Financial Development and Vulnerability to External Shocks: The Role of Sovereign Debt Composition*

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Abstract

There has been a growing concern about the vulnerability of emerging countries to fluctuations in international interest rates. Empirical evidence shows that these countries suffer significant output drops when developed countries raise their interest rates. In this paper, I document that an important determinant of the magnitude of this effect is the ability of countries to issue sovereign debt domestically, rather than to external creditors. Moreover, I find that the level of financial development of domestic markets is positively related with the share of total public debt that is domestically held. I build a model that integrates a domestic banking sector into a sovereign default model where governments can issue domestic and external debt and decide whether to default on debt selectively. Due to financial frictions, issuing domestic debt crowds out investment in capital. As financial markets develop, i) crowding-out costs decrease, and ii) banks demand lower interest rates on domestic bonds. Both effects reduce the relative cost to the government of borrowing domestically, leading to a higher share of domestic debt. I calibrate the model and show that the results are consistent with the pattern of discriminatory default in developing countries. Then, I use the model to decompose the effect of external and domestic shocks on output volatility, and find that financial development decreases the susceptibility of emerging economies to external shocks.

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1 Introduction

Recent empirical evidence shows that developing countries suffer significant output drops when international interest rates increase. This has motivated substantial policy debate regarding the vulnerability of emerging markets to changes in the monetary policies of developed economies.[1] For example, Rey (2015), and Miranda-Agrippino and Rey (2015) document the existence of a global financial cycle and show that fluctuations in emerging markets are partially driven by the monetary conditions in the United States.

In this paper, I document that an important determinant for the magnitude of these spillover effects is the ease with which developing countries can issue sovereign debt to domestic creditors, rather than to external creditors. Intuitively, when world interest rates rise, it becomes more expensive for governments in developing countries to use external credit. Then, if they can easily substitute away from foreign debt and into domestic debt, the negative effects of external shocks on their output are reduced. I show that this intuition holds in the data: countries that have a high fraction of their sovereign debt held by domestic residents are less exposed to external shocks than countries whose sovereign debt is mainly composed of debt held by foreign creditors. This evidence suggests that understanding the incentives of the government to borrow domestically as opposed to from external creditors is crucial to assessing the consequences that monetary policies in developed countries have on emerging countries.

The obvious question is if issuing mostly domestic debt rather than external debt make an emerging economy less vulnerable to fluctuations in world interest rates why don't all emerging market economies issue primarily domestic debt? One feature of the data that is relevant for answering this question is that countries with less developed financial markets tend to issue relatively little domestic debt relative to external debt and that as these financial markets develop the ratio of their domestic debt to external debt rises.

This feature of the data leads me to construct a model in which, although issuing domestic debt is desirable for insulating a country from world interest rate fluctuations, there are other costs to doing so which are particularly high when the domestic economy has less developed financial markets. Moreover, it suggests that as the financial markets in a country develop the costs of issuing domestic debt fall and so that government optimally chooses to increase its share of domestic debt in total debt.

Critical to such an explanation is a framework in which there is a well-defined sense in which financial markets can become more developed so that the model can deliver a cost

[1] See, for example, Bernanke (2017) and Rajan (2015).

of issuing domestic debt that falls with development. Also, for all emerging markets the possibility of defaulting on external debt is a first-order issue. Indeed, vulnerability to world interest rate fluctuations is not just because the cost of borrowing increases but that these higher world rates trigger a default on external debt which in turn exacerbates a domestic downturn.

To formalize such an idea I develop a framework where financial intermediation plays a crucial role for determining the share of total public debt that is held by residents of the country. To also capture the link between vulnerability and default I embed financial intermediation into a sovereign default model with domestic and external debt. In the model banks are the financial intermediaries in the economy and they lend to domestic firms to invest in capital and they hold domestic government bonds. The government chooses how much debt to sell domestically and how much debt to sell externally.

A key ingredient of this financial intermediation is that domestic banks are collateral constrained. I model these constraints in the tradition of Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) in that banks have limited access to households' savings due to an agency problem. I assume that the level of these frictions, captured by a parameter in the collateral constraint reflecting the enforceability of contracts, represents the financial development of the country. The idea is that in less financially developed countries, the ability to enforce contracts is weak in that banks suffer only a small punishment when they break financial contracts such as repaying their depositors. Hence, in such countries consumers are willing to lend to banks relatively small amounts of resources, the ratio of deposits to output is relatively low and the banks are able to fund relatively small amounts of investment. As countries become more developed in their financial markets, these costs are lowered, which translates into an increase in the amount of resources that banks can borrow. Banks then use these resources to invest in capital and in government bonds.

Financial frictions in the model affect the decision of the government regarding what type of debt to issue. There are two forces that determine this decision: the ex-post incentives of the government to default on external and domestic debt, and the ex-ante incentives for issuing each type of debt. The ex-post incentives of the government to default affect the interest rates that they have to pay on their debt. In particular, the higher the probability of default, the higher interest rates creditors will demand. Given that governments can default selectively between domestic and foreign creditors, differences in the costs of default between these types of debt affect the relative likelihood of default and cost of debt.

The costs of default are a combination of the standard exogenous costs of default, adopted from the sovereign default literature and, critically, the endogenous of cost of defaulting on

domestic debt in a model with financial intermediation. These exogenous costs are that upon default on one type of debt countries experience an output loss and enter in an autarky state in which they do not have access to that type of debt market for a random number of periods. To focus attention on the differential endogenous cost of defaulting on domestic and external debt these exogenous costs are assumed equal across the two types of default.

This differential endogenous cost arises because when the government defaults on domestic debt, it is defaulting on its own citizens rather than on foreigners. In particular, a default on domestic debt reduces the net worth of domestic banks and, hence, the amount of resources that they have for investment. Hence, a default on domestic debt reduces capital accumulation which decreases future output in the economy. This endogenously larger ex post cost for domestic default, in turn, leads domestic agents to expect that, for the same amounts of domestic and external debt, the government has less of an incentive to default on domestic debt. Hence, all else equal, this endogenous force tends to lower expected default rates and thus the premium on domestic debt over the world rate relative to that on foreign debt.

In terms of the ex ante incentives to issue the two types of debt, there is also an endogenous differential incentive to do so arising from the way funds are intermediated. Since banks have limited resources to invest in capital and government bonds, increasing the amount of domestic debt in the economy diverts some of these resources to government bonds and thus crowds out the investment in capital by banks. This crowding out cost reduces future output, and therefore makes domestic debt costlier than external debt for the government. Therefore, the interaction between ex-post default incentives, which make domestic debt more attractive due to lower default probabilities, and ex-ante incentives to issue debt, which make domestic debt less attractive from the point of view of the government because it crowds out capital investment in the economy, determines the equilibrium share of domestic debt in a country.

I turn next to how the balance between ex post default incentives and ex ante crowding out costs change as a country's financial markets develop. I model a country's increase in financial development as an increase in its ability to enforce contracts as captured by a parameter in the collateral constraint. As a country's ability to enforce contracts increases, the balance of these ex post and ex ante incentives shifts and the country endogenously chooses to issue a higher share of domestic debt. The mechanism is that as countries become more financially developed, their banks' collateral constraints loosen, the crowding out effects fall, hence, the cost to the government of issuing domestic debt decreases. These crowding out effects fall since the gains to an additional unit of capital fall with the level of capital.

Intuitively in less developed economies, banks are very constrained in how much they can

invest in capital, the aggregate capital in the economy is low and the government chooses to issue mostly external debt since the costs of issuing domestic debt are too high. As the economy develops more deposits are intermediated, the level of capital increases, the ex ante crowding out costs fall and the government endogenously chooses to issue more domestic debt. Hence, the model naturally implies that the ratio of domestic to external debt increases as the economy develops.

Interestingly the model has three implications that are consistent with other evidence in the data that it was not explicitly designed to address. In a sense this consistency can be thought of as external validation of the mechanism.

The first feature is that the ratio of domestic to external debt is countercyclical in the data and the model. In the model this occurs because, on the margin, banks must be indifferent between investing a unit of their resources in domestic debt and investing a unit in physical capital by lending it to firms. When domestic productivity is high so is the return on capital and, hence, governments must pay relatively high return on their domestic debt. Moreover, when productivity is high so are the crowding out costs of diverting a unit of resources to debt from capital, because that is exactly when a unit of investment in capital has high returns. Both of these forces lead the government to choose to issue a lower ratio of domestic to external debt in booms and, hence, lead the share of domestic debt to be countercyclical.

The second feature is the frequency of the different types of default. Reinhart and Rogoff (2011) examine more than 300 historical defaults including those involving only external debt, and overt defaults, that is, those involving both domestic and external debt. They find that in about 80% of the cases the government defaulted only on external debt, over 19% of the cases on both external and domestic debt and almost never on only domestic debt.

The third feature is a pattern of discriminatory default in the data, that I refer to as the *pecking order of default*: in moderate recessions countries tend to default only on external debt and only in severe recessions do they default on both domestic and external debt. That the model also generates this feature is connected to the model's implied countercyclicality of the domestic debt share. If a country starts in a relatively productive state it tends to have a relatively high share of external debt. If following such a state the economy experiences a drop in productivity, given that defaulting on domestic debt is more costly than on external, the government chooses to default only on external debt. If instead the adverse shock happens during a period when the economy was already experiencing low to moderate productivity, the government tends to have a much higher share of domestic debt. Hence, even if it defaults on external debt it does not generate much revenue and hence it

chooses to default on both types of debt.

After the external validation exercise in which I show that my model produces all three of these features, I turn to quantitatively assessing the role of domestic debt in mitigating shocks to international interest rates. Specifically, I assume that external creditors have access to an international risk free asset, the return on which evolves stochastically, and that is calibrated to match the features of the U.S. Federal funds rate.

