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Consumption Baskets and Currency Choice in International Borrowing

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Abstract

Most emerging markets do not borrow much internationally in their own currency, although doing that has been argued as an attractive insurance mechanism. This phenomenon, commonly labeled "the original sin", has mostly been interpreted as evidence of the countries' *inability* to borrow in domestic currency from abroad. This paper provides a novel explanation for that phenomenon: not that countries are unable to borrow abroad in their currency, they might not need to do so. In the model, the small prevalence of external borrowing in domestic currency arises as an equilibrium outcome, despite the absence of exogenous frictions or limits on market participation. The equilibrium outcome is driven by the fact that domestic and foreign lenders have differential consumption baskets. In particular, a large part of domestic lenders' consumption basket is denominated in domestic currency whereas all of foreign lenders' is in dollars. A depreciation of domestic currency, which tends to occur in bad times, is therefore less harmful to domestic savers than to foreign investors. This makes domestic lenders require a lower premium than foreign lenders on domestic currency debt. For plausible calibrations, this consumption basket effect can induce foreign investors to pull out of the domestic currency debt market.

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1 Introduction

Most developing countries do not borrow much internationally in their local currencies (Lane and Shambaugh 2010). Out of 93 low and middle income countries in Lane and Shambaugh's dataset, an overwhelming majority have 0% of their foreign debt liabilities denominated in domestic currencies. Only 4 of them have more than 1%: South Africa (6.5%), Uruguay (2.5%), Thailand (1.8%) and Slovak Republic (1.4%). This may seem puzzling because local currency borrowing is generally seen as a good hedging strategy for a small open economy. In bad times, local currencies usually depreciate, which benefits issuers of local currency bonds who pay back less in real terms. As local currency bonds pay less in bad times and pay more in good times, local currency debt provides insurance against domestic income risk to borrowers. In practice however, we observe very little international borrowing in local currencies. This lack of external local currency borrowing is a longstanding puzzle in international finance and has mostly been interpreted as evidence of developing and emerging countries' *inability* to borrow internationally in their own currency (Eichengreen and Panizza 2005).

This paper contributes to the literature by offering a new explanation for this phenomenon. It argues that countries may not need to borrow abroad in their domestic currencies (e.g. pesos). More precisely, local savers-lenders might be able to lend to domestic firms in pesos at a lower premium than foreigners can. Local workers-savers might accept a lower currency premium on peso bonds because a large part of their consumption basket is denominated in pesos. In a downturn, the lower return on peso-bonds can be less harmful to local workers-savers than to foreign lenders because the former spend a significant part of their current expenditures on non-tradable goods and services in pesos, while the latter have a consumption basket consisting of dollar-denominated goods only. This largely peso-denominated basket can effectively reduce the premium demanded by local savers on peso debt, and in particular can bring this premium down to a level where foreign investors might be pushed out of the peso-bond market. The marginal prevalence of external peso borrowing is thus not the outcome of an exogenously imposed financial friction or limit on market participation, but it rather arises endogenously as an equilibrium outcome.

Our model predicts that the relative willingness of local vs. foreign lenders to hold peso-bonds depends on the degree of synchronization (i.e. correlation) between a country's business cycle and the global economic conditions. If foreign lenders' income from other sources is orthogonal to the developing country's business cycle, foreign

lenders do not require a high premium for holding peso-bonds, thereby pushing local savers, whose income necessarily co-varies with the domestic business cycle, out of the market. Foreign lenders in this case, by lending in pesos, effectively act as an insurer to the small country. This is precisely the rationale of the existing literature on why small countries should borrow in their domestic currencies. On the other hand, when foreign lenders' income is more positively correlated to the small economy's country risk, foreign lenders' incentive to hold peso-bonds declines. And if the "consumption basket" effect is large enough, domestic lenders are more willing to hold peso bonds than foreign lenders.

Besides offering a theory of the currency composition of external borrowing, the paper also sheds light on the determinants of currency choice in domestic credit markets. In line with the earlier work of Ize and Levy-Yeyati (2003), our model emphasizes the relative importance of nominal v.s. real shocks in explaining the extent of domestic financial dollarization. With the presence of real (i.e. productivity) shocks, equilibrium peso-lending arises endogenously in our environment because it enables risk sharing between highly exposed entrepreneurs and relatively less exposed worker-savers. The basic mechanism is as follows: suppose there is a negative shock to the productivity of the country's tradable sector. The tradable good becomes more scarce, and the non-tradable good becomes relatively abundant. Since the international (dollar) price of the tradable good is given, this implies a depreciation of the peso. As the same time, entrepreneurs, as residual claimants, absorb much of the loss and are relatively worse off than workers-savers. Since peso bonds pay less due to the depreciation, peso lending from workers-savers serves as a form of insurance from workers-savers, who are less exposed to the real shocks, to entrepreneurs, who are more so. Note that we assume nominal price stickiness in the non-tradable sector.[1] The role of nominal rigidity is important here, because otherwise in a perfectly competitive and flexible price environment, the impact of the shocks would be proportionately shared between entrepreneurs and workers, and they would be similarly exposed to shocks. This would eliminate the role of peso-lending as an insurance instrument, and lead to a counterfactual result that domestic lending is mostly in dollars.

The impact of nominal shocks on income and consumption, on the other hand, is small, relative to the impact on peso bonds' return. This implies a small amount of peso lending is sufficient to hedge against the nominal shock. This limits the need for

[1]This assumption is broadly consistent with the empirical findings of Burstein, Eichenbaum, and Rebelo (2005).

peso lending as an insurance mechanism. Our model thus predicts a higher prevalence of domestic lending in pesos when real shocks are the dominant source of uncertainty, but a higher share of financial dollarization in environments with larger nominal risks, consistently with the empirical evidence presented in Ize and Levy-Yeyati (2003).

The literature offers three main explanations why countries borrow in dollars. The first is the moral hazard hypothesis. Krugman (1998) and Schneider and Tornell (2004) show that private agents take on risky forms of finance such as dollar debt to take advantage of bailout guarantees. However, Eichengreen and Hausmann (1999) argue that this cannot satisfactorily explain the high level of dollar debt that could be observed in firms that were unlikely to be bailed out. The second line of explanation is the "original sin" hypothesis, by Eichengreen and Hausmann (1999) and their subsequent papers. They argue that markets for emerging market local currency debt do not exist because lenders are afraid that the borrowers will manipulate the exchange rate. Hence any ex-ante risk premium is potentially insufficient if the exchange rate depreciation is large enough. Related to this, Jeanne (2003) suggests that the "original sin" is the result of a lack of credibility in domestic monetary policy that makes borrowers unsure about the real value of their domestic currency debt and decide to dollarize their liabilities instead. The third line of explanation is due to Korinek (2009), who argues that financial accelerator effects create an externality that induces individual borrowers to undervalue the social risks of dollar debt and take on too much of it.

In relation to the literature, our explanation does not rely on any particular friction. It rests on the insight that domestic agents' consumption basket, which is comprised in large part of non-tradable goods, is more favorable than foreign lenders's in terms of peso risk. Hence, domestic lenders can afford a lower risk premium of peso bonds. Unlike the existing literature that tends to treat a developing country as a single borrowing agent, we examine separately the problem of domestic borrowers (usually firms) and that of domestic lenders. Doing this helps us identify differential consumption baskets as another factor that works toward explaining heavy dollarization in international debt markets. We describe in detail the mechanism in a framework of a DSGE model. The model features three agents (domestic workers-savers, entrepreneurs, foreign lenders), two sectors (tradable and non-tradable goods) with sticky prices and wages and endogenous debt currency choices. All agents can borrow and lend in the domestic currency (i.e. the peso) or in a foreign currency (i.e. the dollar). We extend the new solution method developed by Devereux and Sutherland (2010)

and Tille and van Wincoop (2010) to solve for the long run currency choice of workers, entrepreneurs and foreign lenders in a three-agent, two-asset DSGE setup with incomplete markets.

The paper is organized as follows: section 2 describes the model. Section 3 presents the solution of the model. Section 4 analyzes a special case when international borrowing is entirely in dollars. Section 5 analyzes the full-fledged model. And finally section 6 concludes.

2 The model

The framework: In this section we describe a model with a small economy and a set of foreign lenders. Foreign lenders are risk averse, and can choose between dollar and peso bonds. The small economy is populated by a continuum of workers-savers and a continuum of entrepreneurs. Both types of agents consume two goods: a good that can be exchanged with the rest of the world (a tradable good) and a good whose consumption is enjoyed by domestic agents only (a non-tradable good). Both the tradable sector and the non-tradable sector employ labor and make use of a non-traded fixed factor (i.e. capital or land) owned by entrepreneurs. Agents can transfer wealth across periods using money, domestic currency bonds (i.e. peso bonds) and foreign currency bonds (i.e. dollar bonds). The environment features *nominal rigidities* in the labor market and in the non-tradable goods market while tradable goods' nominal prices are flexible[2]. We also assume that the law of one price holds, thus the real price (i.e. dollar price) of the tradable good is driven by its international price. As a standard convention in New Keynesian models, nominal rigidities in the non-tradable sector are modeled by dividing the sector into monopolistic intermediate good producers and competitive retailers. We would like to analyze a situation in which workers-savers lend to the entrepreneur sector of the economy, yet we refrain from modeling capital accumulation for tractability reasons. Thus we essentially assume capital is fixed. In order to induce the desired pattern of credit in the economy, we assume that entrepreneurs discount the future more strongly than workers. As a result, relatively impatient entrepreneurs borrow from relatively patient workers in equilibrium.

