Excessive Dollar Borrowing in Emerging Markets
Balance Sheet Effects and Macroeconomic Externalities

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Abstract
Emerging market economies that borrow in foreign currency are prone to severe financial crises that involve financial amplification, i.e. a feedback loop of depreciating exchange rates, deteriorating balance sheets and declining aggregate demand. This paper shows that such financial amplification effects create a pecuniary externality that induces individual borrowers to denominate too much of their debt in hard dollar debt as opposed to more state-contingent local currency debt. A planner would employ prudential capital controls, e.g. in the form of reserve requirements, to discourage the use of dollar debt and reduce the severity of crises.

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1 Introduction

Foreign currency denominated debts have played an integral role in the emerging market crises of the past quarter century.\textsuperscript{1} As a result, it is often suggested that it would be efficient for emerging market economies to reduce their exposure to dollar debt so as to lower the risk of suffering a crisis.\textsuperscript{2}

From the standpoint of individual borrowers, however, the choice between local currency debt and dollar debt is a private tradeoff between risk and return: in emerging economies, exchange rates are on average counter-cyclical, so local currency debt insures against aggregate fluctuations, but it commands an interest rate premium since international lenders are averse to emerging market risk. When borrowers choose the currency composition of their debt portfolio, they weigh the expected cost of fluctuations in consumption against any savings from the interest rate spread between the local currency and the dollar.

If borrowers have rational expectations and choose to take on the risk of holding dollar debt, why should this decision not be socially efficient? In other words, why should it not be efficient for countries to experience financial crises in some unfortunate states of nature?

This paper offers an answer to this question based on the existence of a pecuniary externality: Decentralized agents in emerging markets take on excessive dollar debts because they fail to internalize the contribution of their borrowing decisions to the financial amplification effects that are triggered during crises.

Such amplification effects arise when borrowing constraints depend endogenously on the value of firms’ collateral, which introduces a positive feedback loop between economic activity and the level of the exchange rate: First, exchange rate depreciations reduce the dollar value of firms’ collateral, which tightens borrowing constraints, forces them to cut back on their spending and reduces aggregate demand. Secondly, lower aggregate demand depreciates the exchange rate.

Decentralized agents have rational expectations regarding the exchange rate and internalize the first part of this feedback loop, but since they are atomistic they take the level of the exchange rate as given and do not internalize the second part, which constitutes a pecuniary externality. In perfect markets pecuniary externalities do not matter, but in the economy examined here the level of the exchange rate determines the valuation of domestic agents’ collateral, and depreciations tighten borrowing constraints. Hence the pecuniary externality has real effects. The resulting pro-cyclical fluctuations in the country’s external borrowing capacity lie at the heart of most third-generation models of currency crises (see e.g. Krugman, 1998, 1999; Chang and Velasco, 2001; Aghion et al., 2004; Jeanne and Zettelmayer, 2005) and corroborated by a growing empirical literature (see e.g. Levy Yeyati, 2006; Mauro et al., 2007).

\textsuperscript{1}This is maintained by the theoretical literature on third generation currency crises (see e.g. Krugman, 1998, 1999; Chang and Velasco, 2001; Aghion et al., 2004; Jeanne and Zettelmayer, 2005) and corroborated by a growing empirical literature (see e.g. Levy Yeyati, 2006; Mauro et al., 2007).

\textsuperscript{2}We use the convention in the literature to refer to all forms of foreign currency denominated debt as ‘dollar debt.’ Similar considerations apply to e.g. foreign currency denominated debts in euros in Eastern Europe.
A novel and important aspect of our paper is that we model how the risk premium on local currency endogenously responds to macroeconomic volatility: a planner who imposes a tax on dollar debt versus local currency debt induces private agents to shift their portfolio towards the latter, which implies that the economy is better insured against strong adverse shocks and exhibits less exchange rate volatility. In general equilibrium, this leads to a decline in the risk premium on the local currency, making it a more attractive borrowing instrument.

The setting in which we analyze the problem is a version of Mendoza (2002)’s model of emerging market crises extended to encompass both dollar and local currency debt. As is common in the finance literature on portfolio allocation, we focus on a three period version of the model in order to study the currency composition of debt and to conduct a rigorous welfare analysis. We label the three time periods 0, 1 and 2. The economy has two goods, a tradable and non-tradable good. We interpret the relative price of the two as a measure of the economy’s real exchange rate.

In period 0, small domestic agents borrow from international lenders to finance investment. They have to allocate their debts between dollars and local currency, which are represented by the price of tradable and non-tradable goods. Local currency debt carries a risk premium because international lenders are averse to exchange rate fluctuations. In period 1, domestic agents produce both tradable and non-tradable goods. An aggregate shock affects productivity in the tradable sector and by extension domestic income and aggregate demand in the emerging market economy. While the market for tradables always clears since international demand for tradable goods is perfectly elastic, the real exchange rate adjusts to equilibrate supply and demand in the non-tradable sector. In case of a negative shock, for example, aggregate demand for non-tradable goods falls and their relative price declines (the real exchange rate depreciates). As a result, the price of non-tradables is pro-cyclical, i.e. the real exchange rate appreciates in high states and depreciates in low states.

By implication, repayments on foreign currency debt are highest in the lowest states of nature, and vice versa. This exacerbates the impact of aggregate shocks. Specifically, the greater a country’s dollar liabilities, the steeper the decline in aggregate demand in response to a negative shock of a given magnitude and the stronger the depreciation in its exchange rate. By contrast, repayments on local currency debt move in parallel with aggregate demand, mitigating the impact of aggregate shocks.

Lenders charge a risk premium on domestic currency debt because they are averse to emerging market exchange rates fluctuations. Borrowers trade off this risk premium against the insurance benefits of local currency debt, leading to an interior optimum in which the small open economy is imperfectly insured against aggregate shocks. This creates a potential for financial amplification effects and the associated externality.

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3This can be thought of e.g. as a productivity slowdown in the tradable sector, as experienced by Thailand in 1996/97, or as a devaluation of a trading partner or a competitor in export markets, which affected other East Asian countries after Thailand’s devaluation and Argentina after Brazil’s devaluation.
A negative shock to the economy reduces aggregate demand, depreciates the exchange rate and reduces international lenders’ valuation of domestic collateral. If the shock is of sufficient magnitude, it triggers binding borrowing constraints and financial amplification: binding constraints imply that agents have to cut back on consumption, which reduces aggregate demand, depreciates the exchange rate even more and tightens constraints further. Decentralized agents take the level of the exchange rate as given and hence fail to internalize that larger amounts of dollar debt lead to stronger financial amplification and deepen crises. As a result they engage in socially excessive dollar borrowing.

Figure 1 illustrates the correlation between the consumption decline during financial crises and the level of foreign currency debt. The figure covers all countries for which the World Bank’s Global Development Finance (GDF) Database reports debt data and encompasses 62 crisis events from 1970 – 2009. The correlation between the two measures is -.41 with a t-statistic of -3.45. Crises are defined as the union of currency crises according to the definition of Frankel and Rose (1996) and banking crises as defined by Reinhart and Rogoff (2009).4 The figure suggests that higher levels of foreign currency debt are generally associated with larger consumption declines.

The existing literature has stressed mostly the positive aspects of financial amplification effects. For example, Krugman (1999), Aghion et al. (2004) and Jeanne and Zettelmayer (2005) analyze how the described feedback loop between economic activity and endogenous borrowing constraints may lead to the sharp declines in economic activity, depreciations in the real exchange rate and reversals in the current account that characterize emerging market crises. Mendoza (2002, 2005) shows that such effects may also quantitatively account for crisis dynamics.

4Restricting our attention to one of the two definitions does not significantly modify our results. Furthermore, focusing on the decline in investment or aggregate GDP during crises instead of consumption yields similar correlations. More on the relationship between foreign currency debt and macroeconomic volatility can be found in Korinek (2011).
Jeanne and Korinek (2010) and Bianchi (2011) analyze normative aspects of financial amplification effects and show that the total quantity of debt in economies that are prone to such effects is excessive. By contrast, the contribution of this paper is to analyze the currency composition of debts. This distinction matters because policy measures that are directed at fostering the use of local currency debt can be very effective in mitigating the downward spirals that occur during financial amplification, even if they leave the total amount of debt unchanged. In our sample calibration we show that for a given level of debt, reducing an emerging economy’s exposure to foreign currency debt by imposing a tax of just 0.66% would reduce both consumption volatility and the risk premium on local currency debt by 40%. Furthermore, Magud et al. (2011) find that capital controls are generally more effective at changing the composition of capital inflows than at affecting their level.

