a higher share of domestic debt when the risk of default is lower.

On the other hand, the total amount of debt sustainable in equilibrium depends on the size of the risky borrowing region. Given the endogenous costs of default, the risky borrowing region is large. This would allow the government to issue debt especially during recessions. This result is in stark contrast with respect to the standard models of sovereign debt and default. In these types of models prices are very elastic and the risky borrowing region is eventually small, reflecting the fact that borrowing at a premium is a worse insurance alternative than defaulting. It is more difficult to issue debt during recessions, because default is a better alternative.

4 Default incentives and the composition of debt across the business cycle

Having described how default incentives and pricing functions behave in a simplified version of the model, we can turn the discussion to the quantitative importance of our model. As in the simplified version of the model, default incentives are stronger in recessions. Moreover, the ratio of domestic over external debt is procyclical. This is sustainable in equilibrium because the large amount of external debt issued in recessions can be repaid in booms through the highly valuable
domestic debt. Around default events the model features soaring interest rate spreads and a run-up in external debt over GDP. Moreover, after the default the government starts accumulating external debt again.

The endowment process is assumed to have persistence\(^ {25} \). During default there is an endowment loss and an exclusion from the financial markets for some periods, as in standard sovereign models. According to our theory of the existence of sovereign debt, these costs are reduced-form representation of the costs incurred by the government to segment again the two debt markets after defaulting. Given these more realistic features, in this section we study the default incentives and the composition of debt across the business cycle.

The model is solved through value function iteration on a discrete state space in Fortran.\(^ {26} \) We calibrate the model on yearly frequency. The endowment process of the consumers is assumed to be a log-Normal AR(1) process with zero mean, persistence \( \rho \) equal to 0.95 and standard deviation of the error, \( \sigma_y \) equal to 0.03, as in standard sovereign models. This process is discretized into a 31-state Markov chain with Tauchen-Hussey method (Tauchen and Hussey, 1991). We use 300 points for the assets grid. The parameter values are summarized in Table 1. The discount factor and the risk aversion of domestic consumers are, respectively, 0.95 and 2, as in calibrated real business cycle models\(^ {27} \). The the risk-free interest rate in the external market is 0.03, thus implying a value for \( \beta^E \) equal to 0.97. In other words, the ratio \( \beta / \beta^E \) of discounting rates is equal to 0.98. The mass of domestic consumers, \( \lambda \), is 0.33, thus implying that their average endowment is half the one of the whole domestic economy.\(^ {28} \) We assume that the probability of re-entering the market in the period following default, \( \theta \), is equal to 0.5, implying two years out of the market on average\(^ {29} \). The fraction of government output lost during default, \( \kappa \), is equal to 0.2, meaning 10 percent of total GDP. In section 6 we discuss in more detail how the punishment structure of our model affects the equilibrium outcomes. Domestic private assets \( L \), which serve as a measure of financial development, amount to 1.3, that means 13 percent of total GDP.\(^ {30} \)

\(^ {25} \)In Appendix B we discuss the numerical results when the endowment shocks are i.i.d..

\(^ {26} \)Hatchondo et al. (2010) find that interpolation techniques applied to the models described in Arellano (2008) and Aguiar and Gopinath (2006) work well. In fact, they are as precise as DSS methods with very fine grids and need much less computation time. We choose to work with a discrete state space, because there is no clear evidence that smoothness-based interpolation techniques are the best way to solve extensions of these problems, as highlighted by Chatterjee and Eyigungor (2012).

\(^ {27} \)The value used for the government’s discount factor is much higher than the values used in the literature. The implied annual discount factor in other studies varies from 0.27 in Yue (2010) to 0.82 in Arellano (2008).

\(^ {28} \)Notice that we can define the total endowment in the economy as \( Y_{tot} = Y + Y^D \). Hence, the endowment of the domestic consumers represents \( \frac{2\lambda}{1+\lambda} \) of the total endowment in the domestic economy.

\(^ {29} \)The average years of exclusion from the market vary across studies. The range varies between 1 to 5 years. We choose 2 years because the structure of the model implies that the government would like to be active in the domestic bond market. If this captures part of the empirical reality, it implies that the government will try to repair the relationship with the creditors as soon as possible.

\(^ {30} \)In section 5 we vary this parameter to describe the effect of financial development on the composition of debt.
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<th>value</th>
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Table 1: Parameter values for persistent shocks.

4.1 Policy functions

We analyse the optimal behaviour 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.

Figure 5 reports the value of the government when it has the option to default for high and low endowment levels. The value function becomes a straight line when default is the optimal choice. It is higher for higher levels of endowment, reflecting the lower default incentives. Moreover, it is higher for lower level of total debt to repay. Figure 6 shows the government’s policy function for defaulting. The policy function features a monotonic relationship with respect to the state variables. Default incentives are stronger for lower endowment shocks and higher debt to repay. 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.

In Figure 7 we plot the price of external government bonds across various amounts of total bonds issued and endowment shocks. 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 fall to zero when the probability of default is one. This decrease in price is slower, the higher is the endowment level. This happens because in equilibrium the probability of default is lower for higher endowment levels, as shown above.

Figure 8 and Figure 9 report the pricing function for domestic government bonds across two dimensions, keeping the third one fixed. As shown in Formula (18), this pricing function depends on three variables: the endowment shock, the new issuance of domestic debt and the new issuance of total debt. In Figure 8 we plot the price of domestic government bonds across different amounts of bonds and across endowment shocks, in case that only domestic debt is issued. Hence, we keep the issuance of external debt fixed to zero for simplicity. 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, the higher is the endowment level. This happens for two reasons. First, the inelastic demand for assets from domestic investors 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 leverage effect stronger. This means that an increase in risky domestic issuance with higher endowment levels does not lead to the same decrease in price as for lower endowment levels. Figure 9 helps visualizing this feature of the pricing function, because it reports the price of domestic bonds across new external debt issuance and endowment levels, 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.

Figure 10 shows the policy function for the issuance of external debt. The amount of debt issued increases with the debt to repay and is higher, the lower is the endowment level. Figure 11 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. On the other hand, the debt issued in the domestic market is higher, the higher is the endowment level. The domestic share of debt is higher, the higher the endowment level. This feature of the debt issuance across the business cycle is more clearly visible in Figure 12, where all the new debt issuances are plotted across endowment shocks, for a given repayment level of total debt.