Entrepreneurs: Entrepreneurs carry out production in both tradable and non-tradable sectors. To model nominal rigidities in the non-tradable market, we separate

[2]Throughout this paper, nominal prices refer to prices in pesos, and real prices refer to prices in dollars

the non-tradable sector into intermediate good producers (entrepreneurs) and retailers. Entrepreneur j produces a differentiated intermediate non-tradable good y_{Njt} using labor L_{jt}^N according to

$$y_{Njt} = \left(L_{jt}^N\right)^{1-\alpha},$$

where α is the share of capital in intermediate non-tradable goods production. The labor input L_{jt}^N is purchased from a competitive employment agency and represents an aggregate of differentiated labor supplied by workers. Entrepreneurs sell their output to competitive retailers who combine these intermediate goods to produce final goods using a constant elasticity of substitution (CES) production function

$$Y_{Nt} = \left[\int_0^1 y_{Njt}^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}},$$

where ω is the elasticity of substitution between any two differentiated intermediate non-tradable goods.

Besides carrying out non-tradable intermediate production, entrepreneurs also run tradable goods production. Entrepreneur j hires aggregated labor L_{jt}^T to produce a tradable good sold on a perfectly competitive market. The production function takes the form

$$y_{Tjt} = A_t^T \left(L_{jt}^T\right)^{1-\eta},$$

where η is the share of capital in tradable goods production.

Entrepreneurs, who act as monopolistically competitive suppliers on the intermediate non-tradable goods market, set the price of their good one period in advance and commit to supply retailers at this price. In period t, entrepreneurs' production decisions consist of setting the price of their non-tradable intermediate good P_{Njt+1} and choosing how much labor L_{jt}^T to hire for tradable good production. In addition, entrepreneurs also choose tradable consumption c_{Ejt}^T, non-tradable consumption c_{Ejt}^N, real dollar bond holdings f_{Ejt}, nominal peso bond holdings B_{Ejt} and money holding M_{Ejt}. Entrepreneur j's expected life-time utility is given by

$$E_0 \sum_{t=0}^{\infty} \psi_t^E \left[\ln\left(c_{Ejt}\right) + \chi \ln\left(\frac{M_{Ejt}}{P_t}\right)\right].$$

Entrepreneurs maximize their expected discounted lifetime utility function, which includes aggregate consumption c_{Ejt} and real cash holdings $\frac{M_{Ejt}}{P_t}$ (P_t is the nominal

price of the tradable good). Aggregate consumption $c_{Ejt} \equiv \left(c^T_{Ejt}\right)^{\gamma}\left(c^N_{Ejt}\right)^{1-\gamma}$ is a CES consumption bundle of tradable and non-tradable goods, $\psi^E_t \equiv (\phi\beta)^t \Pi^t_{k=0} c^{-\mu}_{Ek}$ is an endogenous discount factor that depends on the aggregate (economy-wide) level of entrepreneurs' consumption. As in Schmitt-Grohe and Uribe (2003), this is a simple technical device to induce uniqueness of the deterministic steady state and stationary responses to temporary shocks. Specifically, the endogenous discount factor decreases with the aggregate consumption, which the representative entrepreneur takes as given. In addition, μ is set very small so that in the short run, the deviations of the endogenous discount factor from the standard discount factor $\phi\beta$ are negligible (ϕ is the relative impatience of the entrepreneurs). Entrepreneurs face a sequence of budget constraints

$$\begin{aligned} P_t c^T_{Ejt} + P_{Nt} c^N_{Ejt} + B_{Ejt} + P_t f_{Ejt} + M_{Ejt} = R_t B_{Ejt-1} + R^* P_t f_{Ejt-1} + M_{Ejt-1} \\ + P_{Njt} A^N_t \left(L^N_{jt}\right)^{1-\alpha} + P_t A^T_t \left(L^T_{jt}\right)^{1-\eta} - W_t \left(L^N_{jt} + L^T_{jt}\right) + T_{Ejt}, \end{aligned}$$

where P_{Nt} is the nominal price of the final non-tradable good, P_t is the nominal price of the final tradable good, W_t is the price of aggregated labor, R^* is the exogenous return on dollar bonds, R_t is the return on peso bonds, f_{Ejt} and B_{Ejt} are dollar and peso borrowing of the entrepreneurs, and T_{Ejt} is a government transfer. We rewrite the budget constraint in terms of the tradable good:

$$\begin{aligned} c^T_{Ejt} + p_{Nt} c^N_{Ejt} + b_{Ejt} + f_{Ejt} + \frac{M_{Ejt}}{P_t} = R_t b_{Ejt-1} \frac{P_{t-1}}{P_t} + R^* f_{Ejt-1} + \frac{M_{Ejt-1}}{P_t} \\ + p_{Njt} A^T_t \left(L^N_{jt}\right)^{1-\alpha} + A^T_t \left(L^T_{jt}\right)^{1-\eta} - w_t \left(L^N_{jt} + L^T_{jt}\right) + \frac{T_{Ejt}}{P_t}, \end{aligned} \tag{1}$$

where $p_{Nt} \equiv \frac{P_{Nt}}{P_t}$ is the real exchange rate, $b_{Ejt} \equiv \frac{b_{Ejt}}{P_t}$ is the real amount of peso bonds and $w_t \equiv \frac{W_t}{P_t}$ is the real wage in terms of the tradable good.

Entrepreneurs also face a sequence of constraints given by retailers' demand for their non-tradable intermediate good

$$\left(L^N_{jt}\right)^{1-\alpha} = \left(\frac{P_{Njt}}{P_{Nt}}\right)^{-\omega} Y_{Nt}.$$

The first-order conditions of the entrepreneurs' problem, after imposing symmetry, are presented in Appendix A.

Local workers-savers. Workers-savers supply labor to competitive employment

agencies that aggregate differentiated labor using a CES technology

$$L_t = \left[\int_0^1 L_{it}^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}},$$

where i indexes workers-savers and θ is the elasticity of substitution between any two types of differentiated labor. Worker i is a monopolistically competitive supplier of its individual labor and sets the nominal wage W_{it} one period in advance. In period t, worker sets his/her wage for the next period W_{it+1}, chooses tradable consumption c_{Hit}^T, non-tradable consumption c_{Hit}^N, real dollar bond holdings f_{Hit}, nominal peso bond holdings B_{Hit} and money holding M_{Hit}. Worker i's expected life-time utility is given by:

$$E_0 \sum_{t=0}^{\infty} \psi_t^H \left[\ln\left(c_{Hit}\right) + \chi \ln\left(\frac{M_{Hjt}}{P_t}\right) + \nu \ln(1 - L_{Hit})\right]$$

Workers' utility comprise of consumption, real money holdings and leisure. $c_{Hit} \equiv \left(c_{Hit}^T\right)^{\gamma}\left(c_{Hit}^N\right)^{1-\gamma}$ is a CES consumption bundle of tradable and non-tradable goods, and $\psi_t^H \equiv \beta^t \Pi_{k=0}^t c_{Hk}^{-\mu}$ is an endogenous discount factor that depends on the aggregate (economy-wide) level of workers' consumption. Workers-savers face a sequence of budget constraints

$$P_t c_{Hit}^T + P_{Nt} c_{Hit}^N + B_{Hit} + P_t f_{Hit} + M_{Hit} = R_t B_{Hit-1} + R^* P_t f_{Hit-1} + M_{Hit-1} + W_{it} L_{it} + T_{Hit},$$

where T_{Hit} is a government transfer. Rewrite the budget constraint:

$$c_{Hit}^T + p_{Nt} c_{Hit}^N + b_{Hit} + f_{Hit} + \frac{M_{Hit}}{P_t} = R_t b_{Hit-1} \frac{P_{t-1}}{P_t} + R^* f_{Hit-1} + \frac{M_{Hit-1}}{P_t} + w_{it} L_{it} + \frac{T_{Hit}}{P_t}, \tag{2}$$

where $b_{Hjt} \equiv \frac{b_{Hjt}}{P_t}$ is the real amount of peso bonds. Workers-savers also face a sequence of constraints given by employment agencies' demand for their labor type

$$L_{it} = \left(\frac{W_{it}}{W_t}\right)^{-\theta} L_t.$$

The first-order conditions of the workers-savers' problem, after imposing symmetry, are also in Appendix A.

The markets for the continuum of non-tradable intermediate goods and for the continuum of differentiated labor inputs are summarized in Figure 1.