Our paper stresses the optimality of ex-ante prudential measures to mitigate financial crisis risk. Benigno et al. (2010, 2011) reach different conclusions about the desirability of ex-ante prudential policies. They show that private agents in the free market equilibrium may borrow less than a planner who controls both the amount borrowed ex-ante and an ex-post policy instrument to relax binding constraints. They call this result “underborrowing.” However, since Atkinson and Stiglitz (1980) it is well known that comparing equilibrium quantities in a model with multiple instruments may be a misleading guide for policy. Atkinson and Stiglitz suggest that such an environment requires solving for optimal tax wedges. Jeanne and Korinek (2011) show in a similar framework that the optimal tax wedge on borrowing is positive, even after introducing ex-post policy instruments. This confirms the desirability of ex-ante prudential policy measures even in the presence of ex-post policy instruments to relax binding constraints.

Our paper is also related to a large literature on the reasons for dollar borrowing in emerging economies. Eichengreen and Hausmann (1999) suggest that international capital markets are incomplete and markets for local currency debt simply do not exist for many emerging economies. However, over the past decade, markets in such bonds have developed considerably (Burger et al., 2009), and in historical perspective borrowing in local currency has been common in emerging economies (Reinhart and Rogoff, 2008).

A second strand of this literature emphasizes distortions introduced by government as the reason why countries borrow excessively in dollars. Krugman (1998) and Schneider and Tornell (2004) argue that private agents take on risky forms of finance such as dollar debt in order to take advantage of bailout guarantees. Chamon (2003) and Broda and Levy Yeyati (2006) show that in the absence of strict enforcement of seniority rules, local currency creditors can be expropriated by taking on additional dollar debt. Jeanne (2003) and Tirole (2003) focus on the risk that government may inflate the local currency as a reason why local currency debt is harder to obtain for emerging economies. These approaches are complementary to ours. However, we show that

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See Chamon (2011) for a comprehensive survey.
excessive dollar borrowing and a rationale for policy intervention may arise as the result of a market imperfection—balance sheet effects—even if there are no distortions introduced by government or by the absence of efficient seniority rules.

Caballero and Krishnamurthy (2003) identify an inefficiency that also stems from incomplete financial markets and that leads to excessive dollar borrowing. However, they analyze an economy that has access to a fixed amount of dollars, and the source of their inefficiency is frictions in the domestic financial market. The contribution of our paper is to analyze how a planner can relax external financial constraints rather than how a planner can better allocate a given supply of external credit in domestic financial markets. The importance of stable access to external credit is underlined by the experience of countries in crises: when a country’s access to external credit declines, it leads to capital outflows that exert downward pressure on exchange rates and wreak havoc with the balance sheets of domestic borrowers, as in our model and in the literature on financial amplification more broadly. Our analysis therefore suggests that greater development of domestic financial markets, as suggested by Caballero and Krishnamurthy, will not by itself correct the excessive incentives of domestic agents to take on dollar debt, since it does not address the financial amplification effects that lead to fluctuations in the availability of external credit.

At a theoretical level, our work is related to the literature on the inefficiency of competitive equilibria under incomplete markets. Stiglitz (1982) and Geanakoplos and Polemarchakis (1986) show that when financial markets are incomplete, changes in allocations in financial markets lead to relative price changes in goods markets which have redistributive effects that are not internalized by price-taking atomistic agents. This generically leads to constrained inefficient allocations in the decentralized equilibrium.\(^6\)

We discuss a number of policy remedies to correct the externality to dollar debt. In general, any policy measure that disrupts the financial amplification effects can address the distortion. Examples for such first-best measures include policies to alleviate borrowing constraints, such as better creditor protection, and policies that stabilize exchange rates in low output states.

Among second-best policy options, our preferred measure is a tax on external dollar borrowing in the form of an unremunerated reserve requirement (URR) on dollar debt. This instrument can uniquely and robustly implement the social optimum. In a sample calibration of our model, we find that the externality is of a magnitude of 1.25% per dollar lent in the decentralized equilibrium. The social optimum could be restored by a reserve requirement that, in equilibrium, would impose a cost of only 0.66% per dollar lent, since such a tax would induce decentralized agents to shift towards local currency debt, which would lower macroeconomic volatility and reduce the externality associated with dollar debt.

In contrast to the existing literature that focuses on firm-level currency mismatches (see e.g. Goldstein and Turner, 2004), our findings imply that such a tax should also

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\(^6\)Auernheimer and Garcia-Saltos (2000) show that this applies when financial constraints depend on market prices.
apply to firms in the tradable sector that suffer from no mismatches in the denomination of their assets and liabilities, since the externality that we identify is of a macroeconomic nature.

We also compare the insurance properties of local currency denominated debt with GDP-linked dollar debt. While the two instruments offer similar insurance characteristics in normal times, local currency debt better protects better against financial crises, because during crises the exchange rate typically declines more strongly than GDP.

Note that our externality result applies to competitive equilibria in which agents are price-takers, but does not extend to the borrowing choices of a monopolist or of a government that fully internalizes the pecuniary externalities it creates. In most recent emerging market crises, foreign currency debts were amassed by a large number of private agents.

The remainder of our paper is organized as follows. Section 2 describes the basic model setup. In section 3, we solve for the decentralized equilibrium. We show that a higher fraction of dollar debt in the economy increases macroeconomic volatility for given fundamentals. Section 4 solves for the social optimum and demonstrates the central externality result of the paper. We also provide a numerical example. Section 4.4 discusses policy implications and presents our recommended second-best policy measure, a reserve requirement on dollar debt. Section 5 concludes.

2 Model Setup

2.1 Analytical Environment

Our analytical model describes the portfolio choice between dollar and local currency-denominated debt in a small open emerging market economy. We assume that there are three time periods, labeled by $t = 0, 1, 2$, and two sets of agents: (i) the emerging market economy is inhabited by a continuum of domestic agents of mass 1, (ii) there is a continuum of international lenders, who are large in comparison to the emerging market. We discuss each in detail below.

There are two perishable goods in the economy, tradable goods $T$ and non-tradable goods $N$. Tradable goods can be moved costlessly across borders and can be used for external borrowing and lending transactions. Non-tradable goods have to be consumed in the domestic economy. The prices of the two goods are denoted by $p_{T,t}$ and $p_{N,t}$. We choose tradables as the numeraire so that $p_{T,t} \equiv 1$. By implication, $p_{N,t}$ represents the price of non-tradables relative to tradables, which we interpret as a measure of the real exchange rate.\(^8\)

\(^7\)The externality would also arise in oligopolistic settings: an oligopolist who is responsible for $x\%$ of a country’s borrowing and who holds $x\%$ of the country’s collateral would leave $100 - x\%$ of the externality uninternalized.

\(^8\)The official definition of the real exchange rate is in terms of a composite basket of tradable and non-tradable goods. However, for simplicity we follow a common practice in the theoretical literature
The economy is subject to a random productivity shock that depends on the state of nature \( \omega \in \Omega \), where \( \Omega \) is the set of potential outcomes. This shock is realized at the beginning of period 1 and is observed by all agents.

### 2.2 Domestic Agents

Domestic agents are risk averse and obtain utility from consuming tradable goods \( C_{T,t} \) and non-tradable goods \( C_{N,t} \) according to the utility function

\[
U = E \left\{ \sum_{t=1}^{2} \beta^{t} u(C_{t}^{1+\sigma}) \right\} \quad \text{where} \quad C_{t} = \frac{1}{1+\sigma} C_{T,t}^{\frac{\sigma}{1+\sigma}} C_{N,t}^{\frac{1}{1+\sigma}}
\]  

(1)

\( E \) is the expectations operator, \( \beta \) represents agents’ discount factor, and \( C_{t} \) is a Cobb-Douglas aggregator of tradable and non-tradable consumption with expenditure shares \( \frac{1}{1+\sigma} \) and \( \frac{\sigma}{1+\sigma} \). The period utility function is assumed quadratic \( u(C) = -\frac{1}{2}(\bar{C} - C)^{2} \), as is common in the finance literature on optimal portfolio choice.\(^9\)

We assume that domestic agents are born with an initial amount of financial assets \( A_{0} \), which may be negative. They need to invest a fixed amount of tradables \( \bar{I} \) in both periods 0 and 1. We can collect these terms as the net-of-investment financial wealth \( W_{0} = A_{0} - \bar{I} - \bar{I}R^{\ast} \). As a return on their investment, domestic agents receive a bundle of tradable and non-tradable goods of \((Y_{T,1}^{\omega}, Y_{N})\) in periods 1 and 2.\(^10\) The period 1 output of tradables \( Y_{T,1}^{\omega} \) is subject to the aggregate shock \( \omega \), which can be interpreted as a productivity shock in that sector or as a terms-of-trade shock, such as a devaluation in a neighboring country or a fall in the world market price of the country’s main exports. The expected value of first period output equals \( E[Y_{T,1}^{\omega}] = \bar{Y}_{T} \).

