Persistence of Dollarization after Price Stabilization

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Abstract

Credit contracts in developing countries are often denominated in foreign currencies, even after many of these economies succeeded in controlling inflation. This paper proposes a new interpretation of this apparent puzzle based on the demand for insurance against real aggregate shocks. The fact that devaluations occur more frequently in adverse states of the world provides a motive for holding dollar assets when the risk of recession is the main source of volatility in consumption. This approach implies a complementarity between the optimal monetary policy and the currency denomination of contracts. When a large proportion of liabilities is denominated in a foreign currency, the optimal exchange rate volatility is low. This raises the vulnerability of the economy to aggregate shocks and reinforces the demand for dollar assets. Based on this complementarity, the model predicts persistence in the degree of “dollarization” in economies with low inflationary risk. (JEL: E42, F31, F34, G11)

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1 Introduction

When analyzing the financial arrangements in emerging economies, the literature points out the risks associated with a corporate sector overly exposed to depreciations in the exchange rate.\(^1\) Indeed, a large share of credit contracts among residents in developing countries is denominated in foreign currencies, mainly dollars.\(^2\) These economies are often trapped in suboptimal monetary policies, pegs or regimes with reduced exchange rate volatility. These financial arrangements seem to be inefficient in light of the default risk and output volatility associated with high share of dollar liabilities. However, they result from the free choice of borrowers and lenders, who presumably understand the risks involved in their credit contracts.

The main contribution of this paper is to reassess the motives behind domestic dollarization. I propose a new interpretation of this apparent puzzle based on the demand for insurance against real shocks and identify the main market imperfections that lead to this result. These are:

First, local consumers have imperfect access to international financial markets and, as a result, are underinsured to the country aggregate shocks. The framework of this model is based on a risk sharing problem between risk averse consumers, with no access to international assets, and risk neutral domestic firms. Firms face a real productivity shock, which is the only aggregate risk in this economy. They are protected by limited liability and default in this model is socially costly. Then, domestic corporate sector plays a double role in this economy: it is the sole provider of insurance to consumers and, at the same time, the source of consumption volatility.

Second, credit markets are incomplete. Credit contracts cannot be written contingent on

\(^1\)The level of dollarization is found to increase the likelihood of crisis and the vulnerability of the economy towards real exchange rate perturbations. See Hausmann, Panizza, and Stein (2001), and Calvo, Izquierdo, and Mejia (2004). For a theoretical approach, see, among others, Jeanne and Zettelmeyer (2003), Chang and Velasco (1999), Krugman (1999), and Aghion, Bacchetta, and Banerjee (2001).

\(^2\)As an approximation for the domestic demand of foreign denominated assets, see table in appendix 7.2: share of foreign denominated deposits in selected countries.
the realization of the real aggregate shock. Instead, they can be denominated in foreign (dollar) or domestic (peso) currency. Moreover, credit contracts are non-exclusive. In other words, it is assumed that a lender cannot enforceably restrict the borrower from participating in credit contracts with other agents.\(^3\) In this case, the currency denomination of one credit contract does not characterize the firm’s currency composition of debt, nor its probability of default. Individual contracts cannot provide the right incentives to the corporate sector, which explains its overexposure to exchange rate fluctuations.\(^4\)

I find that dollar and peso contracts enable consumers to trade-off between insurance and default risk. Because devaluations are more likely to occur in bad states of the world, dollar assets provide insurance against the risk of recessions, though they face larger default risk.\(^5\) On the other hand, because devaluation and inflation are positively correlated, real payments of peso debt are lower in bad states. Thus, peso assets involve lower default risk at the expense of a more uneven consumption schedule. The ability of these assets to approximate complete financial markets depends on the magnitude of the devaluation response to aggregate shocks.

The role of foreign currency denominated assets in providing insurance against country risk is also present in Neumeyer (1998), Holmstrom and Tirole (2002), Ize and Levy-Yeyati (2003), and Chang and Velasco (2004). As in there, the exchange rate response to the shock determines the contingent value of the available financial assets. In those models, the insurance capacity of foreign currency denominated assets increases with the exchange rate volatility. The crucial difference with those is that in this model dollar instruments are issued by the domestic corporate

\(^3\)Non-exclusive contracts seem to characterize markets for unsecured or partially secured loans, especially in emerging economies. For evidence on non-exclusive contractual relationships and lack of information sharing among lenders see Jappanelli and Pagano (2000), Morduch (1997), and Radelet and Sachs (1998).


\(^5\)See Chamon (2001) for a model where the correlation between default and depreciation explains the currency denomination of foreign debt. And Broda and Levy-Yeyati (2003) using the same feature in a model explaining incentives for dollarization in domestic banking system.
sector, which has limited capacity of providing insurance. Then, a highly volatile exchange rate increases the default risk of firms with high share of dollar liabilities and the insurance capacity of existing financial assets is reduced, which negatively affects consumers’ welfare. This feature is crucial in explaining the observed level of overexposure of firms to exchange rate volatility, and the potential negative balance sheet effect associated with fluctuations in the exchange rate.

The size of the exchange rate response to the shock is the relevant variable determining the efficiency of the financial market. Along the lines of Kydland and Prescott (1977) and Barro and Gordon (1983), I analyze the Central Bank’s optimal exchange rate volatility when it does not have a commitment technology. The degree of dollarization of the credit market affects the Central Bank’s optimal policy. However, it does not internalize how the ex-post optimal policy feeds back into credit market expectations and determines borrowers’ and lenders’ choice of contract denomination. The interplay between market expectations and the Central Bank’s optimal policy creates the need for commitment. Under full commitment, the optimal monetary policy enables dollar and peso assets to replicate a complete financial market. Conversely, the monetary authority’s lack of commitment implies a suboptimal (from an ex-ante perspective) monetary policy. In this case, the Central Bank pushes the economy towards a default risk below the ex-ante optimum and, as a consequence, consumers are underinsured.

I find that the interplay between the currency composition of debt and the Central Bank’s optimal policy may result in multiple equilibria: an equilibrium with full dollarization in which the Central Bank minimizes exchange rate volatility; and another in which contracts are mainly denominated in domestic currency and the exchange rate is very responsive to the realization of the shock. Under full dollarization, the real aggregate shock has larger impact on output. However, because insurance against the risk of recession is the motive behind dollarization,
consumers are better off under full dollarization than with a high share of peso denominated contracts.

The interaction between monetary policy and the degree of domestic dollarization is also present in Chamon and Hausmann (2002), Cowan and Do (2003), and Ize and Powell (2004). However, the role of dollar assets in providing insurance against the risk of recession has not been emphasized. Caballero and Krishnamurthy (2001, 2003) also introduce a similar interplay between monetary policy and the composition of liabilities. As in there, the promise of a highly volatile exchange rate regime could reduce the share of dollar liabilities, but it is time inconsistent. Applied to the problem of consumers’ underinsurance against the risk of recessions, the main conclusions of those papers are fundamentally altered. In this paper, when credit contracts are mainly denominated in domestic currency, the Central Bank has incentives to follow an excessively responsive monetary policy aimed to redistribute resources from consumers (lenders) to firms (borrowers) above what it is socially optimum. This exacerbates the problem of underinsurance and reduces the welfare of the participants in the financial market.

The predictions of this model are largely supported by available empirical evidence. Calvo and Reinhart (2000 and 2002), Eichengreen, Hausmann and Panizza (2002) and Alesina and Wagner (2005) find that dollarization of liabilities in emerging economies is positively correlated with managed floating or fixed exchange rate regimes. The phenomenon of domestic dollarization is associated in many cases with a history of large inflationary episodes. Denominating contracts in foreign currency protects borrowers and lenders against inflationary risk. However, during the last decade many such countries have made substantial progress in controlling inflation and yet the share of dollar denominated assets in these economies remains high.\textsuperscript{6} The model rationalizes

\textsuperscript{6} Appendix 7.3 illustrates this phenomenon.
the observed positive impact of inflation risk on the share of foreign currency denominated contracts and predicts that price stabilization may have limited efficacy in reducing dollarization.

