Financial Dollarization in Emerging Markets: An Insurance Arrangement

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Abstract

Households in emerging markets hold significant amounts of dollar deposits while firms have significant amounts of dollar debt. Motivated by the perceived dangers, policymakers often develop regulations to limit dollarization. In this paper, I draw attention to an important benefit of dollarization, which should be taken into account when crafting regulations. I argue that dollarization represents an insurance arrangement in which the entrepreneurs that own firms provide income insurance to households. Emerging market exchange rates tend to depreciate in a recession so that dollar deposits in effect provide households with income insurance. With their preference for holding deposits denominated in dollars, households effectively starve local financial markets of local currency, which raises local interest rates. By raising local currency interest rates, they cause entrepreneurs to borrow in dollars. Consistent with my argument, countries in which the exchange depreciates in a recession have a higher level of deposit and credit dollarization. In those countries, I verify that the premium of the local interest rate over the dollar interest rate is higher. This premium is the price paid by households for insurance.

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1 Introduction

In many emerging markets, firms borrow large amounts of funds denominated in foreign currency. This phenomenon of “credit dollarization” is typically regarded as a concern for policymakers and regulators, because it creates significant balance-sheet risks. In fact, when the exchange rate depreciates, interest payments on foreign debt rise, but firms’ revenues do not, since they are usually denominated in local currency. As a result, firms’ balance sheets deteriorate, with negative consequences on investment, production and, ultimately, employment and wages. The typical explanation for the widespread diffusion of credit dollarization is related to the political instability of emerging economies, and the lack of commitment of their central banks, which are responsible for high and volatile domestic interest rates. What is puzzling, however, is that the degree of credit dollarization remains high, despite the fact that macroeconomic conditions have now considerably improved in many of emerging markets (Catao & Terrones (2016))

In this paper, I offer a complementary explanation for the prevalence of credit dollarization. In emerging economies, poor economic performance is typically associated with exchange rate depreciations. Savings accounts denominated in foreign currency provide a hedge against domestic income fluctuations because the foreign currency gains in value exactly when domestic economic growth is low. Therefore, households find it optimal to save considerable amounts in foreign currency. The willingness of domestic households to save in foreign currency, however, decreases the supply of local currency to the banking system, which raises domestic interest rates and induces firms to borrow more in dollars. In other words, rather than just entailing risks, a large share of credit dollarization in emerging economies stems from an insurance arrangement in which firms offer households a hedge against income fluctuations in the form of foreign currency borrowing. Firms pay lower foreign currency interest rates to households on average, but, in return, pay a larger amount when the economic performance is poor.

I formalize the idea of dollarization as an insurance agreement in the context of a small open economy model with financial frictions. In the model, households can save by purchasing assets denominated in either local or foreign currency (deposit dollarization). Entrepreneurs are subject to a Costly State Verification financial friction (Townsend (1979); Gale & Hellwig (1985)) and they can borrow either from local or foreign sources (credit dollarization). The model features the main concern about dollarization, i.e. that the balance sheets of entrepreneurs are adversely affected by exchange rate depre-
ciations due to the mismatch between the denomination of revenues and debt (revenues are in local currency, debt is in dollars). At the same time, the model also captures the insurance aspect of dollarization, which is the focus of this paper. Following an exchange rate depreciation, the value of household savings in foreign assets increases, providing insurance against the adverse effects of this depreciation. When households invest more in foreign assets, to capture their hedging benefits, the supply of local funds falls and the spread between local and foreign interest rates endogenously increases. Due to the desire for savings in foreign assets to smooth income fluctuations, households are content to receive lower interest rates on foreign assets because foreign assets provide income in episodes where the consumption is low.

The main source of uncertainty in the model is foreign interest rate shock, which should be interpreted as the international risk-free rate plus the spread emerging market economies face, and is an important driver of emerging markets business cycles (Neumeyer & Perri (2005); Gertler et al. (2007)). An increase in foreign interest rates causes an exchange rate depreciation because of higher demand for foreign assets by households, and lower demand for local source of funding by the entrepreneurs. Exchange rate depreciation caused by the increase in foreign interest rates adversely affect the economy through raising the cost of capital and deteriorating the balance sheets of entrepreneurs. Entrepreneurs need to pay a larger interest rate cost, which lowers their net worth. Due to the endogenous leverage constraints generated by the financial frictions, lower net worth translates into lower borrowing. Hence, deteriorated balance sheets lead to lower investment and wages, which decrease the household consumption.

I show that households can effectively hedge against foreign interest rate risk by saving in foreign assets that provide high return when foreign interest rates increase, which leads to an exchange rate depreciation and increases the value of foreign assets.

The model generates several empirical regularities observed in the data. Credit and deposit dollarization are correlated in the cross section and comove across time. Economies with high dollar credit have also high household dollar savings, and periods with higher deposit dollarization coincide with higher credit dollarization. Higher dollarization is associated with higher interest rate spread both in the cross section and across time. Dollarization is higher in economies where the correlation between consumption and exchange rate movements is negative. I also show that the more negative this correlation is, the more dollarized a country tends to be.

In my model, policies that limit dollarization have overall unfavorable consequences, de-
spite reducing the balance-sheet effects of depreciations. This is because these policies make the economy more vulnerable to foreign interest rate shocks by reducing households' insurance. When comparing the baseline to a counterfactual economy where households are forced to only save in local currency, credit dollarization is also substantially lower, but consumption becomes 40 percent more sensitive to foreign interest rate shocks. An alternative policy to reduce dollarization would be to tax foreign borrowing. The advantage of this policy is that it does not take away household insurance through foreign currency saving. However, limits to foreign borrowing decreases investment and production in the long run. For example, I find that a tax that eliminates 50% of foreign currency credit raises real interest rates by 1.4% and causes a decline of 5% in steady state capital.

In this paper, I argue that dollarization has an often neglected benefit as well as known costs. Substantial share of foreign currency credit in the economy is part of a beneficial insurance arrangement between firms and households. Policies to limit dollarization might break this insurance and, hence, the effects of these policies on the economy can be costlier than the policymakers think.

2 Related Literature

Dollarization was on the rise until the late '90s. Figure 1 shows the historical movement of dollarization. After 2000, there was a notable switch to local currency, even though the use of foreign currency deposit remained significant. This corresponds to a time of stability in emerging market economies. This trend of “dedollarization” was noted by Catao & Terrones (2016), which shows that dollarization declined until the great recession. The use of foreign currency has been attributed to weakness in financial institutions; however, households hold significant amounts of foreign currency even in emerging economies with stable financial systems. I claim that part of dollarization in these emerging economies can be explained by the hedging property of foreign currency accounts. A similar idea has been pursued by Chari & Christiano (2017), where they see commodity futures trading as part of a hedging arrangement.

The earliest work on dollarization is related to the concept of currency substitution. Currency substitution is where households use foreign currency as a medium of exchange or store of value; earlier work focused on how currency substitution can limit the effectiveness of monetary policy (Brillembourg & Schadler (1979); Miles (1978)).
Currency substitution is thought to be a problem faced by economies with weak institutions (Giovannini & Turtelboom (1992)), and foreign currency borrowing is thought to be a systemic risk factor. High credit dollarization puts balance sheets of firms and the public sector into exchange risk and limits the ability of conducting monetary policy. Overall, dollarization has been seen as a sign of weakness in financial institutions (Mecagni (2015)). In a seminal paper, Ize & Levy Yeyati (2003) argue that dollarization can arise in economies with sound financial system. Borrowers and lenders with mean-variance utility will compare relative volatilities of real exchange rate and inflation and when the inflation is more volatile than the real exchange rate, depositors find it optimal to invest in foreign currency.

It is thought that credit dollarization has negative externality on the economy. An important channel discussed by Eichengreen et al. (2003) is the moral hazard channel. Given the presence of implicit and explicit\(^1\) government guarantees, firms and banks find it optimal to borrow in foreign currency. Burnside et al. (1999) argue that under implicit government guarantees, banks find it optimal not to hedge their exchange rate.

\(^1\)A fixed exchange regime could be thought of as an explicit guarantee where the government promises exchange rate stability.
exposure. Even under flexible exchange rate regimes, authorities use monetary policy to stabilize the exchange rate in the presence of foreign debt. Calvo & Reinhart (2002) argue that many emerging economies who claim to have a floating exchange rate regime actually use monetary policy to avoid depreciations. In fact, a monetary tightening to avoid a depreciation can be the optimal policy in the presence of balance sheet effects of foreign exchange rate (Braggion et al. (2009); Christiano et al. (2004)). Reinhart & Kaminsky (1999) show that there is a pattern in emerging market crises. Currency crises and banking crises often happen jointly. A fall in the value of currency puts the banking sector under risk, and problems in the banking sector cause further collapse in the value of the currency. Thus, the economy enters into a vicious cycle. Rey (2013) argues that changes in the Federal Funds Rate affect the VIX\(^2\) index, which affects global credit conditions and local interest rates. It then becomes difficult for small open economies to conduct monetary policy independent of global financial conditions. Bruno & Shin (2015) argue that an important channel is through bank capital flows. A fall in US interest rates increases cross border capital flows, which end up in the non-financial sector outside the US. Similarly, Aoki et al. (2016) discuss how monetary policy should respond to global financial shocks in emerging markets with dollar denominated debt.