The optimal behaviour described in the previous paragraphs comes from the fact that the two debt instruments have different features, and are both linked to the third insurance instrument, default. The domestic debt is used more in booms than in recessions, because the marginal gain from borrowing domestically in booms is higher than in recessions. The external debt is used more in recessions than in booms, because the marginal gain from borrowing externally is higher in recessions than in booms. Finally, given that the default entails endogenous costs, it allows the government to use the debt instruments more effectively. If default did not entail these costs, it would not have been possible for the government to do so.

The government chooses the optimal combination of debt in order to maximize today’s utility by maximizing the value of total debt. At the same time, the government tries to maximize tomorrow’s utility, that is decreasing in total debt to repay. The optimal composition of debt should give the highest utility today and corresponds to the lowest amount of total debt to repay tomorrow. However, given the market incompleteness, default can arise in equilibrium, as shown in Figure 6. The government needs to issue more debt in recessions to smooth endowment shocks. In our model it chooses mostly external debt, because it affects the price of external bonds less than the price of domestic bonds. Moreover, the fact that the endowment process is persistent implies that the need to issue debt tomorrow will be high as well. When we move towards the good times, the government can decumulate debt by issuing more debt in the domestic market, that is highly valued in good
times. This is sustainable because the same value of the total debt can be achieved by increasing domestic debt and decreasing external debt, leading to a lower amount of total debt. All these results imply that default incentives are stronger in recessions, while more external debt can be issued in those times. The financial autarky has become less attractive as an option to insure against endowment uncertainty. Our model jointly captures the counterintuitive finding that countries tend to default in recessions and sustain more external than domestic debt in those times.\footnote{The same features still hold when the model is solved with i.i.d. shocks to the endowment process. See Appendix B for the comparison.}

Unlike the models of external sovereign debt and default, in our model the government can issue more debt when it is needed, that means in lower endowment shocks. This feature makes the model more similar in behaviour to the incomplete market models with full commitment - \textit{à la} Huggett (1993). Even though the default is possible as an insurance instrument, there are gains from trading in the two segmented debt markets that make the default unattractive. Thus, the gains from capital controls increase the government’s willingness to repay its debt.\footnote{In Appendix \textit{D} we solve the model as a closed economy, allowing only for domestic debt and default. Default incentives are stronger in recessions and the optimal domestic debt issuance is procyclical, for a given repayment level. In the closed economy the government finds it optimal to use more debt in good times, while default is a better insurance instrument in bad times. In fact, the market power of the government implies that it affects the prices significantly with each new debt issuance. The market power does not necessarily increase the government’s willingness to repay. It does so when the government can trade in the two debt markets. This result clarifies the importance of the link between domestic debt and external debt, once default is allowed. The costs from defaulting in our model are large because of the gains from trading across the two debt markets. This fosters the use of debt as an insurance instrument in bad times, especially the external debt.}

However, the behaviour of total debt with respect to the business cycle is not monotonic. Figure 12 shows that total debt is countercyclical up to some endowment level and procyclical afterwards. This happens because default incentives become stronger and external debt is quite stable for the lowest endowment levels.\footnote{We know from the literature on sovereign debt and default that the value of the government’s discount factor plays a crucial role in determining default incentives and debt levels. Hence, we have solved our model with the same parameters as in Table 1, but with $\beta$ equal to 0.9. A lower discount factor implies higher incentives to default because the government is more impatient. This implies that the total debt is countercyclical for a smaller set of endowment levels. However, the share of domestic debt over external debt maintains the same procyclical behaviour described above.}

### 4.2 Summary statistics

Having studied the equilibrium behaviour, we can discuss the main summary statistics of the model. We simulate the model, select 400 default events and extract 100 years before the default event to report the mean statistics in Table 2 and 3.

The average external debt over GDP is higher than the average domestic debt over GDP. Moreover, the domestic debt is less volatile than the external debt. This result is connected to the properties of the pricing functions. As explained above, the domestic debt affects domestic asset prices even when the default risk is null. On the contrary, the external debt affects domestic and external bond prices only when it becomes risky. In the data on non-developed countries provided by Ugo Panizza we find that the standard deviation of domestic debt over GDP is lower than the one of the external debt over GDP. The statistics show that the domestic debt over GDP is slightly procyclical
while the external debt over GDP is strongly countercyclical. This result was anticipated in the discussion of the policy functions in the previous section. Given that the domestic debt was found to be procyclical, the domestic debt over GDP can be either procyclical or countercyclical, depending on the slope of the domestic debt over the endowment. The clear prediction from our model is that the external debt over GDP is going to be countercyclical. This is in line with the descriptive statistics from the dataset on domestic and external debt. In Appendix F we show empirically that the
external debt over GDP is countercyclical, while the domestic debt over GDP is weakly procyclical. Moreover, the share of domestic over external debt is strongly procyclical. This result coincides with the stylized fact 2 presented in Figure 1.
Figure 9: Price function for domestic bonds, conditional on a given value of domestic bonds.

Figure 10: Optimal external debt.

The average and the volatility of the interest rate spreads in the domestic and the external markets is very low. Our model shares this limitation with the standard sovereign debt models
in the literature. It is difficult to obtain high and volatile spreads with proportional default costs. The fact that the domestic interest rate spread is lower than the external one represents the lack
Table 2: Statistics on the two types of debt around default events. All values are in percentage.

<table>
<thead>
<tr>
<th>$E(B^D/Y_{tot})$</th>
<th>$E(B^E/Y_{tot})$</th>
<th>$\sigma(B^D/Y_{tot})$</th>
<th>$\sigma(B^E/Y_{tot})$</th>
<th>$\rho(B^D/Y_{tot}, Y_{tot})$</th>
<th>$\rho(B^E/Y_{tot}, Y_{tot})$</th>
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</thead>
<tbody>
<tr>
<td>13.07</td>
<td>49.37</td>
<td>0.18</td>
<td>2.12</td>
<td>0.12</td>
<td>-0.54</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Table 3: Statistics on interest rate spreads, trade balance and debt ratios around default events. All values are in percentage.

