

Financial Dollarization in Emerging Markets: An Insurance Arrangement*

Husnu C. Dalgic[†]
University of Mannheim

September 2019

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 serves as an insurance arrangement in which firms provide income insurance to households in exchange of low cost of borrowing. Emerging market exchange rates tend to depreciate in recessions so that households prefer holding deposits denominated in dollars, as an insurance against economic downturns. They effectively starve local financial markets of local currency, which raises local interest rates and causes entrepreneurs to borrow in dollars. Consistent with my argument, countries in which the exchange rate depreciates in recessions have higher levels of deposit and credit dollarization and the premium of the local interest rate over the dollar interest rate is higher. This premium is the price paid by households for insurance.

Keywords: emerging markets, financial dollarization, corporate dollar debt

JEL Codes: E44, F32.

*I am indebted to Lawrence Christiano, Martin Eichenbaum, Giorgio Primiceri for their guidance and support. I thank Klaus Adam, Matthias Doepke, Refet Gurkaynak, Ravi Jagannathan, Guido Lorenzoni, Sena Coskun, and Yuta Takahasi for helpful comments. Funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) through CRC TR 224 is gratefully acknowledged.

[†]Department of Economics, University of Mannheim. E-mail:dalgic@uni-mannheim.de

1 Introduction

In many emerging markets, firms borrow large amounts of funds denominated in foreign currency¹ (Figure 1). This phenomenon of “credit dollarization” is typically regarded as a concern for policymakers and regulators, because it creates significant balance sheet risks (Aoki et al. (2016)). 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 (BIS (2014)). 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)) .

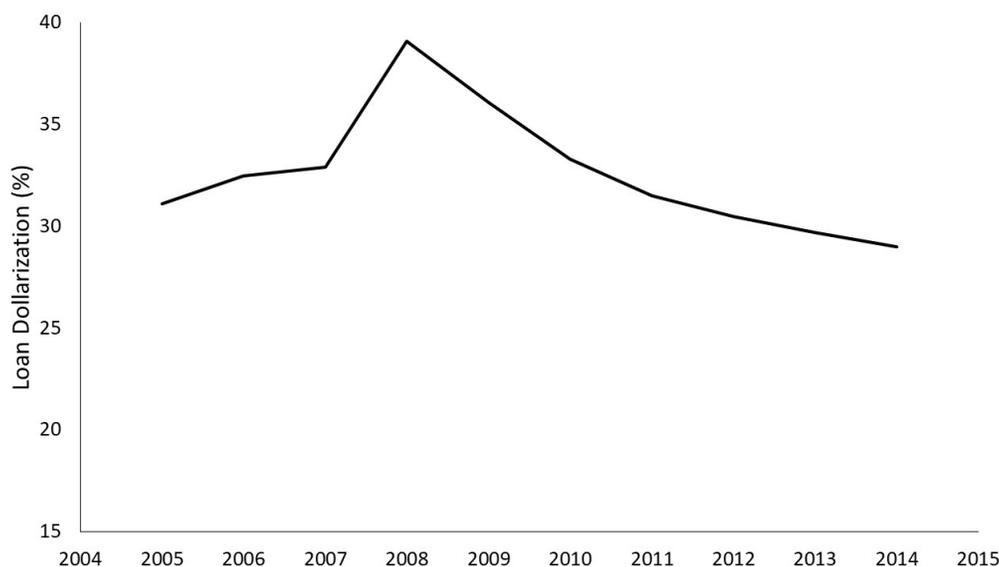


Figure 1: Loan Dollarization in the World

Note: The data source is IMF-Financial Soundness Indicators. The data consists of 83 emerging economies. Loan dollarization is the fraction of loans denominated in foreign currency over total amount of loans. The value in each year represents the average loan dollarization in emerging economies.

¹Throughout the paper, I use dollar to refer to any foreign currency that emerging market residents use in financial intermediation. While disproportionate amount of foreign currency intermediation is in dollars, Euro and Swiss Franc are also used. See Eren & Malamud (2018); Gourinchas et al. (2010) for the dominant role of the US Dollar.