For simplicity, we suppose that tradable production \( Y_{T,2}^{\omega} \) in period 2 is constant and also equals to \( \bar{Y}_{T} \), and we normalize without loss of generality \( \bar{Y}_{N} = 1 \).

Domestic agents access international capital markets and issue foreign and local currency debt. In a given period \( t \), we denote how many units of tradable goods are financed via foreign currency debt and local currency debt by \( F_{t+1} \) and \( L_{t+1} \), which result in period \( t+1 \) repayment obligations of \( R^{\ast}F_{t+1} \) and \( R^{\omega}_{L,t+1}L_{t+1} \). The foreign currency interest rate \( R^{\ast}st \) is determined on world markets. The return on local currency

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\( \ast \)The externality result holds for any utility function in which tradables and non-tradables enter as ordinary goods. Furthermore, the quadratic form for the period utility function \( u(\cdot) \) is not restrictive since any utility function can be approximated by a quadratic utility function using a second-order Taylor expansion. The chosen specification allows us to obtain closed form solutions for the equation describing the optimal portfolio choice of domestic agents.

\( ^{10} \)We can interpret the given model as an endowment economy. However, the requirement to invest \( \bar{I} \) is a natural motivation for the need to borrow in period 1, which makes the potential of binding borrowing constraints in that period more relevant. Endogenizing the amount of investment and output does not change the main result of the paper – agents equalize the expected marginal product of investment to their private cost of dollar debt, ignoring the effects on exchange rate volatility, and therefore borrow excessively in dollars.
debt, expressed in terms of the numeraire, units of tradables, is $R_{L,t+1}$, which is state-contingent as it depends on the realization of the real exchange rate. (Even though foreign creditors can only move tradable goods from/to the emerging market economy, the value of repayments can be made contingent on the price of non-tradable goods, which makes it possible to trade local currency debt.) In the given representative agent framework, there is no scope for a domestic credit market, since agents are identical and have a common, strictly concave utility function.

We denote the budget constraints for domestic agents in periods 0, 1, and 2 as

\[ I = A_0 + F_1 + L_1 \]  
\[ C_{T,1}^{\omega} + p_{N,1}^{\omega} C_{N,1}^{\omega} + \bar{I} = Y_{T,1}^{\omega} + p_{N,1}^{\omega} \bar{Y}_N - R^* F_1 - R_{L,1}^{\omega} L_1 + F_2^{\omega} + L_2^{\omega} \]  
\[ C_{T,2}^{\omega} + p_{N,2}^{\omega} C_{N,2}^{\omega} = Y_T^{\omega} + p_{N,2}^{\omega} \bar{Y}_N - R^* F_2 - R_{L,2}^{\omega} L_2^{\omega} \]

2.3 Borrowing Constraints

We capture the effects of credit market imperfections in the emerging market economy by introducing the possibility that domestic agents renegotiate their debts after borrowing in period 1. Lenders may threaten to take them to court, but because of imperfect legal enforcement they can extract at most a fraction $\kappa$ of the current income of borrowers. Assuming that domestic agents have all the bargaining power, the debt contract is only renegotiation-proof if the total amount borrowed satisfies

\[ F_2^{\omega} + L_2^{\omega} \leq \kappa(Y_{T,1}^{\omega} + p_{N,1}^{\omega} \bar{Y}_N) \]  

When the financial constraint is binding, the term $p_{N,1}^{\omega}$ is what drives financial amplification: a declining real exchange rate $p_{N,1}^{\omega}$ reduces the dollar value of non-tradable income and collateral and therefore tightens borrowing constraints. International lenders value the borrower’s non-tradable income at the prevailing market exchange rate $p_{N,1}$ since they can threaten to seize the non-tradable goods and re-sell them to other domestic agents against foreign currency. It is common for international lenders to grant loans against non-tradable collateral, as illustrated e.g. by the role of real estate loans in many financial crises.\(^{11}\)

Three further remarks are in order. First, total borrowing $F_0 + L_0$ in period 0 is pre-determined by initial wealth, which can be interpreted e.g. as the outcome of an optimal consumption-saving trade-off or of a binding borrowing constraint in period 0. We do not explicitly include a borrowing constraint in period 0, but our results are

\(^{11}\)In the given setup, borrowing is limited to a fraction of current income. This is common in much of the emerging market literature on financial amplification (see e.g. Mendoza, 2002, 2005). As pointed out in Korinek (2010), capturing financial amplification with a borrowing constraint that depends on an agent’s future ability to repay requires that investment is introduced into the model so that there are feedback effects between the ability to borrow in the current period and the ability to repay next period. Our argument would still be valid in such a setup, but we would lose many of the closed-form solutions in the current paper.
robust to deviations from this structure. Secondly, we abstract from the possibility of bankruptcy, as we assume that the borrowing constraint guarantees that incentives for repayment are always met. Explicitly accounting for bankruptcy would introduce more contingency into the payoffs of dollar debt and would complicate the analysis, but would not fundamentally affect our externality result. Thirdly, we denote financial contracts as one-period contracts. However, all allocations can be thought of as being determined in period 0. The model could equivalently be formulated in terms of long-term debt, since the incentive for agents to abscond in period 1 depends on the total value of their debt burden.

In summary, domestic agents maximize lifetime utility (1) subject to the period budget constraints (2), (3), (4) and to the borrowing constraint (5).

### 2.4 International Lenders

International capital markets are populated by a continuum of competitive risk-averse lenders that are large in comparison to the small open emerging market economy. They value payoffs according to a pricing kernel $M_t^\omega$. Empirical evidence suggests that international investors are typically averse towards emerging market risk (see e.g. Cunningham et al., 2001; Dodd and Spiegel, 2005). We capture this through the following assumption:\footnote{Risk averse international investors are also a standard assumption in the recent emerging market business cycle literature (see Arellano, 2008; Lizarazo, 2010).}

**Assumption 1.** The pricing kernel of international lenders is negatively correlated with the output shock in the domestic economy.

$$\text{Corr}(M_1^\omega, Y_{T,1}^\omega) < 0$$

By the definition of pricing kernels, the returns $R_{i,t}$ on any asset $i$ in which international lenders invest must satisfy the pricing condition

$$E \{ R_{i,t} M_t^\omega \} = 1$$

The risk-free interest rate therefore satisfies $R^* = 1/E[M_t^\omega]$, which we assume constant over time.

We denoted by $R_{L,1}$ the payoff of local currency debt in period 1 expressed in terms of tradable goods. We define $\rho$ as a measure of the risk premium on local currency debt so that

$$(1 - \rho)E[R_{L,1}^\omega] = R^*$$

If the return $R_{L,1}$ is indexed to the real exchange rate, then simple no-arbitrage considerations imply that

$$R_{L,1}^\omega = \frac{R^*}{1 - \rho} \cdot \frac{p_{N,1}^\omega}{E[p_{N,1}^\omega]}$$
Substituting this expression into lenders’ equilibrium pricing condition $E[R_{t,1}^{\omega} M_t^\omega] = 1$, we find

$$\rho = -R^* \text{Cov} \left( \frac{p_{N,1}^{\omega}}{E[p_{N,1}^{\omega}]}, M_1^\omega \right)$$

(9)

International lenders only require compensation for holding risk that is negatively correlated with their pricing kernel $M_t^\omega$.

Since there is no uncertainty in period 2, local and foreign currency debt $L_2^{\omega}$ and $F_2^{\omega}$ yield the same riskless return $R^*$ in that period, and one of the two securities is redundant. W.l.o.g. we set $L_2^{\omega} = 0$.