In a recent work, Dalgic et al. (2017) document firm borrowing behavior in emerging economies. They show that it is mostly larger firms and firms with foreign currency revenue that borrow in foreign currency. These firms are more resilient against exchange rate depreciation even though they incur large financial costs in years where exchange rate depreciates, which, in turn, deteriorates their balance sheets. They show that a simple model where foreign currency borrowing is cheaper but risky due to exchange rate movements fits the borrowing behavior of firms. In my model, interest rate spread is generated endogenously, but the firms face a similar choice. Dalgic et al. (2017) also show that exporting firms borrow mostly in foreign currency. However, firms with significant export revenues do not constitute a large part of the economy. Most foreign currency borrowing is done by large firms without significant exporting revenue. Still, the empirical observation supports the view that foreign currency borrowing/lending is conducted in a manner that takes into account (and minimizes) the balance sheet effects.

There is recent literature about currency choice in sovereign borrowing, which notes the

\(^2\)Implied volatility by S&P 500 options, proxy for stock market expectation of volatility.
countercyclicality of exchange rate in developing economies. Perez & Ottonello (2016) argue that foreign currency borrowing is especially expensive for emerging economies because of the fact that the exchange rate depreciation is associated with recessions, but in the absence of a credible monetary policy, sovereigns are unable to borrow in local currency because of the fear that it will devalue. Du et al. (2016) make a similar argument—foreign currency debt helps as a commitment device against future inflation in emerging economies. Private sector foreign currency debt can also discipline the sovereign against inflating local currency sovereign debt (Schreger & Du (2014)).

Contrary to the prevailing view, literature on firm credit dollarization generally finds that the balance sheet effects of currency depreciation are modest (Bleakley & Cowan (2008); Dalgic et al. (2017)). It is mostly large and exporting firms who borrow in dollars (Alp & Yalcin (2015); Dalgic et al. (2017)). Alp & Yalcin (2015) find that overall, foreign currency borrowing is positively related to firm growth. Ranciere et al. (2010) find that in Eastern Europe, it is the small firms which benefit from the access to foreign currency borrowing. In their framework, firms borrow in foreign currency because of implicit bailout expectations. Liquidity injections by EU and IMF to Eastern European countries confirm this expectation (Ranciere et al. (2010)). In a separate analysis, they find that foreign currency borrowing positively correlates with high GDP growth before the crisis but leads to a sharper contraction in 2008. Hedging behavior of the firms who borrow in foreign currency is not well documented. Many authors assume that in most emerging markets, it is too costly to hedge. Moreover, even if the firms hedge some of their exposures, this hedging is not perfect and leaves the firms vulnerable to large depreciations (Chui et al. (2014)). Forbes (2002) finds that in the aftermath of exchange rate depreciations, firms experience lower net income growth but other performance indicators are not affected.

Interest rate spread between the dollar and emerging market currencies is documented by several papers (Ferreira & Leon-Ledesma (2007); Alper et al. (2009); Banerjee & Singh (2006)). In my model, the source of interest rate spread is the household’s desire to hold foreign currency because foreign currency denominated bonds provide insurance against global risks. A similar idea is pursued by Hassan (2013) and Martin (2013). In this context, the US bonds are bought by the investors all around the world. Risk-free US bonds carry a negative premium because it provides insurance against global risks. One of the crucial assumptions driving the results in this paper is that foreigners do not want to invest in local EM currencies. Recent empirical observation supports this
assumption. Gruić & Wooldridge (2013) show that around 70% of all emerging market international securities are denominated in dollars, whereas the share of local currency is around 10%. Similarly, Maggiori et al. (2017) document using a large data set of securities that there is a strong “currency bias” in international financial flows so that residents of developed economies invest mostly in securities denominated in their currency even if the issuer is from another country. This is related to the dollar’s role as a reserve currency (Goldberg (2010); Maggiori & Farhi (2016)). A related idea is the theory of “Original Sin”. Developing economies have difficulty issuing debt in domestic currency. Eichengreen et al. (2003) push forward the idea of Original Sin. According to this theory, emerging markets are unable to borrow in their local currency because of reasons that are currently out of their control. Hausmann & Panizza (2003) find that the only variable to explain this phenomenon is the size of the economy, which makes this phenomenon relevant for small open economies. In the last decade, many countries have started borrowing in local currency in small amounts (In the Appendix, I construct the Original Sin index for the last decade.). Still, the magnitudes are small compared to foreign currency issuance. A recent attempt to rationalize Original Sin claims that foreign currency asset prices are driven by default expectations, whereas local currency assets are mainly driven by inflation expectations. This naturally makes sophisticated foreigners refrain from investing in local currency assets (Bassetto & Galli (2017)). The argument that the domestic currency market needs to clear in the country reminds us of the Feldstein-Horioka Puzzle (Feldstein & Horioka (1980a)), which shows that domestic saving and investment are too closely correlated to be explained by a standard international macroeconomic model. If investment is determined by domestic savings, then this means domestic capital markets clear within the borders. The original paper argues that the puzzle can be reconciled with free capital flows. Short term liquid flows get much attention but most of the capital stock in an economy is in fact highly illiquid. Similarly, the currency derivatives market can be used by foreigners to benefit from higher emerging market interest rates. International financial institutions trade high volumes in these markets. However, Gabaix & Maggiori (2015) note that most of these trades are generally very short term. In their model, collateral constraints lead to limited participation of foreign traders in local currency markets and create interest rate spread.

Another crucial assumption in this paper is that the banks are required to balance currency denomination of assets and liabilities through the loans they extend. This
rules out currency mismatch in the banking sector. There is ample evidence that in emerging economies, currency denomination of liabilities heavily influences the currency denomination of loan portfolios (Brown et al. (2014); Keller (2017)). Neanidis & Savva (2009) show that the tendency of emerging market banks to match the denomination of deposits and loans creates a correlation between deposit and credit dollarization. In a similar context, Bocola & Lorenzoni (2017) show how currency mismatch in financial sector can lead to self-fulfilling bank runs and financial crisis. In line with their policy recommendation, in most emerging markets, banks are not allowed to have currency mismatch on their balance sheets and household foreign currency deposits are under protection of deposit insurance. Banks can typically match denomination of their assets and liabilities by changing loan composition or using forward markets (Keller (2017)). On the other hand, liquid currency derivative securities are commonly very short term, as opposed to long term loans the banks extend. Banks prefer changing loan composition instead of using derivative securities because hedging using these securities will create maturity mismatch (Borio et al. (2017)).

I discuss how global conditions and risks influence domestic dollarization and interest rates, and I consider the effects of an increase in global risk to an emerging market. The starting point is that households hold foreign currency to hedge their exposure to exchange rate risk. An increase in risk will make households want to hold more foreign currency, which will increase overall dollarization of the economy through firm credit dollarization. In order to consider the effects of an increase in risk, I follow an approach similar to Fernandez-Villaverde et al. (2011) in which they consider impulse responses to a shock to the stochastic standard deviation. In my model, standard deviation of the export shock is stochastic. I find that a positive shock to the standard deviation of the export shock increases both credit and deposit dollarization.

I find that policies to reduce dollarization have unintended consequences. As opposed to conventional thinking, I find that preventing household foreign currency deposits makes the economy more vulnerable to global shocks. Similarly, preventing foreign currency credit reduces investment and capital over long term. I argue that policies to limit dollarization should consider the benefits of dollarization, as well as the cost of these policies.
3 Empirical Facts

In this section, I present certain important facts about dollarization in emerging economies. In these economies, a significant portion of financial intermediation takes place in foreign currency. As Figure 2 indicates, in many countries, close to 50% of credit to non-financial firms is denominated in foreign currency. I am going to show that the source of this credit is household foreign currency savings, and it is the household behavior that drives dollarization in these economies.

Figure 2: Ratio of FC deposit and credit in the banking system
Source: Individual central banks, ECB

3.1 Comovement between credit and deposit dollarization

Credit and deposit dollarization are positively correlated across countries. Figure 3 shows the average dollarization in emerging economies\(^3\). In certain economies, more than 50% of financial intermediation takes place in a foreign currency\(^4\).

\(^3\)Monthly averages, from early 2000s to 2016; data obtained from central bank websites.
\(^4\)I replicate this graph for more economies using IMF Financial Soundness Indicators where credit dollarization includes household loans as well as loans to non-financial firms.
Deposit and credit dollarization also correlate in time series. Figure 4 shows the time series movement of credit and deposit dollarization in example economies. Deposit and credit dollarization comove over long periods. The interest rate spread also follows the same trend, which means that as households and firms switch to foreign currency, local interest rates become more expensive.