Fundamentals: We consider two distinct sources of uncertainty in the economy: real

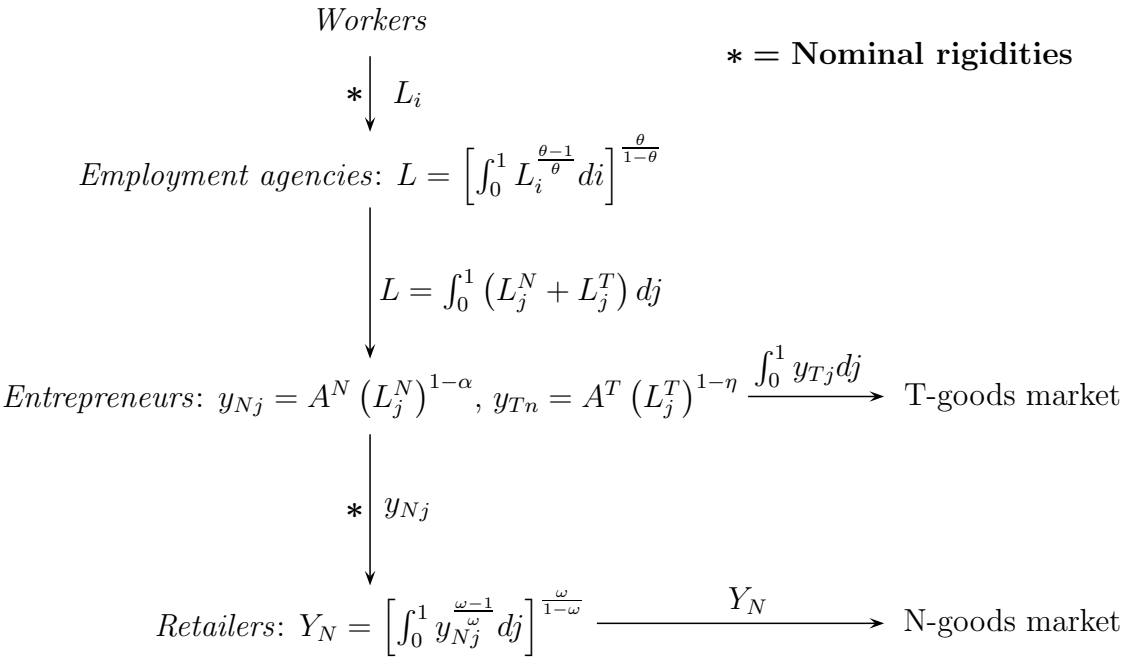

Figure 1: Production structure and nominal rigidities: W_i and P_{Nj} are set one period in advance by workers and entrepreneurs, respectively.

shocks and nominal shocks. Real shocks are assumed to cause random fluctuations in the productivity of the tradable sector, while monetary shocks cause fluctuations in the money supply. We abstract from the role of fluctuations in the productivity of the non-tradable sector, as those are empirically less relevant than their tradable sector counterparts. The log of tradable productivity and of the money supply follow the processes

$$\ln(A_t^T) = \rho_T \ln(A_{t-1}^T) + \epsilon_{Tt}, \tag{3}$$

$$\ln(M_t) = \rho_M \ln(M_{t-1}) + \epsilon_{Mt}. \tag{4}$$

where ρ_T and ρ_M are autoregressive coefficients, and ϵ_t^T and ϵ_t^M are i.i.d. random variables with variance σ_T^2 and σ_M^2, respectively.

Foreign lenders: Foreign lenders are assumed to be small and risk-averse. This is a crucial deviation from the literature. This assumption reflects the fact that due to information barriers and other reasons, foreign investors can only invest in a few foreign markets, and therefore are affected by the investment's performance in those markets.[3]

[3]For example, Didier, Rigobon, and Schmukler (2010) finds that U.S. equity mutual funds that

They have a stochastic endowment of tradable goods in every period. Foreign lenders have access to dollar and peso bond markets. In addition to the loan market of the small country, foreign lenders can also borrow or lend in dollars to the rest of the world at the exogenous rate R^*. Foreign lenders face a sequence of budget constraints

$$c_{Ft} + b_{Ft} + f_{Ft} + d_{Ft} = R_t b_{Ft-1} \frac{P_{t-1}}{P_t} + R^* f_{Ft-1} + R^* d_{Ft-1} + y_{Ft}, \tag{5}$$

where y_t is endowment that follows an exogenous process:

$$\ln(y_{Ft}) = \rho_y \ln(y_{Ft-1}) + \epsilon_{yFt},$$

and f_{Ft} and $b_{Ft} \equiv \frac{B_{Ft}}{P_t}$ are dollar and real peso loans from the foreign lenders to the domestic country, d_{Ft} is the dollar loan to the rest of the world.

A foreign investor's expected life-time utility is given by

$$E_0 \sum_{t=0}^{\infty} \psi_t^F \ln c_{Ft},$$

where $\psi_t^F \equiv \beta^t \Pi_{k=0}^t \left(\frac{c_{Ft}}{\tau}\right)^{-\mu}$ is an endogenous discount factor that depends on the aggregate level of foreign lenders' consumption.

First-order conditions for foreign lenders are as follows:

$$\frac{1}{c_{Ft}} = \beta \left(\frac{c_{Ft}}{\tau}\right)^{-\mu} R^* E_t \frac{1}{c_{Ft+1}} \tag{6}$$

$$\frac{1}{c_{Ft}} = \beta \left(\frac{c_{Ft}}{\tau}\right)^{-\mu} R_{t+1} P_t E_t \frac{1}{c_{Ft+1} P_{t+1}} \tag{7}$$

Note that since R^* will be set equal $\frac{1}{\beta}$, (6) implies that in the steady state, $c_F = \tau$, which we will set to a reasonable value.

Markets. Besides the markets for the continuum of non-tradable intermediate goods and for the continuum of differentiated labor inputs, there are four markets in the model. First, there is a market for the final non-tradable good, where demand from households and entrepreneurs has to equate supply from retailers:

$$c_{Ht}^N + c_{Et}^N = A_t^N \left(L_t^N\right)^{1-\alpha},$$

where we have used the symmetry of the non-tradable sector ($L_t^N = L_{jt}^N$ for all j).

operate globally only invest in a surprisingly limited number of stock, around 100.

Second, on the market for aggregated labor, entrepreneurs' demand for the tradable and non-tradable sector has to match households' supply:

$$L_t^T + L_t^N = L_t,$$

where we have used the symmetry of the household sector ($L_t = L_{it}$ for all i). Third, the net peso bond demand from local savers and entrepreneurs and foreign investors equals to zeros

$$b_{Ht} + b_{Et} + b_{Ft} = 0.$$

In other words, the demand for peso bonds (i.e. peso lending) stemming from domestic and international lenders has to equal the supply of peso bonds (i.e. peso borrowing) of the entrepreneurial sector.

Finally, there is the tradable goods market on which demand for tradable consumption by workers and entrepreneurs has to match domestic tradable goods production and imports from abroad (financed via current account imbalances). Define the entrepreneurs' and workers' net worth as $a_{Et} \equiv f_{Et} + b_{Et}$ and $a_{Ht} \equiv f_{Ht} + b_{Ht}$, the tradable market good clearing implies:

$$c_{Et}^T + c_{Ht}^T + a_{Et} + a_{Ht} = R_t^*(f_{Et-1} + f_{Ht-1}) + \left(R_t \frac{P_{t-1}}{P_t}\right)(b_{Et-1} + b_{Ht-1}) + A_t^T (L_t^T)^{1-\eta} \quad (8)$$

3 Solution of the model and a numerical exercise

3.1 Solving for the long-run currency choice

It is well-known that up to the first-order approximation, the values of the portfolio choices are indeterminate, because at this level of approximation, the two assets are perfect substitutes. Previous literature usually relies on perfect market structures that make portfolio choice irrelevant.

We log-linearize the model around the steady state and extend the method of Devereux and Sutherland (2010) and Tille and van Wincoop (2010) to solve for the long run currency choices of workers, entrepreneurs and foreign lenders. Details are presented in Appendix B.

In essence, workers, entrepreneurs and foreign lenders choose optimal levels of peso loans to cross-insure, that is, the covariance between the difference in their consumption and the peso-dollar bond return differential is zero. In the first-order approximation,

the conditions are the following:

$$E_t[(\hat{r}^B_{t+1} - \hat{R}^*)(\hat{c}^T_{Ht+1} - \hat{c}^T_{Et+1})] = 0 \tag{9}$$

$$E_t[(\hat{r}^B_{t+1} - \hat{R}^*)(\hat{c}_{Ft+1} - \hat{c}^T_{Et+1})] = 0, \tag{10}$$

where $r^B_{t+1} \equiv R_{t+1}\frac{P_t}{P_{t+1}}$ is the real return of the peso bond next period.