3 Decentralized Equilibrium

Given international lenders’ pricing kernel $M_t^\omega$, a competitive equilibrium in the emerging market economy can be characterized as an allocation $(C_{T,t}^{\omega}, C_{N,t}^{\omega}, F_t^\omega, L_t^\omega)$ and a bundle of prices and returns $(p_{N,t}^{\omega}, R^*, R_{L,t}^\omega)$ for $t = 1, 2$ and for all $\omega \in \Omega$, which solve domestic agents’ optimization problem (1) given their budget constraints (2) to (4) and the borrowing constraint (5), which are consistent with international lenders’ pricing condition (6), and which clear goods markets in the three time periods $t = 0, 1, 2$ and for all states of nature $\omega \in \Omega$.

The Lagrangian to the maximization problem is reported in appendix A.1. In the following, we solve the model through backward induction. We first describe the determination of the exchange rate and the payoffs on local currency debt; then we solve for the equilibrium in periods 1 and 2, given a choice of debt composition $(F_1, L_1)$ in period 0. Finally, we analyze the optimal debt composition in period 0.

3.1 Determination of the Real Exchange Rate

The first order condition of the Lagrangian with respect to non-tradable consumption $C_{N,t}^{\omega}$ is

$$p_{N,t}^{\omega} = \sigma \cdot \frac{C_{T,t}^{\omega}}{C_{N,t}^{\omega}} = \sigma C_{T,t}^{\omega}$$

(10)

In the second step we use the market clearing condition for non-tradables $C_{N,t}^{\omega} = \bar{Y}_N = 1$. The equation states that equilibrium in the market for non-tradable goods requires that the real exchange rate $p_{N,t}^{\omega}$ is proportional to the economy’s absorption of tradables $C_{T,t}^{\omega}$. For example, if domestic agents experience a negative shock to tradable output $Y_{T,1}$, tradable goods become relatively scarcer and non-tradable goods more abundant; the relative price of non-tradables $p_{N,1}^{\omega}$ falls, i.e. the real exchange rate depreciates. Loosely speaking, the real exchange rate is pro-cyclical in aggregate tradable consumption.
This implies that \( p_{N,1}^\omega / E[p_{N,1}^\omega] = C_{T,1}^\omega / E[C_{T,1}^\omega] \), and we can denote the return on local currency debt in terms of tradable consumption
\[
R_{L,1}^\omega = \frac{R^*}{1 - \rho} \cdot \frac{C_{T,1}^\omega}{E[C_{T,1}^\omega]}
\] (11)
The period 1 budget constraint can then be written as
\[
C_{T,1}^\omega = Y_{T,1}^\omega + R^*W_0 + F_2^\omega - R^*L_1 \left\{ \frac{C_{T,1}^\omega}{(1 - \rho)E[C_{T,1}^\omega]} - 1 \right\}
\]
\[= Y_{T,1}^\omega + R^*W_0 + F_2^\omega - N \left\{ C_{T,1}^\omega - (1 - \rho)E[C_{T,1}^\omega] \right\}
\] (12)
where we have changed the units of measurement for local currency debt in the second line by defining
\[
N = \frac{L_1 \cdot E[R_{L,1}^\omega]}{E[C_{T,1}^\omega]} = \frac{R^*L_1}{(1 - \rho)E[C_{T,1}^\omega]}
\]
The variable \( N \) is a linear transformation of \( L_1 \) and captures the expected repayment on local currency debt as a fraction of total tradable consumption. Using this unit of measurement will prove convenient to simplify the algebra in the ensuing derivations.

Looking at the curly brackets in equation (12), it can be seen that increasing local currency debt \( N \) amounts to swapping the risky stream of consumption \( C_{T,1}^\omega \) against its certainty equivalent \( (1 - \rho)E[C_{T,1}^\omega] \).

### 3.2 Euler Equation

Under the standard assumption that \( \beta R^* = 1 \), the Euler equation of domestic agents is
\[
u'(C_{T,1}^\omega) = u'(C_{T,2}^\omega) + \lambda^\omega
\] (13)

### Slack Borrowing Constraints

In states \( \omega \) with slack borrowing constraints \( (\lambda^\omega = 0) \), the Euler equation implies full consumption smoothing between periods 1 and 2, \( C_{T,1}^\omega = C_{T,2}^\omega = \bar{Y}_T - R^*F_2^\omega \). This requires period 1 borrowing to be
\[
F_2^\omega = \frac{\bar{Y}_T - C_{T,1}^\omega}{R^*}
\] (14)

We use this in (12) to solve for consumption in an unconstrained state \( C_{T,1}^{\omega,unc} \) as a function of the output shock \( Y_{T,1}^\omega \) and the fraction of local currency debt \( N \)
\[
C_{T,1}^{\omega,unc} = \frac{\bar{Y}_T + R^*Y_{T,1}^\omega + (R^*)^2W_0 + (1 - \rho)NR^*E[C_{T,1}^\omega]}{1 + R^*(1 + N)}
\] (15)
Consumption is less sensitive to productivity shocks the more local currency debt domestic agents have taken on. This is illustrated in figure 2. The higher \( N \), the flatter the lines in the figure, i.e. the less consumption responds to the productivity shock \( Y_{T,1}^\omega \) and the lower consumption volatility.
Bounding Borrowing Constraints and Financial Amplification

Domestic agents borrow to smooth consumption. Therefore the demand for borrowing is decreasing in the output shock $Y_{T,1}^\omega$, as indicated by equation (14). By contrast, the borrowing limit (5) is increasing in the output shock, as higher output implies more collateral. By combining the two equations we obtain a threshold of output $\hat{Y}_{T,1}$ such that the constraint is binding for realizations of the shock with $Y_{T,1}^\omega \leq \hat{Y}_{T,1}$, as detailed in appendix A.2.

When the constraint is binding, borrowing is limited to

$$F_{2,con}^{\omega} = \kappa \left( Y_{T,1}^\omega + p_{N,1}^\omega Y_N \right) = \kappa \left( Y_{T,1}^\omega + \sigma C_{T,1}^\omega \right)$$

The maximum amount that an agent can borrow is an increasing function of aggregate consumption $C_{T,1}^\omega$, since higher consumption appreciates the exchange rate and by implication raises the value of the agent’s non-tradable collateral.

We solve the system of two equations (12) and (16) for the constrained level of period 1 consumption as a function of the output shock and the amount of local currency debt contracted,\textsuperscript{13}

$$C_{T,1}^{\omega,con} = \frac{(1 + \kappa)Y_{T,1}^\omega + R^*W_0 + (1 - \rho)NE[C_{T,1}^\omega]}{1 + N - \kappa \sigma} \quad (17)$$

Figure 3 illustrates the effects of local currency debt on consumption volatility. In states with loose constraints $Y_{T,1}^\omega \geq \hat{Y}_{T,1}$, agents smooth the impact of the output shock

\textsuperscript{13}The equation for $C_{T,1}^{\omega,con}$ requires that $N$ is sufficiently large so that the denominator $1 + N - \kappa \sigma$ is always positive. Given the Inada conditions on their utility function, optimizing domestic agents will always pick a level of $N$ such that this restriction is fulfilled.
by adjusting their borrowing. When borrowing constraints are binding $Y_{T,1}^\omega < \hat{Y}_{T,1}$, the response of consumption to output shocks is magnified by the financial amplification effects.