Critically, the model is able to generate the main features of the data in developing countries in terms of the characteristics of sovereign debt and default in these countries, and its relation with their level of financial development. When there is an unexpected increase in the international risk free rate, governments respond by increasing their share of domestic debt. This happens because when the international risk free asset yields a higher return, the government has to offer higher returns to external creditors, so it becomes more expensive to borrow from foreigners. Therefore, domestic debt becomes relatively cheaper than external debt.

However, when the level of financial development is low, that is, when a large share of the public debt is external, increasing domestic debt is very costly, and hence the government increases domestic debt less than one for one with the increased cost of external debt and finances the rest with tax increases. This increase in taxes leads to a fall in labor and, hence, a larger decrease in output relative to the decrease experienced by more financially developed countries after a shock of the same magnitude. This mechanism is consistent with the data: countries that are more financially developed respond to shocks to international interest rates by increasing their share of domestic debt, whereas for countries that are not developed financially we do not see a significant change in the domestic debt share.

Related Literature

This paper combines elements of the sovereign default and the financial intermediation literature. It contributes to the sovereign default literature by introducing two types of debt, external and domestic, on which the government can selectively default. Standard models of sovereign default, such as Aguiar and Gopinath (2007) and Arellano (2008), focus only on external debt. I include domestic debt motivated by the evidence in Reinhart and Rogoff (2011). They construct a historical series of domestic debt for a large sample of countries and they find that domestic debt represents a large fraction of total sovereign debt in most countries.

My model is related to Gennaioli et al. (2014), Perez (2015), and Bocola (2016). They incorporate financial intermediation and domestic debt to analyze the effect of sovereign

default on domestic banks' balance sheets. However, they assume either that there is only domestic debt, or that default is non-discriminatory. I argue, based on the evidence in Reinhart and Rogoff (2011) and other literature that focuses on the legal aspects of sovereign default, such as Gelpern and Setser (2003), that governments can and actually do discriminate between domestic and foreign creditors. Therefore, I contribute to the sovereign default literature by developing a new framework where governments can issue both domestic and external debt and can default selectively.

This paper also contributes to the growing literature on the spillover effects that monetary policies in developed countries have on emerging markets. Rey (2015), Miranda-Agrippino and Rey (2015), and Bruno and Shin (2015) provide evidence on the existence of a global financial cycle and argue that this cycle is largely driven by monetary policies in the United States, which is unrelated with the economic conditions in developing countries. Here, I show that the spillover effects in developing countries are related to their level of financial development. My results are in line with the empirical literature that indicates that an important mechanism of transmission of international shocks is the financial channel (Canova, 2005), and that countries differ in their response depending on how vulnerable they are to external conditions. In this regard, Iacoviello and Navarro (2018) define a vulnerability index that includes measures such as foreign reserves, current account, and external debt, and show that the differences in the response to external shocks observed across countries are largely explained by this vulnerability index. I add to this empirical literature by providing a new mechanism of transmission that relates to the level of financial development of the country and the borrowing decisions of its government. In my framework, these two factors capture endogenously the level of vulnerability of countries to external shocks. Banerjee et al. (2016) also associate financial intermediation to the response of countries to external shocks. However, they ignore the role of the government and focus mostly on the transactions of domestic banks with international banks.

Finally, my paper complements the literature that studies the implications of an increasing use of domestic debt in developing countries. Bua et al. (2014) documents an increasing trend of domestic debt in low income countries in recent years, and that this increase has been associated with a decrease in their borrowing costs. Panizza (2008) finds similar trends, and studies the potential trade-offs that this switch to domestic debt may have in their economies. I contribute to this literature by providing a new framework to analyze the costs and the benefits of domestic debt, and to understand the incentives of governments that lead them to issue more domestic debt over the last years.

The paper is organized as follows. In Section 2 I explain the model, and in Section 3 I

elaborate on the main mechanisms of the model. Section 4 introduces the data and how the model is parameterized. Section 5 shows the quantitative results of the model regarding the effect of external shocks on developing countries economic outcomes, and how it depends on the level of financial development. Then, Section 6 shows the implications of the model with respect to discriminatory default and compares it with the data.

2 Model

I consider a small open economy model with infinitely lived consumers. The model incorporates a banking sector along the lines of Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) into a sovereign default model with discriminatory default on domestic and foreign debt. The economy is composed by a representative household whose members switch randomly between being workers and bankers, a representative firm, international creditors, and a government. Households consume, and save by holding deposits at banks. Banks are the financial intermediaries in the economy: they use deposits from households to invest in capital and government domestic bonds, but they are constrained on how much they can invest. Firms use capital supplied by banks, and labor supplied by workers to produce a single good, and are subject to an aggregate productivity shock. The government finances a constant amount of public expenditures using taxes on labor income, and issuing domestic bonds that are bought by banks, and external bonds that are bought by international creditors. The government can decide whether to default on each type of debt separately.

Households. There is a representative household composed of a measure 1 of workers and a measure 1 of bankers. Households maximize their utility function over consumption, C_t, and labor L_t, and discount the future at rate β. Their preferences are linear in consumption and $v(L_t) < 0$ captures their disutility from working:

$$\sum_{t=0}^{\infty} \beta^t \left[C_t + v(L_t) \right] \tag{1}$$

They can only save by using deposits at banks at price q^D_{t+1}. A measure $1-\sigma$ of households become bankers every period. The household transfers $\bar{n}$ to these new bankers so that they can start their activity at the bank. They receive dividends, X_t, from existing banks. Households maximize their utility by choosing choose how much to save in deposits, D_{t+1}, and how many hours to work, L_t, subject to their budget constraint

$$C_t + q^D_{t+1} D_{t+1} \leq (1-\tau_t) w_t L_t + D_t - (1-\sigma)\,\bar{n} + X_t \tag{2}$$

where w_t is the wage they receive from each unit of labor supplied, and it is taxed by the government at a rate τ_t.

In order for the household to be willing to supply deposits to the bank it has to be that the price of deposits is at least as large as the rate at which they discount the future, so that, in equilibrium, it must be that $q^D_{t+1} = \beta$. Labor supplied by workers has to satisfy the following condition:

$$-v'(L_t) = (1 - \tau_t)w_t \tag{3}$$

Banks. At the beginning of the period the productivity shock is realized and bankers collect returns from their last period investments. Then, each existing bank receives a shock such that, with probability $1 - \sigma$ the banker has to cease its activity as a banker, and goes back to the household as a worker. In this case, the banker will transfer all its net worth to the household. We need $\sigma > 0$ because otherwise banks would build up enough net worth to make financial constraints not binding, and therefore, irrelevant.

Banks choose investment in capital, k_{t+1}, and government bonds, b_{t+1}. Investment in capital gives a return tomorrow of $R_{K,t+1}$. When banks invest in government bonds they pay a price q_{t+1} today, and they get 1 unit tomorrow if the government repays, $\delta_t = 1$, and nothing if the government decides to default on its domestic debt, $\delta_t = 0$. Banks also decide how much to borrow using households deposits, d_{t+1}, and how much dividends they pay to households, x_t. Net worth for surviving banks is $n_t = R_{K,t}k_t + \delta_t b_t - d_t$, that is, the returns on their investments in capital and bonds, minus what they have to pay back to households from using their deposits. New bankers' net worth is just the transfer that they get from households, $n_t = \bar{n}$. The budget constraint for banks is then

$$x_t + k_{t+1} + q_{t+1}b_{t+1} - q^D_{t+1}d_{t+1} \leq n_t \tag{4}$$

Banks are constrained on how much they can borrow using deposits. In particular, they face the following collateral constraint:

$$d_{t+1} \leq \theta n_t \tag{5}$$

That is, the amount of deposits that the bank can get from households cannot exceed a given proportion θ of the banks' net worth in this period. The problem of a bank at t with

current net worth n, and who has already survived this period is to solve

$$V_t^b(n) = \max_{\{k_{s+1}, b_{s+1}, d_{s+1}, x_{s+1}\}} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t+1} \sigma^{s-t} \left[(1-\sigma) n_{s+1} + \sigma x_{s+1}\right] \tag{6}$$

subject to its budget constraint (4), the collateral constraint (5), and the law of motion for net worth,

$$n_{s+1} = R_{K,s+1} k_{s+1} + \delta_{s+1} b_{s+1} - d_{s+1} \tag{7}$$

The collateral constraint comes from an agency problem between the household and the banks. After the bank makes the portfolio decision given its current net worth, n_t, and deposits from households, d_{t+1}, it can divert a fraction λ of its assets, that is, it can divert $\lambda(n_t + d_{t+1})$, and start as a new bank with net worth $\tilde{n}_t = \lambda(n_t + d_{t+1})$. Then, banks will not divert assets if $V_t^b(n_t) \geq V_t^b(\lambda(n_t + d_{t+1}))$. Given monotonicity of V^b, this implies $n_t \geq \lambda(n_t + d_{t+1})$, that is, $d_{t+1} \leq \frac{1-\lambda}{\lambda} n_t$, which is (5) for $\theta = \frac{1-\lambda}{\lambda}$.

Firms. A representative firm rents capital from banks at rate R_K and labor at wage w_t to operate a constant returns to scale production technology $F(K, L)$. They are subject to an aggregate productivity shock, z, that follows the following stochastic process

$$\log z_{t+1} = \rho_z \log z_t + \epsilon_{t+1} \qquad \text{where,} \quad \epsilon_{t+1} \sim \mathcal{N}(0, \sigma_z)$$

Capital depreciates at rate δ_K. Then, the firm maximizes its profits by solving:

$$\max_{K,L} z_t F(K_t, L_t) + (1-\delta_K) K_t - R_{K,t} K_t - w_t L_t$$

so the first order conditions for the firm are

$$R_{K,t} = z_t F_K(K_t, L_t) + 1 - \delta_K \tag{8}$$

$$w_t = z_t F_L(K_t, L_t) \tag{9}$$

where, F_K and F_L are the derivatives of the production function with respect to capital and labor respectively.