The rest of the paper is organized as follows. Section 2 describes the economic environment. Section 3 solves the credit market equilibrium for a given anticipated devaluation response. Section 4 endogenizes the optimal devaluation response and closes the model. Section 5 discusses the implications of an increase in inflationary risk and the introduction of CPI-indexed credit contracts. Section 6 concludes.

2 Basic Framework

The model describes a small economy subject to real aggregate risk, in this case, a productivity shock. The economy is open to trade while the capital account is assumed to be closed. This is to capture for the fact that in emerging economies a large share of small firms and atomistic consumers do not have access to foreign capital and are unable to diversify country risk.

There are three goods, a nontradable final good, used for consumption and investment, and two intermediates, one tradable and one non-tradable. The economy is populated by risk averse consumers, and a unit measure of risk neutral entrepreneurs.

There is an imperfect set of contracts. Credit contracts cannot be set contingent to the realization of the aggregate shock. Instead, they can only be expressed in terms of a fixed amount of foreign or domestic currency. Contractual relationships between lenders and borrowers are non-exclusive. In other words, it is assumed that a lender cannot enforceably restrict the borrower to participate in credit contracts with other agents.

The timing of events is as follows: date 1 is a fully flexible period in which all contracts are

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7See Bisin and Guaitoli (2002) and Arnott and Stiglitz (1991) for models of moral hazard with multiple contractual relationships.
set. At date 2, the productivity shocks are realized, firms decide whether to repay their debts, and consumption takes place.

Transactions occur at date 1, when consumers sell their endowment, and at date 2 in the two possible states of nature $s \in \{B, G\}$. The vector of prices in this economy is

$\{p^T_B, p^T_G, p^N_B, p^N_G, p^F_B, p^F_G\}$, where the superscript $T$ denotes for tradable, $N$ for non-tradable intermediate goods, and $F$ for the final good. The international price of tradables is assumed constant and normalized to one unit of international currency. The expected price of the final good is used as a numeraire.

### 2.1 Technology

Consumers are endowed with one unit of final good and entrepreneurs do not have initial resources. Entrepreneurs have access to two production alternatives: either they home-produce an amount $K$ of the final good, or undertake a risky project. The project requires a unit of initial investment, and results in date 2 joint output of tradable and nontradable goods: $y^T_{is} = \tau A_{is}$ units of tradables and $y^N_{is} = (1 - \tau) A_{is}$ units of nontradables, where $\tau$ is a fixed proportion $\tau \in (0, 1)$. The technology is affected by an aggregate productivity shock $z_s$ and a firm non-observable idiosyncratic sensitivity towards it, $a_i$. The aggregate shock follows a symmetric binomial distribution, $z_s \in \{-z, z\}$ with $\Pr = 1/2$, and the idiosyncratic shock is uniformly distributed over the unitary interval, $a_i : U[0, 1]$:

$$A_{is} \equiv A (1 + a_i z_s) \quad (2.1)$$

The final good is produced by consumers using tradable and nontradable intermediates. At date 1, the optimal share of tradable and nontradable inputs is chosen. At date 2, when the
state of nature is revealed, the structure of production is fixed. This assumption accounts for the fact that the productive structure cannot adjust instantaneously to unexpected changes in the relative price of inputs. On the other hand, the productive structure can optimally accommodate to foreseen relative prices. Then, the technology is described by the following production function:

\[ y_s^F = \min \left\{ \frac{y_s^T}{\eta}, \frac{y_s^N}{1 - \eta} \right\} \]  

\[ \eta = \arg \max_{0 \leq \eta \leq 1} EU' \left( c_s^* \right) \left\{ y_s^F - p_s^T y_s^T - p_s^N y_s^N \right\} \]  

where \( \eta \) is chosen at date 1, before the state of nature is revealed, and \( U \) is the utility function of consumers.

### 2.2 Goods Market Equilibrium

Prices of intermediate goods are set at date 1. The price of nontradables is set in domestic currency while the price of tradable goods is given by its international price, assumed constant and normalized to one unit of foreign currency. Thus, in local currency denomination, the price of tradables \( p_s^T \) is equal to the nominal exchange rate, while the price of non-tradables \( p_s^N \) is constant across states of nature. The nominal devaluation schedule is assumed exogenous in the basic framework of the model and endogenized in section 4. Importantly, in this context, expected devaluation has no real implications. Only deviations from the expected devaluation, which are necessarily symmetric, impact on relative prices and consumption allocation. Then, I restrict the analysis to a devaluation schedule of the form:

\[ \delta_s = \frac{p_s^T - E \left( p_s^T \right) }{E \left( p_s^N \right) } \in \{ \delta, -\delta \} \]  

\[ (2.4) \]
δ is understood as the deviation from expected devaluation rate, that is, the devaluation response to the aggregate shock.

The goods market is in equilibrium if, for any state of nature \( s \in \{B, G\} \), the nontradable goods market clears, and the trade balance condition is satisfied:

\[
y^N_s = (1 - \tau) \int_{i=0}^{1} A_{is} di \tag{2.5}
\]
\[
y^F_s = y^N_s + y^T_s = \int_{i=0}^{1} A_{is} di \tag{2.6}
\]

The equilibrium conditions (2.5) and (2.6) require the share of tradable intermediate goods produced to be equal to the share demanded \( (\eta = \tau) \), which, together with consumers’ maximization (2.3), pins down the price of non-tradable intermediate goods. Markets are assumed to be competitive in the sense that producing final goods results in zero profits. The price of consumption goods is therefore equal to the marginal cost resulting from (2.2):

\[
p^F_s = \tau p^T_s + (1 - \tau) p^N_s \tag{2.7}
\]

Combining (2.7) and (2.4), the domestic inflation rate is positively correlated with the devaluation response through the proportion of tradable intermediates used in the production of the final good:

\[
\pi_s = p^F_s - E(p^F_s) = \tau \delta_s \tag{2.8}
\]

2.3 The Risk Sharing Problem

The economic structure described above can be summarized in terms of risk sharing between risk averse consumers and risk neutral entrepreneurs.
Consumers are endowed a unit of final good, which is sold to the entrepreneurs at the market price $p_F^F = 1$. Consumers’ resources are lent to the entrepreneurs till date 2, when consumption takes place. Credit contracts can be denominated in domestic currency or dollars. Since firms’ idiosyncratic risk can be perfectly diversified, the return on assets only follows the realization of the aggregate shock $s \in \{B, G\}$. Then, consumers choose the optimal portfolio composition $\mu \in [0, 1]$, subject to short selling constraint, to maximize

$$\max_{\mu} EU (c^c_s)$$

s.t. $c^c_s = \mu q_{ps} R_{ps} + (1 - \mu) q_{ds} R_{ds}$

(2.9)

(2.10)

where $U' > 0$ and $U'' < 0$, $R_{ps}$ and $R_{ds}$ are respectively the real return on peso and dollar assets in the s-state, and $q_{ps}$ and $q_{ds}$ are the proportions of peso and dollar contracts repaid.