### 3.3 Choice of Currency Denomination

We now turn to the agent’s period 0 problem of how much local currency debt to take on. The relevant trade-off is captured by the first-order condition with respect to $L_1$

$$E \left\{ u'(C_{T,1}^\omega) \left[ R^* - R_{L,1}^\omega \right] \right\} = 0$$

The agent holds local currency debt up to the point where the additional insurance effect per unit of local currency debt equals the cost of obtaining the insurance, which is the risk premium. We substitute for the return on local currency $R_{L,1}^\omega = \frac{R^*}{1 - \rho} \cdot \frac{C_{T,1}^\omega}{E[C_{T,1}^\omega]}$ from condition (11) and simplify to obtain

$$\rho = -\text{Cov} \left( \frac{u'(C_{T,1}^\omega)}{E[u'(C_{T,1}^\omega)]}, \frac{C_{T,1}^\omega}{E[C_{T,1}^\omega]} \right) = \frac{\text{Var}(C_{T,1}^\omega)}{E(C_{T,1}^\omega) E \left[ u'(C_{T,1}^\omega) \right]}$$

where the last equality follows from our assumption that utility is quadratic so $u'(C_{T,1}^\omega) = \bar{C} - C_{T,1}^\omega$. In a nutshell, domestic agents choose their optimal level of insurance such that the variance of tradable consumption is directly proportional to the cost of insuring against consumption volatility $\rho$. We denote this relationship the demand locus $DD$ for local currency debt.
Turning to the supply of local currency debt, we insert the equilibrium exchange rate $p_{N,1}^\omega = \sigma C^\omega_{T,1}$ into equation (9) determining the risk premium of lenders to obtain

$$\rho = -R^* \cdot \text{Cov} \left( \frac{C^\omega_{T,1}}{E[C^\omega_{T,1}]}, M^\omega_1 \right) \quad (19)$$

For international lenders, the risk premium is a function of how much domestic tradable consumption (which drives the exchange rate) covaries with their pricing kernel $M^\omega_1$. The more negatively correlated domestic tradable consumption is with the pricing kernel of international lenders, the higher the risk premium that lenders demand as a compensation for taking on local currency debt. We denote this relationship as the supply locus $SS$ of international lenders.

Equilibrium in period 0 is thus characterized by equating the demand locus (18) and the supply locus (19) for local currency, which results in an implicit equation in the amount of local currency debt $N$ that can be solved numerically.

Figure 4 provides a graphical illustration of the equilibrium, plotting the equations in a graph of the risk premium $\rho$ as a function of consumption volatility $\text{Var}(C^\omega_{T,1})$. Both loci are increasing, as borrowers are willing to pay a higher risk premium and lenders demand a higher risk premium the more volatile consumption and the exchange rate. The supply locus $SS$ is a concave function, since the covariance term $\text{Cov}(C^\omega_{T,1}, M^\omega_1)$ is linear in the standard deviation of consumption $\text{Std}(C^\omega_{T,1})$, which is the square root of the variance. The demand locus $DD$ is close to linear.\footnote{A detailed derivation of the curvature of the $DD$ locus shows that it is even mildly concave, since buying more insurance $N$ also affects the expected level and the marginal utility of consumption (see Korinek, 2011, for details).}
As we move to the left along the horizontal axis, the amount of local currency debt increases, as a higher fraction of local currency debt reduces volatility in the economy. In the limit of $N \to \infty$, we end up in the origin. Since lenders are risk-averse, this degenerate outcome cannot be optimal for borrowers: they could obtain a first-order gain in the form of lower borrowing costs by taking on an infinitesimal amount of risk at a second-order utility loss.

The shapes of the two optimality loci thus guarantee a unique non-degenerate equilibrium in period 0, as indicated in the figure. This pins down the equilibrium risk premium $\rho^*$ and equilibrium level of consumption volatility, implicitly defining the equilibrium fraction of local currency debt $N$ and a debt allocation in period 0 of $(F_1, L_1)$. This fully describes the decentralized equilibrium in the emerging market economy.

4 Social Planner

Decentralized agents take prices as given, including the exchange rate $p_{N,t}^*$, which determines the tightness of the borrowing constraint. A planner who coordinates the actions of domestic agents, by contrast, internalizes the effects of her actions on prices and constraints. In particular, she recognizes that increased local currency borrowing makes the exchange rate less volatile, which reduces the incidence and severity of socially costly binding borrowing constraints and raises the welfare of domestic agents. Since international lenders are indifferent between lending in dollars or local currency, this also constitutes a global Pareto improvement.

We strengthen assumption 1 about the pricing kernel of international investors as follows:

**Assumption 1’.** The pricing kernels of international lenders and of domestic agents are in equilibrium linearly dependent,

$$M_1^* \cong \mu^d$$

This assumption guarantees that risk markets between the emerging market economy and international capital markets are effectively complete in the sense of LeRoy and Werner (2001), which simplifies our analysis. One possible interpretation is that international lenders are emerging market specialists that hold bonds from a large number of emerging economies with similar risk factors that lenders cannot diversify.\(^1\)

Formally, we assume the social planner coordinates the borrowing decisions of domestic agents to maximize their utility (1), while internalizing that the exchange rate in the economy represents the ratio of the marginal utility of tradable versus non-tradable consumption. This captures a planner who can regulate borrowing decisions, but who leaves prices to be determined by the market. Appendix A.3 spells out the Lagrangian

\(^{15}\)The assumption also holds naturally in any model in which there are only two states of nature, since two linearly independent bonds automatically span the state space. See Korinek (2011) for an analysis of the implications if assumption 1’ is violated.
of the associated optimization problem. As in our solution to the decentralized equilib-
rium in the previous section, we solve the problem through backward induction.

4.1 Equilibrium in Periods 1 and 2

We first solve for the equilibrium in periods 1 and 2 for a given debt allocation \((F_1, L_1)\)
and realization of the output shock \(Y_{T,1}^\omega\).

\(\mu^\omega\) is the shadow price on the period 1 budget constraint of domestic agents, i.e.
their valuation of liquid wealth in period 1. The planner’s optimality condition on
consumption \(C_{T,1}^\omega\) is

\[
\mu^\omega = u'(C_{T,1}^\omega) + \lambda^\omega \kappa \sigma \tag{20}
\]

The marginal valuation of a unit of liquid wealth in period 1 consists of the marginal
utility of consumption of domestic agents plus an additional term \(\lambda^\omega \kappa \sigma\). This term
captures that a marginal increase in aggregate consumption appreciates the real exchange
rate by \(\sigma\) and relaxes borrowing constraints by \(\kappa \sigma\), which has a utility value of \(\lambda^\omega \kappa \sigma\).
Loosening the constraint is valuable whenever the borrowing constraint is binding so
\(\lambda^\omega > 0\). This term distinguishes the social planner’s solution from the decentralized
equilibrium and is responsible for our central externality result. (For comparison, the
marginal valuation of liquid wealth perceived by decentralized agents is just \(u'(C_{T,1}^\omega)\).)

Substituting expression (20) into the first-order condition on period 2 borrowing \(F_2\),
we obtain the planner’s Euler equation

\[
u'(C_{T,2}^\omega) + \lambda^\omega (1 - \kappa \sigma) = u'(C_{T,1}^\omega) \tag{21}\]

Slack Borrowing Constraints

If borrowing constraints are slack, then by definition \(\lambda^\omega = 0\ \forall \omega\) and the \(\lambda^\omega\)-term drops
from the equation. As a result, the Euler equations of both decentralized agents (13)
and the planner (21) imply smooth consumption across periods 1 and 2.

Binding Borrowing Constraints

When the borrowing constraint is binding, both decentralized agents and the social
planner borrow the maximum amount possible given the constraint (16), i.e. \(F_{2,\text{con}}^\omega = \kappa(Y_{T,1}^\omega + \sigma C_{T,1}^\omega)\). They choose identical consumption allocations for given initial condi-
tions \((F_1, L_1)\) and \(Y_{T,1}^\omega\) in period 1.

Although their real allocations coincide, it is instructive to compare the shadow
prices that they assign to the borrowing constraint:

\[
\begin{align*}
\lambda_{\text{DE}} &= u'(C_{T,1}^\omega) - u'(C_{T,2}^\omega) \\
\lambda_{\text{SP}} &= \frac{u'(C_{T,1}^\omega) - u'(C_{T,2}^\omega)}{1 - \kappa \sigma}
\end{align*}
\]
For a given real allocation \((C_{T,1}^\omega, C_{T,2}^\omega)\), the planner has a higher shadow price \(\lambda^\omega\), i.e. she puts a higher value on relaxing the constraint since she recognizes the multiplier effects that take place via rising exchange rates when the constraint is relaxed.

