The Effect of Monetary Policy on Debt Denomination of Small Open Economies

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Abstract. How can monetary policy affect borrowers' preference over debts denominated in foreign or local currencies? To give a potential answer, I create a simple general equilibrium model, where domestic borrowers and foreign lenders are risk neutral. In a non-constrained credit market, debts denominated in the local or foreign currencies are equivalent. However when borrowers are credit constrained, their investment is proportional to their current wealth. Since future capital stock is a concave function of today's investment, tomorrow's wealth is a concave function of today's wealth. This concavity induces risk-averse behaviors for otherwise risk-neutral borrowers. The model therefore predicts that under a stable exchange rate, borrowers prefer debts in foreign currencies, but under a flexible exchange rate, borrowers prefer debts in the local currency. Monetary policy can therefore have a new channel of real effects, which is particularly important for developing countries.

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1 Introduction

In this paper, we address a somewhat neglected issue in the international macroeconomic literature: How can monetary policy affect the denomination of the private sector's foreign debts?

First of all, debt denomination is very important. The vast majority of developing countries' debts are not denominated in local currencies, but in major currencies like the US Dollars, Yens or Euros, and this currency mismatch plays a non-trivial role in the instability of these countries (see 'The pain of original sin' by Eichengreen et al (2004)). In particular, it was behind the currency crises in East Asia and Latin America in the 1990s (Radelet et al. (1998)).

Most of the literature on currency crises however assumes developing countries' debts are automatically denominated in foreign currencies (see Aghion et al.(2001,2004), Krugman (2000) for example). On the other hand, the literature on optimal monetary policy for small open economies (Clarida, Gali & Gertler (1999), Lane (2001), Benigno & Benigno (2003), Galí & Monacelli (2005)) does not take into account the impact of monetary policy on foreign debts.

There is a recent literature that seeks to explain the 'original sin' (a fancy name for the inability to borrow abroad in one's own currency). Explanations include moral hazards due to the existence of bail-out guarantees from the government (Burnside, Eichenbaum & Evans (2004), Schneider & Tornell (2004)), financial underdevelopment (Caballero & Krishnamurthy (2000)), credibility of monetary authority or related institutions (Jeanne (2005), Tirole (2003)). In this paper, we abstract away from all government's inefficiencies, and in contrast to Caballero & Krishnamurthy, we raise the issue of financial underdevelopment in a neoclassical general equilibrium framework.

The most related paper is probably Chamon & Hausmann (2005). They show that if every firm in an economy borrows in either the local currency or foreign currency, it is optimal for the central bank to stabilize either the exchange rate or the interest rate (respectively). However there is little role for credit market imperfections in their paper. Finally, their model is not embedded in a general equilibrium framework, where welfare issues can be addressed, thus it is difficult to discuss optimal monetary policy in their setting.

In this paper, we create an environment in which local and foreign currency debts enter agents' optimization problem symmetrically. Choices of monetary policy would then tip the preferences to either local or foreign currency. Monetary policy, therefore, has a new channel of impacts on the real economy (beside tackling inefficient price distortions due to nominal rigidities as in the New Keynsian framework).

This paper is the first step towards my final goal of studying monetary policy for developing countries that undergo financial integration. Its goal is very humble: to shed light on a potential causality between policy and the original sin. To serve this purpose, the model is stripped down to its simplest form.

Everything in the model is standard neoclassical, including the capitalists who make non-state-contingent debt contracts with foreign lenders. Just like in Bernanke & Gertler (1989) and Bernanke, Gertler & Gilchrist (1998), we assume both borrowers and lenders are risk-neutral, and there are imperfections in the credit market. The new result requires three simple ingredients: (1) capitalists are allowed to choose between debt contracts in local or foreign currency; (2) capital production takes time, and the production function is concave; (3) capitalists face binding credit constraints when their initial net-worth is low (as in the case for most developing economies).

The logic is the following: Define net-worth as revenues from capital production, minus debt repayment. Tomorrow's capital stock (and thus net-worth) is a concave function of today's investment. When credit constraints bind, today's investment depends on how much a capitalist can borrow. This amount depends on how much net-worth he currently has to pledge as collateral. Therefore if credit constraints bind, *tomorrow's net-worth is a concave function of today's net-worth.* This concavity then induces otherwise risk-neutral borrowers to reduce risks in their debt portfolios.

Inherently, there is no difference between local or foreign currency debts: When there are no borrowing constraints, we show that capitalists are indifferent between two types of debts, as long as the Uncovered Interest Parity holds. However, when the central bank chooses to stabilize the exchange rate and lets the domestic interest rate fluctuate, borrowers would prefer debts in the foreign currency, which have less risk. The reverse is true when the central bank chooses to stabilize the domestic interest rate and lets the exchange rate fluctuate.