International creditors Government borrows from risk neutral international creditors whose risk free rate is r_t^*. There are external shocks that can affect the interest rate on the world risk free asset. In particular,

$$r_t^* = (1-\rho_r)\mu_r + \rho_r r_{t-1}^* + \epsilon_r \qquad \text{where, } \epsilon_r \sim \mathcal{N}(0, \sigma_r) \tag{10}$$

In equilibrium, international creditors make zero profits. Therefore, the expected return on bonds has to be equal to the return on the international asset, that is:

$$\frac{\mathbb{E}_t\left[\delta^*_{t+1}\right]}{q^*_{t+1}} = R^*_t \tag{11}$$

where $R^*_t = 1 + r^*_t$ denotes the gross rate of return.

Government. The government starts each period with a given amount of outstanding debt, (B^*, B) that it owes to external and domestic creditors, respectively. Then, it can decide whether to repay each type of debt or to default on it, and it can do so in a discriminatory way. The difference between defaulting on domestic debt and defaulting on external debt comes from the fact that domestic debt is held by residents of the country. That is, when the government defaults on domestic debt, it defaults on its own citizens. In order to emphasize this feature, I assume that all exogenous costs of defaulting on debt are identical between defaulting on domestic and external debt. The only difference comes from the endogenous effect that defaulting on domestic debt has on the economy. In particular, domestic default affects banks' investment decisions because it decreases their net worth, and therefore, it will affect total output in the country.

Defaulting on either debt implies the immediate exclusion from that credit market. Once the government is excluded from a given market, it can only regain access to it with probability γ every period. I refer to these periods as autarky periods, and, given that the government can default separately on domestic and external debt, there are three possible autarky states in which a country can be: domestic autarky, when it defaults on domestic debt, and has access only to external debt, external autarky, when it defaults on external debt, and has only access to domestic debt, and autarky in both markets, that is, when the government has defaulted on both debts, and has no access to borrowing. In all these autarky periods, the economy experiences an exogenous productivity loss, such that productivity in these periods is $h(z) \leq z$.

The government has to provide a constant amount of public goods G every period, and it can choose taxes τ, and new debt to issue (if it has access to credit). Therefore, the government budget constraint when the country is not in autarky is

$$G + \delta_t B_t + \delta^*_t B^*_t \leq \tau_t w_t L_t + \delta_t q_{t+1} B_{t+1} + \delta^*_t q^*_{t+1} B^*_{t+1} \tag{12}$$

where, δ_t and δ^*_t are the current period default decisions on domestic and external debt respectively. When the country is in one of the three autarky states defined before, the budget

constraint is similarly defined, but it does not include the market to which the country does not have access to.

The country-level budget constraint for the economy in normal times (defined before government default decisions) is

$$C_t + G + K_{t+1} - (1-\delta_K)K_t + \delta_t^* \left(B_t^* - q_{t+1}^* B_{t+1}^*\right) = \delta_t \delta_t^* z_t F(K_t, L_t) + (1 - \delta_t \delta_t^*) h(z_t) K_t^\alpha L_t^{1-\alpha} \tag{13}$$

This constraint aggregates the budget constraint of households, banks, and the government, such that aggregate consumption in private and public goods and investment, plus net exports (payments to foreigners minus transfers from foreigners) must be equal to the production in the economy. If the government defaults on either debt, production is affected by the default productivity cost, $h(z)$. Moreover, if it defaults on external debt, $\delta^* = 0$, the trade balance of the country is zero, because it cannot access international markets in this period.

In this model the government has incentives to issue debt to smooth taxes over the cycle. When productivity is low, labor is reduced, and therefore, the tax revenues that government can get from taxing labor income at a given tax rate are low. That is, if there was no debt, the government would have to raise taxes significantly during downturns in order to finance its expenditures G. Given that taxes are distortionary, the government wants to avoid sharp increases in taxes, and thus, when productivity is low it prefers to issue debt instead, which it will repay during booms.

Competitive equilibrium

Let $S = (B^*, B, K, D, z, a, R^*)$ denote the aggregate state of the economy, where a is an indicator for the current financial state of the country, that is, $a = \{n, d, e, b\}$ indicates non-autarky, domestic market autarky, external market autarky, and both markets autarky, respectively. Given a government policy $\pi(S) = (\delta^*, \delta, B^{*\prime}, B', \tau)$, a competitive equilibrium is an allocation $Y(S, \pi) = (C, L, B^{*\prime}, B', K', D')$, households and banks' value function $V^h(d; S)$, $V^b(n; S)$, and pricing functions $P(S, \pi) = \left(q, q^*, q^D, R_K, w\right)$, such that

1. given prices and government policy, households' allocations, (C, l, d'), and value function, $V^h(d; S)$, solve the household problem
2. given prices and government policy, banks' allocations, (b', k', d'), and value function, $V^b(n; S)$, solve the bank problem
3. given prices and government policy, demand for capital, and labor, solve the firm problem

4. international lenders break-even condition is satisfied

5. government policy satisfies the government budget constraint

6. allocation is feasible: it satisfies the country-level budget constraint

Lemma 1: Characterization of the bank's problem

Banks value function is linear in net worth

$$V^b(n;S) = \nu(S)n$$

where

$$\nu(S) = \beta\mathbb{E}\left\{(1-\sigma+\sigma\nu(S'))\left[R_K(S')\left(1+q^D\theta\right)-\theta\right]\right\}.$$

Moreover, banks prefer not to pay dividends, $x = 0$ if they continue as bankers. They only transfer their net worth to the household when they have to switch back to being workers.

The proof for this lemma can be found in the appendix. Intuitively, all the choices for banks enter linearly in the problem, due to linearity of the budget constraint and the collateral constraint in n. An implication of this lemma is that the aggregate state S does not need to include the measure over individual banks state variables.

The function $\nu(S)$ is then the marginal value of an additional unit of net worth at the bank. Given that the constraint always binds, an extra unit of net worth increases deposits by θ and investment by $1+q^D\theta$. The net return on this investment is then $R_K(S')\left(1+q^D\theta\right)-\theta$. Banks are members of the household, so they discount the future the same rate β. When they collect their returns from last period investment, with probability $1-\sigma$ they have to go back to the household and they give to their household their net worth. With probability σ they continue as bankers, and their value per unit of net worth is $\nu(S')$. Then, the effective discount rate of banks is $m(S') = \beta\mathbb{E}\left(1-\sigma+\sigma\nu(S')\right)$.

I now characterize the set of allocations that constitute a competitive equilibrium. Define $\tilde{z}(S) = z$ if $\delta(S) = \delta^*(S) = 1$ and $a = n$, and $\tilde{z} = h(z)$ otherwise. Also, for notational convenience, let $\delta(\cdot, a = \{d, b\}) = 0$ and $\delta^*(\cdot, a = \{e, b\}) = 0$.

From the banks first order condition, and substituting the R_K from the firm problem, the schedule of prices that the government offers to the bank must be such that for any choices $(B^{*\prime}, B', K', D')$ and given current productivity, z, and autarky state, a, banks' expected value of the return on bonds must be equal to the expected value of the marginal product

of capital:

$$\frac{\mathbb{E}\left[m(S')\delta(S')\middle|S\right]}{q(B^{*\prime},B',K',D';S)}=\mathbb{E}\left[m(S')\left(\tilde{z}(S')F_K(S')+1-\delta_K\right)\middle|S\right] \tag{14}$$

where $m(S')=\beta\mathbb{E}\left(1-\sigma+\sigma\nu(S')\right)$, and, using $q^D=\beta$, the value of the bank per unit of net worth is

$$\nu(S)=\mathbb{E}\left\{m(S')\left[\left(\tilde{z}(S')F_K(S')+1-\delta_K\right)(1+\beta\theta)-\theta\right]\right\} \tag{15}$$

That is, for banks to be willing to hold government debt they have to be indifferent between investing in bonds and in capital. Notice from this condition that the interest rate that the government has to offer to banks is positively related with the returns that they get from investing in capital. Therefore, in periods when returns on capital are high, it is more costly for the government to borrow from banks.

Given that the value of a unit of net worth at the bank is always higher than the value of that unit for the households, banks always borrow to the maximum from households, that is, $D'=\theta N$. Then, aggregating budget constraints of newborn and continuing banks, and substituting the binding collateral constraint, we get that the bank aggregate budget constraint is:

$$K'+q(S)B'=(1+\beta\theta)\left[\sigma\left(\tilde{z}(S)F_K(S)K+\left(1-\delta_K\right)K+\delta(S)B-D\right)+(1-\sigma)\,\overline{n}\right] \tag{16}$$

International creditors break-even condition imply that the bond price schedule that the government offers is such that

$$\frac{\mathbb{E}\left[\delta^*(S')\middle|S\right]}{q^*(B^{*\prime},B',K',D';S)}=R^*$$

Finally, from the labor supply condition of workers, we can write total tax revenues of the government as $T(S)=\left(\tilde{z}(S')F_L(S)+v'(L)\right)L$. Therefore, substituting this condition in the government budget constraint we get:

$$\delta(S)q(S)B'+\delta^*(S)q^*(S)B^{*\prime}=G+\delta(S)B+\delta^*(S)B^*-\left(\tilde{z}(S)F_L(S)+v'(L)\right)L \tag{17}$$

We refer to the resource constraint (13) together with constraints (14)-(17) as the implementability constraints.

Lemma 2: Characterization of competitive equilibrium

An allocation $Y=(C,L,B^{*\prime},B',K',D')$ constitute a competitive equilibrium if and only

if it satisfies the implementability constraints.

Given that the implementability constraints were derived using the equilibrium conditions of banks, households, and firms, and that they satisfy the government, bank, and country-level budget constraints, it is immediate that if Y is a competitive equilibrium then it has to satisfy the implementability constraints. To proof sufficiency we can construct taxes such that $\tau = 1 + v'(L)/zF_L$, and prices, $w = zF_L$, $R_K = zF_K$, $q_D = \beta$, so if Y satisfies the implementability constraints, then Y is part of the competitive equilibrium for these prices and tax rate.