Entrepreneurs choose whether to undertake the project. If they do, they borrow from consumers to finance investment. Credit contracts can be denominated in pesos or dollars. Note that it is optimal for entrepreneurs to default on their debt whenever their profits are negative, in which case consumption is zero. Then, each entrepreneur $i \in [0, 1]$ chooses a strategy $\{i, v_i\} \in \{0, 1\} \times [0, 1]$, where $i$ indicates whether she undertakes the project and $v_i$ corresponds to the currency composition of debt, to maximize:

$$\max_{\{i, v_i\}} E (c^c_{is})$$

s.t. $E (c^c_{is}) = (1 - i) K + i \sum_{s \in \{B, G\}} 0.5 \Pr [A_{is} > R_{is}] E [A_{is} - R_{is} | A_{is} > R_{is}]$

(2.11)

(2.12)

where for $s \in \{B, G\}$:

$$R_{is} = v_i R_{ips} + (1 - v_i) R_{ids}$$
$R_{ips}$ and $R_{ids}$ are respectively the real claims on peso and dollar assets faced by the firm $i$ in the $s$-state, and $A_{ts}$ is defined in (2.1). Liquidation is assumed to be socially costly. For simplicity, I assume that, in the case of default, the firm makes zero profits and consumers get no liquidation value.\(^8\) I make parametric restrictions to assure that defaults only happen in the B-state –i.e. $2K \geq Az \geq K$, in which case the probability of repaying is:

$$
\text{Pr} (A_{iB} > R_{iB}) = \frac{A - v_iR_{ipB} - (1 - v_i)R_{idB}}{Az}
$$

(2.13)

Using (2.7), (2.4), and (2.8), real claims can be rewritten as:\(^9\)

$$
R_{(i)ps} = \begin{cases} 
    r_{(i)p} - \tau \delta & s = B \\
    r_{(i)p} + \tau \delta & s = G 
\end{cases}
$$

(2.14)

$$
R_{(i)ds} = \begin{cases} 
    r_{(i)d} + (1 - \tau) \delta & s = B \\
    r_{(i)d} - (1 - \tau) \delta & s = G 
\end{cases}
$$

(2.15)

where variables with subscript $i$ are firm specific and they otherwise refer to market equilibrium.

Notice from (2.15)-(2.14), that the devaluation response to the aggregate shock differentiates dollar and peso contracts. If devaluations happen in the B-state –i.e. $\delta \geq 0$–, dollar contracts involve larger payments in the negative realization of the shock. From (2.8), inflation and devaluation are positively correlated, thus the real return on peso assets is lower in the B-state. The contingent value of assets is given by the size of the devaluation response.

Finally, firms compete in the credit market and the zero profit condition holds: expected

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\(^8\)This assumption can be interpreted as a reduced form of a model with specificity in production in which the entrepreneur can "divert" the project returns. See Hart and Moore (1998).

\(^9\)Using (2.4) and (2.8), real returns on assets are approximated, for interest rates close to one and devaluation and inflation rates close to zero, using: $r_p \frac{1}{1 + \pi_s} \approx r_p - \pi_s$ and $r_d \frac{1 + \delta_s}{1 + \pi_s} \approx r_d + \delta_s - \pi_s$. 

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entrepreneurs’ profits are equal to their opportunity cost, that is, the home-production of $K$ units of final good. In equilibrium, the free entry condition (2.16) pins down the interest rate so investors retain the expected net present value of production.

$$E(c_{is}^e) = K$$  \hspace{1cm} (2.16)

## 3 Credit Market Equilibrium

The Credit Market Equilibrium is defined as follows:

**Definition 1 (Credit Market Equilibrium)** For a given devaluation schedule $\delta_s \in \{\delta, -\delta\}$, with $\delta \geq 0$, a Credit Market Equilibrium is a set $\{\{r_{ip}\}_{i=0}^{1},\{r_{id}\}_{i=0}^{1},\{v_i\}_{i=0}^{1},\mu\}$ such that:  

i) $\mu$ maximizes (2.9) subject to (2.10) for $\{r_p,r_d\}$; ii) $\forall i \in [0,1] : v_i$ maximizes (2.11) subject to (2.12) for $\{r_{ip},r_{id}\}$; iii) the free entry condition (2.16) is satisfied; and the credit market clears: iv) $\mu = \int_{i=0}^{1} v_i di$; v) $\forall i \in [0,1] : r_p = r_{ip}$ and $r_d = r_{id}$; and vi) $\mu q_{ps} = \int_{i=0}^{1} v_i \Pr[A_{is} > v_i R_{ps} + (1 - v_i) R_{ds}] di$ and $(1 - \mu) q_{ds} = \int_{i=0}^{1} (1 - v_i) \Pr[A_{is} > v_i R_{ps} + (1 - v_i) R_{ds}] di$.

### 3.1 Benchmark: Exclusive Contracts

Suppose lenders and creditors have exclusive contractual relationships. Then, each credit arrangement simultaneously sets the firm’s interest rate and currency composition of debt. As can be observed from the following arbitrage conditions, equalization of marginal utility of lenders across firms imply that the interest rates faced by each firm decreases with its ex-ante
probability of repaying, which is a function of $v_i$, the currency composition of debt.

\begin{equation}
U'(c_B^*) \Pr (A_{iB} > R_{iB}) R_{ipB} + U'(c_G^*) R_{ipG} = U'(c_B^*) \Pr (A_{iB} > R_B) R_{pB} + U'(c_G^*) R_{pG} \\
U'(c_B^*) \Pr (A_{iB} > R_{iB}) R_{idB} + U'(c_G^*) R_{idG} = U'(c_B^*) \Pr (A_{iB} > R_B) R_{dB} + U'(c_G^*) R_{dG}
\end{equation}

where $R_{ids}$ and $R_{ips}$ correspond to the real interest rate faced by the firm $i$, while $R_{ds}$ and $R_{ps}$ correspond to the market interest rates.

The fact that the interest rate faced by each firm increases with the share of dollar debt prevents entrepreneurs from incurring in unduly exchange rate risk, and they choose to diversify the currency composition of liabilities. Firms are ex-ante identical, so in equilibrium the composition of debt is equalized across firms, and is determined by the consumers’ portfolio choice:

\[ \forall i \in [0, 1] : v_i = \mu \]

Following that, in the presence of exclusive contracts, all firms have the same default risk. Moreover, since firms hold both dollar and peso debt, the default risk of both types of assets is identical. Law of large numbers holds, so the proportion of dollar and peso contracts defaulting is equal to the probability of default of an individual firm: $q_{dB} = q_{pB} = \Pr (A_{iB} > R_{iB}) = \Pr (A_{iB} > R_B)$.

Firms and consumers have the same currency composition of assets and liabilities. Then, the decentralized equilibrium replicates the following social planner’s problem: the optimal payment scheduled $\{R_B, R_G\}$ maximizes (2.9), subject to consumers’ budget constraint (2.10), and firms’ free entry condition (2.16). Consumers are restricted by short selling constraints, which imposes limits to the space of the optimal payment scheduled: $\{R_B, R_G\} \in [R_{pB}, R_{dB}] \times [R_{pG}, R_{dG}]$. The
equilibrium under exclusive contracts is characterized by the following first order condition:

\[ \text{foc}_{\text{exc}} := [U'(c_B^*) - U'(c_G^*)] \Pr(A_{iB} > R_B) + U'(c_B^*) R_B \frac{\partial \Pr(A_{iB} > R_B)}{\partial R_B} = \lambda_d - \lambda_p \text{(3.1)} \]

where \( R_B = \mu (r_p - \tau \delta) + (1 - \mu) (r_d + (1 - \tau) \delta) \text{ (3.2)} \)

\( \lambda_d \) and \( \lambda_p \) are the multiplier for the lower and upper bound of \( R_B \) respectively. The first term in (3.1) corresponds to the marginal benefit of improving insurance, while the second term is its cost in terms of default risk. Improving smoothness requires greater payments from the corporate sector to consumers in the adverse realization of the shock, precisely when firms’ revenues are lower, and therefore increases the probability of default.

The only difference between this program and the one characterizing the Second Best equilibrium results from the existence of short selling constraints, which can only bind for low devaluation response to the sock. Augmenting the exchange rate volatility increases the contingent value of assets and reduces the value of the multipliers on the financial restrictions. In this sense, monetary policy is understood as a tool for improving the efficiency of the credit market when contingent credit contracts are not available. Once the binding short selling constraint is relaxed, the solution in (3.1) is invariant to the volatility of the exchange rate. In this case, the currency denomination of contracts, characterized in (3.2), adjusts to the size of the devaluation response so to keep real claims on the corporate sector constant.