Structure of the paper: Section 2 lays out the framework; Section 3 solves the capitalists' problem; Section 4 elaborates on monetary policy's impacts on debt denomination, and is the main part of the paper. We conclude with a brief discussion on robustness and future improvements.

2 The Model

A small open economy exists in three periods $t = 0, 1, 2$. The players are: firms, households, capitalists (a population of measure one of each), foreign investors, and a world market. For convenience, the local currency is labeled (Vietnamese) dong and the foreign currency is labeled dollar. Monetary policy is, for now, assumed to be exogenous.

2.1 Domestic Production

Competitive firms take prices, rental rates of capital and wages as given, and choose K_t and L_t to maximize profits in each period

$$\Pi_t = P_t Y_t - W_t L_t - R_t K_t,$$

subject to a production technology

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}, 0 < \alpha < 1$$

Optimization of firms require:

$$\begin{aligned} R_t K_t &= \alpha P_t Y_t && (1) \\ W_t L_t &= (1-\alpha) P_t Y_t. && (2) \end{aligned}$$

2.2 Households

A representative household consumes home and foreign goods, and provides labor. It maximizes the discounted utility

$$\max \sum_{t=0,1,2} \beta^t U(C_t^H, C_t^F, L_t), \tag{3}$$

where C_t^H is household's consumption of home good, C_t^F is the consumption of foreign (imported) goods, and L_t is labor. (There is no expectation, since households make decisions after the state is revealed, as we shall see in section 2.5.) The price of home good is P_t, while the price of imported good is P_t^* in dollars, which is equivalent to $S_t P_t^*$ dongs, with S_t being the exchange rate at t (1 dollar equals S_t dongs).

For simplicity, $U(C, L)$ is assumed to have the following parametrization

$$U(C, L) = \log C - \frac{1}{2} L^2. \tag{4}$$

Here the consumption index C_t is an aggregate index of home and imported goods:

$$C_t = \frac{(C_t^H)^{\gamma} (C_t^F)^{1-\gamma}}{\gamma^{\gamma} (1-\gamma)^{1-\gamma}}, \quad 0 < \gamma < 1. \tag{5}$$

The household cannot borrow abroad, but can trade domestic bonds at the interest rate i_t set by the domestic central bank. Therefore it is subjected to the following budget constraints:

$$\begin{aligned} P_0 C_0^H + S_0 P_0^* C_0^F + B_1 &= W_0 L_0 \\ P_1 C_1^H + S_1 P_1^* C_1^F + B_2 &= W_1 L_1 + B_1(1+i_0) \\ P_2 C_2^H + S_2 P_2^* C_2^F &= W_2 L_2 + B_2(1+i_1). \end{aligned}$$

where B_t is the amount of one period (from $t-1$ to t) riskless bond that the household trades.

Let $\mathbb{P}_t$ be the consumer price index, defined as

$$\mathbb{P}_t \equiv (P_t)^{\gamma} (S_t P_t^*)^{1-\gamma}, \tag{6}$$

then the budget constraints can be rewritten as

$$\begin{aligned} \mathbb{P}_0 C_0 + B_1 &= W_0 L_0 \\ \mathbb{P}_1 C_1 + B_2 &= W_1 L_1 + B_1(1+i_0) \\ \mathbb{P}_2 C_2 &= W_2 L_2 + B_2(1+i_1). \end{aligned} \tag{7}$$

A more compact version of the budget constraint is:

$$\mathbb{P}_0 C_0 + \frac{\mathbb{P}_1 C_1}{1+i_0} + \frac{\mathbb{P}_2 C_2}{(1+i_0)(1+i_1)} = W_0 L_0 + \frac{W_1 L_1}{1+i_0} + \frac{W_2 L_2}{(1+i_0)(1+i_1)}. \tag{8}$$

Optimization.

The intratemporal First Order Condition (FOC) for the representative household: is

$$\begin{aligned} \frac{U_{L,t}}{U_{C,t}} &= \frac{W_t}{\mathbb{P}_t} \\ \Rightarrow L_t C_t &= \frac{W_t}{\mathbb{P}_t}. \end{aligned} \tag{9}$$

On the other hand, the inter-temporal (or Euler) FOC is:

$$\mathbb{P}_{t+1} C_{t+1} = \beta(1+i_t)\mathbb{P}_t C_t, \quad t = 0, 1. \tag{10}$$

2.3 Capitalists

Only capitalists (sometimes called entrepreneurs in the literature) can create and sell capital to firms. Capital is assumed to depreciate completely after a period. Capitalists consume only in the last period. They are assumed to be risk neutral, hence their utility takes the form

$$U^c = N_2,$$

where N_2 is their net-worth in dongs, to be defined shortly.