<table>
<thead>
<tr>
<th>$E(R^D)$</th>
<th>$E(R^E)$</th>
<th>$\sigma(R^D, Y)$</th>
<th>$\sigma(R^E, Y)$</th>
<th>$\rho(R^D, Y)$</th>
<th>$\rho(R^E, Y)$</th>
<th>$\rho(NX/Y, Y)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.05</td>
<td>-0.001</td>
<td>-0.45</td>
<td>-0.28</td>
</tr>
</tbody>
</table>

of saving instruments for domestic investors. This difference in interest rate spreads is reported even for the recent years in the empirical analysis by Du and Schreger (2013). They document the failure of the long-term covered interest rate parity between emerging economies and the US in the period 2005-2011. After correcting for the exchange rate risk, the spreads on local currency debt and foreign currency debt for emerging economies differ. The local currency debt carries a lower spread than the foreign currency debt, mostly because of liquidity factors.

In terms of correlation with the GDP, both spreads are negatively correlated but the magnitude is much higher for the external market. This is in line with the evidence reported by Neumeyer and Perri (2005) about countercyclical external interest rate spreads. Neumeyer and Perri (2005) report also that the trade balance for emerging economies is counter-cyclical. Our model produces a negative correlation between the trade balance and the output. This means that capital outflows are more likely during bad times. Hence, the economy cannot experience capital inflows in bad times.

4.3 Around default events

In order to understand more clearly what happens around default events, we simulate the model and consider 10 years before and 10 years after the default. One striking empirical feature is that the external debt over GDP increases before default and afterwards as well. This evidence can be found in Mendoza and Yue (2012) (Figure I, page 891). Mendoza and Yue (2012) are able to capture the behaviour before default, but they have difficulties capturing the behaviour after default (see Figure VI, page 928). Our model is able to reproduce both facts. After defaulting and re-entering the markets, the government is able to issue external debt, because domestic debt is highly valuable, making the cost of defaulting very high. When the pre-default levels are reached, the external debt over GDP stabilizes.
Figure 13: Behaviour of GDP, consumption, external debt over GDP and domestic debt over GDP before and after default. The year 0 is the default period. Given the parameter values, the government is excluded from the market on average for 2 years. The average GDP is equal to 10.

Figure 14: Behaviour of total debt over GDP, trade balance over GDP and interest rate spreads in both markets before and after default. The year 0 is the default period. Given the parameter values, the government is excluded from the market on average for 2 years.
The behaviour of GDP, consumption, external debt over GDP and domestic debt over GDP is reported in Figure 13. Output starts falling some periods before the default event. The model not only produces stronger default incentives in recessions, but defaults happen in deep recessions, because the endogenous default cost makes the government more willing to maintain access to the market and use debt for insurance purposes. Consumption follows the same behaviour of output before defaults but picks up much faster than output afterwards. This happens because of the insurance benefits of issuing debt after the re-entrance in the market. There is a run-up in external debt over GDP before the default, while domestic debt over GDP does not vary significantly. When the government re-enters the market, the share of external debt over GDP soars to reach the pre-default levels. This behaviour reflects the strong countercyclicality of external debt over GDP predicted by the model. Domestic debt over GDP picks up after the re-entrance but then decreases to pre-default levels. We are cautious about the behaviour of domestic debt over GDP after default, because we have shown in the previous section that the model predicts the procyclicality of the domestic debt. This implies that domestic debt over GDP can be procyclical or countercyclical.

Figure 14 reports the behaviour of total debt over GDP, trade balance over GDP and interest rate spreads. Total debt over GDP behaves according to external debt over GDP, because the share of domestic debt is small. The trade balance over GDP is slightly increasing before default, implying that the government’s net savings with respect to the rest of the world increase. This reflects the fact that the debt issuance is increasing before default, but its value is decreased by the default risk premium. After default the trade balance over GDP becomes significantly negative because the government increases the external debt issuance at no risk. After four years the trade deficit decreases, because default costs are reduced, leading to a positive risk premium on the debt. Finally, interest rate spreads soar up in the periods directly before the default event, but with different magnitude.

5 Financial development: composition of debt and welfare

One of the key assumptions of our model is that the small open economy is financially underdeveloped. Acknowledging that every economy is characterized by a different level of financial development, it is of great interest to study how the degree of financial development determines the composition of debt and default incentives. The degree of financial development is regulated in our model by the parameter $L$. Therefore, we solve and simulate the model for different values of $L$ to capture different economies. We find that economies with low levels of financial development tend to have higher external-to-domestic debt ratios on average and incur high costs for defaulting. On the other hand, economies with higher levels of financial development tend to have lower external-to-domestic debt ratios on average, accompanied by lower costs from defaulting.

This implies that economies with low financial development can sustain high debt levels, mostly in the external market. Our model shows that the domestic financial development can help explain what levels of total debt are sustainable, because the government can benefit from the financial
repression of the domestic market. Hence, we provide a rationale for the relationship between total debt and its composition that is observed in the data of non-developed economies (see Figure 2).

Our model can be reduced to the standard sovereign model, if the government does not segment the debt market through capital restrictions. Comparing the average debt levels obtained with and without capital restrictions, we show that high debt levels, especially in the external market, can be obtained with segmented debt markets. Hence, the standard sovereign debt model is able to reproduce realistic debt levels with the government trading in segmented debt markets.

Finally, we study the welfare of the government. Given the lack of commitment from the side of the government, there can be a welfare improvement from the adoption of capital controls. In our model, the government can impose and does impose capital controls if it decides to repay the previous debt. We compare the welfare of the government with and without capital controls. The results show large gains for the government from the adoption of capital controls, as long as financial development is not really high. The government can benefit from domestic financial underdevelopment, as long as it imposes capital controls. Moreover, we find that the welfare decreases in the level of financial development. This result comes at no surprise since the government’s monopoly power decreases in $L$.

### 5.1 Financial development and the composition of debt

Before discussing the results of the different simulations, it is important to focus on the role of $L$ for the domestic pricing function. In fact, the amount of domestic private assets regulate the elasticity of the domestic pricing functions to the level of domestic debt issued and its riskiness.