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 (see Table 1). I argue that a large share of credit dollarization in emerging economies stems from an “insurance arrangement” in which households’ willingness to save in foreign currency decreases the supply of local currency, hence rises local interest rates and induces firms to borrow in dollars. In other words, households’ saving in the form of foreign currency provides a hedge against income fluctuations, where firms benefit from low cost of borrowing.

	GDP/FX Correlation	Deposit Dollarization
Countries with (+) corr	0.18	14%
Countries with (-) corr	-0.37	36%

Table 1: GDP/ FX Correlation and Dollarization

Note: Data source is World Bank. The data covers years from 1994 to 2018. GDP/ Exchange rate correlation has been calculated separately for each countries from available (20+ years) time series. Average correlation and average dollarization has been reported for the subsets of countries exhibiting positive and negative correlation. A more detailed version of the data is reported in Figure 5

I formalize the idea of dollarization as an “insurance arrangement” in the context of a small open economy model with financial frictions where local interest rate and exchange rate are endogeneously determined and dollarization endogeneously emerges. Households can save by purchasing either local or foreign assets (deposit dollarization) and entrepreneurs can borrow funds from local or foreign sources (credit dollarization). Households and entrepreneurs make a portfolio choice so that interest spread and dollarization emerge endogenously within the model. As a result of the financial frictions that the entrepreneurs are subject to, the model features the main concern about dollarization, i.e. that the balance sheets of entrepreneurs are adversely affected by exchange rate depreciations 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 endogeneously

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. On the other hand, firms are content to borrow in foreign currency with lower cost.

A disproportionate portion of cross border flows are denominated in US dollars or Euros, which Maggiori et al. (2017) call “currency bias” where international investors are biased towards investing in their own currencies. It has also been documented that emerging market economies have difficulty attracting local currency investment (Eichengreen et al. (2003)). Motivated by these observations, as Aoki et al. (2016), I assume that firms can obtain only dollar denominated funds from international investors. Then, since only households can supply peso funds, household deposit dollarization decreases peso supply in the banking system, which increases local interest rates and pushed firms to borrow in dollars. In the absence of “currency bias”, there will not be a connection between deposit and credit dollarization.

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 (Figure 4, Figure 9). This observation indicates a connection between the level of dollar deposits and dollar credit in the banking system. Higher dollarization is associated with higher interest rate spread both in the cross section and across time (Figure 6, Figure 8). Dollarization is higher in economies where the correlation between consumption and exchange rate movements is negative, which supports the insurance story. I also show that the more negative this correlation is, the more dollarized a country tends to be (Figure 5, Figure 16).



Figure 2: Deposit dollarization in the world

Source: Yeyati (2006), World Bank. The data consists of 108 countries. Deposit dollarization is measured as \$ deposits/ total deposits in the banking system of all countries. Hence, it is similar the weighted average of dollarization.

In my quantitative analysis, I calibrate the model to match the outcomes of emerging economies. Then, I observe the outcomes in these economies under three different counterfactual scenarios. 1- I impose tax on dollar credits. 2- I impose tax on dollar deposits. 3- I allow deep pocket and risk neutral foreign investors to invest freely in local assets. Policies that limit dollarization (scenarios 1 and 2) have overall unfavorable consequences, despite reducing the balance-sheet effects of depreciations. This is because these policies make the economy more vulnerable to income 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. However, this policy reduces household welfare by 0.42% (in consumption units) and leads to 0.53% decline of steady state capital. In fact, since the household loses her insurance against income shocks, the decline in consumption increases 40 percent following a foreign interest rate shock. On the other hand, tax on dollar credits does not take away household insurance through foreign currency saving. However, limits to foreign borrowing decreases investment (5% decline in steady state capital following a tax that eliminates 50% of foreign currency credit). Finally, under the third scenario, I remove frictions on international financial markets, i.e. investors

are not subject to the “currency bias” (or “Original Sin” Eichengreen et al. (2003)). In this economy, households only save in foreign assets and entrepreneurs only borrow from local sources provided by foreign investors. In this benchmark economy, household welfare is 16% higher, long run capital is 24.4% higher. Even though policies to reduce dollarization have unfavorable effects on the household, they improve trade balance in the economy.