Capital Production. Capitalists create capital from home consumption goods and imported consumption goods. The production process takes one period. At each time $t = 0, 1, 2$, capitalists all have access to the same capital producing technology:

$$K_{t+1} = G(I_t), \quad t = 0, 1, \tag{11}$$

where I_t is the aggregate input of home and imported consumption goods, defined by

$$I_t = (I_t^H)^\delta (I_t^F)^{1-\delta}. \tag{12}$$

If we define the capitalist's price index

$$\mathbb{Q}_t \equiv (P_t)^\delta (S_t P_t^*)^{1-\delta}, \tag{13}$$

then the cost of capital investment in period t is $\mathbb{Q}_t I_t$.

As usual, the capital production function G is assumed to be smooth, strictly increasing and strictly concave.

Net Worth and Debts. In the beginning period $t = 0$ each capitalist is endowed with an exogenous amount of capital K_0 (whose range will be rigorously defined later). His return from selling this amount of capital to the firms is R_0K_0 dongs. His net-worth in $t = 0$ is thus $N_0 = R_0K_0$.

At period $t = 0, 1$, before shocks are realized, with net-worth N_t, the capitalist decides how much investment I_t to make. This costs him $\mathbb{Q}_tI_t$ dongs. He then has to borrow $D_t = \mathbb{Q}_tI_t - N_t$ dongs if his current net-worth is insufficient to pay for the investment bill.

Credit Constraint. In this paper, we assume that how much the capitalist borrows depends on his current net-worth:

$$D_t \leq \kappa_t N_t \tag{14}$$

where κ_t is a non-state-contingent parameter representing frictions in the credit market. The smaller κ_t is, the more severe the credit constraint is. This is a typical assumption in the literature (see for example Aghion et al (2001), and can be motivated by imperfect information as in Bernanke Gertler (1989) or Bernanke, Gertler & Gilchrist (1998)).

Choice of Debts. Suppose that capitalists only borrow via non-contingent debt contracts with foreign investors, who are competitive and risk-neutral. His debts can be denominated either in dongs or in dollars. *Before shocks are realized*, he chooses a fraction θ_t of the amount loaned to be in dongs, and the remaining fraction $1 - \theta_t$ in dollars. Hence his debt portfolio consists of θ_tD_t dongs and $(1 - \theta_t)D_t/S_t$ dollars.

In period $t + 1$ he will have to pay back $(1 + i_t)\theta_tD_t$ dongs[1] on his dong debt and $(1 + i_t^*)(1-\theta_t)D_t\frac{1}{S_t}$ dollars on his dollar debt, which is equivalent to $(1+i_t^*)(1-\theta_t)D_t\frac{S_{t+1}}{S_t}$ dongs at period $t+1$ exchange rate. His revenue in $t+1$ comes from sales of capital to firms: $R_{t+1}K_{t+1}$. Thus his net-worth (in dongs) in $t + 1$ is going to be

$$N_{t+1} = R_{t+1}K_{t+1} - \left[(1 + i_t)\theta_t + (1 + i_t^*)(1 - \theta_t)\frac{S_{t+1}}{S_t}\right] D_t. \tag{15}$$

Summary. Given K_0 and taking all prices as given, in each period $t = 0, 1$, before the realization of shocks, the capitalist chooses investment I_t and debt portfolio $(\theta_t, 1 - \theta_t)$ to maximize $\mathbb{E}_tN_2$ with respect to the evolution of net-worth (15), the capital production technology (11), and the borrowing constraint $D_t \leq \kappa_tN_t$.

2.4 Imports, Exports, and World Credit Market

Let X_t^* be an exogenous amount (in dollars) that a representative firm exports to the foreign market.[2] The foreign demand for home goods is thus $X_t^*S_t/P_t$.

[1]Thus we implicitly assume debt contracts denominated in dongs must pay the *ex-post* domestic interest rate. This assumption is motivated by the fact that in practice local-currency debts in developing countries are contracted at shorter terms than foreign-currency debts. See Chamon & Hausmann (2005) (pages 219-220) for more discussions.

[2]This can be justified by assuming that foreign consumers have utility function of the form $(C^H)^\eta(C^F)^{1-\eta} - v(L^F)$; then a constant fraction η of each consumer's wealth will be spent on home goods. In addition assume that changes in the home country are too small to affect the wealth of foreign consumers, then the export value (in dollars) X_t^* is exogenous from the perspective of home producers. This assumption is is also used in, for example, Céspedes et al. (2004).

The price of imported goods in dollars P_t^* is also assumed to be exogenous from the perspective of domestic agents.

Because foreign investors are risk neutral, the Uncovered Interest Parity (UIP) condition must hold to avoid arbitrage:

$$E_t[1+i_t] = (1+i_t^*)\frac{E_t[S_{t+1}]}{S_t}, \quad t=0,1. \tag{16}$$

2.5 Shocks and Information

For clarity, we will impose minimal complexity on the information structure. Suppose the initial domestic Total Factor Production A_0 is non-random. The initial exchange rate S_0 is non-random and can be normalized to one. The world interest rate is assumed to be constant through out the game: $i_0^* = i_1^* = i^*$.