Markov equilibrium

A recursive Markov equilibrium is policy functions $\pi(S;a) = (\delta, \delta^*, B^{*\prime}, B', \tau)$, a set of allocation rules $Y(S,\pi;a) = (C, L, B^{*\prime}, B', K', D')$, and pricing functions $q(S,\pi;a)$, $q^*(S,\pi;a)$ such that

1. the associated outcomes constitute a competitive equilibrium for all S and π, and autarky state a
2. given S, and taking as given future policy functions, allocation rules, and pricing rules, the current policy $\pi(S;a)$ is optimal for the government

Let $V(S)$ be the value function of the government when the country is not in autarky, and let $W_a(S_a)$ be the value when it is in one of the three possible autarky states, $a = \{d, e, b\}$. The *primal Markov problem* is to choose current allocations $Y = (C, L, B^{*\prime}, B', K', D')$, and current policies δ, δ^*, taking as given future policy functions $\delta(S')$,$\delta^*(S')$, pricing functions $q(S')$, value function of the bank, $\nu(S')$, and value functions of the government, $V(S'), W_a(S'_a)$. That is, the value of the government in normal times is

$$V(S) = \max_{Y,\delta,\delta^*} \Big\{ C + v(L) + \beta \mathbb{E}\left[\delta\delta^* V(S') + \delta(1-\delta^*)W_e(S') + (1-\delta)\delta^* W_d(S') + (1-\delta)(1-\delta^*)W_b(S')\right] \Big\}$$

subject to the implementability constraints (13), (14)-(17) conditional on $a = n$. When the country is in domestic or external autarky it can only issue and default on one type of debt. Let δ_a denote the relevant default decision for each type of autarky state. Then, the value of the government in either external autarky, or domestic autarky, $a = \{d, e\}$, is

$$W_a(S) = \max_{Y,\delta_a} \Big\{ C + v(L) + \beta \mathbb{E}\left[\delta_a \left(\gamma V(S') + (1-\gamma)W_a(S')\right) + (1-\delta_a)W_b(S')\right] \Big\}$$

subject to the implementability constraints. Finally, when the government is in complete autarky, there are no default or debt issuing decisions, so the problem for the government is

$$W_b(S) = \max_{Y,\delta_a} \left\{ C + v(L) + \beta \mathbb{E}\left[\gamma V(S') + (1-\gamma) W_b(S')\right] \right\}$$

subject to the implementability constraints.

3 Model forces

Before turning to the quantitative results, it is useful to explain here the main forces in the model. There are two forces in the model that we have to distinguish: ex-post incentives to default on debt, and ex-ante incentives to issue debt. The former refers to the incentives that the government has to default on a type of debt in a given state of the economy. On the other hand, ex-ante incentives affect the decision of the government regarding which type of debt to issue. Therefore, it is the combination of the two what determines the equilibrium realization of defaults and debt composition in the economy.

Ex-post incentives to default

The government decisions to default depend on the current state of the economy, mainly on the current productivity and on the amount of debt that the government owes.

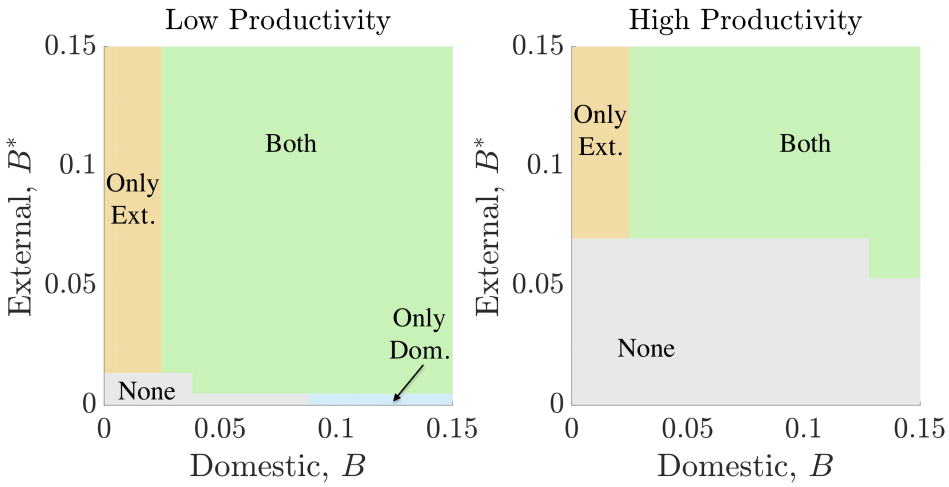
The incentives of the government to default on external debt and on domestic debt differ in that the government takes into account that defaulting on domestic debt affects its own citizens, whereas external debt is only held by foreigners. In particular, domestic default affects banks' investment decisions because it decreases their net worth. Aggregate net worth is,

$$N = \sigma \left(z F_K K + (1-\delta_K) K + \delta B - D \right) + (1-\sigma)\bar{n}$$

Hence, when $\delta = 0$, net worth decreases by σB. Given that the collateral constraint is binding, this means that the total resources that banks have available for investing decreases by $(1+\beta\theta)\,\sigma B$.

This is intentionally modeled as the only difference in default costs between domestic and external debt, because I assume that all the exogenous costs of default are identical for both types of debt. This implies that the cost of defaulting on domestic debt is larger than defaulting on external debt due to the financial frictions in the economy. That is, the decision of the government endogenously affects banks' investment decisions, and therefore total output in the country.

Figure 1: Ex-post default decisions



An implication of this difference in the incentives to default is that the government is more tolerant to holding domestic debt than external debt. Even though for both types of debt the probability of default increases when the debt is larger, it decreases faster for external than for domestic debt. Note that the value for the government of having more outstanding external debt decreases because it is costly to repay, while the value of defaulting does not depend on the amount of debt defaulted. However, although domestic domestic debt is also costly to repay and, therefore, it affects negatively the value of the government, it also has a positive effect because it provides liquidity to banks. When banks' current net worth is very low, repaying them the government bonds that they held in the last period increases their total available resources for investment, both directly from N and because it relaxes their collateral constraint. If the taxes that have to be raised to pay for B are small enough, repaying can be beneficial for the economy as it increases capital investment from banks, and therefore future output. This positive effect is not present when the government repays to external creditors.

Another important factor determining default decision of the government is current productivity. Countries tend to default when productivity is low. In order to quantitatively account for this fact, I follow the literature on sovereign defaults, and assume that the exogenous cost of default is lower when output is low. That is, $z - h(z)$ is increasing in z.

In Figure 1 we can see the government default decisions for a given state of the economy. In the left panel, I plot the default areas as a function of (B, B^*) for which the government would default or repay on each type of debt given that current productivity is low. When domestic debt is relatively low, government will default only on external debt when B^* is high enough. Similarly, when external debt is very low, the government defaults only on

domestic debt when domestic debt, B, is very large. However, it is clear from the graph that the government is more tolerant to domestic debt: the region of only external default is larger both in terms of the minimum B^* for which it defaults, and because it requires a higher B for defaulting on both. As debt becomes larger for both type of debt, the government have more incentives to default on both. The right panel of the figure plots the same but when productivity is higher. In this case, all default sets shrink, and the repayment area becomes larger.

Notice that these are ex-post decisions, so we cannot know from this analysis what are the relevant regions in terms of (B, B^*) where the economy will be in equilibrium. This is determined by the decisions of the government on how much debt of each type to issue.

Ex-ante incentives to issue debt

The decision of the government regarding what type of debt to issue depends primarily on the relative price of domestic and external debt, and on the effect that issuing domestic debt has on banks. In particular, domestic debt crowds out investment in capital. In order to provide intuition for these effects, I compare the government optimal decisions on debt in an environment with only external debt, and in an environment with only domestic debt. Here, I just show the first order conditions with respect to debt. Derivation of these problems can be found in the appendix.

Consider the government first order condition for external debt in an economy where there is no domestic debt:

$$\underbrace{\left[q^* + \frac{\partial q^*}{\partial B^{*\prime}} B^{*\prime}\right]}_{\text{revenue effect}} (1+\lambda) = \beta \underbrace{\mathbb{E}\left[1 + \lambda(S')|\delta(S') = 1\right]}_{\text{repayment effect}} \tag{18}$$

where λ is the multiplier on the government budget constraint, that is, it is the value associated with an additional unit of revenue in the government budget constraint. This term captures the tax distortions associated with an increase in tax revenues[2]. The government condition for issuing external debt equates the revenues from an additional unit of debt to the cost of repaying it in the next period (conditional on repayment). Issuing an additional unit of debt increases total revenues from debt by q^* in that additional unit. However, the government takes into account that when it increases its debt, it affects the price that external creditors demand. In particular, higher debt decreases the probability of repayment, and therefore, the price of debt decreases $\partial q^*/\partial B^{*\prime} < 0$. Therefore, the total marginal revenues

[2]In particular, $\lambda = [zF_L(K,L) + v'(L)]\left(\frac{\partial T(z;K,L)}{\partial L}\right)^{-1}$ where T is tax revenues.

from issuing external debt is the first term in brackets in the left hand side of the equation. These additional resources increase consumption by one unit, and relax the government budget constraint. Repaying the debt to international creditors next period costs one unit of consumption and tightens the government budget constraint.

Government decisions on how much external debt to issue do not affect domestic banks investment decisions. However, when the government decides to issue domestic debt it affects banks investment. This can be seen from the bank aggregate budget constraint:

$$K' + qB' = (1 + \beta\theta)N$$

Given that the collateral constraint binds, banks have a total of $(1 + \beta\theta) N$ units to invest. Then, increasing qB' crowds out investment in capital, which reduces output tomorrow. Therefore, when the government decides how much domestic debt to issue it takes into account its effect on future output.