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 2 shows the historical movement of dollarization. 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)) and costly to the economy (Yeyati (2006); Gumus & Taspinar (2015)).

The insurance role of dollar savings is not a new observation. Gourinchas et al. (2010) show that the US dollar provides insurance against global financial risks; which increase the demand for dollar denominated assets. According to Gopinath & Stein (2018), the safe asset role of the US dollar is related to its role in trade invoicing. In this paper, I show that countercyclical exchange rate in emerging markets leads households to save in foreign currency denominated assets. These assets provide insurance against local as well as global shocks because the source of the countercyclicity of the exchange rate can come from both. I argue that the demand for foreign currency assets in emerging

markets is an important driver of foreign currency borrowing by firms.

Several papers consider the negative externality that credit dollarization exerts on the economy. An important channel discussed by Eichengreen et al. (2003) is the moral hazard channel. Given the presence of implicit and explicit² 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 exposure. 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 VIX³ index, which affects global credit conditions and local interest rates. Similarly, Bahadir & Lastrapes (2015) show how changes in world interest rates affect interest rates in Emerging Markets. Then conducting monetary policy independent of global financial conditions becomes difficult for small open economies. 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. Even though the literature focuses mainly on corporate debt, there are a few papers focusing on Emerging Market household debt (Bahadir & Gumus (2016)).

Balance sheet effects following a depreciation are not found to be strong (Bleakley & Cowan (2008); Dalgic et al. (2017)). Aguiar (2005) finds that investment declines as a response to exchange rate depreciations firms with high short-term dollar debt, while the effect of long-term dollar debt is not significant. Dollar debt is concentrated in firms with more potential to withstand a depreciation; it is the larger firms (Dalgic et al. (2017)), more productive firms (Varela & Salomao (2018)) and exporters (Alp

²A fixed exchange regime could be thought of as an explicit guarantee where the government promises exchange rate stability.

³Implied volatility by S&P 500 options, proxy for stock market expectation of volatility.

& Yalcin (2015)) which typically borrow in dollars. Bacchetta & Benhima (2015) note that many emerging market firms accumulate liquid dollar denominated assets, in the event of a currency depreciation, these asset might also provide a cushion against the ill effects of the depreciation.

There is recent literature about currency choice in sovereign borrowing, which notes the 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)). At the opposite end, it is documented that many emerging market sovereigns accumulate dollar denominated reserves to smooth out income fluctuations (Bacchetta et al. (2013)). 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. Despite the documented interest rate spread, international investors do not invest much in emerging market currency denominated assets. 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)).

In emerging markets, banks tend 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)).

3 Empirical Facts

In this section, I present certain important facts about dollarization in emerging economies. I obtain annual deposit dollarization data from Yeyati (2006). I gather monthly deposit dollarization, credit dollarization, deposit and credit interest rates from individual

central banks⁴ as well as ECB for EU members⁵. For Chile and Turkey, I use central bank survey of expectation data to construct expected real interest spread. In order to construct average interest rate spread, I obtain daily spot and forward currency rates from Reuters/WMR quotes on Datastream.

Dollarization is significant

In emerging market economies, a significant portion of financial intermediation takes place in foreign currency. As Figure 3 indicates, in many countries, close to 50% of credit to non-financial firms is denominated in foreign currency. And around half of household savings are in a foreign currency.