### 4.2 Optimal Debt Denomination in Period 0

In choosing the optimal currency composition of debts in period 0, this difference in the valuation attached to binding constraints has real implications. The planner internalizes that local currency debt affects tradable consumption and therefore the real exchange rate in two ways: on the one hand, local currency debt insures against the output shock, which raises consumption in low states of nature; on the other hand, the cost of insurance, i.e. the risk premium, reduces consumption uniformly across all states of nature. We capture the overall benefit of one unit of local currency debt in relaxing the financial constraint as

\[
\hat{\rho} = -\text{Cov}\left(\frac{\lambda^\omega}{E[\lambda^\omega]}, \frac{p_{N,1}}{E[p_{N,1}]}\right)
\]  

(22)

This captures how much the payoffs of local currency debt covary with the tightness of the constraint \(\lambda^\omega\). Since the constraint is always tighter in low states of nature than in high states, the covariance term is negative so that \(\hat{\rho}\) is always positive. For all our calibrations below, we also find that the value \(\hat{\rho}\) is considerably higher than the equilibrium risk premium \(\hat{\rho} \gg \rho\).

The planner’s first-order condition with respect to local currency debt \(N\) is

\[
E \left\{ \mu^\omega \left[ C_{T,1}^\omega - (1 - \rho)E(C_{T,1}^\omega) \right] \right\} = 0
\]

She uses the social shadow value \(\mu^\omega\) of liquid wealth as given by equation (20) rather than the private value \(u'(C_{T,1}^\omega)\) to value the payoffs of local currency debt. Substituting for \(\mu^\omega\) and following the steps described in appendix A.4, we obtain the demand locus \(DD^{SP}\) of the social planner,

\[
\rho - \theta = \frac{\text{Var}(C_{T,1}^\omega)}{E(C_{T,1}^\omega)E[u'(C_{T,1}^\omega)]} \quad \text{where} \quad \theta = -\kappa \sigma E[\lambda^\omega]E[C_{T,1}^\omega] (\rho - \hat{\rho})
\]

(23)

The term \(\theta\) captures the difference between the planner’s optimality condition and the optimality condition of decentralized agents (18). The uninternalized benefits of local currency debt are akin to a lower risk premium – instead of a cost of \(\rho\) per unit of local currency debt, the planner perceives the effective cost to be only \(\rho - \theta\).

By equating this equation with the supply locus of international lenders (19), we determine the planner’s optimal allocation. We illustrate the result in figure 5, which compares the decentralized equilibrium in the economy with the constrained planner’s optimum.
Proposition 1 (Excessive Dollar Borrowing). If $\rho < \hat{\rho}$, a constrained planner chooses less dollar-denominated debt and more local currency debt than decentralized agents. As a result, the economy exhibits lower consumption and exchange rate volatility and higher welfare.

The details of the proof is provided in appendix A.4. At an intuitive level, the planner compares the cost of insurance $\rho$ with the benefit $\hat{\rho}$ in relaxing financial constraints. If $\rho < \hat{\rho}$, then the externality term is positive $\theta > 0$ and the planner increases the amount of local currency debt compared to the decentralized equilibrium. This condition is generally met – in the ensuing calibration, the value of $\hat{\rho}$ was an order of magnitude higher than the risk premium. It follows directly from the right-hand side of the optimality condition (23) that the resulting equilibrium is associated with lower consumption volatility, which is directly proportional to exchange rate volatility, and therefore a lower risk premium on local currency debt.

4.3 Numerical Illustration

To illustrate our results, we calibrate our model to match the situation of a typical small open emerging economy using the parameter values reported in table 1. We normalize the economy’s output of $T$ and $N$ to 1, and we assume that the output shock $Y_{T,1}^\omega$ is normally distributed around this value with a standard deviation of $\sigma_Y = 4\%$ to match the average yearly standard deviation of emerging economies. The share of tradables in the domestic agent’s utility function (1) is $\sigma = 0.40$, which implies that the value of non-tradable to tradable consumption is $\frac{p_{N,1}Y_N}{C_{T,1}} = \sigma = 1.5$, as suggested by Mendoza (2005). The economy’s initial asset holdings are set to $A_0 = -60\%$ of tradable output, which is approximately the threshold where over-indebtedness problems in emerging economies arise (Reinhart et al., 2003). The investment requirement is set to $I = 22\%$.
of tradable output, which is typical in emerging economies. We assume the discount rate of domestic agents and the risk-free gross interest rate of international lenders to be $\beta = .96$ and $R^* = 1/\beta$. Following Mendoza (2005), we set the pledgeability parameter $\kappa$ in the borrowing constraint to 0.33. We calibrate the risk aversion of domestic agents and of international lenders respectively so as to yield a local currency return premium of $\rho = 3\%$ and an equilibrium fraction of local currency debt of $N = 10\%$ of expected tradable consumption, which is consistent with data reported in the BIS Quarterly Review for typical emerging markets. As we noted before, the utility function of domestic agents is assumed to be a quadratic function, and the pricing kernel $M^\omega_1$ of international lenders is calibrated in accordance with assumption 1'. In the resulting decentralized equilibrium, borrowing constraints are binding with a probability of 13.8%, which is consistent with the economy facing binding constraints roughly once every seven years, consistent with vulnerable emerging economies. Our simulations yield that the externality $\theta$ associated with decentralized agents’ dollar borrowing in such an economy is 1.25 cent per unit of dollar debt.

**Robustness**

We check the robustness of our result on excessive dollar borrowing by examining whether the condition $\rho < \hat{\rho}$ continues to hold for alternative calibrations. The parameter that most affects the two variables is the risk aversion of international lenders. Figure 6 illustrates the effect of varying the relative risk aversion of lenders between 1 and 20 (horizontal axis) on the equilibrium risk premium $\rho$ as well as on the threshold $\hat{\rho}$.

<table>
<thead>
<tr>
<th>$\sigma_Y$</th>
<th>$\sigma$</th>
<th>$\beta$</th>
<th>$\kappa$</th>
<th>$\bar{I}$</th>
<th>$A_0$</th>
<th>$N$</th>
<th>$\rho$</th>
<th>$\theta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>.04</td>
<td>.40</td>
<td>.96</td>
<td>.33</td>
<td>.22</td>
<td>-.60</td>
<td>.10</td>
<td>3.0%</td>
<td>1.25%</td>
</tr>
</tbody>
</table>

**Table 1:** Structural parameters, calibrated values, and resulting externality
\( \hat{\rho} \) (vertical axis). As can be seen, the threshold is in all cases at least five times larger than the risk premium.\(^{16} \)

### 4.4 Policy Implications

The externality that we analyzed in this paper is rooted in financial amplification effects that arise from the interaction of foreign currency debts with borrowing constraints. First-best policy measures would directly address the capital market imperfections that underlie these borrowing constraints to interrupt the amplification dynamics in the economy. However, this goal has long proven elusive to emerging market policymakers that aim to shield their economies from crises. Recognizing the limitations of such first-best policy measures, let us analyze second-best measures that take the existence of financial constraints as given.

A planner could induce private agents to internalize the social cost of dollar debt by imposing a tax in the amount of the externality \( \theta^{SP} \) so that decentralized agents face an effective risk premium of only \( \rho^{SP} - \theta^{SP} \) on local currency debt, where we use the superscript \( SP \) to denote variables in the social planner’s optimal allocation. By comparing the planner’s equilibrium condition (23) with that of decentralized agents (18), it can be seen that a tax satisfying this condition indeed implements the social optimum. We analyze two specific forms of taxation:

**Linear Tax on Dollar Debt**

A linear (or specific) tax \( t \) on dollar debt obliges a borrower to pay $\( t \) in taxes for every dollar in debt taken on, irrespective of the interest rates on dollar or local currency debt. In order to reduce the risk premium on local currency debt by \( \theta^{SP} \), a policymaker has

\(^{16}\)Additional robustness test show similar results and are availbale from the author upon request.
to raise the cost of dollar debt by a linear $t^*$ that satisfies

$$[1 - (\rho^{SP} - \theta^{SP})]E[R^{\omega}_{L,1}] = R^* + t^* \quad \text{or} \quad t^* = \theta^{SP} E[R^{\omega}_{L,1}] \quad (24)$$

In equilibrium, this optimal linear tax raises the cost of dollar debt to the point that the return differential to local currency debt reflects the private insurance benefit of local currency debt, i.e. the social benefit $\rho^{SP}$ minus the externality $\theta^{SP}$. This is illustrated in figure 7, where the decentralized demand $D$, the decentralized demand-cum-tax $D^{CE} + t^*$ and the social planner’s demand for local currency as well as international lenders’ supply of local currency debt are plotted against the risk premium. An appropriate linear tax $t^*$ can implement the social optimum $N^*$.