Shocks only come at period $t=1$, and are permanent. That is $A_2(s) = A_1(s), X_2^*(s) = X_1^*(s), P_2^*(s) = P_1^*(s)$. The true state s is revealed in period $t=0$, *after* capitalists' debt contracts are signed, and *before* all other transactions take place. That is, capitalists are the only agents who set their actions before observing the true state. (This assumption reflects the fact that debt contracts are usually written before investments actually take place.)

2.6 Equilibrium

Given an interest rate policy $\{i_0, i_1\}$ and an exchange rate policy $\{S_1, S_2\}$ that satisfy the UIP condition (16), and given initial capital stock K_0, an equilibrium constitutes of

- Households' choice of labor supply L_t^s, consumption schedule $\{C_t^H, C_t^F\}$ for $t=0,1,2$, and domestic bond holdings $\{B_0, B_1\}$;
- Firms' demand for capital K_t^d and demand for labor L_t^d;
- Capitalists' demand of home and foreign consumption goods $\{I_{t+1}^H, I_{t+1}^F\}$ to create capital supply K_{t+1}^s, and choice of debt portfolio θ_t;
- Price of home good P_t, price of capital R_t and wage rate W_t

such that

1. Each household's utility is maximized subject to its constraints,
2. Each firm's profit is maximized in each period,
3. Each capitalist's expected utility is maximized subject to his borrowing constraints, and net-worth evolution equation (15),
4. Market for home goods clears in each period

$$Y_t = C_t^H + I_t^H + \frac{X_t^* S_t}{P_t}, \tag{17}$$

5. Markets for labor and capital clear ($L_t^d = L_t^s, K_t^d = K_t^s$) in each period,
6. Market for domestic bonds clears: $B_0 = B_1 = 0$,

3 Investment & Choice of Debt

In this section we solve the capitalists' decision problem. We first show that when there is no credit constraint, debts denominated in dollar and debts denominated in dongs are perfect substitutes for capitalists. Then we ask the question: when do the credit constraints bind? From then on, we assume credit constraints bind, and show that capitalist's final net-worth N_2 is a concave function of the net-worth at period one N_1. Thus the relative risks of dong debts and dollar debts at $t = 0$ matter to capitalists, who tries to maximize $\mathbb{E}_0 N_2$. We leave the issue of monetary policies to the next section.

The representative capitalist's **optimization problem at time t = 1** is

$$\begin{aligned} \max_{I_1,\theta_1} N_2 &= R_2 G(I_1) - \left(\theta_1(1+i_1) + (1-\theta_1)(1+i^*)\frac{S_2}{S_1}\right) D_1 \\ \text{where } D_1 &= \mathbb{Q}_1 I_1 - N_1 \\ \text{subject to } D_1 &\leq \kappa_1 N_1 \end{aligned} \tag{18}$$

There are two things to notice: First, there are no expectations, since there are no shocks at $t = 2$. Second, for the same reason, the exchange rate does not have to adjust in period two, so $S_2 = S_1$

Thus the two kinds of debts are equivalent at $t = 1$ (as the Uncovered Interest Parity becomes Covered Interest Parity: $1 + i_1 = (1 + i^*)\frac{S_2}{S_1}$). In other words, the choice of debt is indeterminate.

Now, let us solve for the optimal investment level.

$$\max_{I_1 \leq \frac{(1+\kappa_1)N_1}{\mathbb{Q}_1}} N_2 = R_2 G(I_1) - (1+i^*)(\mathbb{Q}_1 I_1 - N_1). \tag{19}$$

If the credit constraint does not bind, then $I_1 = I_1^{interior}$ where $I_1^{interior}$ solves

$$R_2 G'(I_1^{interior}) = (1+i^*)\mathbb{Q}_1. \tag{20}$$

If the constraint binds however, then $\mathbb{Q}_1 I_1 - N_1 = D_1 = \kappa_1 N_1$, thus

$$I_1 = I_1^{boundary}(N_1) \equiv \frac{(1+\kappa_1)N_1}{\mathbb{Q}_1}. \tag{21}$$

Hence, in equilibrium

$$I_1 = \tilde{I}_1(N_1) \equiv \min\left\{I_1^{interior}, I_1^{boundary}(N_1)\right\}. \tag{22}$$

And

$$N_2 = R_2 G(\tilde{I}_1) - (1+i^*)(\mathbb{Q}_1 \tilde{I}_1 - N_1). \tag{23}$$

Recall the net-worth evolution:

$$N_1 = R_1 G(I_0) - \underbrace{\left[\theta_0(1+i_0) + (1-\theta_0^*)(1+i_0^*)\frac{S_1}{S_0}\right]}_{\Sigma_0}(\mathbb{Q}_0 I_0 - N_0). \tag{24}$$