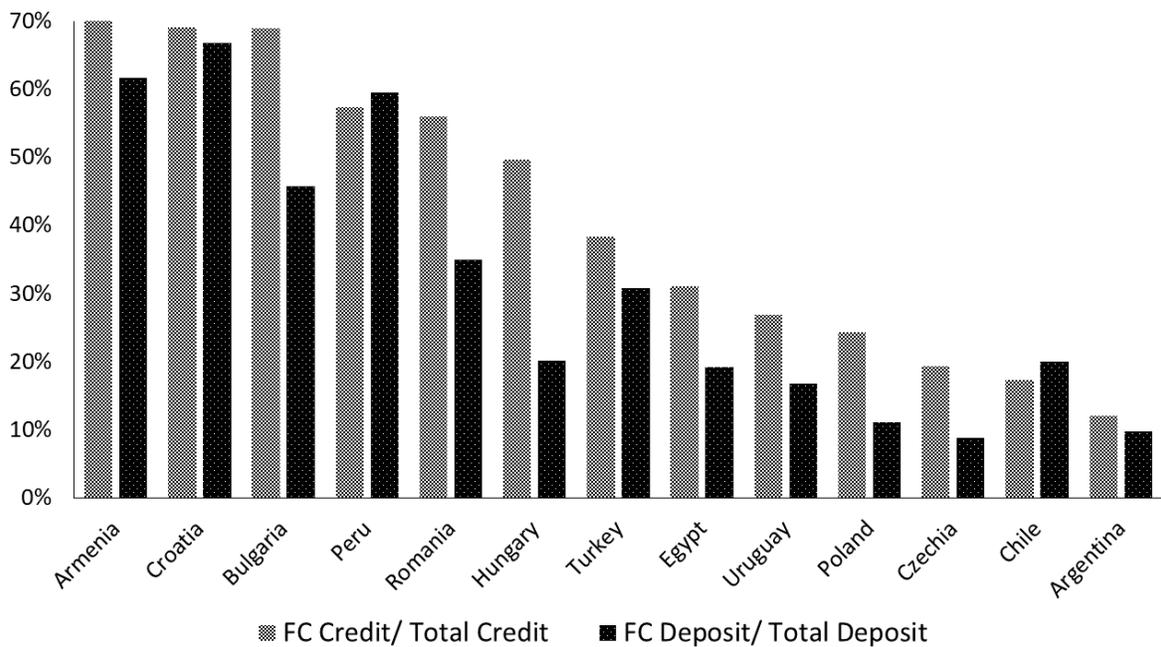


Figure 3: Ratio of FC deposit and credit in the banking system

Source: Individual central banks, European Central Bank (ECB). Reported numbers are the averages of 10 years.

Deposit and credit dollarization are correlated

Credit and deposit dollarization are positively correlated across countries. Figure 4 shows the average dollarization in emerging economies⁶.

⁴Argentine, Armenia, Chile, Egypt, Peru, Turkey, Uruguay

⁵Bulgaria, Croatia, Czechia, Hungary, Romania, Poland. I use the generalized term “dollarization” yet it refers to any major currency. In emerging Europe, it is likely to be Euro or Swiss franc.

⁶Monthly averages, from early 2000s to 2016; data obtained from central bank websites.