**Proposition 1 (Exclusive Contracts)** 10 The Credit Market Equilibrium is characterized by:

i) \( \forall i \in [0, 1] : v_i = \mu \); ii) \( \lim_{\delta \to \infty} \mu (\delta) = 1 - \tau \); iii) \( \forall \delta < \delta_{SB} : \frac{\partial \text{EU}(c)}{\partial \delta} > 0 \) and \( \forall \delta > \delta_{SB} : \frac{\partial \text{EU}(c)}{\partial \delta} = 0 \); iv) Underinsurance case: if, evaluated at \( \delta = 0 : \text{foc}_{\text{exc}} > 0 \), then \( \forall \delta < \delta_{SB} : \)

\(^{10}\) All proofs are gathered in the appendix

\(^{11}\) When the exchange rate volatility goes to infinite, the portfolio choice converges to the portfolio in the case without limit liabilities, which is included in the appendix.
\[ \mu(\delta) = 0, \text{ and } \forall \delta > \delta_{SB} : \frac{\partial \mu(\delta)}{\partial \delta} > 0; \text{ iv) Overinsurance case: if, evaluated at } \delta = 0: f_{oc_{exc}} < 0, \] then \( \forall \delta < \delta_{SB} : \mu(\delta) = 1, \text{ and } \forall \delta > \delta_{SB} : \frac{\partial \mu(\delta)}{\partial \delta} < 0. \]

Since I am interested in characterizing emerging markets, in what follows I restrict the analysis to the case in which, for low devaluation response, consumers are constrained in their demand for insurance (see figure 1).

### 3.2 Non-Exclusive Contracts

Turning to the case where firms have non-exclusive contractual relationships, I characterize the credit market equilibrium for a given devaluation response. In this case, the currency denomination of one credit contract does not characterize the firm’s currency composition of debt, nor its probability of default. Then, the interest rate faced by each firm is invariant to the currency composition of its liabilities.

*Entrepreneurs*

Entrepreneurs choose the currency composition of debt \( v_i \in [0, 1] \) to maximize expected consumption (2.11) subject to (2.12). Default is assumed to occur only in the B-state, in which case the probability of remaining active is a function of the composition of debt, specified in (2.13). The interest rates faced by each firm are invariant to the firm’s currency composition of debt -i.e. \( R_{ips} \) and \( R_{ids} \) are not affected by \( v_i \). Then, entrepreneurs face a convex objective function and choose extreme composition of liabilities, either entirely denominated in pesos \( (v_i = 1) \) or dollars \( (v_i = 0).^{12} \)

As long as consumers diversify their portfolio composition, firms with dollar and peso debt must coexist. Thus, the equilibrium interest rates \( \{r_p, r_d\} \) leave firms indifferent between the

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12Chamon (2001) and Broda and Levy-Yeyati (2003) also find that currency-blind credit contracts incentive entrepreneurs (or banks) towards excessive currency risk.
two extremes of debt composition and the free entry condition (2.16) is satisfied:

\[ E \left( c_{is}^e | v_i = 1, r_p \right) = E \left( c_{is}^e | v_i = 0, r_d \right) = K \]  

(3.3)

The proportions of firms with dollar and peso denominated debt are determined by the demand side.

\[ \{v_i\}_0^\mu = 0, \{v_i\}_\mu^1 = 1 \]

**Credit Market Equilibrium**

The probability of default of firms with peso and dollar debt are different, and so are the probabilities of default associated with the respective credit contracts. Consumers diversify away the idiosyncratic risk and the law of large numbers holds. Hence, the proportion of performing peso denominated contracts (resp. dollar) in the B-state is equal to the probability that a firm with only peso debt (resp. dollar) remains active:

\[ q_{pB} = \Pr (A_{iB} > R_{pB}) \]

\[ q_{dB} = \Pr (A_{iB} > R_{dB}) \]

where the probabilities of remaining active for firms with peso and dollar debt are specified in (2.13) for \( v_i = 1 \) and \( v_i = 0 \) respectively.

Consumers choose the currency composition of assets \( \mu \in [0, 1] \) to maximize expected consumption (2.9) subject to (2.10). The credit market currency composition is given by consumers’ first order condition:

\[ foc_c : U'' (c_B^n) [q_{pB} R_{pB} - q_{dB} R_{dB}] + U'' (c_G^n) [R_{pG} - R_{dG}] = \lambda_d - \lambda_p \]  

(3.4)
where $\lambda_d$ and $\lambda_p$ are the multipliers for the lower and the upper bound of $\mu$ respectively, and the free entry condition (3.3) is satisfied.

When devaluation volatility is low, this problem is equivalent to the one under exclusive contractual relationships. Indeed, in the limit of $\delta = 0$, expressions (3.4) and (3.1) are equivalent. In this paper, we focus on the underinsurance case for which \( foc_{exc}(\delta = 0) > 0 \). Then, for low devaluation response, the credit market is fully dollarized and consumers are underinsured (see figure 1.a).\(^{13}\)

\[
\lim_{\delta \to 0^+} foc_c = \left[ U'(c_B^\delta) - U'(c_G^\delta) \right] \Pr(A_iB > r) + U'(c_B^\delta) r \frac{\partial \Pr(A_iB > r)}{\partial r} > 0 \quad (3.5)
\]

where $R_{ds}(\delta = 0) = R_{ps}(\delta = 0) = r$ satisfies the free entry condition (2.16).

**Proposition 2** The Credit Market Equilibrium is characterized by: \( \{v_i\}_{i=0}^\mu = 1 \) and \( \{v_i\}_{i=0} = 0 \). Moreover, if expression (3.5) is positive, then: \( \exists \delta_1, \delta_2 : \delta_1 \geq \delta_{SB} \geq \delta_2 \) such that i) $\forall \delta < \delta_1 : \mu(\delta) = 0$; ii) $\forall \delta > \delta_2 : \mu(\delta) = 1$; iii) $\forall \delta > \delta_{SB} : \frac{\partial EU(c^\delta)}{\partial \delta} < 0$; and $\forall \delta < \delta_{SB} : \frac{\partial EU(c^\delta)}{\partial \delta} > 0$.

The intuition is simple. When the exchange rate volatility is low, the contingent value of dollar assets is insufficient to provide the optimal level of insurance under short selling constraints. The market is fully dollarized and still, consumers are underinsured to the realization of the shock. Augmenting the exchange rate volatility increases the contingent value of assets and reduces the value of the multipliers on the financial restrictions. However, for $\delta > \delta_{SB}$, the optimal allocation requires firms to diversify their composition of liabilities, which is not an equilibrium outcome under non-exclusive contractual relationships. Then, the default risk on

\(^{13}\)The case in which, evaluated at $\delta = 0$, the consumers are constrained in the demand for peso assets, has similarities to Holmstrom and Tirole (1996). As in there, welfare is higher when the real value of money is responsive to aggregate shocks. In that case, there is a redistribution of resources from consumers to firms in the B-state, reducing default risk and therefore increasing expected return.
dollar assets increases with the devaluation volatility and their insurance capacity is reduced. These results are plotted in figure 1.

4 Policy Equilibrium

The size of the exchange rate response to the shock is the relevant variable determining the efficiency of the financial market, the default risk, and the degree of underinsurance of consumers. I do not analyze here the sign of the covariance between the real shock and the exchange rate, which would require a more complete description of the real side of the economy. Instead, I start by recognizing that depreciations tend to happen in adverse states of nature, and analyze the optimal size of the response based only on its implications to the domestic financial market. As it was explained in section 2, devaluation bias does not affect the results presented here but only deviations from expectations. For that reason, I am restricting the analysis to devaluation responses of the form \( \{ \delta_B, \delta_G \} = \{ \delta, -\delta \} \), where \( \delta \geq 0 \).