To see how the decision of the government to issue domestic debt differs from the decision on external debt issuance, consider now the first order condition of the government when there is only domestic debt:

$$\underbrace{\left[q + \frac{\partial q}{\partial B'}B'\right]}_{\text{revenue effect}}(1+\lambda) = \quad \beta\underbrace{\mathbb{E}\left[\lambda(S') - (1+\beta\theta)\,\sigma\Omega(S'')\middle|\delta(S') = 1\right]}_{\text{repayment effect}}$$

$$+\beta\left(q + \frac{\partial q}{\partial B'}B'\right)\underbrace{\mathbb{E}\left[z'F_K(K',L') + \lambda(S')\frac{\partial T(S')}{\partial K'} + z'\frac{\partial\left(F_K(K',L')K'\right)}{\partial K'}(1+\beta\theta)\,\sigma\Omega(S'')\right]}_{\text{crowding out effect}} \tag{19}$$

where, $\Omega(S'') = \beta\frac{\partial\mathbb{E}V(S'')}{\partial K''} - 1$ is the net value for the government of higher investment tomorrow.

Issuing domestic debt implies an additional cost for the government that is not present when the government issues external debt. This is captured by the last term in equation (19) which I refer to as the crowding out effect. When the government issues an additional unit of domestic debt, it decreases investment in capital by $q + \frac{\partial q}{\partial B'}B'$, which comes from the bank budget constraint. This affects the value for the government tomorrow in three ways. First, lower capital decreases output, and therefore consumption, by $z'F_K(K', L')$. Moreover, when capital is low, returns to labor decrease, which decreases labor supplied by workers.

This decreases tax revenues collected by the government by $\partial T/\partial K'$, and thus tightens the budget constraint of the government. The last term from the crowding out effect reflects the fact that lower investment today decreases total returns that banks get from capital, and therefore decreases next period net worth by $z'\partial\left(F_K(K', L')K'\right)/\partial K'$, which in turn decreases also future investment. Therefore, the crowding out effect reflects the cost that issuing domestic debt has on the economy in terms of having lower amounts of capital in the future.

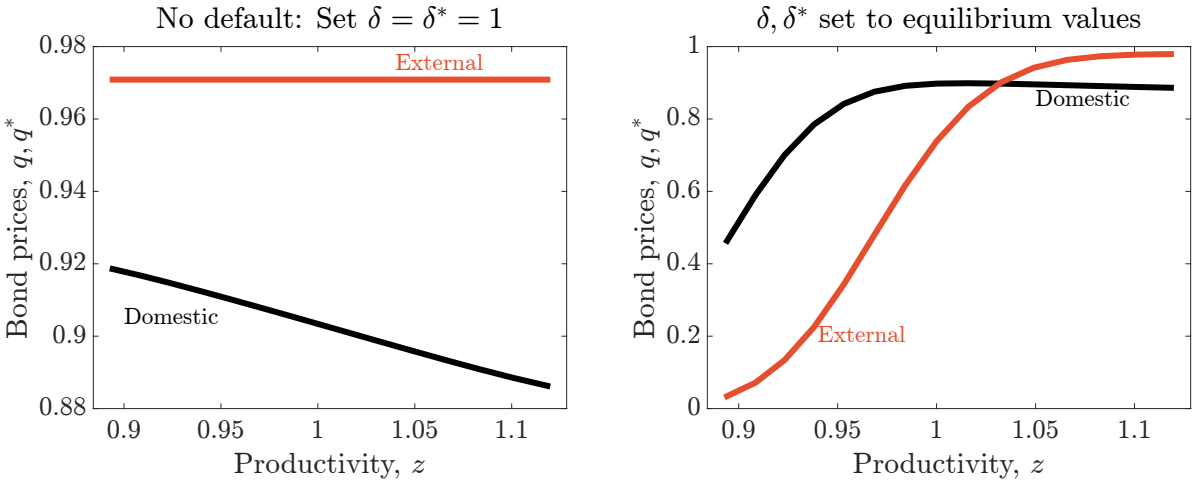
On the other hand, conditional on the government repaying, tomorrow's net worth for the banks increases by one unit from the return on bonds. This effect appears in the repayment effect of issuing domestic debt. This makes the cost of repaying domestic debt lower than the cost of repaying external debt. However, this effect is quantitatively small relative to the crowding out effect. Therefore, keeping fixed the prices of debt, issuing domestic debt is more costly than issuing external debt because it negatively affects banks' net worth.

Bond price schedules. Ex-ante decisions on how much and what type of debt to issue also depend on the relative prices of debt, that is, on the interest rate that the government has to pay to either banks or external creditors. Both prices depend on the probability of default, and given that for the same amount of debt defaulting on domestic is more costly than on external, keeping everything else equal and ignoring the crowding out effect, this makes domestic debt cheaper for the government than external debt. However, there are other factors that affect prices. External debt prices are subject to the international shock that affects the return on the risk free asset. The higher this rate is, the higher the interest rate that the government has to offer to international creditors for them to be willing to buy bonds. On the other hand, domestic bond prices are affected by the domestic productivity. When productivity in the country is high banks expect large returns on capital due to high marginal product of capital. This implies that when current productivity is high interest rates on domestic bonds must be high as well so that the bank is indifferent between investing in capital or in government bonds. This can be seen from the equilibrium condition on domestic bond prices (14), which we can rewrite as

$$\frac{\mathbb{E}\left[\delta(S')\right]}{q(S)} + \frac{\text{Cov}\left[m(S'), \delta(S')\right]}{\mathbb{E}\left[m(S')\right]} = \mathbb{E}\left[z'F_K(S') + 1 - \delta_K\right] + \frac{\text{Cov}\left[m(S'), z'F_K(S') + 1 - \delta_K\right]}{\mathbb{E}\left[m(S')\right]}$$

Notice that given that banks are constrained, the value a unit at the banks tomorrow, $m(S')$, is greater than one because it helps them to relax the collateral constraint. Therefore, if the return on capital is high in states when banks value more an additional unit of net worth, the expected return on bonds must be higher than the expected return on capital. Similarly, when the covariance of $m(S')$ and the repayment of bonds is high, expected return on capital

Figure 2: Bond Prices, q and q^*



must be higher than the expected return on bonds. In general, these covariance terms will offset each other, and therefore will not be quantitatively relevant.

To see how domestic and external prices differ consider first the following case in which I set the default probability to zero. That is, the interest rate on external debt, $1/q^*$ is just equal to the risk free asset return, R^*, and the interest rate on domestic debt depends on the returns to capital next period. Therefore, as domestic productivity increases, the interest rate on domestic debt increases, whereas the one for external debt remains constant, thus making external debt relatively cheaper in high productivity periods than in low productivity periods. This can be seen in the left panel of Figure 2, where I plot q and q^* as a function of productivity, for given $(B^{*\prime}, B', K', D')$. However, if we let the repayment functions be their equilibrium values, we have that default probability of default for external debt decreases faster than the probability of default for domestic debt as z decreases, due to higher costs of default on the later. This implies that when productivity is high external debt is relatively cheaper for the government, that is, it has lower interest rates, due to high probability of repayment on external debt, and high marginal returns on domestic capital. As productivity decreases, external debt becomes relatively more expensive for the government due to higher probability of default.

4 Data and Parameterization

Data Sources

I use data for developing countries since 1965. I restrict attention to countries for which there is available data on the main variables of interest.[3] Data on debt service to GDP is from the World Bank, and I use quarterly data on GDP from the data used in Iacoviello and Navarro (2018). Government expenditures data is from the Fiscal Prudence and Profligacy database from the IMF. Here I briefly discuss the main features of the datasets I use for the rest of the variables. Further details can be found in the Appendix.

Domestic debt. There are different definitions that can be used for domestic debt. In this paper I refer to domestic debt as debt held by residents of the country as opposed to foreigners. However, there is no long time series data available on this definition. I use data on domestic debt from Reinhart and Rogoff (2011) which uses the definition of domestic debt based on the market where it was issued. In general, in developing countries, debt issued in domestic debt has been held by residents of the country, and debt issued abroad by foreigners. Moreover, it is usually the case that domestic markets issue debt denominated in local currency, whereas when it issued abroad, it is denominated in foreign currency, which makes it more likely for these two definitions of domestic debt to be positively correlated. The World Bank and IMF has recently released new data on domestic debt where they can differentiate between residents and foreigners based on who holds the debt. This time series is too short for being used in my analysis. However, by comparing it with the definition by market of issuance, we can see that for developing countries they exhibit similar levels and trends.

Default events. The list of historical default events across developing countries is also taken from Reinhart and Rogoff (2011). Moreover, I use their classification between defaults that involved only external debt, and those that involved both, domestic and external debt.

Financial development. I use data on liquid liabilities to GDP from the World Bank Financial Structure and Development Dataset as a measure of financial development. In particular, liquid liabilities consists of a broad definition of model including demand and interest-bearing liabilities, such as deposits, at domestic financial institutions. This has been one of the main measures of financial development in the literature (see for example,

[3]The countries in my sample are: Argentina, Brazil, Chile, China, Colombia, Ecuador, El Salvador, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, South Africa, Thailand, Turkey, and Venezuela.