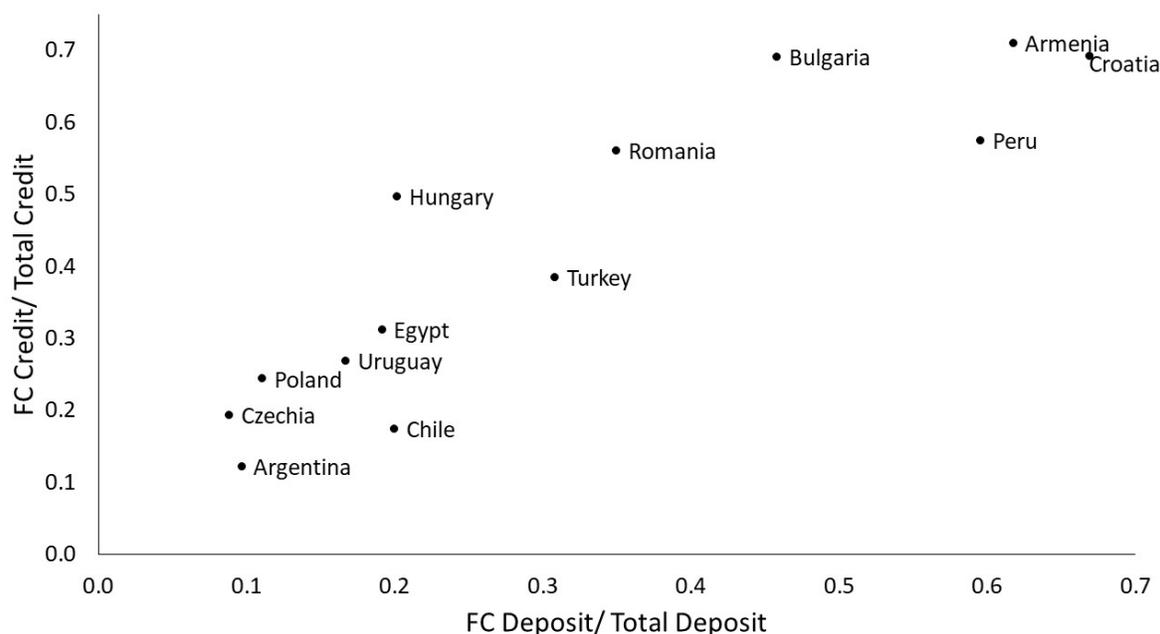


Figure 4: Average credit and deposit dollarization across selected countries
Source: Individual central banks, European Central Bank (ECB). Reported numbers are the averages of 10 years.

Hedging motive exists

I argue that one of the underlying reasons behind deposit dollarization is hedging motive. In order to find out the correlation between GDP and exchange rate in each country, I run the following regression for each country in my dataset,

$$\Delta \log(GDP_t) = \alpha_i + \beta_i \Delta \log\left(\frac{S_t}{P_t}\right) + e_t$$

5 plots average dollarization against each country β . In emerging economies, exchange rate depreciations are associated with lower growth. Figure 5 presents the evidence for this fact, in economies with high dollarization, correlation between real GDP growth and exchange rate⁷ 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 positive⁸.

⁷Here, exchange rate is defined as the nominal dollar exchange rate divided by CPI of that economy. This is how I define the exchange rate in the model

⁸Inflation volatility has been also suggested as a motive for dollarization. In Appendix, I produce the same graph for inflation and real exchange volatility, see Figure 21