---

14This is a reduced form of a model where devaluation has, additionally, an expansionary effect on the economy. An extension that endogenizes the lower bound for the optimal devaluation in the B-state is available upon request.
A committed and credible Central Bank that maximizes consumers’ welfare can push the economy towards the Second Best equilibrium. The optimal monetary policy under full commitment results from maximizing consumers’ expected utility (2.9) before the credit contracts are set, internalizing its impact on the currency composition of contracts (3.4) and the equilibrium interest rates (3.3). It can be verified that such equilibrium corresponds to $\delta = \delta_{SB}$ and the credit market is fully dollarized: $\forall i \in [0,1]: v_i = \mu = 0$.

However, a time-inconsistent monetary authority will not implement this ex-ante optimal devaluation response. In what follows, I assume that the exchange rate intervention occurs after the credit contracts have been set. Taking the portfolio currency composition and the market interest rates as given, the Central Bank chooses a devaluation response that maximizes consumers’ expected utility. The mechanism presented here is in line with the common agency problem developed in Tirole (2003). Government is a common agent of all consumers, and its incentives depend on a representative local investor’s portfolio, but not on a single investor’s choice. Then, consumers exert externalities on each other through their impact on the Central Bank’s incentives.

**Definition 2 (Policy Equilibrium)** The Policy (subgame perfect) Equilibrium is a set

$\left\{ \{r_{ip}\}_{i=0}^{1}, \{r_{id}\}_{i=0}^{1}, \{v_{i}\}_{i=0}^{1}, \mu, \delta \right\}$ such that: i) $\{\{r_{ip}\}_{i=0}^{1}, \{r_{id}\}_{i=0}^{1}, \{v_{i}\}_{i=0}^{1}, \mu \}$ is a Credit Market Equilibrium given a devaluation schedule $\{\delta_B, \delta_G\} = \{\delta, -\delta\}$; ii) the devaluation schedule $\{\delta_B, \delta_G\} = \{\delta, -\delta\}$, with $\delta \geq 0$, maximizes consumers’ utility (2.9) subject to their budget constraint, for a given Credit Market Equilibrium $\{\{r_{ip}\}_{i=0}^{1}, \{r_{id}\}_{i=0}^{1}, \{v_{i}\}_{i=0}^{1}, \mu \}$. 

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4.1 Optimal Policy

The monetary authority intervenes in the exchange rate market after credit contracts have already been set. Given a Credit Market Equilibrium \(\{r_p, r_d, \{v_i\}_{i=0}^1, \mu\}\), the Central Bank chooses \(\delta \geq 0\) to maximize consumers’ expected utility (2.9) subject to their budget constraint (2.10). The optimal exchange rate volatility is given by the following first order condition:

\[
\text{foc}_{CB} : -\mu \tau \left[ (U' (c_B^e) \Pr(A_{IB} > R_{pB}) - U' (c_G^e)) + U' (c_B^e) R_{pB} \frac{\partial \Pr(A_{IB} > R_{pB})}{\partial R_{pB}} \right] + (1 - \mu) (1 - \tau) \left[ (U' (c_B^e) \Pr(A_{IB} > R_{dB}) - U' (c_G^e)) + U' (c_B^e) R_{dB} \frac{\partial \Pr(A_{IB} > R_{dB})}{\partial R_{dB}} \right] = -\lambda
\]

(4.1)

where \(\lambda\) is positive when \(\delta = 0\).

Although at the time of the intervention credit contracts have already been set, the Central Bank’s policy feeds back into borrowers’ and lenders’ ex-ante devaluation expectation. As a result, from an ex-ante perspective, the Central Bank’s optimal devaluation response is biased against insurance. This can be seen in the Central Bank’s first order condition, evaluated at expected and actual null devaluation response \(\delta = \delta^e = 0\):

\[
\lim_{\delta^e \to 0} \text{foc}_{CB} (\delta = 0) : (1 - \tau) \left[ U' (c_B^e) \Pr(A_{IB} > r) - U' (c_G^e) + U' (c_B^e) r \frac{\partial \Pr(A_{IB} > r)}{\partial r} \right] = 0
\]

(4.2)

where \(r = R_{pB} = R_{dB}\) when \(\delta = 0\). Central Bank’s first order condition (4.2) departs from the consumers’ (equation (3.5)) in its undervaluation of smoothness.

If (4.2) is negative, the optimal monetary policy lowers the number of defaulting firms. That

\[\text{Qualitatively the same results arise if the Central Bank seeks to minimize the gap between current output and an ideal target.}\]
is, monetary intervention reduces consumers’ insurance. Then, the exchange rate volatility is minimized when the credit market is heavily dollarized, in order to avoid the negative effect on firms’ balance sheet. The Central Bank’s interior optimum is attained if credit contracts are mainly denominated in the domestic currency. In that case, by letting the exchange rate fluctuate with the shock, peso claims are lower in the B-state, so default risk is reduced at the expense of lower insurance.

On the other hand, if (4.2) is positive, policy intervention improves consumers’ insurance. If the market is heavily dollarized, the Central Bank’s interior optimum is achieved by letting the exchange rate fluctuate with the shock. Improving insurance is not possible when credit contracts are mainly denominated in pesos because the Central Bank is constrained to nonnegative devaluations in the B-state. In this case, the best the monetary authority can do is to minimize the exchange rate volatility and preserve the real value of peso claims.

**Proposition 3** For given Credit Market Equilibrium \( \{r_{ip}\}_{i=0}^1, \{r_{id}\}_{i=0}^1, \{v_i\}_{i=0}^1, \mu \}, \) the optimal devaluation schedule of the form \( \{\delta_B, \delta_G\} = \{\delta, -\delta\}, \) with \( \delta \geq 0, \) satisfies: i) when (4.2) is negative \( \exists \mu^* \in (1 - \tau, 1), \) such that \( \forall \mu < \mu^*: \delta = 0, \) and \( \forall \mu > \mu^*: \frac{\partial \delta}{\partial \mu} > 0; \) ii) when (4.2) is positive \( \exists \mu^* \in (0, 1 - \tau), \) such that \( \forall \mu > \mu^*: \delta = 0, \) and \( \forall \mu < \mu^*: \frac{\partial \delta}{\partial \mu} < 0 \)

### 4.2 Policy Equilibrium

The degree of dollarization and the market interest rates determine the Central Bank’s optimal policy. The ex-post optimal policy feeds back into the credit market expectations and maps into a credit market equilibrium. Along the lines of Kydland and Prescott (1977) and Barro and Gordon (1983), the policy equilibrium is the set of fixed points for which the market foreseen devaluation response coincides with the ex-post optimum.
If (4.2) is positive, the Central Bank improves consumption smoothness by increasing the contingent value of dollar assets. However, because of its bias against insurance, the exchange rate intervention is insufficient to achieve the Second Best allocation. In this case, there is a unique equilibrium characterized by full dollarization of the credit market and positive but suboptimal devaluation response.

More interesting is the case in which (4.2) is negative. In this case the Central Bank pushes the economy towards a reduction of insurance. A complementarity arises between the credit market currency composition, described in proposition 2, and the optimal monetary policy, characterized by proposition 3. When the credit market is mainly composed of peso assets, the Central Bank chooses an excessive devaluation response relative to the optimum under full commitment. And because dollarized firms cannot bear large exchange rate volatility, the default risk on dollar assets is excessive. The market’s reaction is to increase the share of peso denominated assets, reinforcing the motive for a countercyclical monetary policy. Correspondingly, when the credit market is heavy dollarized, the Central Bank minimizes the exchange rate volatility, departing from the optimal policy under full commitment. From proposition 2, the credit market intensifies its degree of dollarization when the devaluation response is low, which exacerbates the monetary lack of response.