The price of domestic bonds decreases with $L$, because the price of domestic private assets decreases with $L$. Moreover, the market power of the government decreases with $L$. This is reflected in the elasticity of $q^D$ to $B^D$ and $B'$. Figure 15 plots the pricing function for domestic bonds for two values of $L$, by keeping the amount of external bonds and the endowment level fixed. The elasticity of the price to $B^D$ decreases with $L$, as long as the bonds are not risky. This is due to the decreasing weight of government bonds with respect to the total domestic assets. However, the elasticity of the price to $B^D$ increases with $L$, as long as the bonds are risky. The endogenous leverage effect of the default risk on $q^D$ decreases with $L$. This feature can be seen more clearly in Figure 16, that reports the pricing function for domestic bonds for two values of $L$, by keeping the amount of domestic bonds and the endowment level fixed. Hence, the figure shows the elasticity of $q^D$ to $B^{E}$, that is only due to the change in the default risk. For higher values of $L$ the price of domestic bonds decreases faster with an increase in risk. The marginal gain from borrowing in the domestic market decreases slowly for larger amounts of domestic private assets only if the government is not risky.

Now we present the results of the simulations of the model for different values of the parameter $L$. Table 4 reports the statistics on the cyclicality of the two debts and their share. As expected from the model’s policy functions, the cyclicality of domestic debt over GDP varies with the level of $L$.

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34When we vary the parameter $L$, we focus the analysis on a range of values that is relevant.
Figure 15: Price function for domestic bonds for different values of $L$, conditional on no external bonds issued and a given endowment level. Vertical lines represent the bond level where the risk of default is strictly positive.

Figure 16: Price function for domestic bonds for different values of $L$, conditional on a given value of domestic bonds and endowment level. Vertical lines represent the bond level where the risk of default is strictly positive.

financial development. Weak procyclicality corresponds to very low levels of financial development, while strong procyclicality is associated with higher levels of financial development. On the other hand, the external debt over GDP is strongly countercyclical for any value of $L$. As a consequence, the ratio of domestic debt over external debt is strongly procyclical. For all values of financial development considered, the model reproduces the stylized fact 2 in Figure 1: procyclical domestic-to-external debt ratio.

Figure 17 shows one of the main results of our analysis. The average equilibrium debt levels
exhibit a non-monotonic behaviour with respect to the level of domestic financial development. For very low levels of financial development the government is able to issue large amounts of external debt and smaller amounts of domestic debt. For intermediate levels of financial development the domestic share of debt is higher. Finally, the share of domestic debt decreases for more financially developed economies. To understand this behaviour it is important to analyse the equilibrium prices corresponding to the different levels of $L$. Figure 18 reports the average prices of domestic and external government debt. The government finds it optimal to close the gap between the two prices, the higher is the level of domestic financial development. When the domestic economy has few domestic private assets the government has a large market power, affecting the prices considerably. Hence, it does not find it optimal to issue domestic debt to the level that closes the gap between the two markets. Evidence of a positive gap between international and domestic interest rates on government debt of developing countries is reported by Guidotti and Kumar (1991), Giovannini and de Melo (1993) and Gordon and Li (2003).

The government’s market power is very high when the domestic economy is characterized by severe financial underdevelopment. The government benefits greatly from domestic investors’ demand for saving instruments. This implies very high endogenous costs for defaulting and thus a large risky borrowing region. When the government needs debt in bad times, it issues mostly external bonds. When times are better, the government decreases the debt issuance. In good times it relies more on the domestic market, because of the higher value of the domestic debt. As explained before, domestic asset prices are high but very elastic to domestic debt levels, as long as the government is not risky. High debt levels are sustainable in equilibrium, because the value of domestic debt is very high, thus making the option to repay and continue issuing debt in the future highly valuable. In these cases the endogenous borrowing constraint binds less often. On average the government finds it optimal to issue more external debt than domestic debt.

Moderate levels of $L$ imply lower market power for the government. The commitment technology represented by the ability to impose capital controls is less strong, making the risky borrowing region smaller. The debt levels that are sustainable have to be lower with respect to the previous

<table>
<thead>
<tr>
<th>$L/\overline{Y}^{tot}$</th>
<th>$ρ(B^D/\overline{Y}^{tot}, \overline{Y}^{tot})$</th>
<th>$ρ(B^E/\overline{Y}^{tot}, \overline{Y}^{tot})$</th>
<th>$ρ(B^D/B^E, \overline{Y}^{tot})$</th>
</tr>
</thead>
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<tr>
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<td>0.04</td>
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<td>0.64</td>
</tr>
<tr>
<td>13</td>
<td>0.12</td>
<td>-0.54</td>
<td>0.59</td>
</tr>
<tr>
<td>21</td>
<td>0.90</td>
<td>-0.50</td>
<td>0.81</td>
</tr>
<tr>
<td>29</td>
<td>0.97</td>
<td>-0.78</td>
<td>0.93</td>
</tr>
<tr>
<td>37</td>
<td>0.98</td>
<td>-0.86</td>
<td>0.94</td>
</tr>
<tr>
<td>45</td>
<td>0.98</td>
<td>-0.88</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Table 4: Statistics on the two types of debt around the default events for different values of $L$. All values are in percentage.
Table 5: Average debt and default probabilities for different values of $L$, percentage values.

<table>
<thead>
<tr>
<th>$L/Y_{tot}^l$</th>
<th>$E(B^D/Y_{tot}^l)$</th>
<th>$E(B^E/Y_{tot}^l)$</th>
<th>$E(B^{tot}/Y_{tot}^l)$</th>
<th>$P(def)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>11.09</td>
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<td>117.97</td>
<td>0.01</td>
</tr>
<tr>
<td>13</td>
<td>13.06</td>
<td>49.00</td>
<td>62.06</td>
<td>0.02</td>
</tr>
<tr>
<td>21</td>
<td>12.01</td>
<td>28.48</td>
<td>40.49</td>
<td>0.02</td>
</tr>
<tr>
<td>29</td>
<td>9.76</td>
<td>20.52</td>
<td>30.28</td>
<td>0.02</td>
</tr>
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<td>37</td>
<td>6.80</td>
<td>19.05</td>
<td>25.85</td>
<td>0.02</td>
</tr>
<tr>
<td>45</td>
<td>3.37</td>
<td>21.00</td>
<td>24.37</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 6: Average debt and default probabilities without capital restrictions, percentage values.