Comovement between credit dollarization and interest rates support the view that firms follow the the cheaper source of funding. On the other hand, when households switch to saving in foreign currency, it coincides with an increase in local interest rates. This lends to the view that the underlying reason for deposit dollarization is not the relative interest rates.

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5In the Appendix, graphs of all countries in the dataset are listed.

6In short horizons, exchange rate movements can create a spurious correlation but we observe long periods where deposit and credit dollarizations comove.

7For the lack of consistent expectation data, I use the difference between nominal deposit interest rates. In the Appendix I use exchange rate expectation data for Chile and Turkey, and show that the results are practically the same.
Figure 4: Credit and deposit dollarization in time series
Source: Individual central banks, ECB

Figure 5: Deposit dollarization and interest rate spread
Source: Individual central banks, ECB
3.2 Hedging motive

I argue that one of the underlying reasons behind deposit dollarization is hedging motive. In emerging economies, exchange rate depreciations are associated with lower growth. Figure 6 presents the evidence for this fact. In economies with high dollarization, correlation between real GDP growth and exchange rate\(^8\) depreciations is typically negative. On the other hand, in developed economies where we do not observe dollarization, the covariance is either close to zero or positive.

![Figure 6: Correlation between change in GDP and exchange rate](source: World Bank)

3.3 Interest Rate Spread in Dollarized Economies

The model has a clear implication about interest rate spread. In this section, I provide evidence for high interest rates in dollarized economies. Households hold foreign currency due to hedging motive, which drives up local currency interest rates. Due to the interest rate spread in favor of emerging market currencies—investing in currencies of dollarized economies should give on average positive returns. I follow the strategy

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\(^8\)Here, exchange rate is defined as the nominal dollar exchange rate divided by CPI of that economy. This is similar to how I define exchange rate in the model.
outlined in Burnside et al. (2011) to check whether emerging economies with higher dollarization yield higher returns. Monthly data covers the period 2004-2017. Data is taken from Reuters/WMR quotes on Datastream and covers the period 2004-2017. For Bulgaria, Croatia, Hungary, Romania, and Poland, the Euro is taken as benchmark; for others USD is the benchmark.

I assume that covered interest rate parity holds. I denote $S_t$ as the spot exchange rate and $F_t$ as the forward rate. Covered interest parity implies that returns domestic interest rate has to be equal to a hedged foreign position.

$$R_t = \frac{F_t}{S_t} R^f_t$$

(1)

Return to holding local currency is

$$R_t - \frac{S_{t+1}}{S_t} R^f_t$$

Then, replacing $R_t$, I get that borrowing in foreign currency and investing in local currency yields,

$$x^L_t = \left(\frac{F_t - S_{t+1}}{S_t}\right) R^f_t$$

(2)

The evidence suggests that currencies of dollarized economies yield higher returns on average. There is a positive relation between average spread and average dollarization. Figure 7 plots average dollarization and interest rate spread.

Average interest rate spread can be due to high risk that these emerging markets carry. In Figure 8, I plot Sharpe Ratio instead of average return. Highly dollarized economy local asset returns are higher, even after being standardized by standard deviation.

3.3.1 Interest Rate Spread and GDP Exchange Rate Correlation

Equation 28 implies that interest rate spread is proportional to the covariance between the consumption and exchange rate. In Figure 9, I plot the average interest rate spread

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9 Otherwise, there will be an arbitrage opportunity where any investor can invest large amounts and earn essentially riskless profit. On the other hand, some recent literature finds that in the aftermath of recent financial crisis, violations of covered interest rate parity are observed (Sushko et al. (2016); Amador et al. (2017)).

10 Average return divided by standard deviation of returns.
Figure 7: Average Interest Rate Spread and Average Deposit Dollarization

Figure 8: Sharpe Ratio for Interest Rate Spread and Average Dollarization
and correlation between exchange rate and consumption. In line with the evidence from Figures 6 and 7, a negative correlation between GDP and exchange rate fluctuations are associated with higher interest rate premium.

![Figure 9: Interest Rate Spread and GDP ER Correlation](image)

3.3.2 Carry Trade

In this section, I am going to replicate the above results from the perspective of US investors. Imagine a US investor who has access to risk-free funding, investing in an emerging market asset currency yields,

\[
R_t \left( \frac{S_t}{S_{t+1}} - R_t^f \right)
\]

Using equation 1, I can write this difference as

\[
R_t^f \left( \frac{F_t - S_{t+1}}{S_{t+1}} \right)
\]

Equation 3 is very similar to equation 2. Figure 10 shows Sharpe Ratio as a function of average dollarization. Average Sharpe Ratio for emerging economies with dollarization
of more than 15% turns out to be 21.19%. I calculate US equity Sharpe Ratio for the same period to be 16.85%\textsuperscript{11}.

![Figure 10: Sharpe Ratio and Average Dollarization](image)

3.4 VIX Index and International Risk

In the literature, the VIX index has been used as a proxy for uncertainty in the international financial markets and is found to comove with global financial cycles (Rey (2013)). There is some evidence that dollarization in certain economies comove with VIX index. An increase in global uncertainty will make households save in foreign currency, this will in turn amplify credit dollarization at a time when global risk is the higher. Figure 11 shows some examples that global uncertainty about the economy is associated with increased dollarization in emerging markets\textsuperscript{12}.

\textsuperscript{11}Monthly returns and risk free-rate are taken from Ken French’s website.

\textsuperscript{12}More examples can be found in the Appendix
Figure 11: Dollarization and VIX index
Source: Individual central banks, ECB, CBOE

4 The Model

The model is based on a standard small open economy model with two goods (home good and foreign good). Exchange rate is determined endogenously through current account identity. Endogenous local interest rates clear local financial markets. In order to capture balance sheet effects of exchange rate, the model features financial frictions that are based on the Costly State Verification (CSV) mechanism from Gale & Hellwig (1985). Bernanke et al. (1999) use the same structure, and it is among the first papers to embed a financial system inside a macroeconomic model. CSV mechanism has also been applied previously in the context of open economies. I allow entrepreneurs in the model to choose endogenously the currency of borrowing. Foreign

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13See Christiano et al. (2011) for a review. In particular, Faia (2007) shows that CSV-type financial frictions amplifies comovement between open economies. Similarly, Gertler et al. (2007) show how a small open economy reacts to shocks to interest rate premium under different exchange rate regimes.
currency\textsuperscript{14} borrowing creates balance sheet effects of exchange rate movements.

4.1 Household

I consider a standard small open economy. Consumption good is a composite good of home good \((c_{h,t})\) and foreign good \((c_{f,t})\).

\[
C_t = \left( \omega^{\frac{1}{\sigma}} c_{h,t}^{\frac{\sigma-1}{\sigma}} + (1 - \omega)^{\frac{1}{\sigma}} c_{f,t}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}
\]

(4)

with \(\omega > 0.5\) representing the home bias and \(\sigma\) is the elasticity of substitution between home and foreign good. Price index of composite good,

\[
P_t = \left( \omega p_h^{1-\sigma} + (1 - \omega) S_t^{1-\sigma} \right)^{\frac{1}{1-\sigma}}
\]

(5)

where price of home good is fixed \(p_h = 1\). \(S_t\) denotes the relative price of foreign good; I refer to \(S_t\) as exchange rate throughout the paper. Households have access to a one period risk-free foreign bond at an exogenous world interest rate \(R_f\). \(f_t\) denotes household foreign asset holdings in terms of home good; \(d_t\) is the amount of local asset holdings that pays local interest rate \(R_t\), which is determined endogenously. Each household is endowed with 1 unit of labor, which he lends to production firms at the competitive wage rate \(w_t\). Representative household maximizes life-time utility subject to the budget constraint,

\[
\sum_{t=0}^{\infty} \beta^t \mathbb{E} \left( \frac{C_t^{1-\gamma}}{1-\gamma} - \frac{\xi^{1+\phi}}{1+\phi} h_{t}^{1+\phi} \right)
\]

(6)

\[
P_t C_t + \widehat{d_t} + \widehat{f_t} = w_t h_{t} + d_{t-1} \quad R_{t-1} + f_{t-1} \quad \frac{S_t}{S_{t-1}} \quad \frac{R_f}{R_{t-1}}
\]

(7)

In many emerging economies, households hold savings in both local and foreign currencies; the model captures this behavior by allowing households to hold domestic and foreign assets. I refer to the ratio \(\frac{f_t}{f_t+d_t}\) as “deposit dollarization”. The first order conditions of household maximization problem are

\textsuperscript{14}This is an abuse of notation. Since this is not a monetary model, any reference to foreign currency means foreign good. Exchange rate refers to relative price of foreign good with respect to home good.
\[
\frac{C_t^{-\gamma}}{P_t} = \beta R_t E \left( \frac{C_{t+1}^{-\gamma}}{P_{t+1}} \right) 
\]
\[
\frac{C_t^{-\gamma}}{P_t} = \beta R_t E \left( \frac{C_{t+1}^{-\gamma}}{P_{t+1}} \frac{S_{t+1}}{S_t} \right) 
\]
\[
\xi l_{h,t}^\phi C_t^{-\gamma} = \frac{w_t}{P_t} 
\]