In our earlier sample calibration, the risk premium on local currency debt and the externality on dollar debt in the decentralized equilibrium were $\rho^{DE} = 3\%$ and $\theta^{DE} = 1.25\%$ respectively. In the social planner’s equilibrium of that economy, the amount of local currency debt increases fourfold to $N^{SP} = .30$, the risk premium on local currency declines almost by half to $\rho^{SP} = 1.74\%$ and the magnitude of the (now internalized) externality is $\theta^{SP} = 0.61\%$ in this equilibrium. Using equation (24) we calculate the optimal linear tax on dollar debt as $t^* = 0.66\%$.

This illustrates that a relatively small tax on dollar debt can induce a comparatively large change in the behavior of domestic agents because it leads to a virtuous circle: the more local currency debt agents take on, the more stable the economy, therefore the lower the risk premium and the greater the incentive for domestic agents to take on even more safe local currency debt.

However, a specific tax $t^*$ has an important drawback: it leads to multiple equilibria. Aside from the social optimum, it may also lead to an overly conservative equilibrium with an inefficient amount of local currency debt (denoted as $N^I$ in figure 7). In that equilibrium, volatility in the economy is low because of the high amount of domestic currency debt; hence the externality $\theta$ is considerably smaller than it would be in the social optimum. But since the tax $t^*$ on dollar debt is fixed and does not adjust to the smaller externality, it induces borrowers to take on an inefficiently large amount of local currency debt.$^{17}$

### Proportional Tax on Dollar Debt

A policy measure that uniquely implements the social optimum is a tax on dollar debt that is proportional to the risk premium $\rho$ on local currency debt, with a factor of proportionality of $\tau$. The optimal magnitude of this $\tau$ is determined by the condition

$$[1 - (\rho^{SP} - \theta^{SP})]E[R^{\omega}_{L,1}] = R^* + \tau \rho^{SP} \quad \text{or} \quad \tau = \frac{\theta^{SP}}{\rho^{SP}} E[R^{\omega}_{L,1}] = \frac{\theta^{SP} \cdot R^*}{\rho^{SP}(1 - \rho^{SP})} \quad (25)$$

In example 3 above, the optimal $\tau = 37\%$. Figure 8 shows that such a proportional tax accounts for the fact that the size of the externality varies as the amount of local

$^{17}$In the frameworks of e.g. Jeanne and Korinek (2010) and Bianchi (2011), this issue of multiplicity does not arise because there is only one form of debt.
currency debt in the economy changes. The demand curve $D^{CE} + \tau \rho$ of decentralized agents that are subject to proportional taxation closely resembles the social planner’s demand curve $D^{SP}$ and the social optimum is uniquely implemented.

Risk premia are not directly observable in financial markets. However, our proposal of a tax proportional to the risk premium on local currency can be implemented by imposing a particular form of reserve requirement on lenders that grant dollar loans: every lender has to hold $\tau$ dollars in a reserve account with the central bank per dollar lent to domestic agents; the reserve holdings would be denominated in local currency (possibly inflation-indexed), but would be remunerated only at the interest rate on dollar loans. As a result, the expected loss in interest from such a reserve requirement would equal the risk premium between dollar and local currency debt.\textsuperscript{18}

Changes in International Risk Aversion

Risk premia faced by emerging markets are strongly influenced by external factors such as global risk aversion (see e.g. Longstaff et al., 2007), which often fluctuates at high frequencies.

Figure 9 illustrates the effect of e.g. an increase in the risk aversion of international lenders, represented by a mean-preserving spread in their pricing kernel $M_\omega^*$ (Rothschild and Stiglitz, 1970): their optimality locus shifts from $SS_1$ up to $SS_2$: for a given level of macroeconomic volatility, they demand a higher risk premium on local currency. As depicted in the figure, this entails a multiplier mechanism: given the higher risk premium, domestic agents find it optimal to borrow less in local currency and more

\textsuperscript{18}Requiring unremunerated reserves in dollars would be isomorphic to the linear tax that we discussed earlier and would be subject to the same limitations. A linear tax $t^*$, for example, could equally be implemented as a reserve requirement of $\frac{t^*}{R^* - 1}$ per dollar lent. A similar approach was used by Chile to regulate short-term capital flows (see e.g. Gallego et al., 2002).
Small changes in the risk aversion of international lenders can thus lead to large changes in the equilibrium risk premium on local currency debt. An increase in lenders’ risk aversion also raises the externality $\theta$, as captured in the figure by the increasing vertical difference between the $DD$ and $DD^{SP}$ loci. This points to a further advantage of a proportional tax on dollar debt: A planner who imposes a specific tax would have to continuously adjust the tax rate in response to changes in international risk aversion in order to implement the social optimum. On the other hand, for a planner who uses a proportional tax $\tau$, changes in the risk premium automatically lead to changes in the effective tax burden on dollar borrowers; therefore the proportional tax rate can be kept constant.

**Dollar Debt in the Tradable Sector**

It is often argued that the most important element in avoiding emerging market crises is to avoid currency mis-matches in the balance sheets of borrowers (see e.g. Goldstein and Turner, 2004). Our research adds a new dimension to this emphasis on mis-matches at the microeconomic level: we argue that this leaves out an important macroeconomic dimension. Even if firms have matched the currency denomination of revenues and liabilities, dollar debt makes a country’s macroeconomy, and its exchange rate in particular, more volatile. Decentralized agents in the tradable sector do not internalize this and therefore impose an externality on other agents who own non-tradable collateral. It is therefore desirable to impose restrictions on the use of dollar debt at the macroeconomic level, even if regulations that restrict risk-taking at the microeconomic level are already in place.
Optimal Indexation of Debt Instruments

It is often discussed whether CPI-indexed local currency bonds or GDP-linked bonds provide better risk-sharing to emerging economies (see e.g. Borensztein et al., 2004). In our model, the answer to this question is clear: the real exchange rate always moves in parallel to consumption and is therefore an excellent instrument to insure the sharp drops in consumption that occur when borrowing constraints are binding. By contrast, bonds with payoffs that are linked to the output shock do not provide extra insurance when borrowing constraints are binding and $\hat{Y}_{T,1}^\omega < \hat{Y}_{T,1}$, as illustrated in figure 10.

Since individuals care about smooth consumption not smooth output, this suggests that CPI-indexed local currency debt is a superior risk-sharing instrument to GDP-linked debt. The countries affected by the East Asian crisis present a clear case in point: even though the variance of quarterly changes in their real exchange rates was smaller then the variance in growth over the past quarter century, the depreciation in their real exchange rates during the Asian financial crisis was many times stronger than the fall in GDP.\(^{19}\) Local currency debt would thus have provided much better insurance against the East Asian crisis than GDP-linked debt.

5 Conclusions

This paper analyzed the optimality of the debt composition of private borrowers in emerging economies. We found that if an economy is subject to collateral-dependent borrowing constraints, decentralized agents engage in socially excessive dollar borrowing because they fail to internalize that dollar debt reinforces the financial amplification effects that are triggered when borrowing constraints become binding. Dollar debt

\(^{19}\)Data from International Financial Statistics, 1984 – 2010, and author’s calculations.
implies that aggregate demand declines more strongly and exchange rates depreciate further in low states of nature. In the absence of market imperfections, this would be a purely pecuniary externality. However, in emerging markets strong depreciations in the exchange rate have contractionary effects because they deteriorate balance sheets and tighten borrowing constraints. As a result, the exchange rate volatility created by dollar debt entails a real externality. Small decentralized agents rationally take exchange rates as given, do not internalize their contribution to the contractionary effects of exchange rate depreciations and take on too much dollar debt.

We discussed a number of potential policy remedies to correct the distortion: While a linear tax on dollar debt can result in multiple equilibria, we showed that a tax on dollar debt that is proportional to the risk premium on local currency debt uniquely implements the social optimum and is robust to fluctuations in the risk aversion of international lenders. Such a tax can be implemented through a reserve requirement that is held in local currency and remunerated below market rates.

At a methodological level, our contribution was to show that the financial amplification effects that have frequently been used to describe financial crises in the literature on emerging market finance (see e.g. Krugman, 1999; Mendoza, 2006) create an externality that introduces a bias towards excessive dollar borrowing.

The existing literature on financial crises has taken it as a given that emerging economies routinely use uncontingent dollar debt rather than local currency debt. This literature has shown that dollar debts play an essential role in the propagation of crises by contributing to the balance sheet effects that drive financial amplification dynamics. We complement this literature by showing that the externalities created by financial amplification effects are an important reason why decentralized agents hold such large amounts of dollar denominated debt.