3.2 Calibrations

In the numerical exercise, the values of the discount factor and the parameters for the utility function $\beta, R^*, \gamma, \chi, \nu$ are set as standard. We also choose reasonable values for the parameters of the stochastic processes $\rho_T, \rho_M, \rho_{yF}, \sigma_T, \sigma_M, \sigma_{yF}$ and $\bar{M}$. Note that we assume the money supply is more volatile than the technological process of the tradable sector. The elasticities of substitution ω and θ are in line with the literature (for example, see Chugh (2006)). We also set the endogenous discount factor coefficient μ small. This leaves the parameters of the production functions. We set $\eta = \frac{1}{3}$ and $\alpha = \frac{1}{4}$ since non-tradable production is less capital intensive. We set $A^T = 6$ to obtain a reasonable labor input (about 0.3 in the steady state). Then we choose A^N and ϕ to generate the levels of domestic lending and external debt to match those of Mexico (the average percentages of private credit to GDP and of external debt to GDP for Mexico in the last decade are both about 20%, according to the World Development Indicators). For the foreign lenders, we choose $\tau = c_F = 5$, about twice the average total consumption of the borrowing country (for the steady state values of entrepreneurs and workers' consumption, see table 2). We choose $y_{yF} = 5$. The full set of parameters is in Table 1.

3.2.1 Steady state

For the benchmark parameters above, the steady state values of the non-portfolio choice variables are in Table 2.

In the steady state, total output of the country (in terms of the tradable good) is 3.7689 (units). Total lending from domestic savers to entrepreneurs in terms of the tradable good is 0.9538, about 25.3% of total output. Total borrowing of domestic entrepreneurs is 1.9338. The net asset of the country is then -0.9801, about 26% of output. These figures match the averages of Mexico. Total labor supply is the sum of labor supplies in both sectors, which is 0.2932. This makes the (real) wage bill equal

β	Discount factor	0.97
ϕ	Entrepreneurs' relative impatience coefficient	0.99921
R^*	Dollar-bond interest rate	$\frac{1}{\beta}$
μ	Endogenous discount factor coefficient	0.001
γ	Consumption component (utility)	$\frac{1}{3}$
χ	Coefficient of the Utility from Money	0.05
ν	Coefficient of the Utility from Leisure	2.27
η	Share of capital in the tradable production	$\frac{1}{3}$
α	Share of capital in the non-tradable production	$\frac{1}{4}$
A^N	TFP of the non-tradable production	5.35
A^T	TFP of the tradable production	6
ω	Elasticity of input substitution for non-tradable production	10.5
θ	Elasticity of labor substitution	21
ρ_T	Persistence of the tradable productivity shocks	0.5
ρ_M	Persistence of the monetary shocks	0.5
σ_T	Standard deviation of the tradable productivity shocks	0.01
σ_M	Standard deviation of the monetary shocks	0.04
M	Long run money supply	1
$\tau = c_F$	Foreign consumption	5
y_F	Mean of foreigners' other income	5
ρ_F	Persistence of foreign income shocks	0.5
σ_{yF}	Standard deviation of foreign income shocks	0.01

Table 1: Values of benchmark parameters

2.5423, about 67.45% of GDP. The rest is then the profit of entrepreneurs. All of these figures seem reasonable.

4 A special case: No foreign lenders

This section considers a special case of the model, in which we do not model explicitly foreign lenders. Essentially, it means that the countries can borrow internationally inelastically in dollars, at an exogenous world interest rate. In effect, this is similar to standard small open economy models. Domestic borrowers and lenders can borrow and lend with each other in pesos and dollars, but international borrowing has to be done in dollars. Without explicit consideration of foreign lenders, we will be able to examine why local workers are willing to lend in pesos to entrepreneurs in the first place. We will show that productivity (i.e. real) shocks generate peso lending, and if monetary shocks are more prevalent than productivity shocks, domestic financial dollarization can persist.

To solve for the optimal currency portfolios of domestic lenders and borrowers, we follow the standard approach of Devereux and Sutherland (2010) and Tille and van Wincoop (2010)

L_N	Labor in the Non-tradable production	0.1950
L_T	Labor in the Tradable production	0.0981
Y_N	Non-tradable Output (units)	1.5701
Y_T	Tradable Output (units)	1.2765
p	Price of Non-tradable relative to Tradable	1.5874
$Y_T + p * Y_N$	Total Output in terms of tradable	3.7689
w	Real wage	8.6721
C_T^E	Tradable consumption of Entrepreneurs (units)	0.3889
C_T^H	Tradable consumption of Workers (units)	0.8573
C_T^E	Non-Tradable consumption of Entrepreneurs (units)	0.4900
C_N^H	Non-Tradable consumption of Workers (units)	1.0801
a^E	Net asset position of Entrepreneurs	-1.9338
a^H	Net asset position of Households	0.9538
a^H	Net asset position of the country	-0.9801

Table 2: Steady State Values

to solve for the long run currency choices of workers-savers and entrepreneurs. Essentially, the covariance between the difference in their consumption and the peso-dollar bond return differential is zero, as equation (9) implies:

$$E_t[(\hat{r}^B_{t+1} - \hat{R}^*)(\hat{c}^T_{Ht+1} - \hat{c}^T_{Et+1})] = 0$$

4.1 Zero peso loan

We start with the benchmark case in which no peso bond is allowed to trade in the domestic market, i.e. all of the domestic lending and borrowing are done in dollars. Essentially in this benchmark case, all lending and borrowing are done in dollars. This is to completely isolate income fluctuations from holding or issuing peso bonds. We will examine the impacts of monetary and real shocks on agents' income and consumption, and then on the real return of a *hypothetical* peso bond. From that, we will assess if holding or issuing peso bonds would provide a good hedge to the shocks.

First we consider the monetary shock. We consider a 1% decrease in the money supply and pay particular attention to changes in tradable consumption[4]. Figure 5 in the appendix shows the impulse responses to the shock. For all the variables, the y-axes represent *percentage* deviations from the steady state values. The first reaction is that both entrepreneurs and workers' consumption decline, but the declines are very small. The detailed responses are as follows: following the shock, the nominal price of

[4]Since the relative changes of non-tradable consumption are the same due to the Cobb-Douglas aggregator (see equations A1 and A2 in the appendix), we just need to look at the changes in tradable consumption

the tradable good goes down, while the nominal price of the non-tradable good remains unchanged due to nominal rigidity. This causes the real exchange rate- defined as the price of the non-tradable good divided by the price of the tradable good- to appreciate. In the first period, the real wage goes up because the nominal wage is sticky. After the first period, the real wage immediately goes back to the steady state level because agents then can adjust the nominal wage. Entrepreneurs respond to the higher real wage by employing less and producing lower output. Both income and consumption of workers and entrepreneurs decline. The magnitude of the decline, however, is small: the percentage changes of consumption are from 0.5×10^{-3} to 1.5×10^{-3} . On the other hand, the decrease in the nominal price of the tradable good, which is effectively the increase in the real return of a hypothetical peso bond, is much larger: 6×10^{-2}. This is important. This implies that a small amount of peso bond lending would be sufficient for workers and entrepreneurs to completely hedge against income fluctuations caused by monetary shocks.

Next we consider a 1% decrease in the productivity of the tradable production (Figure 6). We will see here that as opposed to the monetary shock, the magnitude of the real shock's impacts on income and consumption is similar to that of a hypothetical peso bond's return. This drives a larger need for domestic peso lending from domestic workers-savers to entrepreneurs as an insurance mechanism. Specifically, the responses of the economic variables are as follows: The decrease in tradable productivity shrinks the production of the tradable good and raises its price, both in nominal and relative terms: the real exchange rate depreciates. The production of the non-tradable good does respond, but only very mildly compared to the reduction of the tradable production. Both entrepreneurs and workers are worse off: their income and consumption fall. Workers' income decreases because their employment declines (in the tradable sector), and their real wage falls. Entrepreneurs also suffer: their production, particularly tradable production, falls significantly. They are more relatively worse off than workers: their consumption drops more. The changes in consumption of workers and entrepreneurs are about 6×10^{-2} (percentage).

On the other hand, a hypothetical peso bond would pay less because the price of the tradable good goes up: the percentage change is about 6×10^{-2}. We can see that unlike the case of monetary shocks, the changes in consumption and in the return of a hypothetical peso bond are of the same magnitude in response to real shocks. There is therefore a need for a larger quantity of peso bond lending to hedge against

income fluctuations caused by real shocks. In particular, since peso bonds pay less when entrepreneurs's consumption drops more, issuing peso bonds can provide a very good hedge for entrepreneurs to offset the relative declines in income and consumption. In other words, workers-savers who are less exposed to real shocks insure entrepreneurs who are more so[5].

From the two impulse responses, the main driving force that drives domestic lending in pesos is the productivity shocks to the tradable production. The reason is that productivity shocks have larger impacts on real variables such as income and consumption than nominal shocks do, which suggests a stronger role of peso bonds to insure against real shocks. The monetary shocks play a negligible role, implying a higher level of dollarized lending if monetary shocks are more prevalent. This is consistent with Ize and Levy-Yeyati (2003).