Putting the last three equations together we have the **capitalist's problem at $\mathbf{t = 0}$**:

$$
\begin{aligned}
\max_{I_0,\theta_0} E_0 N_2 &= E_0 \left[R_2 G(\tilde{I}_1) - (1+i_0^*)(\mathbb{Q}_1 \tilde{I}_1 - N_1) \right] \qquad (25) \\
\text{where } \tilde{I}_1 &= \min \left\{ I_1^{interior}, \frac{(1+\kappa_1)N_1}{\mathbb{Q}_1} \right\} \\
N_1 &= R_1 G(I_0) - \left[\theta_0(1+i_0) + (1-\theta_0)(1+i^*)\frac{S_1}{S_0} \right] (\mathbb{Q}_0 I_0 - N_0).
\end{aligned}
$$

3.1 Benchmark: No credit constraints

Suppose there were no credit constraints. Then $I_1 = I_1^{interior}$, thus independent of N_1. Therefore N_2 in equation (23) can be rewritten as an affine function of N_1:

$$
N_2 = \overbrace{R_2 G(I_1^{interior}) - (1+i^*)\mathbb{Q}_1 I_1^{interior}}^{\text{independent of } N_1} + \overbrace{(1+i^*)N_1}^{\text{linear in} N_1} \equiv L(N_1). \qquad (26)
$$

Thus at period $t = 0$, maximizing $\mathbb{E}_0 N_2 = \mathbb{E}_0 L(N_1)$ is equivalent to maximizing $\mathbb{E}_0 N_1$.

Recall from (24) that N_1 itself is an affine function of Σ_0. Because the expectation of $1+i_0$ and $(1+i^*)\frac{S_1}{S_0}$ are equal (UIP), $\mathbb{E}_0\Sigma_0 = \mathbb{E}[1+i_0]$ for all θ_0. So the optimal portfolio problem is again indeterminate. In other words, when there are no credit constraints, local currency debts and foreign currency debts are equivalent to domestic borrowers. For example, in a financially developed country like Japan, Japanese capitalists are indifferent between denominating their foreign debts in Yens or in US Dollars.

Proposition 1 *If a country does not face credit constraints, its capitalists are indifferent between debts denominated in the local or foreign currency.*

3.2 Concavity

We show that N_2 is a concave and increasing function of N_1, and locally strictly concave when the credit constraints are binding. This concavity is crucial for the main results of the paper.

If the borrowing constraint $D_1 \leq \kappa_1 N_1$ binds, from equations (21) and (23), the capitalist's net-worth at $t = 2$ is:

$$
N_2 = R_2 G\left(\frac{(1+\kappa_1)N_1}{\mathbb{Q}_1} \right) - (1+i^*)\kappa_1 N_1 \equiv \Phi(N_1). \qquad (27)
$$

If it does not bind, then as we saw in (26) from the previous subsection, N_2 is a linear function of N_1: $N_2 = L(N_1)$. Hence

$$
N_2 = \begin{cases} \Phi(N_1) & \text{if } (1+\kappa_1)N_1/\mathbb{Q}_1 < I_1^{interior} \\ L(N_1) & \text{otherwise} \end{cases} \equiv \Gamma(N_1). \qquad (28)
$$

Lemma 1 *The net-worth evolution function $\Gamma(\cdot)$, as defined in (28), is concave and strictly increasing. It is strictly concave when the credit constraint is binding.*

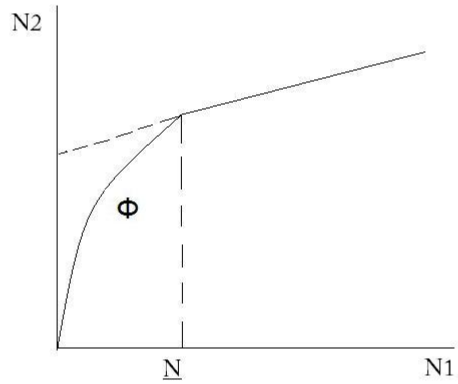

Figure 1: When $(1+\kappa_1)N_1/\mathbb{Q}_1 < I_1^{interior}$, N_2 is strictly concave in N_1, otherwise it is linear.

Proof. Since G is strictly concave, it follows that, Γ is strictly concave when the credit constraint is binding, and linear otherwise.