Table 1: Parameter Values

Fixed Parameters:

Average world risk free rate	$\mu_R = 0.013$	Average US interest rate (quarterly rate)
Risk free rate autocorrelation	$\rho_R = 0.947$	AR(1) on US interest rate
Risk free rate standard dev.	$\sigma_R = 0.002$	AR(1) on US interest rate
Productivity autocorrelation	$\rho_z = 0.95$	AR(1) GDP developing countries
Productivity standard dev.	$\sigma_z = 0.015$	AR(1) GDP developing countries
Autarky duration	$\gamma = 0.1$	Gelos et al. (2011)
Inverse Frisch elasticity	$\phi = 0.5$	Keane and Rogerson (2012)
Capital share	$\alpha = 0.3$	Standard
Banks initial net worth	$\bar{n} = 0.002$	Gertler and Karadi (2011)

Parameters from Matching Moments:

Discount factor	$\beta = 0.97$	Default probability
Productivity cost of default	$\bar{z} = 0.97$	Debt service to GDP
Banks survival rate	$\sigma = 0.95$	Deposits to GDP
Collateral constraint	$\theta = 0.75$	Share of domestic debt
Gov. expenditures	$G = 0.06$	Government expenditures to GDP
Disutility of working	$\xi = -1.7$	Hours worked

King and Levine (1993)). This variable measures the size of the financial sector relative to economic activity, which is known as "financial depth". Intuitively, when liquidity is high, it is easier to trade among agents in the economy. Low liquidity may indicate the presence of financial frictions that prevent agents to transform their assets.

Parameterization

A period in the model is one quarter. I assume that the disutility of working for households takes the following form: $v(L) = \xi \frac{L^{1+\phi}}{1+\phi}$, where ϕ is the inverse of the Frisch elasticity, and the production function is Cobb-Douglas, $F(K, L) = K^{\alpha} L^{1-\alpha}$ where α is the capital share of production. For the productivity function when the government is in autarky I follow the literature on sovereign defaults and assume that the productivity cost is nonlinear and is higher for high realizations of z. Specifically, I assume a similar function than in Arellano

(2008).[4]

$$h(z) = \begin{cases} z & \text{if } z < \bar{z} \\ \bar{z} & \text{otherwise} \end{cases}$$

for some parameter $\bar{z}$. This implies that when current productivity realization is low enough such that $z < \bar{z}$, the only exogenous default cost is losing access to the credit markets, but there is no productivity cost in the period of default.

Assigned parameters. The parameters that I use are reported in Table 1. For the international interest rate process I estimate an AR(1) process using data on the U.S. Federal Funds rate. The process is persistent, with an autocorrelation $\rho_R = 0.947$, and standard deviation of the error term is $\sigma_R = 0.002$. I also estimate the processes for z using data on real GDP for each country. Then, ρ_z and σ_z are the averages across developing countries of the autocorrelation coefficient, and the standard deviation.

Some parameters are standard: I use a capital share value of 0.3 and an annual capital depreciation rate of 10%. I set the Frisch elasticity to 2, which is in the range of the macroeconomic estimates (Keane and Rogerson, 2012). Finally, for the initial net worth of newborn banks, I use the same value as in Gertler and Karadi (2011).

Parameters from moment matching. I set the rest of parameters $\{\beta, \bar{z}, \sigma, \theta, \xi, G\}$ to match five moments from the data. The average default probability is computed using the default events documented in Reinhart and Rogoff (2011). I compute average default probability for each country in the sample (including countries that never defaulted), and take the average across developing countries. I also target are debt service to GDP, deposits to GDP, government primary expenditures to GDP, and the share of domestic debt, all averages across the countries in the sample. Finally, I set the disutility of working parameter,ξ, to match the standard fraction of hours worked of 0.3. The parameters values that I get are similar to what other literature finds. Table 2 compares the data and the model in terms of the targeted moments at an annual rate. Overall the model can reproduce the main features of the data that I target.

5 Vulnerability to External Shocks

In this section I study how shocks to world interest rates affect economic outcomes of developing countries. I do this in two parts. First, I show that in the data higher levels of financial development are associated with higher shares of domestic debt, and I perform a

[4]Same functional form, but in Arellano (2008) it is an endowment economy.

Table 2: Model fit

	Data	Model
Default probability	0.02	0.03
Debt service to GDP	0.05	0.06
Deposits to GDP	0.43	0.44
Share of domestic debt	0.54	0.52
Government expenditures to GDP	0.18	0.13
Hours worked	0.3	0.4

quantitative exercise in the model to see how the model can predict this fact. Second, I document that countries with higher shares of external debt are more sensitive to increases in international interest rate. I use the model to quantitatively account for these findings.

5.1 Financial development

In the data there is a strong positive relationship between the level of financial development of a country and its share of domestic debt. This can be seen in the left panel of Figure 3 that plots the average level of financial development for each country during the period 1965 to 2010 against the average fraction of domestic debt over total government debt. Morerover, as can be seen in the right panel of that figure, countries where financial development increased more during that period experienced larger increases in their share of domestic public debt. This positive relationship is robust to country and time fixed effects, and to the inclusion of other variables that may affect the share of domestic debt such as the level of GDP, and the level of total public debt. Table 3 shows the results from a cross-country panel regression where the dependent variable is domestic debt share. These results confirm the strong positive relationship between the level of financial development of a country and its share of domestic debt. In particular, an increase in the ratio of liquid liabilities to GDP of 10 percentage points increases the share of domestic debt betweeen 1 to 3 percentage points and this increase is statistically significant.

In the model the level of financial development of a country is controlled by the parameter θ in the collateral constraint (5). The higher θ is the lower the frictions in the financial sector. Specifically, higher θ is associated with a lower fraction of assets that banks can divert. This can be interpreted as improving the monitoring technology that depositors have over banks' behavior, which I associate with a higher development of domestic financial markets.

To see the implications of the model regarding the level of financial development I perform

Figure 3: Financial development and domestic debt share

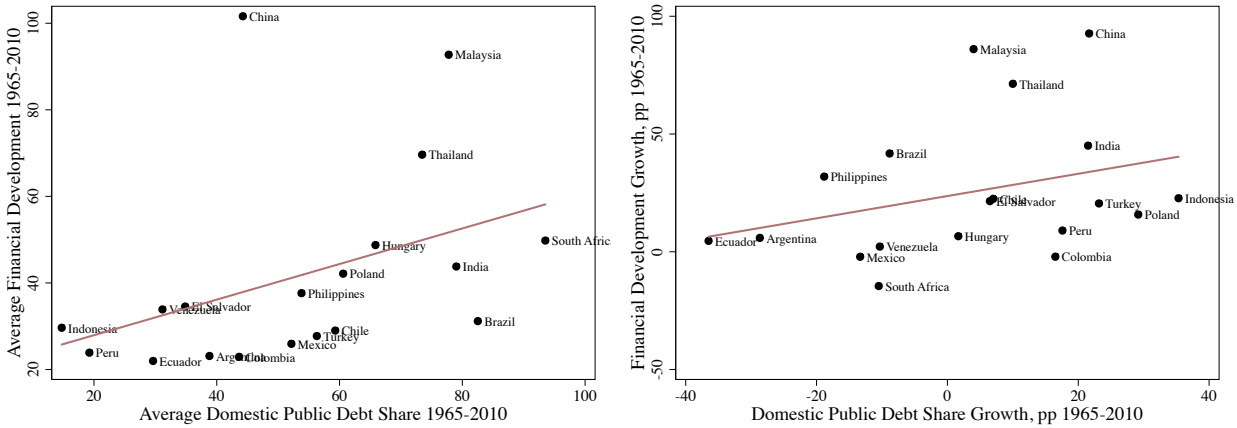


Table 3: Financial development and domestic debt share

Dependent variable: Domestic debt share

Financial development	0.323***	0.050*	0.126***	0.320***	0.201***	0.137***
	(0.031)	(0.029)	(0.032)	(0.031)	(0.040)	(0.039)
Controls	No	No	No	Yes	Yes	Yes
Country Effects	No	Yes	Yes	No	Yes	Yes
Year Effects	No	No	Yes	No	No	Yes
Observations	1286	1286	1286	1230	1230	1230

Standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01
Controls in this regression include: GDP per capita, total public debt, exports and imports to GDP, and linear trends.

the following quantitative exercise. First, I divide countries between low and high financial development depending on whether their average level of financial development is above or below the median level in the sample. Then, I vary the parameter θ so as to match the average level of deposits to GDP in each of the groups: low and high financial development. Note that in this exercise I only change the value of the parameter θ, and I keep the other parameters fixed at their level as in Table 1. In the data, the average share of domestic debt for countries that are less financially developed is 0.44 whereas in countries that are more financially developed this share is 0.71. Moreover, the difference in the means across these two groups is significantly different from zero.

Table 4 compares the levels of financial development and shares of domestic debt in the data and the ones generated by the model. The model captures the differences in the share of domestic debt between high and low financially developed countries. There are two mechanisms in the model that generate this result. First, when banks face lower constraints, that is, countries are more financially developed, the interest rate that the government has to pay on domestic debt decreases. This is because, lower constraints imply lower returns

to capital due to lower marginal product of capital. Similarly, when constraints are more relaxed, the crowding out cost from issuing domestic debt is lower. Therefore, domestic debt becomes more attractive relative to the case where financial constraints are tighter, and governments issue more domestic debt.

Table 4: Model predictions: Financial development and domestic debt shares

	Data		Model	
Financial development:	*Low*	*High*	*Low*	*High*
Deposits to GDP	0.26	0.66	0.27	0.66
	(0.004)	(0.018)		
Share of domestic debt	0.44	0.72	0.42	0.67
	(0.014)	(0.011)		

Note: Data columns show averages across observations in each group
Numbers in parenthesis represent standard errors of the means.

5.2 International Interest Rate Shocks

It is standard in the VAR literature that analyzes the effects of monetary shocks on the real economy to assume that the interest rate is a function of lagged values of itself and contemporaneous and lagged values of output, inflation, and other variables that might predict the decision of the central bank to change interest rates (see Christiano et al. (1999)). The residual from this equation is assumed to be the monetary shock as it captures fluctuations in the interest rates that are not due to the current economic conditions in the country and thus eliminates the problem of endogeneity.