References


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A Mathematical Appendix

A.1 Problem of Decentralized Agents

We substitute the budget constraints (2) and (4) in the decentralized agent’s maximization problem to obtain the Lagrangian

\[
L^{DE} = E \left\{ u \left( [C_{T,1}^\omega][C_{N,1}^\omega]^\sigma \right) + \beta u \left( [\hat{Y}_T + p_{N}^\omega(\check{Y}_N - C_{N,2}^\omega) - R^* F_2^\omega][C_{N,2}^\omega]^\sigma \right) - \mu^\omega [C_{T,1}^\omega - Y_{T,1}^\omega + p_{N,1}^\omega (C_{N,1}^\omega - \check{Y}_N) - R^* W_0 - L_1 (R^* - R_{L,1}^\omega) - F_2^\omega] \right. \\
- \left. \lambda^\omega \left[ F_2^\omega - \kappa (Y_{T,1}^\omega + p_{N,1}^\omega \check{Y}_N) \right] \right\}
\]

where we collecte the the initial asset holdings minus the investment requirements of the agent in a net wealth variable \( W_0 = A_0 - I - \frac{T}{B} \). We assign \( \mu^\omega \) and \( \lambda^\omega \) as the multipliers on the period 1 budget constraint and the borrowing constraint.

We obtain the following first-order conditions, where we have employed the market clearing condition \( C_{N,t}^\omega = \bar{Y}_N = 1 \) to simplify notation:

- \( \text{FOC}(C_{T,1}^\omega): \mu^\omega = u'(C_{T,1}^\omega) \)
- \( \text{FOC}(C_{N,1}^\omega): \sigma u'(C_{T,1}^\omega) C_{T,1}^\omega = \mu^\omega p_{N,1}^\omega \)
- \( \text{FOC}(L_1): E \left[ \mu^\omega (R^* - R_{L,1}^\omega) \right] = 0 \)
- \( \text{FOC}(F_2^\omega): \mu^\omega = \beta R^* u'(C_{T,2}^\omega) \)

A.2 Derivation of \( \hat{Y}_{T,1} \)

At the cutoff \( \hat{Y}_{T,1} \), the constrained and the unconstrained levels of consumption \( C_{T,1}^{\text{con}} \) and \( C_{T,1}^{\text{unc}} \) are equal so that the constraint is marginally binding. We find \( \hat{Y}_{T,1} \) as the value of \( Y_{T,1}^\omega \) for which the two expressions (15) and (17) are equal.

\[
[1 + R^*(1 + N)][(1 + \kappa)\hat{Y}_{T,1} + R^* W_0 + (1 - \rho) NE(C_{T,1})] = \\
[1 + N - \kappa \sigma][\check{Y}_T + R^* \hat{Y}_{T,1} + (R^*)^2 W_0 + (1 - \rho) N R^* E(C_{T,1})]
\]

This can be solved for

\[
\hat{Y}_{T,1} = \frac{- (1 + \kappa \sigma R^*) [R^* W_0 + (1 - \rho) NE(C_{T,1})] + \check{Y}_T (1 + N - \kappa \sigma)}{1 + \kappa [1 + R^* (1 + N - \sigma)]}
\]
A.3 Social Planner’s Optimization Problem

The Lagrangian of the social planner’s optimization problem is

\[
\mathcal{L}^{SP} = E \left\{ u \left( C^\omega_{T,1} \right) + \beta u \left( \bar{Y}_T - R^* F^\omega_2 \right) - \lambda^\omega \left[ F^\omega_2 - \kappa \left( Y^\omega_{T,1} + \sigma C^\omega_{T,1} \right) \right] \\
- \mu^\omega \left[ C^\omega_{T,1} - Y^\omega_{T,1} - R^* W_0 + N \left( C^\omega_{T,1} - (1 - \rho) E C_{T,1} \right) - F^\omega_2 \right] \\
- \nu \left[ \rho E C_{T,1} + (C^\omega_{T,1} - E C_{T,1})(R^* M^\omega_1 - 1) \right] - \eta \left[ E C_{T,1} - C^\omega_{T,1} \right] \right\} \quad (26)
\]

where \( \lambda^\omega \) is the multiplier on the borrowing constraint in state \( \omega \), \( \mu^\omega \) is the shadow value of increasing period-1 consumption \( C^\omega_{T,1} \), and \( \nu \) and \( \eta \) are the multipliers on the constraint (19) determining international lenders’ risk premium and on the auxiliary equation \( E C_{T,1} = E[C^\omega_{T,1}] \).

Note that the covariance term in the constraint determining lenders’ risk premium \( \rho E[C^\omega_{T,1}] = R^* \text{Cov}(C^\omega_{T,1}, M^1_1) = E \left[ (C^\omega_{T,1} - E[C^\omega_{T,1}]) (R^* M^\omega_1 - 1) \right] \) contains two nested expectations which need to be calculated using two different integrating variables. We address this problem in our setup of \( \mathcal{L}^{SP} \) by introducing \( E C_{T,1} \) as a separate auxiliary variable and including the equation \( E C_{T,1} = E[C^\omega_{T,1}] \) as an additional constraint in the problem.

The resulting first-order conditions are

\[
\text{FOC}(C^\omega_{T,1}) : \quad u'(C^\omega_{T,1}) + \lambda^\omega \kappa \sigma = \mu^\omega (1 + N) + \nu (R^* M^\omega_1 - 1) - \eta \quad \forall \omega \\
\text{FOC}(F^\omega_2) : \quad \beta R^* u'(C^\omega_{T,2}) + \lambda^\omega = \mu^\omega \quad \forall \omega \\
\text{FOC}(N) : \quad E \left\{ \mu^\omega [C^\omega_{T,1} - (1 - \rho) E C_{T,1}] \right\} = 0 \\
\text{FOC}(\rho) : \quad E[\mu^\omega] N E C_{T,1} = -\nu E C_{T,1} \\
\text{FOC}(E C_{T,1}) : \quad E[\mu^\omega] N (1 - \rho) = \nu \rho + \eta
\]

Combining the first-order conditions on \( \rho \) and \( E C_{T,1} \), we express the two shadow prices \( \nu = -N \cdot E[\mu^\omega] \) and \( \eta = N \cdot E[\mu^\omega] \) and re-write the first condition as

\[
\text{FOC}(C^\omega_{T,1}) : \quad u'(C^\omega_{T,1}) + \lambda^\omega \kappa \sigma = \mu^\omega (1 + N) - N \cdot E[\mu^\omega] R^* M^\omega_1 \quad \forall \omega \quad (27)
\]

Using assumption 1’ we simplify the condition to

\[
\text{FOC}(C^\omega_{T,1}) : \quad u'(C^\omega_{T,1}) + \lambda^\omega \kappa \sigma = \mu^\omega \quad \forall \omega
\]

A.4 Planner’s Optimality Condition for Debt Composition

We substitute this value of \( \mu^\omega \) in the first-order condition \( \text{FOC}(N) \) to obtain

\[
\rho E[u'(C^\omega_{T,1})] E(C^\omega_{T,1}) + \text{Cov}(u'(C^\omega_{T,1}), C^\omega_{T,1}) + \kappa \sigma E \left\{ \lambda^\omega \left[ C^\omega_{T,1} - (1 - \rho) E(C^\omega_{T,1}) \right] \right\} = 0
\]

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The last term in curly brackets can be re-written

\[ E \{ \lambda^\omega \left[ C_{T,1}^\omega - (1 - \rho)E(C_{T,1}^\omega) \right] \} = \rho E[\lambda^\omega] E[C_{T,1}^\omega] + \text{Cov} \left( \lambda^\omega, C_{T,1}^\omega \right) = E[\lambda^\omega] E[C_{T,1}^\omega] (\rho - \hat{\rho}) \]

After dividing by \( E[u'(C_{T,1}^\omega)] E(C_{T,1}^\omega) \), the planner’s optimality condition is

\[ \rho + \kappa \sigma E[\lambda^\omega] E[C_{T,1}^\omega] (\rho - \hat{\rho}) = \frac{\text{Var}(C_{T,1}^\omega)}{E(C_{T,1}^\omega) E[u'(C_{T,1}^\omega)]} \]