4.2 Equilibrium case: Optimal peso loan

Next, we will examine the equilibrium case, in which workers and entrepreneurs are allowed to borrow and lend in both dollars and pesos (international borrowing is still restricted entirely in dollars). The optimal mix of dollar and peso loans will give the agents perfect hedges against the shocks. That is, in the equilibrium, the covariance between the entrepreneurs-households consumption difference and the dollar-peso bond return differential is zero, as equation (9) indicates.

With our benchmark calibration, in the equilibrium, domestic savers lend 82.24% of their total lending in pesos. The rest is in dollars. Now consider a 1% decrease in productivity of tradable production (Figure 8 in the Appendix). Contrasting the impulse responses between the benchmark case (i.e. a zero peso loan) and the equilibrium case, one can see a difference in the agents' consumption. The gap in the change of workers and entrepreneurs' consumption is smaller now than that in the benchmark case, suggesting an insurance role of peso bonds in play. That is, smaller (real) repayments of peso-denominated bonds partly counteract entrepreneurs' relative declines in income and consumption in bad times.

Figure 8 indicates that peso bonds do not completely close the entrepreneurs-workers consumption gap when real shock hits: entrepreneurs are still relatively worse

[5]This is the opposite to the finding in the implicit contract literature, in which risk-neutral entrepreneurs use implicit contracts to insure risk-averse workers against fluctuations in their income. A crucial difference in this paper is that both entrepreneurs and workers-savers are risk averse and actively choose an optimal mix of dollar and peso bonds.

off than workers when a positive real shock hits. Does this imply that the amount of peso lending is still too little? In other words, why would entrepreneurs and workers not borrow and lend more in pesos? The intuition is the following: Entrepreneurs do not want to borrow more in pesos because they also desire to hedge against monetary shocks. As Figure 7 shows, in the equilibrium, the amount of peso loan is already too much to provide a perfect hedge against monetary shocks. As peso bonds pay more in response to a negative monetary shock, additional peso borrowing would make entrepreneurs' consumption decline further in response to a negative money supply shock. Therefore, the optimal peso loan in the equilibrium is the best compromised hedge against the two types of shocks, although it is not perfect against any individual one.

4.3 Monetary shocks v.s. Real shocks

In this section we investigate the relative importance of the monetary shocks and the real shocks in the formation of the domestic currency choice. We will show that as in Ize and Levy-Yeyati (2003), if the real shocks are more prevalent, there will be more peso lending; if the monetary shocks are more prevalent, there will be more dollar lending between firms and households (i.e. a higher degree of financial dollarization). In our model, if we change both the absolute volatilities of the shocks, but keep the relative volatility constant, the optimal amount peso loan would remain unchanged. In other words, absolute volatility does not matter. We will show that the relative volatility of the real shocks and the monetary shocks determines the optimal amount of the domestic peso loan.

It is probably already clear from the impulse exercises in sections 4.1 and 4.2 why real shocks generate more peso lending and reduce domestic financial dollarization. The reason is very simple: real shocks generate relatively larger impacts on income and consumption compared to impacts on peso bonds' return than monetary shocks do. Hence a larger amount of peso lending is required to hedge against income and consumption fluctuations caused by real shocks.

In the exercise, we keep the standard deviation of the real shocks at the benchmark value (0.01), and change the standard deviation of the nominal shocks from 0.001 to 0.1. Note that the standard deviations of the shocks only affect the long run optimal currency choice, they do not affect the steady state values of other variables.

Figure 2 presents the corresponding optimal peso loan. When the real shocks are

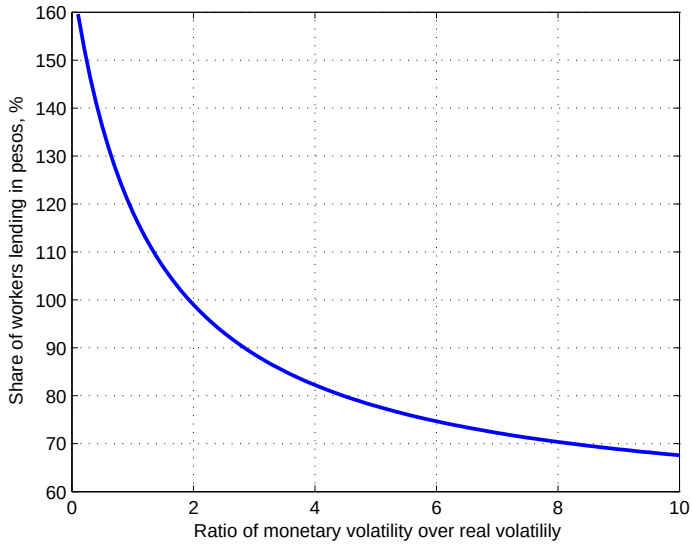

Figure 2: Optimal Peso loans, for different volatility of the monetary shocks

more volatile relative to the monetary shocks, the need for peso loans is high. As explained above, workers who are less exposed to the real shocks insure entrepreneurs who are more so. When the volatility of the monetary shocks is high relative to that of the real shocks, the optimal peso loan is smaller. In that case, the main concern of firms and households is monetary shocks, and a small amount of peso lending is sufficient to hedge against the shocks. Much of the lending between firms and households therefore is done in dollars. The result implies that chronical financial dollarization can persist even if inflation has been controlled. What matters is the relative volatility of inflation (monetary shocks) compared to that of productivity (real shocks). If the volatility of productivity happens to dampen down along with the decline of inflation shocks, the need for peso bonds continues to be weak.

5 The full model with foreign lenders

The previous section shows why domestic workers-savers lend in pesos to entrepreneurs: domestic workers-savers insure entrepreneurs against relative income and consumption fluctuations caused by the real shocks. This section considers the full-fledged model where we also include small, risk-averse foreign lenders who can lend/borrow in both dollars and pesos. In effect, all agents: entrepreneurs, domestic workers-savers and

foreign lenders can lend and borrow in both pesos and dollars. We will examine why domestic savers may afford a lower premium for peso bonds than foreign lenders can.

5.1 Zero peso loan

To understand the demand for peso bonds, we consider the impulse responses in the case of no peso loans. This is to isolate the impact of the shocks on agents' income and consumption from the return of peso loans. Subsequently, we will determine if a hypothetical peso bond could provide a good hedge against the income shocks. This scenario is similar to the one in section 4.1, except now we also examine the responses of foreign lenders, who are small and risk-averse.

First, we consider a 1% decrease in tradable productivity only, and focus on the relative consumption responses of domestic savers and foreign lenders. Notice that the y-axes represent *percentage* deviation from the steady state values, with one exception. The y-axis of the country's total borrowing (the upper right panel) represents absolute deviation from the steady state value (which is -0.9909). Figure 9 in the appendix shows the impulse responses to the shock. Domestic workers-savers' income goes down due to the lower employment and lower real wages, and that has an impact on their consumption. Income and consumption of domestic entrepreneurs also decline because of lower tradable production. Foreign lenders' income, however, does not change, since their endowment does not change and the dollar bonds' return is pre-determined. Additional borrowing (in dollars) from the country is accommodated by foreigners' additional borrowing from other sources (also in dollars). For those reasons, foreign lenders' consumption does not change.

The decline in tradable productivity on the other hand leads to an increase in the nominal price of the tradable good and a depreciation of the peso. With the depreciation, the return of a hypothetical peso bond would decline. Hence foreign lenders have incentives to offer peso loans, with a premium, to domestic agents to insure them against the real shock, because peso bonds pay less in bad times. This is the standard argument in the literature about why a country should borrow abroad in its domestic currency, if foreign lenders' income from other sources is orthogonal to the country's business cycle.[6]

[6] An additional assumption in the literature is that foreign lenders are large and risk-neutral, hence they have incentives to insure risk-averse domestic borrowers. In this paper, we make a crucial departing assumption that foreign lenders are small and also risk-averse.

If foreign lenders' income from other sources is more correlated to the country's business cycle, foreign lenders' incentive to hold peso-bonds declines. And if the "consumption basket" effect is large enough, domestic lenders can be more willing to hold peso bonds than foreign lenders. We can see this in the next exercise of impulse responses: we consider a 1% decrease in foreign lenders' endowment and a 1% decrease in domestic productivity shock at the same time. This is to illustrate the extreme case when the domestic economy is perfectly correlated to the world's business cycle. As we can see from figure 10, foreign lenders' consumption also falls significantly, indicating that peso lending would now be much less desirable for foreign lenders. Domestic savers may afford a lower peso premium than foreign lenders because they have a more favorable consumption basket: they consume mostly peso-denominated goods whose prices typically adjust slowly to shocks.