4.2 Production Firms

Production firms produce home good according to the production function,

\[
y_t = z_t K_t^\alpha L_t^{1-\alpha} 
\]

Capital \((K_t)\) is operated by the entrepreneurs, which will be discussed in the next section. \(z_t\) is the exogenous productivity process. Firms hires labor \((L_t)\) from both household and entrepreneur; labor is aggregated according to,

\[
L_t = l_{h,t}^\Omega l_{e,t}^{1-\Omega} 
\]

where \(l_{h,t}\) and \(l_{e,t}\) are labor provided by household and entrepreneurs, respectively. Return to capital is given by

\[
R_t^k = E \left( \frac{z_{t+1}\alpha K_{t+1}^\alpha L_{t+1}^{1-\alpha} + Q_{t+1}(1-\delta)}{Q_t} \right) 
\]

which is equal to the marginal product of capital plus the resale price of undepreciated capital divided by the current price of capital. \(Q_t\) is the price of capital and \(\delta\) is the depreciation rate. Capital investment is made by the representative household. Each period, households buy back the capital from entrepreneurs. Capital evolves according to

\[
K_{t+1} = (1-\delta)K_t + I_t - \Phi \left( \frac{I_t}{K_t} \right) K_t 
\]

with capital adjustment costs \(\Phi(\cdot)\).
4.3 Foreign Economy

Foreign economy produces foreign good and this good is traded competitively without trade costs. Foreign good can be exchanged for $S_t$ amount of home good. Foreign households demand a certain amount of home good for consumption ($c_{xt}$), their consumption demand is given by

$$c_{xt} = S_t^\varphi x_t$$  \hspace{1cm} (15)

where $x_t$ is an exogenous demand, $\varphi$ is the elasticity of demand and $S_t$ is the relative price of foreign good. Foreign households own foreign banks, which borrow and lend at the exogenous interest rate $R^f_t$. Figure 12 summarizes the trade and production in the model.

![Goods market diagram](image)

Figure 12: Goods market

4.4 Banks

In the model, there are two types of banks: local and foreign. Local banks are owned by households and intermediate local funds. Following Eichengreen et al. (2003), I assume that local banks can only borrow from the household. This means that foreign
investors do not have access to financial intermediation in terms of local currency. Recent empirical observation by Maggiori et al. (2017) verifies that this assumption is reasonable. Local financial markets need to then clear within the small open economy\(^\text{15}\) through local interest rates \(R_t\). Foreign banks intermediate in terms of foreign currency and are owned by risk neutral foreign investors \(^\text{16}\). They borrow at the exogenous interest rate \(R_t^f\) from foreign investors and the local household. Figure 13 shows the financial sector in the economy.

Another important assumption is that the banks cannot have currency mismatch; they need to match denomination of their liabilities and loans. Many studies verify that emerging market banks do not carry currency mismatch due to regulation or risk management (Dalgic et al. (2017); Keller (2017); Brown et al. (2014)). I also assume that the banks are totally separate and they do not insure each other; the implication is that each loan has to satisfy bank zero profit condition separately, which means that banks do not extend loans they know they would make a loss from.

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\(^\text{15}\)This is similar to Feldstein-Horioka puzzle (Feldstein & Horioka (1980b)).

\(^\text{16}\)This assumption is made because lending to entrepreneurs in foreign currency will typically carry aggregate risk.
4.5 Entrepreneurs

Following Bernanke et al. (1999), entrepreneurs are modeled as separate households. They are risk neutral and maximize lifetime income\textsuperscript{17}. Entrepreneurs operate the capital in the economy. Even though all entrepreneurs are ex-ante identical, each entrepreneur operates capital with efficiency $\omega_i$. Given the return to capital $R_k^t$, an entrepreneur gets a return of $\omega_i R_k^t$. The realization of $\omega_i$ depends on the distribution function $\omega_i \sim F(\omega)$ where $\mathbb{E}(\omega_i) = 1$.

Each entrepreneur has net worth $N_i$, which can be used as collateral to borrow more. They are subject to a particular financial friction, Costly State Verification, introduced by Townsend (1979). In particular, banks can observe efficiency $\omega_i$ only after paying a monitoring cost $\mu$ of total assets of the entrepreneur. Gale & Hellwig (1985) show that the optimal contract in this environment is a debt contract and the entrepreneur is monitored only if he declares bankruptcy. The bank offers a menu of contracts that specify an interest rate and leverage. The interest rate offered by the bank carries a risk premium reflecting the likelihood of default. The interest rate offered by the foreign bank reflects the exchange rate risk. An entrepreneur picks the contract to maximize expected profit. In the model, there are two sources of borrowing, which means there will be two endogenous bank interest rates ($R_{b,t}^f$, $R_{b,t}^l$) and two leverages ($L_{l,t}^f$, $L_{l,t}^l$) for foreign and local borrowing, respectively, which become two equilibrium contracts offered by banks ($R_{b,t}^f$, $L_{l,t}^f$) for local and ($R_{b,t}^l$, $L_{l,t}^l$) for foreign borrowing. Given the level of leverage, the interest rate uniquely determines default cutoff for two types of borrowing ($\bar{\omega}_l^t$, $\bar{\omega}_f^t$), where the entrepreneur defaults if the realization of individual efficiency is less than the cutoff. Finally, entrepreneurs decide how to divide their net worth between two sources of borrowing.

Entrepreneur Choice and Capital

Details and equations for entrepreneurs are in the Appendix. Entrepreneurs maximize expected profit,

$$\max_{\theta_t, \omega_l^t, \omega_f^t} \quad R_k^t N_t \left( \left[ 1 - \Gamma^l(\bar{\omega}_l^t) \right] L_l^t (1 - \theta_t) + \theta_t \mathbb{E} \left[ 1 - \Gamma^f(\bar{\omega}_f^t \frac{S_{t+1}}{S_t}) \right] L_f^t \right)$$

\textsuperscript{17}For simplicity, they only consume home good.
the expected payment to the bank given the default cutoff\footnote{This function is explicitly defined in the Appendix}. Since the bank interest rate uniquely determines a default cutoff, entrepreneurs choose,

- \((R_{b,t}, L_l^t)\) Interest rate and leverage for local borrowing
- \((R_{b,t}^f, L_f^t)\) Interest rate and leverage for foreign borrowing
- \(\theta_t\) amount of net worth used as collateral for foreign borrowing

where, \(N_t(1 - \theta_t)(L_l^t - 1)\) is the amount raised through local sources and \(N_t\theta_t(L_f^t - 1)\) through foreign sources. Similar to deposit dollarization, I denote “credit dollarization” as the portion of credit funded by foreign sources. Credit dollarization in the model is equal to

\[
\frac{N_t\theta_t(L_f^t - 1)}{N_t\theta_t(L_f^t - 1) + N_t(1 - \theta_t)(L_l^t - 1)}
\]

Then, the entrepreneur buy capital with the fund they raised,

\[
Q_tK_{t+1} = N_t\theta_tL_f^t + N_t(1 - \theta_t)L_l^t
\]

Since entrepreneurs are risk neutral, in equilibrium they are indifferent between borrowing in either source. First order condition for the entrepreneur maximization problem with respect to \(\theta_t\) implies\footnote{Two other first order constraints are derived in the Appendix},

\[
[1 - \Gamma(\tilde{\omega}_{lt})]L_{lt} = \mathbb{E}\left[1 - \Gamma\left(\tilde{\omega}_{ft}\frac{S_{t+1}}{S_t}\right)\right]L_{ft}
\]

**Foreign Borrowing and Balance Sheet Effects**

In the model, entrepreneurs are free to borrow from either local or foreign banks by choosing the amount of net worth to allocate to each type of borrowing. Foreign borrowing is subject to exchange rate risk since return to capital is in terms of local good. A depreciation will increase the default rates and the payments of the entrepreneurs who borrowed form the foreign bank. This will decrease net worth of the entrepreneurs and decrease the amount of investment and production. Households will be affected through a decrease in wages. Due to limited liability, entrepreneurs are only liable
to the amount that they pledge to the bank. In case the entrepreneur defaults on his foreign loan, a foreign bank does not have the right to liquidate the investment financed by local funds.