<table>
<thead>
<tr>
<th>$E(B^{tot}/Y_{tot}^l)$</th>
<th>$P(def)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.2</td>
<td>0.01</td>
</tr>
</tbody>
</table>

region. In fact, domestic government bonds are less valuable. Moreover, if the government issues large amounts of external debt and becomes risky, this risk has a direct effect on domestic asset prices. The value of domestic bonds decreases fast when the government becomes risky. As shown before, domestic asset prices are more elastic to risky government bonds for higher levels of $L$. The endogenous borrowing constraint binds more often and this is the region where we observe more defaults. This limits the optimal amount of external debt that the government wants to issue. Hence, the average share of domestic debt over total debt is higher.

Economies with higher levels of financial development are characterized by lower domestic asset prices. This implies that issuing debt in the domestic market is not as valuable as before. Actually, for some part of the state space prices it can be so low that saving in the domestic market may be a better choice. The total debt that is sustainable in equilibrium is higher than in the previous region because the government highly values the possibility of being allowed to trade in the domestic and external markets. Hence, the government finds it optimal to issue more external than domestic debt.

Figure 17 highlights also a quantitative feature of our model. External debt levels reach values between 19 percent and 107 percent. Total debt levels vary between 24 and 117 percent. Our model is able to produce high levels of debt with standard parameter values. In order to compare these values with standard sovereign debt models, we carry out the following exercise. We solve our model assuming that no capital restrictions are in place, hence domestic investors can freely trade abroad and the government does not segment the debt market. The model without capital controls coincides with a standard sovereign debt model with proportional endowment costs for defaulting, comparable to Aguiar and Gopinath (2006). The prices of the two debts coincide, hence we cannot distinguish the two debt issuances. Table 5 and 6 report the results of average debt and default probabilities. The results of model without capital restrictions correspond to the lower bound of the results obtained with capital restrictions. In particular, total debt over GDP can be up to five times
higher in the case of capital restrictions. The use of capital controls allows the government to benefit from the domestic need for saving instruments. At the same time, the default probability, although low in all cases, can double with capital controls.

Therefore, by enriching the standard sovereign debt model with the domestic financial market and allowing for financial repression, we have improved its performance in terms of average debt levels. The gains from imposing capital controls represent a commitment technology for the government.  

Figure 17: Average domestic and external government debt over GDP for different values of $L$, percentage values. Bars represent the share of domestic debt.

Figure 19 reports the relationship between domestic and external debt over GDP with respect to total debt over GDP. We report the levels of debt obtained before by varying the level of financial development. The plot obtained with the simulated data closely resembles the empirical regularity of the third stylized fact, reported in Figure 2. Our model is able to reproduce the pattern observed in the data for different countries across the years in terms of domestic and external debt ratios. When total debt is low, the composition of debt is quite balanced. This corresponds to the case where the domestic financial development is intermediate. When total debt is high, the share of domestic debt is negligible. This corresponds to severe financial underdevelopment. Economies with poor financial development are able to sustain high total debt because the government gains

\[35\]The high levels of debt that we obtain are not only related to the inelastic demand for assets from the domestic investors, but to the government’s increased willingness to repay its debt. This is more clear from the solution of the model as a closed economy with only domestic debt, reported in Appendix D. By using the same parameter values as in the main part of the paper and varying the parameter $L$, we obtain at most an average domestic debt over GDP equal to 13 percent. In fact, the government affects the prices in the domestic market, reducing the optimal level of domestic debt issued.

40
substantially from imposing capital controls and default is less tempting. At the same time, the effect of issuance on prices gives higher incentive for external debt issuance rather than domestic debt issuance.

Hence, our model offers a new view on the role of the financial development to explain the levels of total debt that are sustainable. Economies with low level of financial development can sustain
Table 7: Welfare of the government for different values of L.

<table>
<thead>
<tr>
<th>$L/\overline{Y}^{tot}$</th>
<th>Cert. equiv. cons.</th>
<th>$\frac{\sigma(C)}{\sigma(Y)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7.44</td>
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<tr>
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<td>5.09</td>
<td>1.16</td>
</tr>
<tr>
<td>45</td>
<td>5.00</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Table 8: Welfare of the government without capital controls.

<table>
<thead>
<tr>
<th>Cert. equiv. cons.</th>
<th>$\frac{\sigma(C)}{\sigma(Y)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.97</td>
<td>1.02</td>
</tr>
</tbody>
</table>

high debt, because the government benefits significantly from trading in the two segmented debt markets.

5.2 Welfare analysis for the government

We conduct a welfare analysis for the government. Following Chatterjee and Eyigungor (2012), we compute the average utility of domestic consumers in the stationary distribution, assuming no initial debt and using the invariant distribution of the Markov chain for the endowment process. We repeat the calculation for different values of $L$. In Table 7 and 8 we report the value of the certainty equivalent consumption for the case with and without capital controls, respectively.\textsuperscript{36}

For all the values of $L$ considered, the government gains\textsuperscript{37} from imposing capital controls. This also coincides with the possibility of sustaining higher levels of total debt in equilibrium. The welfare of the government is higher when the financial underdevelopment is severe and the market power for the government is more sizeable. The highest welfare is achieved with high levels of external debt and high share of external-to-domestic debt. The compensation in consumption that should be given to domestic consumers to move from a world with $L$ equal to 5 percent of average GDP to a world with $L$ equal to 45 percent of average GDP is 32 percent of their final consumption equivalent. Moreover, the relative volatility of consumption with respect to GDP decreases in $L$, but it is always above 1. In fact, Durdu et al. (2013) report that the average relative volatility of consumption with respect to output for a set of developing countries is 1.32, in contrast to 0.97 for more developed economies.

\textsuperscript{36}The certainty equivalent consumption is $c$ such that: $c^{\frac{\beta}{\beta-1}} = \sum V^*(Y, 0)\Pi(Y)$.