5.2 Optimal peso loan

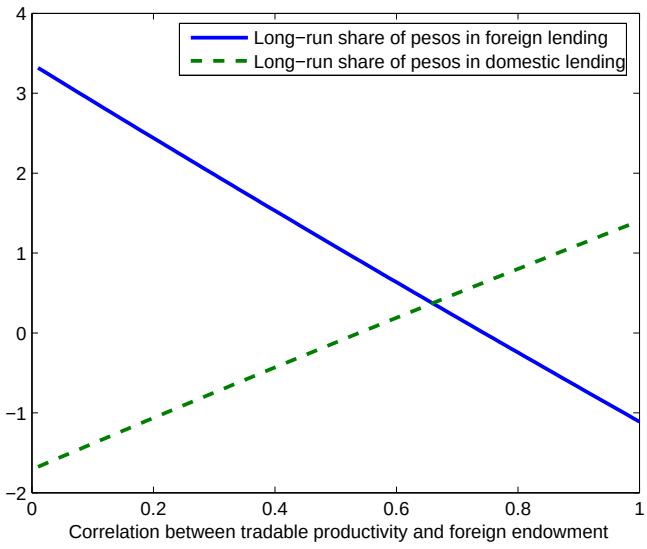

Figure 3: Shares of peso lending when the consumption basket has less non-tradable goods

In this section, we examine the equilibrium case for the full model, in which entrepreneurs, workers and foreign lenders can lend and borrow in pesos. We pay particular attention to the correlation between foreign endowment and the country's tradable productivity. Figure 3 below shows the long run peso shares when the correlation

changes. When the correlation is low (i.e. the country's business cycle is more independent to the world's), most of the peso lending is done by foreign lenders and they effectively insure the country. When the correlation is high however, the role of local savers' more favorable consumption basket becomes more dominant: local savers increasingly take on peso lending to domestic firms. When the correlation is larger than 0.75, foreign lenders no longer lend in pesos. Rather, in our numerical exercise, they borrow pesos from domestic savers. Domestic savers lend pesos to both domestic entrepreneurs and foreigners.

A simple numerical exercise indicates that favorable consumption baskets for domestic savers can go a long way in explaining international debt dollarization, without having to resort to market frictions.

When the consumption basket is more tilted toward non-tradable goods and less toward tradable goods, we should expect peso lending shifts even more to domestic savers. In the following exercise, we increase α from the benchmark value of 1/4 to 0.27, to make the non-tradable production less productive at each unit of labor input. As a result, in the steady state, the relative share of non-tradable output (compared to tradable output) is smaller than the benchmark case. Figure 4 below shows that now to induce foreign lenders stop lending in pesos, the correlation between foreign endowment and the country's tradable productivity has to be larger than 0.8, as opposed to 0.75 in the benchmark case.

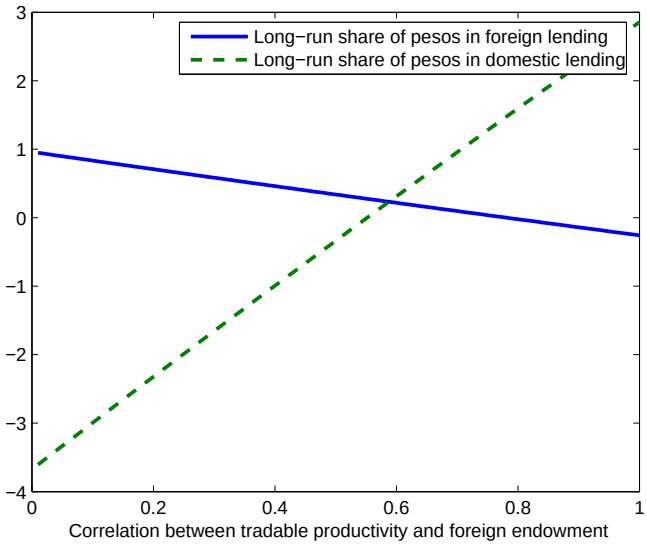

Figure 4: Shares of peso lending when the consumption basket has less non-tradable goods

6 Conclusion

This paper provides a new explanation of why developing countries may appear to be unable to borrow much internationally in their domestic currency. We argue that countries might not need to, as entrepreneurs can borrow in the domestic currency from domestic savers at a lower premium than they could from foreign lenders. Local savers might accept a lower risk premium than foreign lenders on local currency bonds because a large part of their consumption basket consists of non-tradable goods whose nominal prices typically adjust slowly to shocks. Therefore in downturn, a peso depreciation is less damaging to domestic peso bond holders than to foreign ones, whose consumption baskets are entirely in dollars.

We developed a simple DSGE model to provide a quantitative evaluation of the mechanism. The model features three agents (domestic workers-savers, entrepreneurs, and foreign lenders), two sectors (tradable and non-tradable goods) with sticky prices and wages and endogenous currency choice. We show that the relative willingness of local and foreign lenders to hold peso-bonds depends on the relative size of the non-tradable sector, and on the degree of synchronization between a country's business cycle and the global economic conditions. Our results indicate that differential consumption baskets can go a long way to explaining international debt dollarization,

without having to resort to market frictions. For example, in our numerical exercise, when the correlation between tradable productivity and foreign endowment is larger than 0.75, foreign lenders no longer lend in pesos. They find it optimal to lend entirely in dollars, or even borrow in pesos.

An extension of the model, which incorporates investment and an empirical test for the main results in this paper, is left for further research.

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A Appendix A

After imposing symmetry, optimal behavior by entrepreneurs is characterized by the following conditions:

$$\frac{P_{Nt}}{P_t} = \frac{1-\gamma}{\gamma}\frac{c^T_{Et}}{c^N_{Et}}, \tag{A1}$$

$$\frac{1}{c^T_{Et}} = \phi\beta c^{-\mu}_{Et} R^* E_t \frac{1}{c^T_{Et+1}}, \tag{A2}$$

$$\frac{1}{c^T_{Et}} = \phi\beta c^{-\mu}_{Et} R_{t+1} P_t E_t \frac{1}{c^T_{Et+1} P_{t+1}}, \tag{A3}$$

$$\frac{\gamma}{c^T_{Et}} = \chi\frac{P_t}{M_{Et}} + \phi\beta c^{-\mu}_{Et} P_t E_t \frac{\gamma}{c^T_{Et+1} P_{t+1}}, \tag{A4}$$

$$L^T_{jt} = \left(\frac{W_t}{P_t}\frac{1}{A^T_t(1-\eta)}\right)^{-\frac{1}{\eta}}, \tag{A5}$$

and

$$E_t \frac{1}{c^T_{Et+1}}\left[(1-\omega)\frac{Y_{Nt+1}}{P_{t+1}} + \frac{\omega}{1-\alpha}\frac{W_{t+1}L^N_{t+1}}{P_{t+1}P_{Nt+1}}\right] = 0. \tag{A6}$$

Equation (A1) is a static optimality condition describing the composition of the entrepreneur's consumption basket between tradable and non-tradable goods. Equations (A2), (A3) and (A4) are Euler equations for dollar bonds, peso bonds and money holdings. Equation (A5) is a labor demand equation, and (A6) is an optimal price setting condition.

After imposing symmetry, optimal worker-saver behavior is characterized by the

conditions

$$\frac{P_{Nt}}{P_t} = \frac{1-\gamma}{\gamma}\frac{c^T_{Ht}}{c^N_{Ht}}, \tag{A7}$$

$$\frac{1}{c^T_{Ht}} = \beta c^{-\mu}_{Ht} R^* E_t \frac{1}{c^T_{Ht+1}}, \tag{A8}$$

$$\frac{1}{c^T_{Ht}} = \beta c^{-\mu}_{Ht} R_{t+1} P_t E_t \frac{1}{c^T_{Ht+1} P_{t+1}}, \tag{A9}$$

$$\frac{\gamma}{c^T_{Ht}} = \chi \frac{P_t}{M_{Ht}} + \beta c^{-\mu}_{Ht} P_t E_t \frac{\gamma}{c^T_{Ht+1} P_{t+1}}, \tag{A10}$$

and

$$E_t\left[\frac{\gamma}{c^T_{Ht+1}}(1-\theta)\frac{L_{t+1}}{P_{t+1}} + \nu\theta\frac{L_{t+1}}{(1-L_{t+1})W_{t+1}}\right] = 0. \tag{A11}$$

As for entrepreneurs, equation (A7) is a static optimality condition describing the composition of the household's consumption basket between tradable and non-tradable goods. Equations (A8), (A9) and (A10) are Euler equations for dollar bonds, peso bonds and money holdings. Equation (A11) is an optimal wage setting condition.