4.6 Saving and Debt Denomination

In the model, two equations determine the choice of denomination and the interest rate spread, Euler equations, and the entrepreneur choice.

\[
R_t \mathbb{E} \left[ \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \right] = R_t^f \mathbb{E} \left[ \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \frac{S_{t+1}}{S_t} \right]
\]

(20)

It is clear that the deviation in expected interest rates can come from the covariance between expected exchange rate and marginal utility. An increase in the covariance between marginal utility and the exchange rate will be reflected as the widening in the interest rate spread that the entrepreneurs will face when borrowing. In the equilibrium, entrepreneurs are indifferent between borrowing in two sources.

\[
[1 - \Gamma(\bar{\omega}_t)] L_{lt} = \mathbb{E} \left[ 1 - \Gamma \left( \bar{\omega}_{ft} \frac{S_{t+1}}{S_t} \right) \right] L_{ft}
\]

(21)

Where \([1 - \Gamma(\cdot)]\) is the share of gross earnings kept by the entrepreneur net of expected interest expenses and default costs. An increase in the interest rate spread will be reflected in the interest cost. Even though the entrepreneurs are risk neutral, financial frictions prevent them from erasing the interest rate difference. In equilibrium, a higher interest spread leads firms to borrow more from foreign sources.

4.7 Equilibrium Conditions

Exchange rate \((S_t)\) and local interest rate \((R_t)\) is determined endogenously with three equilibrium conditions\(^{20}\).

- Local bank needs to clear borrowing and lending within the small open economy, which means that local borrowing needs to be equal to household local savings

\[
d_t = N_t(1 - \theta_t) \left( L'_t - 1 \right)
\]

(22)

\(^{20}\)Due to Walras’ Law, financial market clearing and current account identity implies market clearing for home good.
• Current account identity implies that trade surplus needs to be equal to the change in net investment position (Current Account - Capital Account = 0),

\[
\text{Current Account : } \frac{c_{xt}}{S_t} - c_{ft}
\]  

(23)

Capital Account : \[ \left( \frac{f_t}{S_t} - \frac{f_{t-1}}{S_{t-1}} R_{t}^f \right) - \left[ \frac{\theta_t N_t}{S_t} (L_t^f - 1) - \frac{\theta_{t-1} N_{t-1}}{S_{t-1}} (L_{t-1}^f - 1) R_{t-1}^f \right] - \Pi_b^b \]

Household net foreign investment Entrepreneur net foreign borrowing Foreign Bank Profit

(24)

Default rates change with exchange rate movements, which affect the payments received by foreign banks.

• Market clearing for home good

\[
c_{h,t} + c_{e,t} + c_{x,t} + I_t + M_t + \Pi_b^b S_t = z_t K_t^\alpha L_t^{1-\alpha}
\]  

(25)

c_{h,t}, c_{e,t}, c_{x,t} are home good consumption demand by the household, entrepreneurs and foreigners, respectively. \( M_t \) is the default costs given by

\[
M_t = R_{t-1}^k N_{t-1} \left( \mu G(\bar{\omega}_{t-1} L_{t-1}^f (1 - \theta_{t-1}) + \mu G(\bar{\omega}_{f,t-1} S_{t-1}^f S_t^f S_{t-1} \theta_{t-1}) \right)
\]  

(26)

4.8 Shocks in the model

The economy is subject to the following shocks:

• Technology shock, \( z_t \), mainly works through increasing marginal product of capital. An increase in productivity increases wages and profits. Due to the income effect, households increase consumption, which drives up the relative price of foreign good. Hence, a positive technology shock is associated with increased consumption and exchange rate depreciation.

• Export demand shock, \( x_t \), affects the economy through current account equation. An increased foreign demand increases the amount of foreign good in the economy and decreases the price of foreign good. Since households are net buyers of foreign good, this increases consumption.
• Foreign interest rate shock, $R_t^f$, can also be considered as external premium shock similar to Gertler et al. (2007). Neumeyer & Perri (2005) claim that foreign interest rate shock is an important driver of emerging economy business cycles. I argue that households can protect themselves from foreign interest rate shock by holding foreign assets. Foreign interest rate shock is subject to stochastic volatility ($\sigma_R$), as in Fernandez-Villaverde et al. (2011). An increase in the standard deviation of foreign interest rate increases macroeconomic uncertainty. I show that households shift their portfolios to foreign currency in response to increased uncertainty.

5 Model Parameterization

5.1 Small Open Economy

I use quarterly discount factor $\beta = 0.9923$, which corresponds to a 3% steady state annual interest rate. Elasticity of intertemporal substitution is 0.2, which implies $\gamma = 5$. Home bias in consumption is set $\omega = 0.7$, which is the roughly average import/consumption ratio in emerging economies. Elasticity of intratemporal substitution is set to $\sigma = 1.5$ (Faia (2007), Backus et al. (1993)). In a similar model, Christiano et al. (2011) estimates inverse elasticity of labor $(1 + \phi) = 7.7$. This number is pretty high compared to estimates from the US economy; a low elasticity is thought to give a more realistic reaction of hours to interest rate shocks in developing economies (Fernandez-Villaverde et al. (2011)). $\xi$ is set such that the labor in the non-stochastic steady state is equal to unity. Elasticity of export demand is equal to unity $\varphi = 1$ and the mean export demand is set such that the non-stochastic steady state exchange rate is equal to 1 ($S = 1$), which implies that the price index equal to 1 as well ($P = 1$).

5.2 Finance and Investment

Steady state capital return spread is set $\frac{R^k}{R} = 1.0045$, which targets the steady state level of leverage of 2.04 — the average leverage of nonfinancial firms calculated by Dalgic et al. (2017). Share of capital in production is $\alpha = 0.36$. Depreciation rate is $\delta = 0.025$, and investment is subject to quadratic capital adjustment costs $\Phi(\cdot)$. I borrow standard
parameters used in the literature using the CSV framework\textsuperscript{21}. Entrepreneur efficiency follows lognormal distribution with standard deviation $\sigma_e = 0.26$, and the losses in case of bankruptcy is $\mu_e = 0.12$ (Gertler et al. (2007); Faia (2007)). Entrepreneurs retire with rate $(1 - \gamma_e) = 0.0333$; entrepreneur labor share is set to $(1 - \Omega) = 0.09$.

5.3 Shocks

All shocks follow AR(1) process. I use $\sigma_R = 0.0025$ as the standard deviation of interest rate shock. This number is very similar to the estimated values in the literature (Neumeyer & Perri (2005); Fernandez-Villaverde et al. (2011)). Later, I show that in the last 10 years, standard deviation of foreign interest rates has fallen across emerging markets. I set $\rho_R = 0.96$, which is roughly the number estimated by above papers and my own estimates. I use the VIX index as a proxy for uncertainty shock. I estimate an AR(1) process on the log of VIX index; I estimate, $\rho_\sigma = 0.72$ and $\sigma_\sigma = 0.25$. The standard deviation I estimated is very close to the ones in Fernandez-Villaverde et al. (2011).

For productivity and export shocks, I use an autocorrelation coefficient of 0.92. I use $\sigma_z = 0.08$ and $\sigma_x = 0.04$ to target output volatility of 3% and real exchange rate volatility of 3.8%, which are approximately the quarterly volatility of industrial output and real exchange rate observed in emerging markets.

5.4 Solution

I use third order perturbation to solve the model. Fernandez-Villaverde et al. (2011) show that this method works to analyze the effects of uncertainty shocks. In order to ensure stationarity, I use quadratic portfolio adjustment costs, which is standard in the literature\textsuperscript{22}. This requires me to set deposit and credit dollarization in the non-stochastic steady state; I set 25% deposit dollarization and 25% credit dollarization. As I show under results, these numbers change endogenously in the stochastic steady state.

\textsuperscript{21}See Bernanke et al. (1999); Gertler et al. (2007); Faia (2007)
\textsuperscript{22}I use adjustment cost parameter $\epsilon = 1e - 3$. See Schmitt-Grohe & Uribe (2003) for a review of other means to ensure stationarity.
6 Results

6.1 Deposit dollarization, credit dollarization and interest rate spread move together in time series

The model is able to match the empirical regularities about dollarization in emerging economies. In the model, deposit and credit dollarizations comove like in the data, and the interest rate spread moves with them. Figures 14 and 15 show an example simulation where deposit and credit dollarizations move together. Higher expected interest rate spread is associated with a higher dollarization. Note that the simulations look remarkably similar to the data in Figure 4 and Figure 5.

<table>
<thead>
<tr>
<th></th>
<th>Turkey</th>
<th>Chile</th>
<th>Peru</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corr(FC Deposit, FC Credit)</td>
<td>0.43</td>
<td>0.48</td>
<td>0.48</td>
<td>0.41</td>
</tr>
<tr>
<td>Corr(FC Deposit, Spread)</td>
<td>0.36</td>
<td>0.60</td>
<td>0.72</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Table 1: Correlations between deposit and credit dollarization and interest rates

Figure 14: Simulated credit and deposit dollarization
6.2 Deposit dollarization moves negatively with the correlation between consumption and exchange rate

The model is able to match the empirical observation that household dollarization exists in economies in which exchange rate depreciations are associated with a recession. In order to change the covariance between consumption and exchange rate, I change the volatility of the foreign interest rate $\sigma_R \in [0, 0.005]$. I interpret foreign interest rate not as US interest rates but as dollar interest rates in emerging markets. Similar to the literature, this offers the interpretation that foreign interest rates in the model capture not only the movements in US interest rates but also the risk premia emerging markets face. Increased uncertainty about the interest rates creates consumption risk, which the household uses foreign currency savings to hedge. Figure 16 shows the relation between consumption and exchange rate covariance and dollarization. The model is able to capture the main trend in the data.