\textsuperscript{37}Giovannini and de Melo (1993) have undertaken an empirical investigation to calculate the gains from financial repressions for a set of emerging economies between 1974 and 1987. They found an average gain of 2 percent of GDP for the countries considered.
6 The role of the default punishment

In this section we discuss the role of the exogenous default punishment. First, we show that the gains from capital controls can be so high for the government that external debt is sustainable in equilibrium even without punishment. In the spirit of Bulow and Rogoff (1989), we consider the case when the government’s punishment for defaulting is to be excluded from borrowing and only allowed to save in future periods. For very low levels of financial development, external debt can be sustained in equilibrium. Second, we show how the model behaves when we vary the size of the proportional endowment loss that the government faces after defaulting. Third, we explain how the equilibrium behaviour of the model is affected when we adopt the type of asymmetric default cost as in Arellano (2008).

6.1 Only savings after default

In their seminal paper, Bulow and Rogoff (1989) prove that the international government debt cannot be sustained in equilibrium with reputation mechanisms if the defaulting government has access to cash-in-advance contracts after defaulting. Many papers have studied the conditions under which such argument does not hold. One of these studies is Cole and Kehoe (1998), where the spillovers from reputation losses are considered. If default entails damaging the government’s relationship not only with its international creditors, but also with its workers, external debt can be sustained in equilibrium. This possibility was already mentioned in Bulow and Rogoff (1989). Another strand of the literature has analysed how internal costs of default can sustain external debt, even in the absence of default punishment. One of these studies is Mengus (2014), who shows that the existence of domestic unbacked government debt allows the existence of external debt. Finally, Hellwig and Lorenzoni (2009) consider a framework with multilateral lack of commitment, where the international interest rate is not fixed. External debt can be sustained if the international rate adjusts to such low levels (negative) that a bubble in international markets can emerge.

In our model default entails spillover effects across lending relationships, due to the correlation of the exogenous default punishments. If the government defaults on one type of bondholder, it finds it optimal to default on other type as well. Moreover, the government loses access to the market where it can impose capital controls. We obtain external debt in equilibrium even if the government is prohibited from borrowing, but not from saving, in all the periods after defaulting. This happens when the financial underdevelopment of the domestic economy is really low, thus making the gains from financial repression sizeable. This result implies that international lending can be sustained even without default punishment and positive international interest rates, as long as the government imposes capital controls to realize large gains from the two segmented debt markets.
6.2 The size of proportional default costs

So far we have considered proportional output costs for the government during the default and autarky periods. Proportional default costs act as a strong punishment in low endowment states, due to the effect on the marginal utility. Given that default incentives are stronger in low endowment states, higher proportional costs make the value from defaulting unattractive and thus the government debt a better insurance instrument. In our case the external debt is countercyclical, so this mechanism implies higher external debt in equilibrium. The importance of proportional endowment costs is more relevant for intermediate levels of financial development, because the endogenous borrowing constraint binds more often. In the unrealistic case of the absence of proportional output costs the external debt can be lower than the domestic debt in that region. In the case of low financial development the debt that is sustained in equilibrium is almost unaffected.

6.3 Asymmetric default output costs

After Arellano (2008) most of the sovereign debt literature has used an asymmetric output cost for the default period in order to align the statistics on default probability and interest rate spreads with the data, without assuming a very impatient government.

\[
\gamma^{\text{def}} = \begin{cases} 
\gamma E(Y) & \text{if } Y > \gamma E(Y), \\
Y & \text{if } Y \leq \gamma E(Y).
\end{cases}
\]  

The cost function, represented in Formula (25), penalizes booms more than recessions. Given that default incentives are stronger in recessions, the asymmetric default cost favours default events. Moreover, it reduces the insurance role of debt in recessions. More default events imply higher probability of default and interest rate spreads in the simulated data. Chatterjee and Eyigungor (2012) mention that the asymmetric default cost generates more volatile spreads because it increases the sensitivity of the default output cost to the endowment shock. Moreover, a very patient government would like to borrow more in recessions, but the higher default incentives do not allow debt as an instrument for intertemporal consumption smoothing. Hence, average debt levels are low.

Our model features a greater role of debt as insurance instrument. The asymmetric default cost penalizes debt in favour of default during recessions, because it reduces the cost of defaulting. For realistic values of the government’s discount factor this still implies more borrowing in recessions than in booms, but at much lower levels. For this reason we consider proportional default output costs more relevant for our model.

However, for the sake of completeness we solve the model using the same parameter values as in Table 1, except for the parameter \( \kappa \) that is not used and replaced with the parameter \( \gamma \). We fix \( \gamma = 0.8 \), that means that only endowment states above the 80 percent of the average are penalized during default and autarky periods. The policy functions reflect the asymmetry introduced in the model with respect to the endowment levels (see Figure C.1, C.2, C.3 and C.4 in Appendix C). For low endowment states default incentives are really strong and the debt that
can be sustained in equilibrium is very limited. On the other hand, default incentives are weaker for high endowment states, increasing the debt sustainability. The default cost has magnified the difference in the behaviour across the business cycle.

The variability and countercyclicality of the spreads is increased. The trade balance is still counter-cyclical (see Table C.1 in Appendix C). The average levels of domestic debt are almost the same compared to the case of proportional output costs. The average levels of external debt are lower. Default incentives are now even stronger in bad states and external debt is mostly issued in bad states. This explains the lower average levels of external debt. As expected, the probability of default has increased, in some cases more than ten times (see Table C.2 in Appendix C).

7 Empirical analysis

We conduct a cross-country empirical analysis to compare the predictions of our model with the data. We use the dataset constructed by Ugo Panizza. It contains data on domestic and external government debt over GDP for 123 countries for the period 1970 - 2010. Debt is distinguished between domestic and external according to the place where it is issued and the legislation under which it is issued. As a proxy for the level of domestic financial development $L$ we use data on domestic credit to private sector over GDP from the Financial Development and Structure Dataset, described in Beck et al. (2009) and Čihák et al. (2012). This variable refers to financial resources, such as through loans, purchases of nonequity securities, trade credits and other accounts receivable, that establish a claim for repayment, provided to the private sector. It is a measure of the depth of the financial system. In our model the parameter $L$ represents the amount of claims, excluding government bonds, that the economy is able to produce. Hence, we consider the domestic credit to private sector a good measure. As a robustness check, in Appendix F we repeat our analysis with two other measures of the depth of the financial system, provided in the same dataset.