I follow this approach in order to identify changes in the interest rates in the United States. In particular, I follow Iacoviello and Navarro (2018) and estimate at a quarterly level:

$$r_t^* = \alpha + \rho r_{t-1}^* + \sum_{i=0}^{4} y_{t-i}^* + \sum_{i=0}^{4} \pi_{t-i}^* + \sum_{i=0}^{4} s_{t-i}^* + u_t$$

where, r_t^* is the U. S. Federal funds rate, y^* is U.S. GDP, π^* is U.S. inflation, and s^* are U.S. corporate spreads.[5] Then, the residual from this regression, u_t, is the identified shock to the international interest rate. By using this approach I avoid identifying changes in the output of emerging countries that are correlated with changes in the output of the United States but independent of the US interest rates.

[5]I use data from Iacoviello and Navarro (2018).

Then, I estimate the dynamic response of emerging countries' output to a shock in the US interest rates using the linear projection method proposed by Jordà (2005). For every period $h = \{0, 1, ..., H\}$ after the shock, output response is estimated as follows:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h u_t + \gamma_h \mathbb{I}_{i,t}^{high} \times u_t + \theta_{i,h} X_{i,t-1} + \epsilon_{i,h}$$

where, y_i is log GDP of emerging country i, and $X_{i,t}$ includes controls for trade openness of the country (exports to and imports from the U.S. over GDP) and U.S. GDP growth to control for a global cycle, and a linear trend. I include these controls because these variables might affect output growth of emerging countries but are not included in the model. The coefficient on the interest rate shock, β_h, measures the effect on output after h quarters of a shock that increases the interest rate by one percentage point for that countries have low levels of financial development, and $\beta_h + \gamma_h$ for countries with high levels of financial development.[6]

Figure 4 plots the results from this regression. On average, output drops around 0.4% after an increase of 1 percentage point in the international interest rate shock for countries that have high levels of financial development, but it drops significantly more, 0.8%, for countries with low levels of financial development.[7]

To analyze the robustness of these results to the classification of countries between the two groups according to their level of financial development, I run the same regression but including an interaction between the shock to the interest rate and the level of financial development in country i at time t, $FD_{i,t}$.

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h u_t + \gamma_h \left(FD_{i,t} \times u_t\right) + \theta_{i,h} X_{i,t-1} + \epsilon_{i,h}$$

If the coefficient on this interaction term, γ_h, is positive, it means that the higher the financial development of a country at the time of the shock, the higher the growth of its output. Given that β_h is negative, this implies that the contraction of output in emerging countries due to an increase in the international interest rates is lower the higher its level of financial development.

[6]See Appendix C for a comparison of the effects of an increase in the U. S. Federal Funds rate on U.S. output and on the output of emerging countries. In the United States a shock to the U. S. interest rate of 1 percentage point decreases output by 0.6 percent. This result is in line with the literature where the effects range between 0.3 percent and 0.8 percent. For example, Christiano et al. (1999) finds a peak drop of 0.7 percent, Uhlig (2005) 0.3 percent, and Gorodnichenko (2006) 0.8 percent. The effect in emerging countries is of a similar magnitude than in the United States, but while in the United States the peak drop happens around 2 years after the shock, in emerging market countries the peak is around 4 years after the increase in the U.S.

[7]Shaded areas in the plot represent a 1 standard deviation from the estimated coefficient.

Figure 4: Increase in International Interest Rates

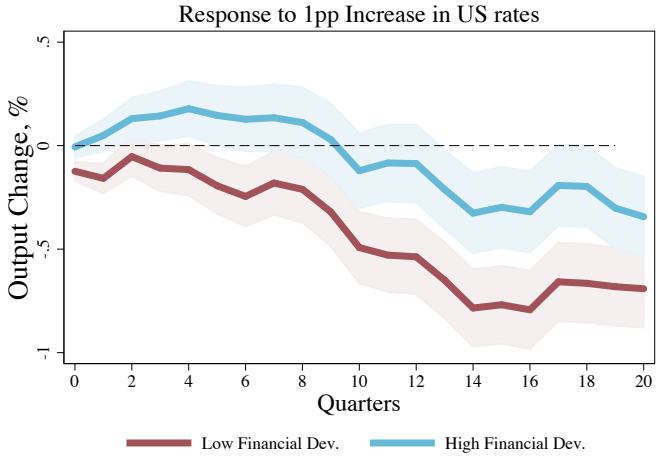


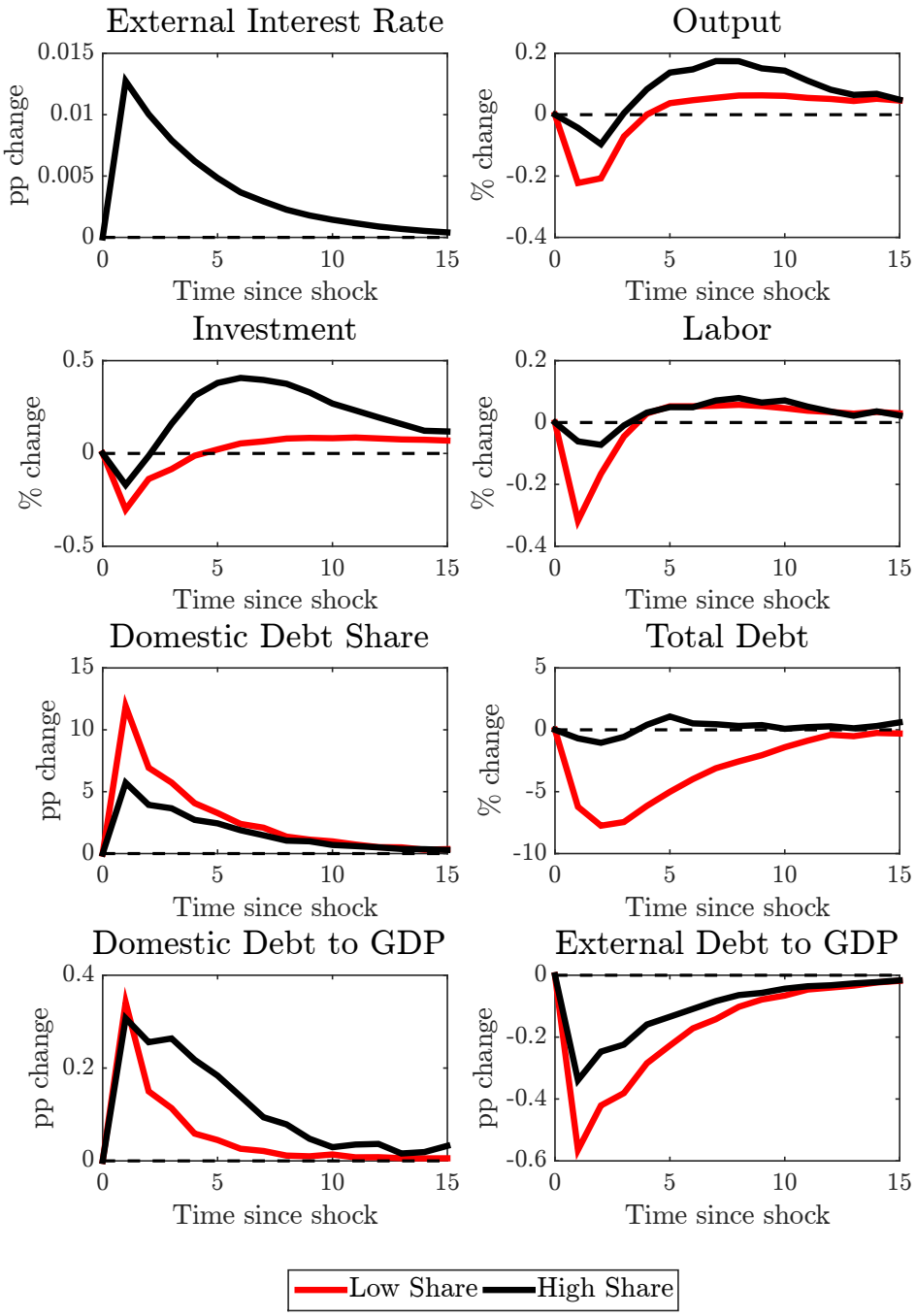
Table 5: Output response to international interest rate shock

	Quarters after shock								
	0	2	4	6	8	10	12	14	16
β_h	0.10	-0.23	-0.47	-0.70	-0.86	-1.16	-0.87	-1.02	-0.86
	(0.255)	(0.194)	(0.046)	(0.012)	(0.005)	(0.000)	(0.009)	(0.003)	(0.015)
γ_h	-0.003	0.002	0.008	0.011	0.011	0.012	0.006	0.006	0.003
	(0.082)	(0.507)	(0.096)	(0.057)	(0.063)	(0.067)	(0.329)	(0.364)	(0.662)

Note: Numbers in parenthesis represent p-values.

In the model, I perform a similar exercise. I simulate a shock that increases the interest rate in the international risk free asset, that is, an increase in ϵ_r in (10). Responses to this shock are plotted in Figure 5. I distinguish two cases: when the economy has a low level of financial development (red line), and when it has a high level of financial development (black line). In both cases, output decreases after an increase in international interest rates. This happens because, given that external debt is more expensive after the shock, the government responds by decreasing the amount of external debt, and substituting it with higher taxes, and higher amounts of domestic debt. Therefore, there are two effects that imply lower levels of output: First, higher taxes depress labor supply, and therefore output falls. Second, issuing domestic debt has a crowding out effect on investment, and thus capital is lower, which also leads to lower levels of output.

Figure 5: Impulse response: Shock to international interest rates



There are two main differences between the economy with low levels of financial development and the one that is more financially developed. First, that that taxes have to increase by more when the economy is less financially developed. And, second, that investment de-

creases more in this economy. Since when financial development is low the government tends to borrow more from external creditors due to high costs of borrowing domestically, when there is an increase in the international interest rate it is more costly to these countries. In this situation, the government wants to decrease it amount of external debt, but to do so, it needs to increase domestic debt and increase taxes. Both of these options are costly in terms of output: domestic debt decreases investment, and taxes are distortionary so decrease labor in the economy. That is why the output drop for less financially developed countries is larger than for more financially developed countries.