6.3 Credit and deposit dollarization are linked

In the model, steady state deposit and credit dollarizations are linked. Figure 17 shows the relationship in the stochastic steady state. Increased uncertainty pushes households to invest in foreign assets; through higher interest rate spreads, entrepreneurs are pushed to borrow from foreign banks.
Figure 16: Deposit dollarization and correlation between consumption and exchange rate

Figure 17: Deposit and credit dollarization in the steady state
6.4 Macroeconomic uncertainty increases dollarization through household hedging motive

In the model, the source of deposit dollarization is hedging against uncertainty coming from outside shocks. In the following exercise, I shock the economy with increased uncertainty. The shock is similar to the one employed by Fernandez-Villaverde et al. (2011), and it is an increase in the standard deviation of the international interest rate process. With no deposit dollarization, the shock does not affect the portfolio composition of the economy. On the other hand, in the benchmark economy, households shift its portfolio from local assets to foreign assets, which provide hedging in the presence of increased uncertainty. Credit dollarization increases only when households can invest in foreign assets.

6.5 Net Outside Finance: Source of Foreign Currency Matters

I define net outside finance as the portion of foreign currency credit not financed by household foreign currency deposits. For the previous exercise in Figure 24, I kept net finance constant in both scenarios. Here, I am going to show that the size net outside finance is crucial. I repeat the same exercise using economies with different levels of net foreign finance.

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Net Saver</th>
<th>Net Borrower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit Dollarization</td>
<td>33%</td>
<td>25%</td>
<td>54%</td>
</tr>
<tr>
<td>Credit Dollarization</td>
<td>41%</td>
<td>23%</td>
<td>82%</td>
</tr>
<tr>
<td>FC Deposit / FC Credit</td>
<td>76%</td>
<td>113%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Table 2: FC Deposit / FC Credit ratios in example economies

Figure 19 shows that in the net borrower economy, net worth collapses. With the collapse of net worth, investment and wages collapse. Then, the decline in consumption is more pronounced in net borrower economy compared to the others. In most emerging economies, FC Deposit / FC Credit ratio is close to 1 as shown in 20, which means that foreign currency credit is financed internally. In Figure 21, I show that in the last

---

23 Even though steady state levels of foreign currency deposits are the same, households responds to high foreign currency credit by saving more in dollars.

24 FC Credit includes bank credit obtained from central banks and dollar denominated international security issuances obtained from BIS.
Impulse Response to Uncertainty Shock

Figure 18: Impulse response to uncertainty shock
decade, the amount of household foreign currency savings as a ratio of foreign currency
borrowing by non-financial firms is increasing\textsuperscript{25}.  

It has been discussed in the literature that dollarization might increase the probability
of a sudden stop, where sudden stop is defined as “large and largely unexpected decline
in capital flows” (Calvo et al. (2008)). The idea is that sudden reversal of capital inflows
will depreciate the currency and it will deteriorate firm balance sheets if they borrowed
in foreign currency. This argument misses the point that most foreign currency finan-
cial intermediation takes place between residents. This evidence is in line with the
observation that banking systems in emerging economies do not carry significant cur-
rency mismatch due to prudential measures (Kiguel et al. (2005)). Another observation
is that in emerging market economies, currency mismatch is mostly in non-financial
sector that is typically much less leveraged.

\subsection*{6.5.1 International Security Issuances and Official Reserves}

Figure 20 shows the ratio of FC Deposit over FC Credit in the non-financial sector. In
reality, countries also hold FX reserves against global shock. In Figure 22, I also add
all international foreign currency denominated securities to the stock of FC Credit and
Official Reserves to FC Deposits.

\textsuperscript{25}The figure includes bank deposit and credit and international security issuances by non-financial
sector. Full set of countries can be found in the Appendix.
Impulse Response to Foreign Interest Rate Shock

Figure 19: Impulse response to foreign interest rate shock
Figure 20: Average FC Deposit / FC Credit in Emerging Markets
Source: Individual central banks, ECB, BIS

Figure 21: Ratio of foreign currency deposits to credit in selected emerging economies
7 Mechanism

International interest rate risk has been noted to be an important driver of emerging market business cycles (Neumeyer & Perri (2005); Gertler et al. (2007)). Foreign currency deposits can hedge households against this risk by providing higher income when international interest rates are high. On the other hand, by holding foreign currency accounts, households decrease local currency supply in the banking system. This raises the local interest rates and pushes firms to borrow in foreign currency. Thus, indirectly, firms are providing insurance for households against currency risk. In turn, high foreign currency credit creates balance sheet risks, which makes households save even more in foreign currency. Figure 23 summarizes the mechanism where household behavior amplifies overall dollarization in the economy.

An increase in foreign interest rates causes a Dornbusch-like depreciation in the local exchange rate. In a classical model where UIP holds, depreciation comes from the parity condition. In this model, equation 20 and 21 have a similar purpose. Even in the absence of deposit dollarization, foreign currency credit channel causes a depreciation
via equation 21\textsuperscript{26}. Entrepreneurs are indifferent between borrowing from either sources. An increase in foreign interest rates does not have a first order effect on local currency borrowing, but it increases the cost of funds from abroad. In order for the equation to hold, the exchange rate depreciates. Equation 27 shows the two effects of exchange rate depreciation on the household. Cost of imported goods increases, which increases the price level (trade). An increase in relative price of foreign good is bad for the household because households are net buyers of foreign good and net seller of home good. The other channel is through balance sheet effects. In the aftermath of a depreciation, entrepreneurs face higher interest rate costs if they borrowed in foreign currency. Lower net worth leads to lower investment and lower production and wages.

\[
\begin{align*}
\text{Trade} & \uparrow \\
\frac{1}{P_t} C_t + d_t + f_t &= \underbrace{w_i l_{h,t}}_{\text{Balance Sheet}} + d_{t-1} R_{t-1} + f_{t-1} - \frac{S_t}{S_{t-1}} R_{t-1}^f \\
\text{Insurance} & \uparrow
\end{align*}
\]

Foreign currency deposits provide a perfect hedge against foreign interest rate risk because its returns are high when the exchange rate depreciates. At the same time, households benefits from increased foreign interest rates. As Figure 24 shows, households do not decrease consumption as much and is able to increase savings after an increase in foreign interest rates.

In order to see how an increase in uncertainty affects interest rate spread, let’s rewrite Euler equations

\[
\begin{align*}
R_t \mathbb{E} \left[ \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \right] &= R_t^f \mathbb{E} \left[ \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \frac{S_{t+1}}{S_t} \right] \\
&= \mathbb{E} \left[ \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \right] \mathbb{E} \left[ R_t^f \frac{S_{t+1}}{S_t} \right] + \text{cov} \left( \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}}, R_t^f \frac{S_{t+1}}{S_t} \right) \\
\mathbb{E} \left[ R_t - R_t^f \frac{S_{t+1}}{S_t} \right] &= \text{cov} \left( \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}}, R_t^f \frac{S_{t+1}}{S_t} \right) / \mathbb{E} \left[ \frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \right] (28)
\end{align*}
\]

Expected interest spread is related to the covariance between marginal utility and exchange rate. An increase in the uncertainty increases the covariance and leads to expected interest rate difference. Later, I am going to verify whether increased dollarization is actually related to interest rate spread.

\textsuperscript{26}The case where both foreign currency credit and deposit are not allowed is not discussed because in this case, foreign interest rate becomes irrelevant and the economy has to balance trade every period.
8 Policy Experiments

8.1 Preventing Foreign Currency Deposits

I argue that household dollarization acts as a hedge against exchange rate risks. I consider the effects of an increase in international interest rates. Neumeyer & Perri (2005) argue that movements in international interest rates are an important source of volatility in emerging economies. I consider two economies with the same steady state level of consumption and total savings. In one economy, households are not allowed to hold foreign currency savings and in the benchmark economy, households hold foreign currency savings. Table 3 summarizes the nature of dollarization in both economies. Except for steady state levels of dollarization, both economies have the same level of consumption and total savings. The second economy is the steady state of the benchmark economy with a heavy tax on dollar deposits.

An increase in foreign interest rates leads to a decline in consumption and exchange rate depreciation in both economies. The net worth of entrepreneurs in the economy
Impulse Response to Foreign Interest Rate Shock

Figure 24: Impulse response to foreign interest rate shock
Table 3: Dollarization parameters in two economies

with high dollarization collapses, but the consumption does not decrease much because exchange rate depreciation leads to gains to household wealth due to foreign currency savings. The decline in net worth becomes less crucial because as seen in Figure 24, households can afford to save more to recapitalize the entrepreneurs, which results in higher leverage offered by the banks in the benchmark economy. In Table 4, I document the welfare of the household and the entrepreneurs under both benchmark economy and the economy where households cannot hold foreign currency. Preventing households from holding foreign currency decreases both household and entrepreneur welfare. In this economy, taxing dollar deposits results in the same welfare as reducing consumption by 0.8%.