As a consequence, there are potentially two stable equilibria: one with low dollarization and excessive exchange rate volatility and another with full dollarization and no devaluation response (see figure 2.a). Consumers are underinsured in both equilibria. However, if the economy is fully dollarized, the Central Bank is constrained in its attempt to further reduce smoothness. On the other hand, when credit contracts are mainly denominated in pesos, the monetary authority succeeds in implementing its unconstrained optimum. In this equilibrium, dollar assets have
excessive default risk in the B-state and therefore fail to provide insurance. Moreover, since monetary policy is highly countercyclical, the return on peso assets is extremely uneven. As a result, consumers are unambiguously worst off in the equilibrium with high share of peso contracts (see figure 2.b).

These findings are summarized in the following proposition

**Proposition 4** If \( \Pr(A_i \in \mathcal{B} > r) < \frac{U'(\Pr(A_i \in \mathcal{B} > r)r)}{U'(r)} \left[ \Pr(A_i \in \mathcal{B} > r) - \frac{r}{\delta_2^*} \right] < 1 \), there are potentially two stable Policy Equilibria: i) Full dollarization equilibrium with \( \forall i \in [0, 1] : v_i = \mu = 0, \) and \( \delta_1^* = 0; \) and ii) Low dollarization equilibrium with \( \forall i \in [0, 1] : \{v_i^\mu\}_{i=0}^\mu = 1, \{v_i^\mu\}_{i=0}^\mu = 0, \mu \in (1 - \tau, 1], \) and \( \delta_2^* > \delta. \) The equilibrium with full dollarization always exists if \( \frac{U'(\Pr(A_i \in \mathcal{B} > r)r)}{U'(r)} \left[ \Pr(A_i \in \mathcal{B} > r) - \frac{r}{\delta_2^*} \right] > 1, \) there is a unique Policy Equilibrium that satisfies: \( \forall i \in [0, 1] : v_i = \mu = 0, \) and \( \delta_1^* \in (0, \delta_{SB}) \)
5 Robustness of the full dollar equilibrium

5.1 Persistence in the share of dollar liabilities

The existence of multiple equilibria explains why the share of dollar denominated credit contracts remains high in economies that succeeded in controlling inflation and why many of these heavily dollarized economies often have a history of important inflationary episodes.

The easiest way to analyze the implications of changes in the inflationary risk is by introducing a mean preserving spread over the inflation rate in (2.8): \( \pi_s = \tau \delta_s + \varepsilon \), where \( \varepsilon : N \left( 0, \sigma^2_\varepsilon \right) \). To focus on pure monetary disturbances, I assume that the relative price of tradables and non tradables is not affected by the inflationary risk: \( \delta_s - \pi_s = (1 - \tau) \delta_s \).

Inflationary risk does not affect real returns on dollar assets. They are still given by the real claims on contracts (2.15) and the probability of repayment in the B-state \( \Pr \left( A_{iB} > R_{dB} \right) \), defined in (2.13) for \( v_i = 0 \). On the other hand, inflationary risk has an impact on real return on peso assets. Indeed, expected return of peso assets decreases in \( \sigma_\varepsilon \) and its variance is larger. Therefore, a mean preserving spread over inflation increases the demand for dollar denominated assets for any given devaluation response.

The high peso-share equilibrium disappears for high enough inflation variance while the full dollar equilibrium is robust. An episode of large inflation volatility can trigger a jump into the complete dollarized credit market equilibrium (see figure 3). Once the credit contracts are fully denominated in foreign currency, the Central Bank’s optimal policy is to reduce the devaluation response to aggregate shocks, which perpetuates consumers’ preference towards dollar assets. This equilibrium is stable even if the mean preserving spread over the inflation rate disappears.

\[ \text{Normalizing the mean of the noise to zero is not a crucial assumption as the interest rate in pesos (} r_p \text{) collects any expected inflation bias.} \]

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5.2 The introduction of CPI-indexed bonds

In the debate on “de-dollarization” it has been often recommended the introduction of CPI-indexed bonds. Indeed, if dollar denominated domestic assets are demanded as an insurance against inflationary risk, consumers should substitute their holdings of dollar denominated assets for CPI-indexed bonds. However, the fact that inflation indexed credit instruments are not demanded over dollar denominated assets suggests that the underlying problem is not fear of surprise inflation. In the context of this model, the full-dollarization equilibrium is robust to the introduction of CPI-indexed bonds.

Entrepreneurs still choose an extreme currency composition of debt, in this case, either full dollar or full inflation adjustable contracts. As long as consumers diversify their portfolio composition, firms with dollar and CPI-indexed debt must coexist. Thus, the equilibrium interest rate is the one that leaves firms indifferent between the two extremes of debt composition and the free entry condition (2.16) is satisfied.

Using the results derived here for CPI-indexed contracts, consumers maximize (2.9) subject

to the equilibrium interest rates given by (2.16) for firms with dollar and CPI-indexed contracts, and the following budget constraint:

\[ c_s^c = \bar{\mu} r_{cpi} \Pr (A_{is} > r_{cpi}) + (1 - \bar{\mu}) R_{ds} \Pr (A_{is} > R_{ds}) \]

where \( \bar{\mu} \) is the share of CPI-indexed instruments. Notice that the real claim on CPI-indexed instruments, \( r_{cpi} \), is independent of \( \delta \) and therefore of the realization of the aggregate shock. However, these contracts still face default risk in the B-state: \( \Pr (A_{iB} > r_{cpi}) = A_{st} - r_{cpi} / A_{st} \). The first order condition for low devaluation response coincides with (3.5). Therefore, under the same condition as in proposition 2, consumers are again constrained in their demand for insurance and thus, the full dollar equilibrium is robust to the introduction of inflation adjustable contracts.

The intuition behind this result is similar to the one presented in the previous section. When the exchange rate volatility is low, risk averse consumers prefer dollar denominated assets, for which real claims are negatively correlated with the default risk, over CPI-indexed assets that offer zero correlation with the risk of recessions. Although, in light of these findings, the introduction of CPI-indexed bonds is not expected to reduce the level of dollarization, it is a useful instrument to prevent the dollarization of the credit market in periods of high inflationary risk.\(^{18,19}\)

\(^{18}\)The introduction of adjustable instruments may have downsides in terms of the level of inflation in equilibrium (see, for example, Fisher and Summer (1989) ). Still, it is important to consider that the trade-off may involve jumping into dollarization.

\(^{19}\)For example, Chile’s adjustable instruments (Unidad de Fomento) date back to 1967 and were in place during its period of high inflation. This economy succeeded in preserving the credit market largely denominated in local currency. See Herrera and Valdes (2003) for a review on Chilean experience regarding indexation.
6 Conclusion

After years of high inflationary risk, many developing countries succeeded in stabilizing their monetary variables. Today, these economies’ fears center on underinsurance against aggregate shocks. The main contribution of this paper is to illustrate this topic from the perspective of risk averse residents, whose consumption volatility is mainly driven by the risk of recession. In this framework, dollar assets are demanded as an insurance against real aggregate risks.

Based on the interplay between the currency composition of the credit market and the Central Bank’s optimal policy, the model explains persistence in the share of dollar liabilities in economies with low inflationary risk. Indeed, this interplay may result in multiple stable equilibria: an equilibrium with a high degree of dollarization in which the Central Bank minimizes exchange rate volatility; and another in which contracts are mainly denominated in domestic currency and monetary policy is highly countercyclical.

When insurance against the risk of recession is the motive behind dollarization, consumers are better off under full dollarization than with a high share of peso denominated contracts. If the share of peso denominated contracts is large, the optimal policy reduces the number of defaulting firms at the expense of a more volatile return on savings. On the other hand, in the fully dollarized equilibrium, the real value of savings is preserved during recessions, when investors value it the most.