Monotonicity: Let $\underline{N}$ be the value of N_1 at which the constraint is binding, namely $\underline{N} \equiv I_1^{interior}\mathbb{Q}_1/(1+\kappa_1)$. When $N_1 < \underline{N}$, from problem (19) we see that

$$R_2 G'\left(I_1^{boundary}\right) > (1+i^*)\mathbb{Q}_1 \tag{29}$$

(where $I_1^{boundary} = \frac{(1+\kappa_1)N_1}{\mathbb{Q}_1}$), because the capitalist would like to increase I_1 if he were not constrained. Taking the derivative of Φ (defined in (27)) with respect to N_1:

$$\begin{aligned}\Phi'(N_1) &= \frac{1+\kappa_1}{\mathbb{Q}_1} R_2 G'\left(\frac{(1+\kappa_1)N_1}{\mathbb{Q}_1}\right) - (1+i^*)\kappa_1 \\ &> \frac{1+\kappa_1}{\mathbb{Q}_1}(1+i^*)\mathbb{Q}_1 - (1+i^*)\kappa_1 \text{ (because of (29))} \\ &= 1+i^* > 0.\end{aligned}$$

Thus Φ is strictly increasing in N_1. Obviously $L(N_1) = (1+i^*)N_1$ is strictly increasing in N_1. Hence Γ is strictly increasing. ■

3.3 Binding Constraints

Next we find out when credit constraints bind.

Lemma 2 *There exists a threshold $\underline{K} > 0$ such that when the initial capital stock is below this ($K_0 < \underline{K}$), the borrowing constraint binds at $t = 1$.*

The proof is straightforward, and is written in the appendix.[3]

From now on we will always operate under the following assumption (which reflects the fact that our country represents a developing country):

Credit Trap Assumption: $K_0 < \underline{K}$.

[3] A similar results holds for the index of financial development: there exists a threshold of κ below which borrowing constraints will always bind at $t = 1$.

4 Monetary Policy

Finally, we are at the main part of the paper. We are about to give two illustrations of how monetary policy affects debt denominations. First, under a flexible exchange rate, capitalists prefer debts denominated in the local currency. Second, under a stable exchange rate where the domestic interest rate fluctuates, they prefer debts denominated in dollars instead.

The intuition is this: under the credit trap assumption, N_2 is a strictly concave function of N_1, which depends on period zero debt portfolio $(\theta_0, 1-\theta_0)$. Thus given two portfolios that give the same expected return, capitalists prefer the less risky one. Dollar debts and dong debts have the same expected gross interest rates (after adjusting to the exchange rates, as formalized in the UIP condition), but one type would be risky while the other would be riskless. Thus the conclusion that either $\theta_0 = 0$ or $\theta_0 = 1$ naturally follows.

Some terminology: when we say a variable Y_1 fluctuates, we mean $Y_1(h) \neq Y_1(l)$ (so Y_1 is a random variable with respect to the information at time $t = 0$). When we say Y_1 is stable, we mean $Y_1(h) = Y_1(l)$ (so Y_1 is non-random with respect to time zero information). The exchange rate is said to be flexible when $S_1(h) \neq S_1(l)$, and is stable otherwise.

4.1 Stable Domestic Interest Rate

Suppose shocks come only from the outside world. Then sometimes the central bank can absorb all these shocks by floating the exchange rate, while keep the domestic interest rate stable. An example of this is shown in the appendix. In such scenarios, we have the following result:

Proposition 2 *When the central bank can adjust the exchange rate to absorb all shocks, and stabilizes the domestic interest rate, capitalists strictly prefer debts denominated in dongs.*

Proof. Recall from (25), the problem in period zero is:

$$\begin{aligned} \max_{I_0,\theta_0} \mathbb{E}_0 N_2 &= \mathbb{E}_0 \overbrace{\left[R_2 G\left(\frac{(1+\kappa)N_1}{\mathbb{Q}_1} \right) - (1+i^*)\kappa N_1 \right]}^{\Phi(N_1)} \qquad (25) \\ \text{where } N_1 &= R_1 G(I_0) - \underbrace{\left[\theta_0(1+i_0) + (1-\theta_0)(1+i^*)\frac{S_1}{S_0} \right]}_{\Sigma_0} (\mathbb{Q}_0 I_0 - N_0). \end{aligned}$$

The only thing that is random in the expressions above (i.e. whose value is different in different states) is S_1, because all shocks are assumed to be absorbed by S_1. From the perspective of the capitalist when choosing $\theta_0 \in [0,1]$, the two interest rates in Σ_0 have the same expected value:

$$\mathbb{E}_0[1+i_0] = \mathbb{E}_0[(1+i^*)S_1/S_0]$$

but $1+i_0$ is non-random, while $(1+i^*)S_1$ is random. Since Φ is strictly concave (as established in section 3.2), the domestic debt will be strictly preferred: $\theta_0 = 1$. ■

4.2 Stable Exchange Rate

Now suppose the central bank can stabilize all domestic prices by adjusting the domestic interest rate i_0 to the shocks, while stabilizing the exchange rate S_1. (This is possible when all shocks are domestic. See the appendix for an illustration.)

If the central bank follows this strategy, then from the persecutive of the capitalist, despite having the same mean, gross domestic interest rate is risky ($1+i_0$ is random), while the gross dollar interest rate is not ($(1+i^*)S_1$ is non-random). Also no other terms in the capitalist's problem (25) is random. Thus, in contrast to the scenario in previous section, the capitalists strictly prefer debts denominated in dollars: $\theta_0 = 0$.