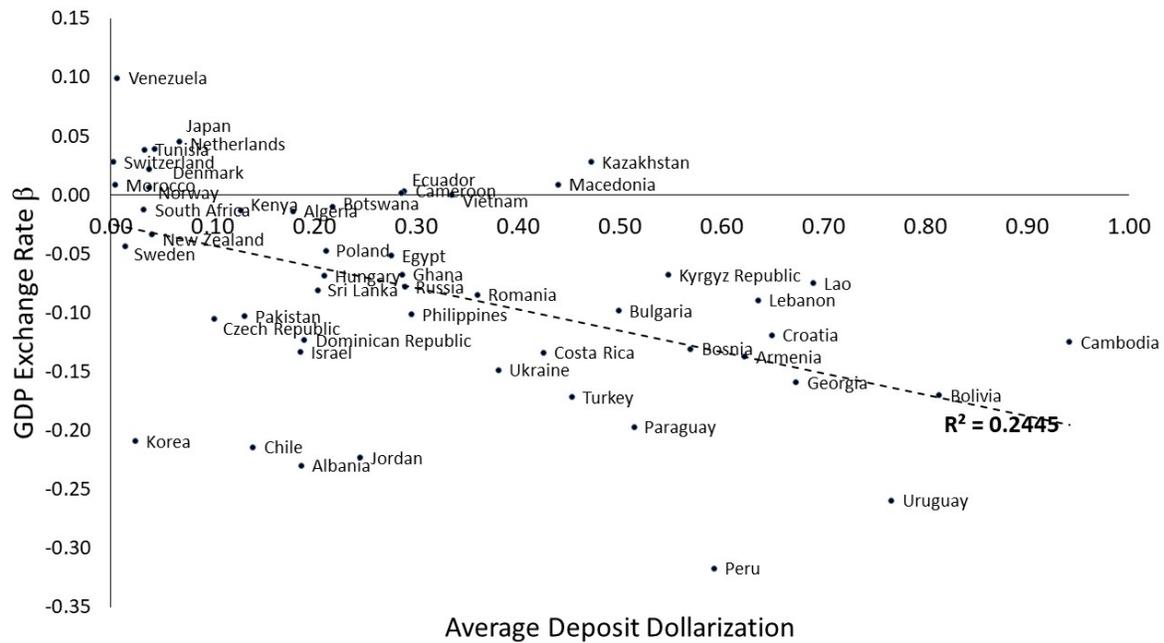


Figure 5: Correlation between change in GDP and exchange rate

Note: Data source is World Bank, Yeyati (2006). The data covers years from 1994 to 2018. GDP/ Exchange rate β has been calculated separately for each countries from available (20+ years) time series.

Interest rate spread is high in dollarized economies

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 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 holds⁹. 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.

⁹Otherwise, 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)).

$$R_t = \frac{F_t}{S_t} R_t^f \quad (1)$$

Return to holding local currency is

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

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

$$x_t^L = \left(\frac{F_t - S_{t+1}}{S_t} \right) R_t^f \quad (2)$$

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 6 plots average dollarization and interest rate spread.

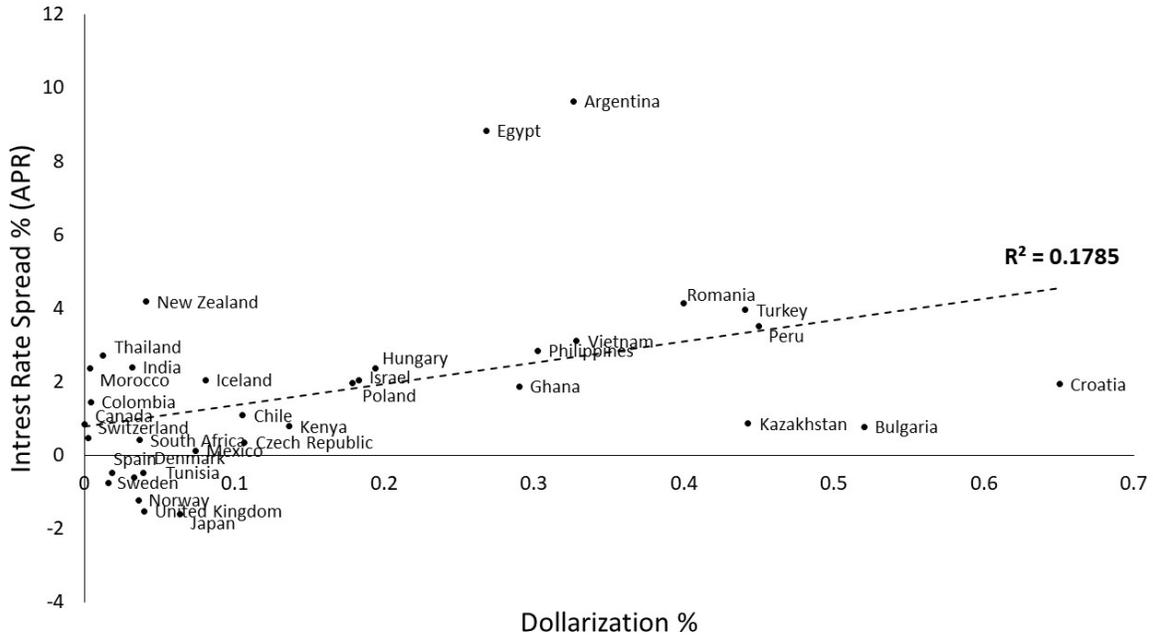


Figure 6: Average Interest Rate Spread and Average Deposit Dollarization

Note: Data source is Yeyati (2006) and Reuters/WMR quotes on Datastream . The data covers years from 2004 to 2017. Average spread is calculated as the mean return from local interest rate minus exchange rate adjusted dollar(euro) interest rate, where local interest rate is calculated using derivative prices.

Average interest rate spread can be due to high risk that these emerging markets carry.

In Figure 7, I plot Sharpe Ratio¹⁰ instead of average return. Highly dollarized economy local asset returns are higher, even after being standardized by standard deviation.