B Appendix B: Solving for portfolio choices of entrepreneurs, workers and foreign lenders

This appendix presents the solution for the zero-order portfolio choices in the case where households and entrepreneurs trade both dollar bonds and peso bonds with foreign investors, and where we make the assumption that the foreign lenders are small and risk averse. Define the entrepreneurs' and households' real holdings of peso bonds as $b_{Et} \equiv B_{Et}/P_t$, $b_{Ht} \equiv B_{Ht}/P_t$ and $b_{Ft} \equiv B_{Ft}/P_t$ and their net worth as $a_{Et} \equiv f_{Et} + b_{Et}$, $a_{Ht} \equiv f_{Ht} + b_{Ht}$ and $a_{Ft} \equiv f_{Ft} + b_{Ft}$. The only equilibrium conditions of the model where these peso bond and net worth positions show up are the entrepreneurs' budget constraint, the foreign lenders' budget constraint and and the economy's resource constraint[7]. We rewrite the equations:

$$\begin{aligned} c^T_{Et} + p_{Nt} + c^N_{Et} + a_{Et} &= R^*_t a_{Et-1} + (R_t\frac{P_{t-1}}{P_t} - R^*_t)b_{Et-1} + p_{Nt}A^N_t(L^N_t)^{1-\alpha} \\ &\quad + A^T_t(L^T_t)^{1-\eta} - w_t(L^N_t + L^T_t). \end{aligned} \tag{B.1}$$

[7]The households' budget constraint can be obtained by combining these constraints.

and

$$c_{Ft} + a_{Ft} + d_{Ft} = R^* a_{Ft-1} + (R_t \frac{P_{t-1}}{P_t} - R_t^*) b_{Ft-1} + R^* d_{Ft-1} + y_{Ft} \tag{B.2}$$

and

$$c_{Et}^T + c_{Ht}^T + a_{Et} + a_{Ht} = R_t^*(a_{Et-1} + a_{Ht-1}) + \left(R_t \frac{P_{t-1}}{P_t} - R_t^* \right) (b_{Et-1} + b_{Ht-1}) + A_t^T (L_t^T)^{1-\eta} \tag{B.3}$$

Denote the first-order components of the excess return of the portfolio of entrepreneurs and households as $\epsilon_t^E \equiv b_E R(\hat{P}_{t-1} - \hat{P}_t + \hat{R}_t - \hat{R}_t^*)$ and $\epsilon_t^H \equiv b_H R(\hat{P}_{t-1} - \hat{P}_t + \hat{R}_t - \hat{R}_t^*)$. Following the approach of Devereux and Sutherland, we initially consider ϵ_t^E and ϵ_t^H to be exogenous i.i.d. random variables. The first-order approximations of the terms $(R_t \frac{P_{t-1}}{P_t} - R_t^*) b_{Et-1}$ in (B1), $(R_t \frac{P_{t-1}}{P_t} - R_t^*) b_{Ft-1}$ in (B2) and $\left(R_t \frac{P_{t-1}}{P_t} - R_t^* \right) (b_{Et-1} + b_{Ht-1})$ in (B3) are expressed by ϵ_t^E,$-(\epsilon_t^E + \epsilon_t^H)$ and $\epsilon_t^E + \epsilon_t^H$ respectively.

From this we can solve for the first order approximation of the model, with ϵ_t^E and ϵ_t^F as the two *iid* state variables. Rearranging terms gives us the first-order accurate solution for the excess return on peso bonds:

$$\hat{r}_{xt+1} = \theta_r^H \epsilon_{t+1}^H + \theta_r^E \epsilon_{t+1}^E + \theta_r \varepsilon_{t+1} \tag{B.4}$$

where ε_{t+1}=$[\epsilon_{Tt+1}\ \epsilon_{Mt+1}]$ is a vector of real and nominal shocks. Consumption differences between foreign lenders and entrepreneurs, and households and entrepreneurs, respectively are:

$$\hat{c}_{Ft+1} - \hat{c}_{Et+1}^T = \theta_{FE}^H \epsilon_{t+1}^H + \theta_{FE}^E \epsilon_{t+1}^E + \theta_{FE} \varepsilon_{t+1} + \tilde{\theta}_{FE} \hat{x}_t \tag{B.5}$$

$$\hat{c}_{Ht+1}^T - \hat{c}_{Et+1}^T = \theta_{HE}^H \epsilon_{t+1}^H + \theta_{HE}^E \epsilon_{t+1}^E + \theta_{HE} \varepsilon_{t+1} + \tilde{\theta}_{HE} \hat{x}_t \tag{B.6}$$

where $\hat{x}_t$ is a vector of endogenous state variables.

Recognizing that $\epsilon_{t+1}^H = b_H R \hat{r}_{xt+1}$ and $\epsilon_{xt+1}^E = b_E R \hat{r}_{xt+1}$, we substitute them back into (B4):

$$\hat{r}_{t+1} = \frac{\theta_r \varepsilon_{t+1}}{1 - \theta_r^H b_H R - \theta_r^E b_E R} \tag{B.7}$$

and (B5),(B6):

$$\hat{c}_{Ft+1} - \hat{c}^T_{Et+1} = (\theta^H_{FE} b_H R + \theta^E_{FE} b_E R) \frac{\theta_r \varepsilon_{t+1}}{1 - \theta^H_r b_H R - \theta^E_r b_E R} + \theta_{FE} \varepsilon_{t+1} + \tilde{\theta}_{FE} \hat{x}_t \quad \text{(B.8)}$$

$$\hat{c}_{Ht+1} - \hat{c}^T_{Et+1} = (\theta^H_{HE} b_H R + \theta^E_{HE} b_E R) \frac{\theta_r \varepsilon_{t+1}}{1 - \theta^H_r b_H R - \theta^E_r b_E R} + \theta_{HE} \varepsilon_{t+1} + \tilde{\theta}_{HE} \hat{x}_t \quad \text{(B.9)}$$

The idea is substitute (B8) and (B9) into second-order approximations of the Euler equations of workers, entrepreneurs and foreign lenders:

$$E_t[(\hat{c}_{Ft+1} - \hat{c}^T_{Et+1}) \hat{r}_{xt+1}] = 0 \quad \text{(B.10)}$$

$$E_t[(\hat{c}^T_{Ht+1} - \hat{c}^T_{Et+1}) \hat{r}_{xt+1}] = 0 \quad \text{(B.11)}$$

After substituting (B8) and (B9) into (B10) and (B11), they become:

$$\left[R b_H (\theta^H_{FE} \theta_r - \theta^H_r \theta_{FE}) + R b_E (\theta^E_{FE} \theta_r - \theta^E_r \theta_{FE}) + \theta_{FE} \right] \Sigma \theta'_r = 0 \quad \text{(B.12)}$$

$$\left[R b_H (\theta^H_{HE} \theta_r - \theta^H_r \theta_{HE}) + R b_E (\theta^E_{HE} \theta_r - \theta^E_r \theta_{HE}) + \theta_{HE} \right] \Sigma \theta'_r = 0 \quad \text{(B.13)}$$

where $\Sigma = E_t \varepsilon_{t+1} \varepsilon'_{t+1}$.

From the two equations above, we can derive b_E and b_F,as follows:

First, denote $a_1 \equiv R(\theta^H_{FE} \theta_r - \theta^H_r \theta_{FE}) \Sigma \theta'_r$, $a_2 \equiv R(\theta^E_{FE} \theta_r - \theta^E_r \theta_{FE}) \Sigma \theta'_r$, $a_3 \equiv \theta_{FE} \Sigma \theta'_r$; and $d_1 \equiv R(\theta^H_{HE} \theta_r - \theta^H_r \theta_{HE}) \Sigma \theta'_r$, $d_2 \equiv R(\theta^E_{HE} \theta_r - \theta^E_r \theta_{HE}) \Sigma \theta'_r$, $d_3 \equiv \theta_{HE} \Sigma \theta'_r$.

(B12) and (B13) become:

$$a_1 b_H + a_2 b_E + a_3 = 0 \quad \text{(B.14)}$$

$$d_1 b_H + d_2 b_E + d_3 = 0 \quad \text{(B.15)}$$

Hence,

$$b_E = \frac{a_1 d_3 - a_3 d_1}{a_2 d_1 - a_1 d_2} \qquad \text{and} \qquad b_H = \frac{a_2 d_3 - a_3 d_2}{a_1 d_2 - a_2 d_1}.$$