Proposition 3 *Under a stable exchange rate regime where the domestic interest rate fluctuates to stabilize domestic prices, capitalists strictly prefer debts denominated in dollars.*

This result matches the strong empirical evidence linking debts denominated in dollars and the 'fear of floating' in emerging market economies (see Calvo & Reinhart (2002), Hausmann & Panizza (2002)). It highlights a potential direction of causality.

5 Conclusion and Discussion

We have illustrated that monetary policy can have a real effect on the denomination of debts in a small open economy with small start up capital. This is a channel that, according to my limited knowledge, has not been fully discussed in the international macroeconomic literature. And it is a non-trivial channel, since excessive foreign currency debts seem to create tremendous instability for developing countries, as we have witnessed in the East Asian and Latin American currency crises in the 90s, and the recent crises in the Baltic economies of Latvia, Estonia and Lithuania[4].

To make excessive dollar debts 'painful' (and stable exchange rate 'costly'), we need to add new dimensions to the model, for example limited foreign reserves, or exports that are sensitive to exchange rate volatility. Once a stable exchange rate regime bears the risk of a devaluation in some bad states of the world, a balance sheet contraction (in the style of Aghion et al. (2001)) will have real effects on the economy because capitalists can invest less.

In the model I intentionally leave out nominal rigidities for the benefit of clarity. Once price and/or wage stickiness is incorporated, monetary policy will have two channels 'running parallel': that mentioned above, and that in the typical New Keynsian literature. An optimal monetary policy will have to take into account both. It is one of my ultimate goals to study this optimization problem.

Proposition 1 is not robust to relaxations of the UIP condition, or if foreign investors impose different constraints (or premia) on the two types of debts. In other words, if the UIP somehow fails (as widely documented in practice), or if the two gross interest rates (adjusted to exchange rates) have different means, non-constraint borrowers would not necessarily be indifferent to different kinds of debts. However this does not weaken propositions 2 and 3, only that we will have to use more elaborate mean-variance analysis to solve the capitalists' optimal debt portfolio problem, and generally the solution will no longer be at the corners. This shall enrich the model.

[4]'Latvia's troubled economy', *The Economist*, December 18th 2008.

Propositions 2 and 3 are not robust to the introduction of a perfect forward currency market, but robust if this market is imperfect. As long as the exchange rate risk cannot be completely hedged away, the capitalist would still strictly prefer the type of debt that has no risk. So our story would not apply to countries like Sweden or Finland, but is still relevant to most developing countries, whose forward currency markets may well be imperfect.

Propositions 2 and 3 are not robust when the borrowing constraint κ_1 is state-contingent. However, when κ_1 only depends on the state s via the exchange rates $S_1(s), S_2(s)$ (see this footnote[5] for a microfoundation of such a constraint), under a stable exchange rate regime, since both S_1 and S_2 are non-state-contingent, κ_1 is also non-state-contingent. Hence proposition 3 still holds. In other words, our argument still shows that when the exchange rate is stable while the domestic interest rate fluctuates, borrowers prefer debts in dollars.

A Appendix

A.1 Proof of Lemma 2

Time zero net-worth $N_0(= R_0K_0)$ only matters when the borrowing constraint in that period is binding. If it is, then the level of investment I_0 is strictly increasing in N_0: $I_0 = (1+\kappa_0)N_0/\mathbb{Q}_0$ (and $D_0 = \mathbb{Q}_0 I_0 - N_0 = \kappa_0 N_0$).

It is also immediate that next period's net-worth N_1 is increasing in N_0 (the more you have today, the more you can invest today, and thus the more you will have tomorrow). Hence N_1 is strictly increasing in N_0 (and in K_0).

The borrowing constraint binds in $t = 1$ if

$$I_1^{interior} \geq \frac{(1+\kappa_1)N_1}{\mathbb{Q}_1} \tag{31}$$

So for N_1 low enough, this will bind.

Putting all the claims above together, it follows that when K_0 is small enough, the borrowing constraint will bind in $t = 1$. To be rigorous, let $\mathcal{K}$ be the set of $k > 0$ such that whenever $K_0 \leq k$, inequality (31) holds. When $K_0 \to 0$, the initial wealth N_0 approaches zero, and hence the borrowing constraints will bind in both periods. This, together with the fact that N_1 is strictly increasing and continuous in K_0, implies $\mathcal{K}$ is non-empty. Let $\underline{K} \equiv \sup \mathcal{K}$. This $\underline{K}$ satisfies the condition in the lemma.