The result in Figure 24 depends on the leverage in the economy. Non-financial firms in emerging markets are typically not highly leveraged. The steady state leverage in the model is 2.04 which is similar to the leverage in non-financial firms in the US. In the Appendix, I replicate the same exercise in an economy with steady state leverage of 5. Figure 30 shows that a policy of preventing deposit dollarization makes the economy less vulnerable in the case where firms are highly leveraged.

Table 4: Welfare gains of preventing foreign currency deposits

<table>
<thead>
<tr>
<th></th>
<th>ΔWelfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH Welfare (in C-units)</td>
<td>−0.8%</td>
</tr>
<tr>
<td>Entrepreneur Net Worth</td>
<td>−1.33%</td>
</tr>
</tbody>
</table>

8.2 Preventing Foreign Currency Credit

A standard response to high credit dollarization is a tax on foreign currency borrowing. In Figure 25, I show that a tax on foreign currency borrowing is similar to a sudden stop. When firms are forced to borrow in local currency, they raise local interest rates. Lower foreign currency credit and high local interest rates push household to switch
to local currency. However, the decrease in deposit dollarization is not big because households still want to keep foreign currency for insurance purpose. The end result is higher interest rates and lower investment. This result is supported by the evidence in Maggiori et al. (2017) where they find that firms who are unable to borrow in foreign currency face higher cost of capital. Eventually, the drop in consumption recovers but in the new steady state, the level of net worth, capital, and investment is lower. Household saving is high in the new equilibrium, which supports the level of consumption even though the production is low.

<table>
<thead>
<tr>
<th>Δ</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>0.7%</td>
</tr>
<tr>
<td>Real Interest Rates</td>
<td>1.4%</td>
</tr>
<tr>
<td>Net Worth</td>
<td>−4.5%</td>
</tr>
<tr>
<td>Capital</td>
<td>−5%</td>
</tr>
</tbody>
</table>

Table 5: Welfare gains of preventing foreign currency credit

9 Conclusion

A Significant amount of financial intermediation in emerging economies takes place in foreign currency, and this has been thought of as a source of fragility in the financial system. In this paper, I show that part of foreign currency use can be explained by the hedging properties of foreign currency accounts. Household deposit dollarization increases interest rate spread in the economy and pushes firms to borrow in foreign currency. I think of this as a hedging arrangement between the household and non-financial sector, where non-financial firms provide households with hedging in exchange for lower foreign interest rates. Macroeconomic uncertainty increases dollarization through household hedging motive. Dollarization increases currency mismatch in the non-financial sector and creates balance sheet effects after exchange rate movements. Increased currency mismatch coincides with periods of higher exchange rate uncertainty. Nevertheless, foreign currency accounts provide households with hedging against foreign interest rate risk, which is an important source of uncertainty in emerging economies. Combined with the observation that emerging economies have difficulty attracting local currency foreign investment, policies to reduce dollarization have counterproductive results. In particular, preventing household FC deposits makes
Figure 25: Impulse response to tax on FC credit
the economy more vulnerable to foreign interest rate shocks, and preventing FC credit reduces investment. Policymakers should be aware of the costs of macroprudential reforms to limit dollarization.

References


## A Appendix

### A.1 Deposit and Loan Dollarization

I replicate Figure 3 using Loan Dollarization data from IMF Financial Soundness Indicators data where each country reports the ratio of foreign currency loans in the banking system. This includes loans extended to households as well as to non-financial firms (it also includes loans extended across borders but this should be negligible in emerging economies).

![Figure 26: Average Deposit and Loan Dollarization (2004-2008)](image)
A.2 Financial Frictions

Here I describe the financial frictions and entrepreneur problem in detail. I provide details for foreign borrowing. For the local borrowing, the equations are identical when the exchange rate is assumed to be constant. In the spirit of CSV, there is a continuum of entrepreneurs. Each entrepreneur can operate capital. $K$ with efficiency $\omega$. $\omega$ is distributed according to cdf $F(\omega)$.

A.2.1 Entrepreneur Problem

Consider, gross return to capital $R^k_t$ and the risk free foreign interest rate $R^f_t$. Entrepreneur with net worth $N_t$ borrows $B_t$ at interest rate $R^b_t$ to form assets $A_t$. He defaults is $\omega < \bar{\omega}$, where $\bar{\omega}$ is characterized by,

$$R^k_t A_t \bar{\omega} = R^k_t B_t \frac{S_{t+1}}{S_t}$$

$$\bar{\omega} = \frac{R^k_t B_t D_{t+1}}{R^k A_t} = \bar{\omega} D_{t+1}$$

Where $\frac{S_{t+1}}{S_t} = D_{t+1}$ is the depreciation. Similarly,

$$\omega = \frac{R^k_t}{R^k} \frac{L_t - 1}{L_t}$$

$$E \left[ \frac{\int_{\omega_D}^{\infty} R^k_t A_t \omega - R^k_t B_t D_{t+1} dF(\omega)}{N_t R^f_t E(D_{t+1})} \right]$$

$$E \left[ \frac{\int_{\omega_D}^{\infty} R^k_t A_t \omega - R^k_t A_t \bar{\omega} D_{t+1} dF(\omega)}{N_t R^f_t E(D_{t+1})} \right]$$

$$E \left[ \frac{\int_{\omega_D}^{\infty} (\omega - \bar{\omega} D_{t+1}) R^k_t A_t dF(\omega)}{N_t R^f_t E(D_{t+1})} \right]$$

$$E \left[ \int_{\omega_D}^{\infty} (\omega - \bar{\omega} D_{t+1}) dF(\omega) \right] \frac{R^k}{R^f_t E(D_{t+1})} L_t$$

$$E \left[ \left[1 - \Gamma(\bar{\omega} D_{t+1})\right] \frac{R^k}{R^f_t E(D_{t+1})} L_t \right]$$
\[ \max_{\bar{\omega}_F} \mathbb{E} \left( 1 - \Gamma(\bar{\omega}_F D_{t+1}) \right) R^k L^f \]

### A.2.2 Foreign Bank

Foreign bank intermediates foreign loans. The bank collects deposits from the household and the rest of the world and it lends to entrepreneurs. It is owned by foreign investors who have deep pockets.

\[
\mathbb{E} \left[ \frac{1}{S_{t+1}} \left( 1 - F(\bar{\omega}_{D_{t+1}}) \right) R^k B_t D_{t+1} + (1 - \mu) \int_0^{\bar{\omega}_D} \omega dF(\omega) R^k A_t \right] = \mathbb{E} \left[ \frac{1}{S_{t+1}} R^k_t B_t D_{t+1} \right]
\]

\[
\mathbb{E} \left[ \frac{1}{S_{t+1}} \left( 1 - F(\bar{\omega}_{D_{t+1}}) \right) \bar{\omega}_D D_{t+1} + (1 - \mu) \int_0^{\bar{\omega}_D} \omega dF(\omega) \bar{\omega}_D A_t \right] = \mathbb{E} \left[ \frac{R^k_t B_t}{R^k S_A t} \right]
\]

\[
\mathbb{E} \left[ \frac{S_t}{S_{t+1}} \left( 1 - F(\bar{\omega}_{D_{t+1}}) \right) \bar{\omega}_D D_{t+1} + (1 - \mu) \int_0^{\bar{\omega}_D} \omega dF(\omega) \right] = \frac{L^f_t}{L^f} - 1
\]

\[
L^f_t = \frac{1}{1 - \frac{R^k}{R^k_t} \mathbb{E} \left( \frac{1}{D_{t+1}} \left( \Gamma(\bar{\omega} D_{t+1}) - \mu G(\bar{\omega} D_{t+1}) \right) \right)}
\]