and $b_F = -(b_E + b_H)$

C Appendix C: Figures

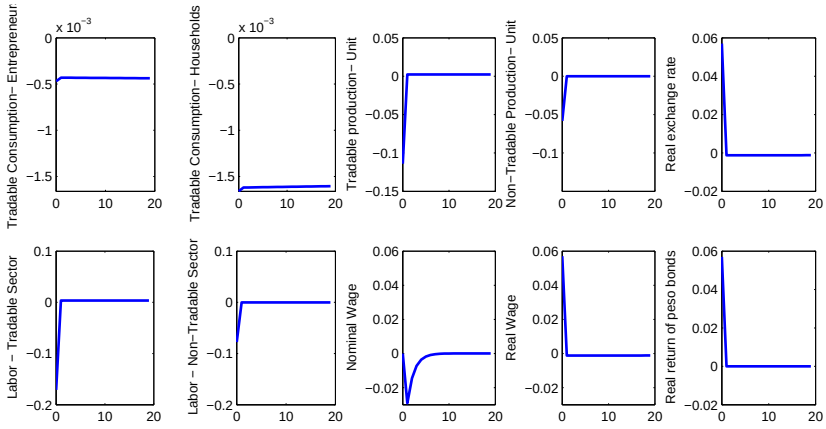

Figure 5: Impulse Responses to a 1% decrease in the Money Supply, Zero peso loan

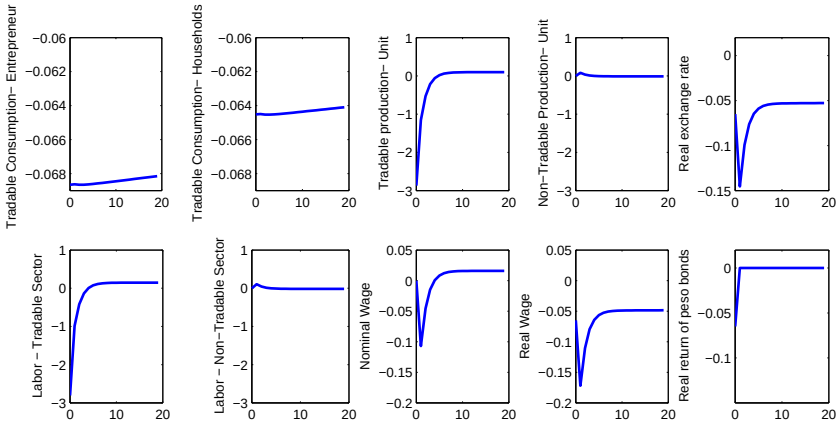

Figure 6: Impulse Responses to a 1% decrease in Productivity, Zero peso loan

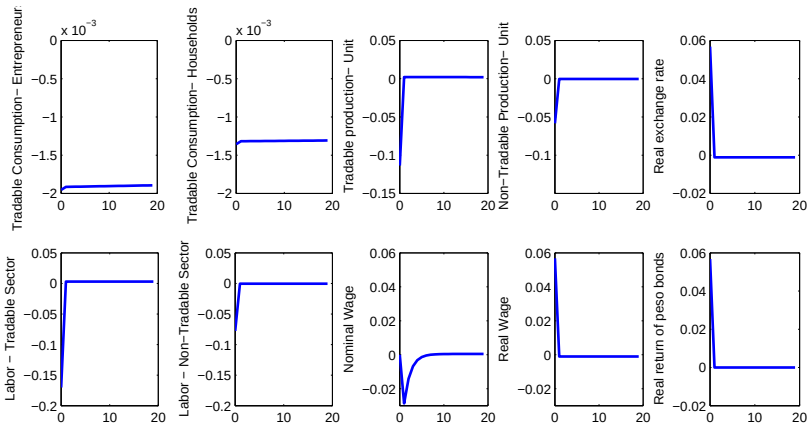

Figure 7: Impulse Responses to a 1% decrease in the money supply, optimal peso loan

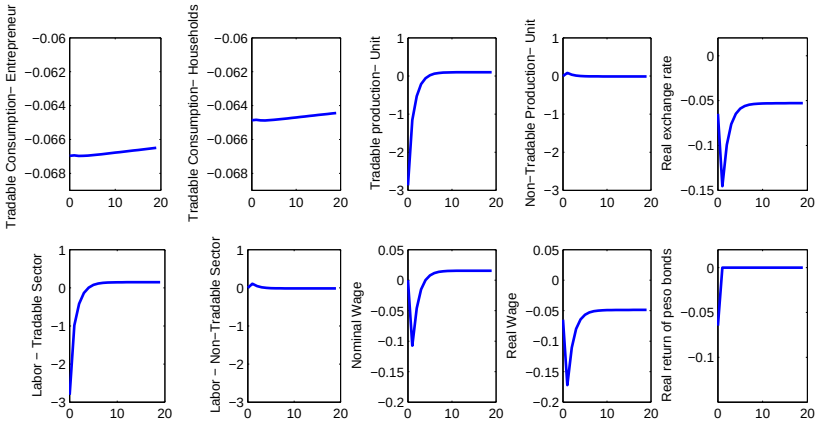

Figure 8: Impulse Responses to a 1% decrease in Productivity, optimal peso loan

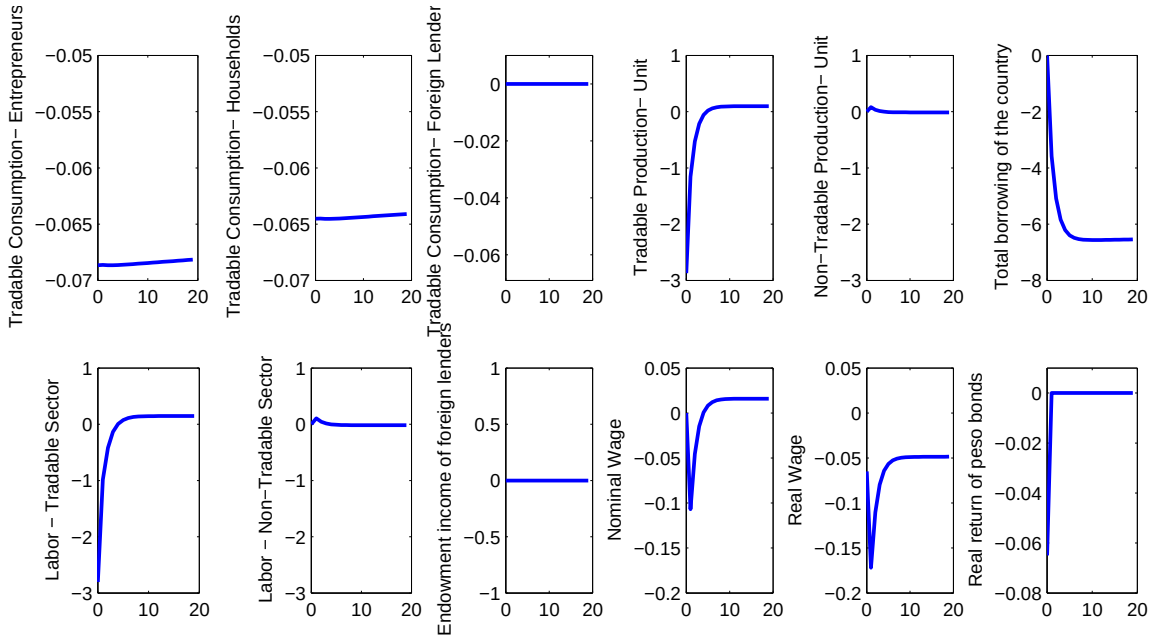

Figure 9: Impulse Responses to a 1% decrease in Productivity, Zero peso loan

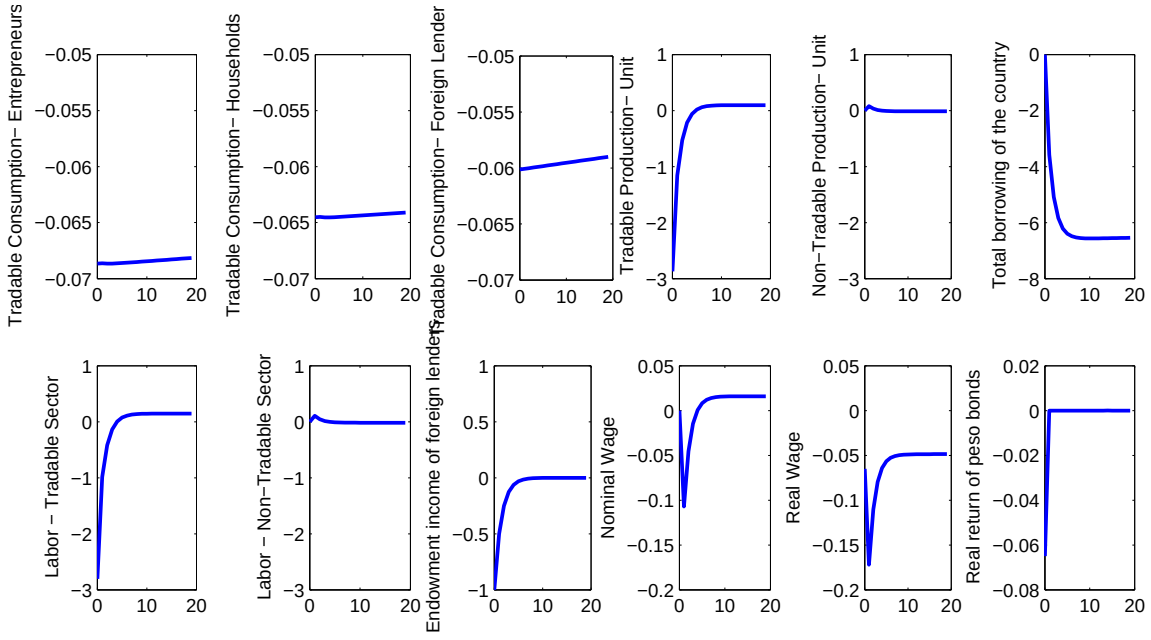

Figure 10: Impulse Responses to a 1% decreases in Productivity and Foreign Endowment, Zero peso loan