[5] Suppose in case of a default, lenders can only seize a fraction $\overline{\kappa}$ of the borrower's net-worth ($0 \leq \overline{\kappa} \leq 1$). Suppose at time t a Vietnamese capitalist borrows a total amount that is equivalent to D_t/S_t dollars from an American investor, and promises to pay back at $t+1$ the amount gross the dollar interest rate, i.e. $(1+i^*)\frac{D_t}{S_t}$. Now at $t+1$, the capitalist has two choices: to keep the promise, or to run away. The second option costs him $\overline{\kappa}N_t$ dongs, which is equivalent to $\overline{\kappa}N_t\frac{1}{S_{t+1}}$ dollars in $t+1$. Therefore, a risk-neutral capitalist prefers to not run away when:

$$(1+i^*)\frac{D_t}{S_t} \leq \overline{\kappa}N_t E_t \frac{1}{S_{t+1}}.$$

A rational foreign investor thus imposes the following constraint on any debt contract:

$$\begin{aligned} D_t &\leq \kappa_t N_t. \\ \text{where } \kappa_t &\equiv \frac{\overline{\kappa}}{1+i^*} S_t \mathbb{E}_t \frac{1}{S_{t+1}}. \end{aligned} \tag{30}$$

Since there is no shock in the last period, equation (30) at $t = 1$ is simply $\kappa_1 \equiv \frac{\overline{\kappa}}{1+i^*}\frac{S_1}{S_2}$, which shows that κ_1 is not dependent on state s.

A.2 Adjusting Exchange Rate to Foreign Shocks

In this section we illustrate how in some scenarios the central bank could adjust the exchange rate to absorb all external shocks, while keeping the domestic interest rate stable.

For simplicity, assume there are two states of the world: $s \in \{h, l\}$, which have equal priors $Pr(s|\text{Information at } t = 0) = 1/2, s = h, l$. Suppose the shocks at $t = 1$ come from exports and from prices of imported goods, and there is no domestic shocks. That is: $A_1(h) = A_1(l) = A_0$, but $X_1^*(h) > X_0^* > X_1^*(l)$ and $P_1^*(h) > P_0^* > P_1^*(l)$. For simplicity, let us assume $X_1^*(h) = 2X_0^*, X_1^*(l) = \frac{X_0^*}{2}$, and similarly $P_1^*(h) = 2P_0^*, P_1^*(l) = \frac{P_0^*}{2}$.[6] We now show central bank can let the exchange rate adjust to absorb all of these shocks.

There are two places where the foreign shocks hits the domestic economy: the aggregate demand for home good, and the relative price between home and foreign goods.

$$Y_1 = C_1^H + I_1^H + \frac{X_1^* S_1}{P_1} \tag{32}$$

$$P_1 C_1^H + P_1^* S_1 C_1^F = W_1 L_1 - B_2 + B_t(1 + i_1). \tag{33}$$

After seeing the state of the world, if the Central Bank lets $S_1(h) = \frac{S_0}{2}$ (devaluate in high state) and $S_1(l) = 2S_0$ (appreciate in low state), then the term $\frac{X_1^* S_1}{P_1}$ in the first equation, and $P_1^* S_1 C_1^F$ in the second, shall remain unchanged from those in period zero. Thus domestic prices do not have to change. Also the domestic interest rate can simply equate the world interest rate in this case, preventing any arbitrage in the foreign exchange market (i.e. the UIP holds):

$$1 + i_0 = 1 + i^* = (1 + i^*)\mathbb{E}_0 \left[\frac{S_1}{S_0} \right].$$

A.3 Adjusting Domestic Interest Rate to a Domestic Shock

In this section we show the claim in section 4.2 that the domestic interest rate i_0 can adjust to cushion domestic prices against a permanent shock to the domestic total factor production A_1. Again, assume there are two states of the world: $s \in \{h, l\}$, and $A_2(h) = A_1(h) > A_2(l) = A_1(l)$.

The proof is particularly simple in this framework, where there is no nominal rigidity (though I believe a similar result holds in an environment with price stickiness). When all prices are flexible, as a well-known dichotomy in the monetary policy literature (see for example Galí (2008), chapter 2), consumption and real factor prices do not depend on monetary policy. In particular, $C_1(s)$ does not depend on i_0.

Recall the Euler condition (10):

$$\begin{aligned} P_1(h)C_1(h) &= \beta(1 + i_0(h))P_0 C_0 \\ P_1(l)C_1(l) &= \beta(1 + i_0(l))P_0 C_0. \end{aligned}$$

Thus:

$$\frac{P_1(h)}{P_1(l)} = \frac{1 + i_0(h)}{1 + i_0(l)} \frac{C_1(l)}{C_1(h)}.$$

[6] These shocks can happen when there is for example a shock to the aggregate demand in the foreign economy.

So $P_1(h) = P_1(l)$ if we choose $i_0(h), i_0(l)$ such that

$$\frac{1 + i_0(h)}{1 + i_0(l)} = \frac{C_1(h)}{C_1(l)} \tag{34}$$

(this is a well-defined linear equation since the right-hand-side does not depend on i_0).

Now it remains to let $S_1 = S_0\mathbb{E}[1 + i_0]/(1 + i^*)$, which is by definition non-random.

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