An important caveat must be made. In an attempt to emphasize the interplay between credit market currency composition and the optimal monetary policy, the framework was simplified to only include agents participating in the domestic financial market. However, concerns regarding dollarization arise from its negative consequences in terms of output volatility. Indeed, in this model, output volatility is larger in the equilibrium with high share of dollar contracts. For
that reason, the current debate in many of these countries is centered on the “de-dollarization” dilemma. This model, by explaining the motives underlying the dollarization of domestic credit contracts, offers some insights to this debate:

1. Although an increase in inflationary risk may trigger the dollarization of the credit market, price stabilization will have limited success in reducing it. During episodes of high inflationary risk, borrowers and lenders denominate their credit contracts in a more stable unit, typically dollars. However, once inflation is controlled and the countercyclicality of the monetary policy is diminished, the motive behind the demand for dollar assets changes. Dollar assets are now demanded for their contingent value against the risk of recessions. In these economies, foreign currency denominated assets are the natural substitute for the missing contingent contracts precisely because dollar instruments are in place from the time of large inflationary risk.

2. If dollar assets are demanded for their insurance capacity, the introduction of CPI-indexed bonds will have limited success in reducing the level of dollarization. These instruments do not provide any insurance against the risk of recession. Nonetheless, CPI-indexed bonds are useful for preventing the dollarization of the credit market in periods of high inflationary risk.

References


7 Appendix

7.1 First Best: Absence of Limited Liabilities

The basic framework without limited liability results in First Best allocation. That is, the corporate sector bears the aggregate and the unobservable idiosyncratic risk and freely insures consumers.

From (2.14), (2.15), and (2.12), entrepreneurs' expected consumption is linear in the currency composition of debt \( v_i \). Then, firms are indifferent between peso and dollar debt as long as the respective interest rates are equalized, \( r_{ip} = r_{id} \). Moreover, all firms are ex-ante identical, so they all face the same interest rates, \( r_{ip} = r_{id} = r \), which is pinned down from the free entry condition (2.16).

The aggregate productivity shock indirectly affects consumers through the realization of the devaluation response, \( \delta_s \in \{\delta, -\delta\} \), which determines the real return on assets. The optimal portfolio composition is \( \mu = 1 - \tau \). From (2.10), at \( \mu = 1 - \tau \) consumers avoid the currency risk by holding a portfolio that replicates the share of tradables and nontradables in the consumption price index.\(^{20}\) Consumption in each state of nature \( s \in \{B, G\} \) is simply given by the fixed real payment \( r \). In this case, the size of the devaluation response \( \delta \) is irrelevant and does not affect real allocations.

7.2 Proofs:

Proposition 1. Follows from (3.1) and (3.2). 

Proposition 2. Under non-exclusive contracts the interest rate is not firm specific. This

\(^{20}\) The same optimal portfolio choice arises in an economy where the default risk is independent of the currency risk. See Ize and Levy Yeyati (1998, 2003) for a model of asset substitution along these lines.
allocation cannot be superior than the one under exclusive contracts, where interest rates can be set according to each firm currency composition of debt. In the case of exclusive contracts, there is \( \delta_{SB} > 0 \) such that for all \( \delta < \delta_{SB} \) consumers are constrained in their demand for dollar assets. Optimal contracts in that case do not diversify the currency composition of debt. This type of contract is also available in the case of non-exclusive contract, so for \( \delta < \delta_{SB} \) the credit market equilibrium is identical in both cases.

To prove ii), it is sufficient to point out that there is a sufficiently high \( \delta \) such that \( q_{p}R_{pB} > q_{d}R_{dB} \) so trivially, there is a lower \( \delta \) such that the market is fully pesified.

Finally, the Second Best allocation with limited liability \( \{R_{B}, R_{G}\} \) satisfies the free entry condition (2.16) and the following:

\[
[U'(e_{B}^{c}) - U'(e_{G}^{c})]Pr(A_{iB} > R_{B}) + U'(e_{B}^{c})R_{B} \frac{\partial Pr(A_{iB} > R_{B})}{\partial R_{B}} = 0
\]

The effect of \( \delta \) on \( EU(C_{s}^{c}) \) is given by:

\[
\frac{\partial EU(C_{s}^{c})}{\partial \delta} = -\frac{\mu_{T}}{1 + Pr(A_{iB} > R_{pB})} \left\{ [U'(e_{B}^{c}) - U'(e_{G}^{c})]Pr(A_{iB} > R_{pB}) + U'(e_{B}^{c})R_{pB} \frac{\partial Pr(A_{iB} > R_{pB})}{\partial R_{pB}} \right\} \\
+ \frac{(1 - \mu)(1 - \tau)}{1 + Pr(A_{iB} > R_{dB})} \left\{ [U'(e_{B}^{c}) - U'(e_{G}^{c})]Pr(A_{iB} > R_{dB}) + U'(e_{B}^{c})R_{dB} \frac{\partial Pr(A_{iB} > R_{dB})}{\partial R_{dB}} \right\}
\]

For \( \forall \delta < \delta_{SB} : \mu = 0 \) and \( R_{dB} < R_{B} \). Then: \( \forall \delta < \delta_{SB} : \frac{\partial EU(C_{s}^{c})}{\partial \delta} > 0 \) And \( \forall \delta > \delta_{SB} : R_{pB} < R_{B} \) and \( R_{dB} > R_{B} \). It follows that \( \forall \delta > \delta_{SB} : \frac{\partial EU(C_{s}^{c})}{\partial \delta} < 0 \)

**Proposition 3.** If expression (4.2) is positive, then for all \( \delta \geq 0 \): expression in (4.1) decreases monotonically in \( \mu \). It follows that: i) since evaluated at \( \delta = 0 \), expression (4.1) is positive at \( \mu = 0 \) and negative at \( \mu = 1 - \tau \), then \( \exists \bar{\mu} \in (0, 1 - \tau) \) such that the Central Bank’s interior optimum is satisfied with \( \delta = 0 \). ii) since the expression in (4.1) is monotonically decreasing in
δ, it follows that whenever the Central Bank constraint is not binding, the optimal exchange rate volatility decreases monotonically in the share of peso assets: \( \frac{\partial \delta}{\partial \mu} < 0 \) for all \( \mu < \mu^* \).

Similarly it can be shown that if (4.2) negative, then \( \exists \mu^* \in (1 - \tau, 1) \) such that the CB’s interior optimum is satisfied with \( \delta = 0 \), and \( \frac{\partial \delta}{\partial \mu} > 0 \) for all \( \mu > \mu^* \). ■

**Proposition 4.** Follows from Proposition 2 and 3 ■
7.3 Share of Foreign Currency Denominated Deposits in Domestic Banking

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<td>2001</td>
<td>32.9%</td>
<td></td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>1999</td>
<td>44.7%</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>2001</td>
<td>58.3%</td>
<td></td>
</tr>
<tr>
<td>Tajikistan</td>
<td>2000</td>
<td>67.8%</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>2001</td>
<td>32.4%</td>
<td></td>
</tr>
<tr>
<td>Uruguay</td>
<td>2001</td>
<td>84.4%</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>1998</td>
<td>36.6%</td>
<td></td>
</tr>
<tr>
<td>Vanuatu</td>
<td>1999</td>
<td>69.7%</td>
<td></td>
</tr>
<tr>
<td>Yemen, Republic of</td>
<td>2001</td>
<td>52.6%</td>
<td></td>
</tr>
<tr>
<td>Zambia</td>
<td>2001</td>
<td>42.6%</td>
<td></td>
</tr>
</tbody>
</table>

7.4 Dollarization and Inflation

* Different degrees of legal restrictions to foreign currency denominated deposits were imposed in Peru between 1985 and 1989. Dollar denominated deposits were not allowed in Bolivia between 1982 and 1984.