### A.2.3 Entrepreneur Choice

\[
\mathbb{E} \left( [1 - \Gamma(\bar{\omega} D_{t+1})] \right) \frac{R^k}{R^k_t \mathbb{E} (D_{t+1})} \frac{1}{1 - \frac{R^k}{R^k_t} \mathbb{E} \left( \frac{1}{D_{t+1}} \left( \Gamma(\bar{\omega} D_{t+1}) - \mu G(\bar{\omega} D_{t+1}) \right) \right)}
\]

\[
\max \mathbb{E} \left( [1 - \Gamma(\bar{\omega} D_{t+1})] \right) \frac{1}{1 - \frac{R^k}{R^k_t} \mathbb{E} \left( \frac{1}{D_{t+1}} \left( \Gamma(\bar{\omega} D_{t+1}) - \mu G(\bar{\omega} D_{t+1}) \right) \right)}
\]
\[
\mathbb{E} \left( (1 - F(\bar{\omega}D_{t+1})) D_{t+1} \right) \frac{1}{1 - \frac{R^k}{R^f} \mathbb{E} \left( \frac{1}{D_{t+1}^D} (\Gamma(\bar{\omega}D_{t+1}) - \mu G(\bar{\omega}D_{t+1})) \right)} = \\
\mathbb{E} \left( [1 - \Gamma(\bar{\omega}D_{t+1})] \right) \frac{R^k}{R^f} \mathbb{E} \left( [1 - F(\bar{\omega}D_{t+1}) - \mu \bar{\omega} F'(\bar{\omega}D_{t+1})] \right) \left[ 1 - \frac{R^k}{R^f} \mathbb{E} \left( \frac{1}{D_{t+1}^D} (\Gamma(\bar{\omega}D_{t+1}) - \mu G(\bar{\omega}D_{t+1})) \right) \right]^2
\]

\[
\frac{\mathbb{E} \left( (1 - F(\bar{\omega}D_{t+1})) D_{t+1} \right)}{\mathbb{E} \left( [1 - \Gamma(\bar{\omega}D_{t+1})] \right)} = \frac{\frac{R^k}{R^f} \mathbb{E} \left( [1 - F(\bar{\omega}D_{t+1}) - \mu \bar{\omega} F'(\bar{\omega}D_{t+1})] \right)}{\left[ 1 - \frac{R^k}{R^f} \mathbb{E} \left( \frac{1}{D_{t+1}^D} (\Gamma(\bar{\omega}D_{t+1}) - \mu G(\bar{\omega}D_{t+1})) \right) \right]^2}
\]

### A.2.4 Equilibrium borrowing

Each entrepreneur decides how to allocate his net worth as collateral to each type of borrowing. In the end, he maximizes expected return, 

\[
\max_{\theta} R^k_t N_t \left( [1 - \Gamma^d(\bar{\omega}^d)] L^d_t (1 - \theta) + \theta \mathbb{E} \left[ 1 - \Gamma^f(\bar{\omega}^f D_{t+1}) \right] L^f_t \right)
\]

Now, it is apparent that the entrepreneur will choose a corner solution unless in equilibrium both options yield the same revenue. I hope it will be the case that local interest rate will adjust to make sure that happens. My prior is that foreign borrowing will have lower interest rate with lower leverage.
A.3 Impulse Response to Shocks

Figure 27: Impulse response to technology shock
Figure 28: Impulse response to export shock
Figure 29: Impulse response to export shock
A.4 Impulse Response to Foreign Interest Rate in Leveraged Economy

In the case where entrepreneurs are highly leveraged, balance sheet effects are stronger. Collapse in investment and wages can dominate the insurance benefit of dollar deposits.

Figure 30: Impulse response to foreign interest rate in leveraged economy
A.5 Real vs. Nominal Interest Rate Spread

Most emerging economies do not hold reliable expectation data which is necessary to estimate expected interest rate spread. I compare real vs nominal interest rate spread in Turkey and Chile using expectation surveys. The results are basically the same. This is not surprising because overwhelming evidence that exchange rate behavior is close to a random walk over short horizons (Zorzi et al. (2016)). Real interest spread is constructed in the following way

\[
\text{Real Spread} = \frac{R_t}{P_{t+1}^e} - \frac{R^f_t}{P^e_{t+1}} \frac{S^e_{t+1}}{S_t}
\]

where \(R_t\) and \(R^f_t\) are average local currency and foreign currency deposit interest rates, \(P_t\) is CPI, \(S_t\) is dollar exchange rate. Superscript \(P^e_{t+1}\) and \(S^e_{t+1}\) denote CPI and exchange rate expectations for 12 months ahead respectively.

A.6 Data Sources

Time series data for dollarization and interest rates come from central bank websites. For the European economies, the source is ECB. Annual data for deposit dollarization is coming from Yeyati (2006)\textsuperscript{27}. World Bank data is used for real GDP, nominal exchange rate and CPI. For the real exchange rate, BIS data is used. If BIS data is not available, World Bank data is used.\textsuperscript{27}

\textsuperscript{27}Kindly provided by the author.
In this part, I included international securities issued in foreign currency obtained from BIS.
A.7.2 Credit and Deposit Dollarization
A.7.3 Deposit Dollarization and Interest Rates
A.7.4 VIX index and Dollarization

[Graphs showing VIX index and Dollarization for Peru, Hungary, Poland, and Turkey over a time period from 2010 to 2017, with some graphs showing decrease in VIX and increase in Dollarization, and others showing an increase in VIX and decrease in Dollarization.]
A.7.5 Ratio of Foreign Currency Deposits to Credit

Figure 31: Ratio of FC Deposit / FC Credit
A.7.6 Ratio of Foreign Currency Deposits to Credit in the Banking System

![Chart](image1)

Figure 32: Average FC Deposit / FC Credit in Emerging Markets in the Banking System
Source: Individual central banks, ECB

A.7.7 Ratio of Foreign Currency Credit from Banks to Total Foreign Currency Credit

![Chart](image2)

Figure 33: FC Bank Credit as a Share of Total FC Credit
Source: Individual central banks, ECB, BIS
A.8 GDP Real Exchange Rate Correlation

Here I show the relationship between GDP-Exchange Rate covariance and dollarization.

![Figure 34: Consumption Exchange Rate Correlation vs Dollarization](image)

A.9 Original Sin and Deposit Dollarization

According to the Original Sin hypothesis, emerging economies are unable to borrow in their currencies for reasons outside their control. Then, currencies of emerging economies are not used in cross border financial transactions. This restricts the demand for local currencies and puts a limit to arbitrage. When households in emerging economies invest in foreign currency, local interest rates increase since there is limited demand for the local currency. Factors like high inflation, political instability etc were offered as reasons behind foreigners’ aversion to emerging economy assets but the most significant determinant of original sin is found to be the size of the economy Hausmann & Panizza (2003).
Figure 35: Real GDP Exchange Rate Correlation vs Dollarization

Figure 36: Dollarization vs GDP Real Exchange Rate Correlation
I construct original sin index. The index is defined as the ratio of foreign currency denominated securities among all the international securities issued by a country. In figure 37, I plot original sin index and average deposit dollarization. Only economies subject to original sin observe a deposit dollarization above 20%. Otherwise, there does not seem to be any meaningful relationship.

Figure 37: Original Sin index and deposit dollarization

A.10 Monetary Policy and Deposit Dollarization

In the model, the link between credit and deposit dollarization is coming from the movement of local currency interest rates. This link is coming from the credit market clearing equations and depends crucially on the fact that deposit interest rates are endogenous. If the interest rates are set by the monetary authority, this link does not

\[ \text{The data is from BIS Debt Securities Statistics for years, 2000-2009} \]
exist. The evidence suggests that deposit interest rates can deviate significantly from policy rates. Acharya & Mora (2015) argue that in the aftermath of financial crisis, US banks increased deposit interest rates significantly to attract deposits. The reason behind chasing deposits is that the banks do not want to finance loans with short term credit. Shin (2009) argues that the reason behind the run on Northern Rock Bank in the UK was its reliance on short term debt. On the other hand, bank deposits (with deposit insurance attached) provides a reliable source of funds to banks. Figure 38 plots the difference between central bank policy rate and average deposit interest rates in Turkey. The spread is correlated with deposit dollarization which indicates that when households switch to foreign currency savings, banks raise deposit interest rates above policy rates to attract local currency deposits.

![Figure 38: Spread between policy rate and average deposit interest rate](image)

Figure 38: Spread between policy rate and average deposit interest rate
## A.11 Average Currency Returns

<table>
<thead>
<tr>
<th>Country</th>
<th>Mean</th>
<th>Sharpe Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>0.80%</td>
<td>25.99%</td>
</tr>
<tr>
<td>Egypt</td>
<td>0.74%</td>
<td>10.75%</td>
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<tr>
<td>Turkey</td>
<td>0.64%</td>
<td>14.81%</td>
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<td>New Zealand</td>
<td>0.35%</td>
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<tr>
<td>Romania</td>
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<td>Peru</td>
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<td>Philippines</td>
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<tr>
<td>Thailand</td>
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</tr>
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</tr>
<tr>
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</tr>
<tr>
<td>Israel</td>
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<td>Japan</td>
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</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
<td>Explanation</td>
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<td>-------</td>
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<td>$\beta$</td>
<td>$(1.03)^{-1/4}$</td>
<td>Discount factor Steady state 3% annual rate</td>
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<tr>
<td>$R$</td>
<td>$1/\beta$</td>
<td>Steady state interest rate</td>
</tr>
<tr>
<td>$\omega$</td>
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<td>Home Bias Import/Consumption</td>
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<td>SS level of local assets Deposit dollarization: 33%</td>
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<td>$\bar{f}$</td>
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<td>SS level of foreign assets Credit dollarization: 41%</td>
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