There are other papers in the literature that have considered the relationship between the composition of government debt and the level of financial development. The study by Forslund et al. (2011) is closer to ours in terms of government debt data, because they use the original dataset by Panizza (2008). They study the correlation between country characteristics and the share of domestic-to-total debt in non-developed countries. As a proxy for the size of the financial system they use M2 over GDP. They find that there can be a positive relationship between the ratio of M2 over GDP and the domestic debt share. Guscina and Jeanne (2006) and Guscina (2008) use a smaller dataset (constructed in a similar way as the one by Panizza (2008)), that comprises 19 developing countries. Guscina and Jeanne (2006) find a positive correlation between the average share of domestic debt over total debt and the average level of financial development. Guscina (2008) extends the analysis with a static panel approach with fixed country effects, using various measures

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38We use the updated version of his dataset, described in Panizza (2008).
39We prefer to use measures of domestic credit to private sector because they better represent the ability of financial intermediaries to provide savings instruments. Instead, measures of monetary aggregates represent which levels of transaction services are provided by the financial system, including the central bank.
of financial development. The only variable delivering significant and robust results is the measure of domestic credit to private sector over GDP.\textsuperscript{40} The results point towards a negative correlation between the domestic share of total debt and the level of domestic credit.

We conduct a cross-section analysis and a panel data analysis, using the Autoregressive Distributed Lag (ARDL) methodology. We find a positive and significant long-term relationship between the domestic share of total debt and the domestic credit to private sector over GDP.

7.1 Cross-section analysis

We conduct a cross-section analysis, by averaging the variables across time. Hence, our unit of observation is the country. We fit the best polynomial\textsuperscript{41} for the relationship between average domestic and external debt over GDP and average credit over GDP. The results are reported in Figure 20. The picture closely resembles the results obtained with our model by varying the availability of private assets in the domestic economy, as shown in Figure 17. Given the apparent similarities, we conduct a more in-depth analysis, focusing on the positive relationship between the ratio of domestic debt over total debt and financial development.\textsuperscript{42}

In order to take into account the possibility of reverse causality from the domestic-to-total debt ratio to the credit over GDP, we proceed with an instrumental-variable regression. As instrument for credit we use the creditors right index computed by Djankov et al. (2007), extending the methodology by La Porta et al. (1998). This indicator is found to be a good predictor of credit market development, but the data are limited to the period 1978 - 2003. Hence, we run the instrumental variable regression on a reduced dataset, consisting of 92 countries. Moreover, we use the average inflation rate and the average log GDP as controls. The former variable can account for a channel related to the currency composition of government debt, while the latter one accounts for the size of the economy. The results are reported in Table 9 and confirm a significant positive relationship between the average credit over GDP and the average domestic-to-total debt ratio.\textsuperscript{43}

7.2 Panel data analysis

In the previous section we have discarded the time dimension and worked with averages across countries. Now we consider the time dimension as well. Our dataset comprises a long time period and many countries. In fact, the time dimension is so large that standard panel data techniques are not well suited. Moreover, it is standard to assume homogeneity across countries, except for a fixed effect. In our analysis we allow for heterogeneity across countries beyond the fixed effect and we distinguish between short-term dynamics and long-term dynamics. This distinction is crucial,

\textsuperscript{40}This variable is used for our robustness check in Appendix F.
\textsuperscript{41}The best polynomial is selected on the basis of the Information Criteria.
\textsuperscript{42}Our model predicts that this ratio increases with the level of financial development and then starts decreasing after some threshold. Figure 20 show that we do not have many observations for the last part of the figure, so we focus on the initial positive relationship between domestic-to-total debt ratio and the level of financial development.
\textsuperscript{43}In Appendix F we run the same regression with other two measures of credit to the private sector. The results are qualitatively the same.
because there can be short-term effects from credit to the composition of debt. For example, credit to GDP may crowd in or crowd out domestic debt in the short-run. However, in the long run the level of credit is related to some institutional features of a country that are stable across time and may have a different effect on the long-run composition of sovereign debt. We use the Autoregressive Distributed Lag (ARDL) model, because it allows us to identify short-term and long-term effects by including lags of dependent and independent variables.\textsuperscript{44} We consider the domestic-to-total debt ratio as dependent variable and the domestic credit over GDP as independent variable. The ARDL methodology has been shown to be valid regardless of whether the regressors are exogenous or endogenous and irrespective of whether the variables are integrated of order zero or one.\textsuperscript{45}

The ARDL model can be written in the following way.

\begin{equation}
y_{i,t} = \alpha_i + \sum_{j=1}^{p} \beta_{i,j} y_{i,t-j} + \sum_{j=0}^{q} \gamma_{i,j} x_{i,t-j} + \epsilon_{i,t}. \tag{26}
\end{equation}

It can be rewritten in error correction form to highlight the long-term relationship and the short-

\textsuperscript{44}This analysis is not a direct test of our model. However, if the data suggest the existence of a positive long-term relationship between the composition of government debt and the level of financial development, we can argue that the data do not reject our results.

\textsuperscript{45}This has been shown in Pesaran and Smith (1995), Pesaran (1997) and Pesaran and Shin (1998).
Table 9: Average credit and average domestic-over-total debt ratio.

<table>
<thead>
<tr>
<th>DEPENDENT VARIABLE</th>
<th>Av Dom/Total Debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>VARIABLES</td>
<td>IV</td>
</tr>
<tr>
<td>av credit</td>
<td>0.880**</td>
</tr>
<tr>
<td></td>
<td>(0.438)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0254</td>
</tr>
<tr>
<td></td>
<td>(0.0768)</td>
</tr>
<tr>
<td>Observations</td>
<td>92</td>
</tr>
</tbody>
</table>

The dependent variable measures the average ratio of domestic debt over total debt. The independent variable measures the average domestic credit to private sector over GDP. It is instrumented with the creditor rights index. The data cover the period 1970 - 2010. Additional controls used are inflation and log GDP. We use robust standard errors (in parenthesis).