Sources: Data on inflation from IFS-IMF, data on deposits denomination from Levy-Yeyati (2003) and data on legal restrictions on dollar deposits from Arreata (2002, 2003).
8 Expansionary Effect of Devaluation

The model can be extended with the introduction of an expansionary effect of devaluation, which provides a motive for devaluing the currency in the adverse state of nature. This way, the restriction imposed in section 4 that constrained the Central Bank from revaluing the currency in the B-state arises endogenously.

Modification to the Basic Framework

I extend the basic framework presented in section 2 with an additional date. At date 0, all contracts are set according to the basic set-up described in section 2. At date 1, after contracts are set, the productive project has an intermediate productive outcome and operational cost, wages. Wages are assumed to be set at date 0 in terms of nontradable goods. For simplicity, I assume risk neutral workers with a constant opportunity cost in terms of consumption \( w = 1 \).

Each productive unit has then short term and long term outcome \( A_{1is} \) and \( A_{2is} \), a proportion \( \tau \) of which is tradable, and the rest is nontradable. The technology is affected by the aggregate shock and a unobservable idiosyncratic sensitivity towards it, as described in (2.1). Total output at date \( t \in \{1, 2\} \) is therefore given by \( A_{tis} = A_t (1 + a_i z_s) \). In addition to the unit of capital, the productive project requires hiring a date-1 worker. It can be verified that the goods market is in equilibrium for the same set of prices presented in section 2 and the inflation rate in the s-state, \( \pi_s \), is given by equation (2.8).

As before, the firm abandons the market and defaults on its debt in the B-state if date-2 revenues do not suffice to repay financial debts. This extension introduces another source of default: the firm is forced to abandon the market irrespectively of its overall profits if date-1 revenues do not suffice to cover operational costs. Then, the probability that a firm repays is

39
debt is:21,22
\[
\Pr(\text{repay}) = \min \{ \Pr(A_{1iB} > w - \tau \delta), \Pr(A_{2iB} > R_{iB}) \} \tag{8.1}
\]

where \( \Pr(A_{2iB} > R_{iB}) \) is given by (2.13) and default is assumed to happen only in the B-state

**Firms’ optimal currency composition of liabilities when date-1 constraint is binding**

Entrepreneurs choose \( v_i \in [0, 1] \) to maximize expected consumption (2.11), subject to:

\[
E(c^F_{is}) = \Pr(A_{1is} \geq w - \tau \delta_s) \left[ E(A_{1is} - (w - \tau \delta_s) \mid A_{1is} \geq w - \tau \delta_s) + \right. \\
E(A_{2is} - (1 - v_i) R_{ds} - v_i R_{ps} \mid A_{1is} \geq w - \tau \delta_s) \right]
\]

The probability of being active in the B-state is independent of the currency composition of debt when date-1 constraint is binding. Therefore, entrepreneurs’ expected consumption is linear in \( v_i \). In equilibrium, they are indifferent in the currency composition of their debt and the expected real claims for dollar and peso debt are equalized. Their share of peso denominated debt (\( v_i \)) is then determined in equilibrium by the demand side:

\[
\forall i \in [0, 1]: v_i = \mu \tag{8.2}
\]

**Consumers portfolio choice when date-1 constraint is binding**

Since firms hold both dollar and peso debt, the default risk of both types of assets is identical. Law of large numbers holds, so the proportion of dollar and peso contracts defaulting is equal

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21 As in section 2, the real value the operational cost is approximated for inflation rate close to zero and wages close to one with:

\[
\frac{w}{1 + \pi_s} \simeq w - \pi_s = w - \tau \delta_s
\]

22 Notice that if \( \frac{A_{1i} - (w - \tau \delta)}{A_{1is}} \geq a_i > \frac{A_{2i} - v_i R_{ds} - (1 - v_i) R_{ps}}{A_{2is}} \), firm \( i \) defaults but its overall profits are still be positive. Firms’ idiosyncratic shock is not observable, therefore date-1 profits are also private information. As a result, when the exit decision occurs at date 2, the firm retains date-1 profits.
to the probability of default of an individual firm: \( q_{ds} = q_{ps} = \Pr(A_{1is} \geq w - \tau \delta_s) \). Consumers choose \( \mu \in [0, 1] \) to maximize expected utility (2.9) subject to their budget constraint

\[
c^c_s = \Pr(A_{1is} \geq w - \tau \delta_s)[\mu R_{ps} + (1 - \mu) R_{ds}]
\]

where real claims on dollar and peso assets are given by (2.14) and (2.15).

The first order condition for the consumers' maximization problem is:

\[
\text{foc}(\mu|\delta) : \delta \left[ U'(c^c_G) - U'(c^c_B) \right] = \lambda_d - \lambda_p \tag{8.3}
\]

where \( \lambda_d \) and \( \lambda_p \) are the multiplier for \( \mu \geq 0 \) and \( \mu \leq 1 \) respectively.

As long as the devaluation response is not null, the interior solution for (8.3) implies perfect insurance. The interior optimal share of peso assets results from equalizing consumption in both states:

\[
\mu = \frac{1 + \Pr(A_{1is} \geq w - \tau \delta_s)}{4 \Pr(A_{1is} \geq w - \tau \delta_s) \delta} \left[ - (1 - \Pr(A_{1is} \geq w - \tau \delta_s)) r_d + (1 + \Pr(A_{1is} \geq w - \tau \delta_s)) (1 - \tau) \delta \right]
\]

The demand for dollar denominated assets decreases in the devaluation response for two reasons: First, since the default risk decreases in the devaluation response \( \delta \), so does the demand for insurance. And second, a larger devaluation response augments the contingent value of dollar assets and a lower quantity of such assets is required to provide the optimal insurance.

The interior solution cannot be achieved for low devaluation responses. In such cases perfect insurance would required long positions of dollar assets and the short selling constraint binds: \( \lim_{\delta \to 0} \mu(\delta) = 0 \). Inversely, when the devaluation is large enough as to prevent any firm from defaulting, the optimal currency composition is the one that perfectly hedges against the currency
risk: $\mu = 1 - \tau$.\textsuperscript{23}

Then, for $\delta_s \in \{\delta, -\delta\}$ such that $\forall v_i \in [0, 1]: \frac{A_1 - (w - \tau \delta)}{A_1 z} \leq \frac{A_2 - v_i R_{ip} - (1 - v_i) R_{id} b}{A_2 z}$, the credit market equilibrium is characterized by: i) $\forall i \in [0, 1]: v_i = \mu$; ii) $\delta \in (0, \delta_L): \mu(\delta) = 0$, where $\delta_L: foc(\mu = 0|\delta_L) = 0$; and iii) $\delta \geq \delta_L: \mu(\delta) = 1 - \tau$, where $\delta_L: \frac{A_1 - (w - \tau \delta_L)}{A_1 z} = 1$

**Optimal Devaluation Response**

The Central Bank maximizes consumers’ expected utility (2.9) by intervening in the currency market at date 1, after all contracts have been set, in line with section 4. The return on assets depends on the binding margin governing the default risk (8.1), which is endogenous to the devaluation response.

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\textsuperscript{23}This portfolio choice corresponds to the case without limited liabilities, presented in the appendix.
of consumption and it is always optimal to reduce the number of firms abandoning the market. Therefore, it has to be that in equilibrium $\delta \geq \hat{\delta}$ and date-2 constraint binds. This case is qualitatively identical to the one analyzed in section 4 and the optimal devaluation response depends on the currency composition of debt.

This extension endogenizes a lower bound for the optimal devaluation response: $\delta \geq \hat{\delta}$. As long as $\hat{\delta}$ is not as large as to be in the neighborhood of the high peso equilibrium, the results presented in the body of the paper hold.