6 Patterns of Discriminatory Default

In the model I assume that governments can discriminate when they default between external and domestic creditors. This is consistent with what we observe in the data. Reinhart and Rogoff (2011) catalogue all default episodes between those involving external debt only, and overt defaults that involved both domestic and external defaults. Their classification of overt defaults include cases where the government forced conversions of deposits, bank deposits were frozen, imposed lower coupon rates, there was a unilateral reduction of principal, or suspension of payments. They find that in most cases countries default only on external debt: 250 external debt defaults and 68 cases of overt default. I take this as evidence that governments can actually default in a discriminatory way.

Another important aspect of discriminatory default that we see in the data is that the circumstances under which governments default only on external debt and when they default on both, domestic and external, are very different. The left panel of Figure 6 shows the average evolution of real GDP around the time of default across all the events of default in the data, distinguishing between cases where countries defaulted only on its external debt, and where they defaulted on both types of debt. Output deviation is measured as deviations from its HP filtered series. In both cases, output was below its trend at the time of default. However, we can see that when governments default only on external debt output drop is much lower, 1.4%, than when they defaulted on both, when it drops around 4%. I refer to this pattern as pecking order of default: In moderate recessions, countries tend to default only on their external debt, and it is only when the recession is severe enough that they default on both, domestic and external debt. Moreover, it is important to notice that the output path before the time of default was also different. In particular, we see that output in the year before defaulting on external debt was slightly above trend, whereas the year before defaulting on both output was already 2% below trend.

The model is able to generate the same patterns that we observe in the data. In the right

Figure 6: Output deviation at the time of default: Data and Model

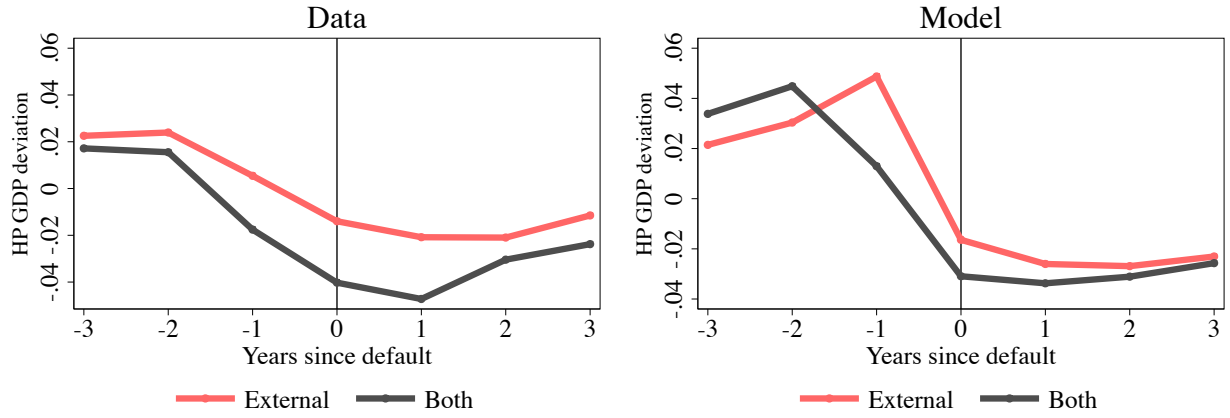


Table 6: Pecking order of default

	Data		Model	
Output deviation from trend:	External only	Both	External only	Both
Period before default, $t-1$	0.5%	-1.7%	4.8%	1.1%
Default period, t	-1.4%	-4.0%	-1.6%	-3.1%
Period after default, $t+1$	-2.1%	-4.7%	-2.6%	-3.4%
Frequency of default:	80%	19%	88%	12%

panel of Figure 6 I plot the average across default events from simulating the model over a large number of periods. As in the data, both in the period of default and the period prior to default output is much lower when the country defaults on both debts than when it only defaults on external debt. Table 6 summarizes these results. Moreover, the model is also able to generate the high frequency of discriminatory default.

In order to understand why the model generates this pattern it is important to see what are the cyclical properties of domestic debt. We have seen in the model that higher productivity today increases the expected returns to capital, and therefore, given that the price of debt must be such that banks are indifferent between investing in bonds or in capital, the interest rates that the government has to offer are higher when productivity is high. Moreover, higher productivity implies that the costs from the crowding effect of issuing debt are larger, because high z todays implies a high expected marginal product of capital tomorrow, so that an additional unit of investment would be turn into relatively high output, and therefore consumption, tomorrow. These two effects, that is, relatively higher interest rates on domestic debt, and higher costs from issuing domestic debt, makes this

type of debt less attractive to the government when productivity is high. This results into a countercyclical share of domestic debt, which is consistent with what we see in the data.

This mechanism explains the pecking order of default. When productivity is high, like in the period before defaulting on external debt (see Figure 6), the government has incentives to issue more external debt than domestic because it is relatively cheaper and it does not crowd out capital at a time where investment in capital is very valuable. Then, a drop in productivity will induce defaulting only on external debt because defaulting on domestic debt is more costly, and the share of domestic debt is low.

On the other hand, if productivity is already low, like in the period before defaulting on both domestic and external debt, the price of external debt becomes more expensive due to a relatively higher probability of defaulting on external than on domestic debt. Moreover, both the crowding cost and the interest rates from issuing domestic debt are lower than when productivity is high. Therefore, the government starts issuing a higher share of domestic debt. Then, when there is a sharp decrease in productivity the government has to default on both types of debt, because, given the low shares of external debt, defaulting on foreign creditors is not enough to solve the financing problems of the government.

7 Conclusions

The key motivation for my work is the evidence that the aggregate fluctuations and default rates in emerging market economies are not driven solely by internal shocks, as is typically assumed, but also by external shocks, such as movements in world interest rates. I argue that a serious omission of the existing work is the link between financial development, the share of domestic debt, and the vulnerability of developing economies to fluctuations in world interest rates.

I have shown that empirically, countries that are less financially developed, as measured by their deposit to output ratio, have low shares of domestic government debt to externally issued government debt. Such countries are also more vulnerable to fluctuations in world interest rates.

I developed a model consistent with all these features. By embedding a financial intermediation sector into an otherwise standard model of sovereign default, I have a way to naturally model financial development as a strengthening of the ability of enforce contracts as measured by a parameter governing the tightness of the resulting collateral constraint. As this ability to enforce contracts increase so does the share of domestic debt and, through

the equilibrium, the vulnerability to external shocks decreases. Comfortingly, the model naturally also produces other key features of the data: the pecking order of default and the countercyclicality of the domestic debt share.

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Appendix

A. Proof Lemma 1

Consider the recursive formulation of the bank problem. To write the problem of the bank it is sufficient to have as an individual state variable its net worth, n. Then, the value of a bank that after the realization

$$V^b(n;S) = \beta \max_{k',b',d'} \mathbb{E}\left[(1-\sigma)n' + \sigma V^b(n';S')\right] \tag{20}$$

subject to the budget constraint

$$k' + q(S)b' - q^D d' \leq n \tag{21}$$

collateral constraint,

$$d' = \theta n \tag{22}$$

and, evolution of net worth

$$n' = R_K(S')k' + \delta(S')b' - d' \tag{23}$$

Given that the constraint always binds, we can substitute d' into the budget constraint:

$$k' = (1 + q^D\theta)n - q(S)b'$$

and this into the evolution of net worth:

$$n' = \left(\delta(S') - R_K(S)q(S)\right)b' + \left(R_K(S)(1+q^D\theta)n - \theta\right)n$$

Guess that the value function is linear in n. Then, the problem for the bank is:

$$V(n,S) = \beta \max_{b'} \mathbb{E}\left\{(1-\sigma+\sigma\nu(S'))\left[\left(\delta(S') - R_K(S)q(S)\right)b' + \left(R_K(S)(1+q^D\theta) - \theta\right)n\right]\right\}$$

Taking first order condition with respect to b':

$$\mathbb{E}\left[(1-\sigma+\sigma\nu(S'))\left(\delta(S') - R_K(S)q(S)\right)\right] = 0$$

so,

$$\frac{\mathbb{E}\left[(1-\sigma+\sigma\nu(S'))\,\delta(S')\right]}{q(S)} = \mathbb{E}\left[(1-\sigma+\sigma\nu(S'))\,R_K(S)\right]$$

Substitute first order condition into the right hand side of the value of the bank:

$$\begin{aligned} V(n,S) &= \beta \mathbb{E}\left\{(1-\sigma+\sigma\nu(S'))\left[\left(R_K(S)(1+q^D\theta)-\theta\right)n\right]\right\} \\ &= \nu(S)n \end{aligned}$$

where, given $q^D = \beta$:

$$\nu(S) = \beta \mathbb{E}\left\{(1-\sigma+\sigma\nu(S'))\left[(R_K(S)(1+\beta\theta)-\theta)\right]\right\}$$

B. Data description

I focus on the following sample of countries: developing countries since 1965 for which we have data on the main variables of interest. I use the classification of the IMF to distinguish between developed and developing countries.

Domestic debt share. I use the data on domestic debt shares from Reinhart and Rogoff (2011). Their data comes from the UN Department of Economic Affairs Statistical Yearbooks until 1983, and they extend their data post-1983 using different sources for each country from historical statistical compendiums, or individual scholars collections. The definition of domestic public debt is government debt issued under home legal jurisdiction.

Domestic and external defaults. Reinhart and Rogoff (2011) provide a classification of default events between defaults that were only on external debt, and defaults that involved both domestic and external debt. Their definition of external sovereign default is the standard one: failure to meet principal or interest payment on the due date, or episodes involving rescheduled debt in less favorable terms. The definition for overt defaults is the same but involving both domestic and external debt. Moreover, it is also considered a domestic default cases that involved the freezing of bank deposits and or forcible conversion of deposits.

C. International interest rate shocks: United States vs. Emerging Economies

Figure 7: Output Response to a 100 bp increase in the U.S. interest rate