*** p < 0.01, ** p < 0.05, * p < 0.1.

dependent variable adjustment to that.

\[
\Delta y_{i,t} = \alpha_i + \phi_i (y_{i,t-1} - \theta_i x_{i,t}) + \sum_{j=1}^{p-1} \beta_{i,j} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \gamma_{i,j} \Delta x_{i,t-j} + \epsilon_{i,t},
\]

where \( \theta_i = \frac{\sum_{j=0}^{q-1} \gamma_{i,j}}{1 - \sum_{j=1}^{p} \beta_{i,j}} \) and \( \phi_i = -(1 - \sum_{j=1}^{p} \beta_{i,j}) \). The term \((y_{i,t-1} - \theta_i x_{i,t})\) is the error correction term, representing the long-run relationship and \( \phi_i \) is the short-run adjustment to the long-term relationship. We allow for heterogeneity in the fixed effects and the short-term dynamics, but we study the case of a homogeneous long-term relationship. Hence, we assume that \( \theta_i = \theta \), while the short-term coefficients represent averages across countries. In fact, the reduce time length implies too few degrees of freedom for allowing heterogeneity also in the long-term relationship. The estimator we use is called Pooled Mean Group estimator and has been developed by Pesaran et al. (1999).46 We use a balanced dataset and therefore we have to reduce the size of our sample to 51 countries for the period 1980 - 2008.

The results for the specifications with 2 and 3 lags are reported in Table 10. The long-term relationship between financial development and the domestic-to-total debt share is positive and strongly significant. The coefficient in front of the error-correction term is negative and strongly significant, thus supporting the existence of a long-run relationship.47 The speed of adjustment to the long-run relationship is low. These results confirm the importance of distinguishing between short and long-term effects. According to our analysis, the negative correlation found in Guscina

46 We also run the Hausman test to verify the efficiency of this estimator with respect to an estimator that allows for all types of heterogeneity (called Mean Group estimator) or only intercept heterogeneity (called Dynamic Fixed Effects model).

47 In Appendix F we run the same regression with other two measures of credit to the private sector. The results are qualitatively the same.
may be due to that fact that short and long-term effects have not been distinguished.

8 Conclusion

We have provided a new mechanism to explain the existence of sovereign debt in the presence of limited commitment to repay. Our observation is that in developing countries the domestic economy is often financially underdeveloped. 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. As we have shown, this mechanism increases the government’s willingness to repay its debt and makes default inferior to government debt as an insurance instrument to smooth income fluctuations. Our theory is quantitatively relevant, as it is able to reproduce realistic debt levels and the empirically observed composition of debt in developing countries.

The government can sustain higher external to domestic debt ratios during recessions, when default incentives are higher. Regarding the behaviour around default events, we obtain an increase of external debt over output before the default event. After the government regains access to the markets, there is a rapid build up of external debt over output. This leads consumption to reach pre-default levels earlier than output.

In the second part of the paper we show that the domestic financial development determines the long-run composition of debt. In economies with low financial development the government issues more external than domestic debt. The benefits from trading in two segmented debt markets connected through the default risk are high, making default very costly. For higher levels of financial development default costs are lower. This makes default more attractive as an insurance instrument and leads to a more balanced composition of debt. All in all, we obtain that the less developed economies tend to have higher total debt ratios with more unbalanced composition and lower incentives to default. The level of domestic financial development is a crucial element to determine the levels and compositions of debt that countries can sustain. We conduct an empirical analysis to investigate whether the long run composition of debt is associated with the level of financial development. Our results hint towards a similar relationship in the data as the one found in the model.

When we study the welfare of the government in economies with or without capital controls, we find that the difference in welfare is positive and decreasing in the level of financial development. In general, this highlights that in the presence of underdeveloped financial institutions and lack of commitment from the side of the government, unconventional tools, such as capital controls, can be welfare improving for the government. Our model provides a reason why developing countries seem reluctant to fully liberalize their financial market. For low levels of financial development there are large welfare gains for the government from restricting outward capital flows. These gains come from the domestic financial repression and its consequences in the government’s credibility in the international financial market. Hence, improving domestic financial institutions can be the way
Table 10: Credit and domestic-over-total debt ratio.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>ARDL</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>error-corr</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>D.credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LD.domratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LD.credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2D.domratio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2D.credit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>1,377</td>
<td>1,326</td>
</tr>
<tr>
<td>Countries</td>
<td></td>
<td>51</td>
<td>51</td>
</tr>
</tbody>
</table>

The dependent variable measures the ratio of domestic debt over total debt. The independent variable measures the domestic credit to private sector over GDP. The balanced panel covers the period 1980 - 2008. We estimate the Autoregressive Distributed Lag (ARDL) model with 2 and 3 lags with the Pooled Mean Group estimator, allowing for heterogeneity in the fixed effects and the short-term dynamics, but we study the case of a homogeneous long-term relationship. We use robust standard errors (in parenthesis).

*** p<0.01, ** p<0.05, * p<0.1.
to incentivize these countries to abandon capital restrictions.

There are some interesting extensions of the model that we would like to consider for our future research. First, an extension to a production economy would allow us to consider the role of investment. In this way we could account for the trade-off faced by the government when imposing capital restrictions. On one hand, encouraging foreign investment implies higher output and wages for the economy. On the other hand, encouraging foreign investment hinders the benefits of financial repression in the presence of underdeveloped financial institutions.

Second, we could study what the Ramsey policy prescribes in our setting. Dovis (2012) has shown that capital controls can be the solution to a Ramsey problem for a small open economy with lack of commitment, but the role of domestic investors and domestic debt is not considered. Once the government is allowed to issue also domestic debt and the domestic financial market is underdeveloped, the gains from capital controls could be even higher.

An obvious extension of the model is to allow the government to issue long-term debt. We have assumed that the government can issue only one-period bonds in both markets. Following the same setup as in Chatterjee and Eyigungor (2012), we could consider different durations of the two types of debt. This would allow us to study the interaction of the composition of debt and the duration of debt.

References