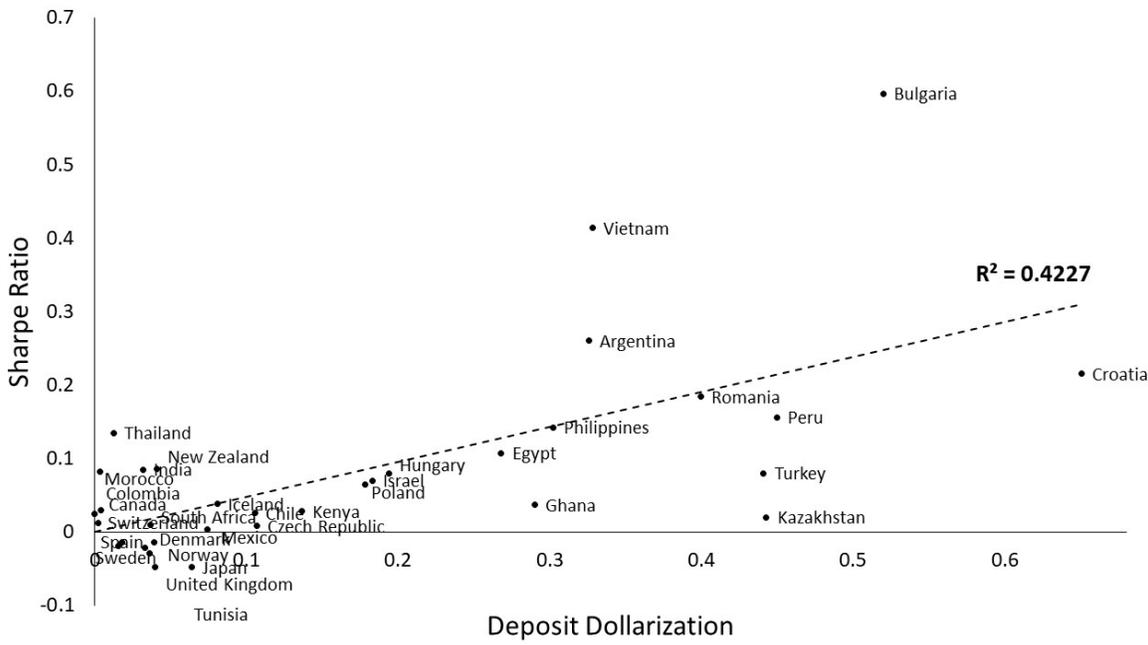


Figure 7: Sharpe Ratio for Interest Rate Spread and Average Dollarization

Note: Data source is Yeyati (2006) and Reuters/WMR quotes on Datastream . The data covers years from 2004 to 2017. Sharpe ratio is calculated as the average spread divided by the standard deviation of the spread. Average spread is calculated as the mean return from local interest rate minus exchange rate adjusted dollar(euro) interest rate, where local interest rate is calculated using derivative prices.

Interest rate spread is high when GDP exchange rate correlation is negative

Interest rate spread is proportional to the covariance between the consumption and exchange rate¹¹. In Figure 16, I plot the average interest rate spread and correlation between exchange rate and consumption. In line with the evidence from Figures 5 and 6, a negative correlation between GDP and exchange rate fluctuations are associated with higher interest rate premium.

Interest rate spread comoves with dollarization

Using central bank survey of expectation data, I calculate the real interest spread between dollar and local currency deposits in Turkey and Chile.

¹⁰Average return divided by standard deviation of returns.

¹¹See equation 27

$$\text{Real Spread} = R_t^l \frac{P_t}{P_{t+1}^e} - R_t^f \frac{P_t}{P_{t+1}^e} \frac{S_{t+1}^e}{S_t}$$

where R_t^l and R_t^f are average local currency and foreign currency deposit interest rates, P_t is CPI, S_t is dollar exchange rate. Superscript P_{t+1}^e and S_{t+1}^e denote CPI and exchange rate expectations for 12 months ahead respectively. 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.

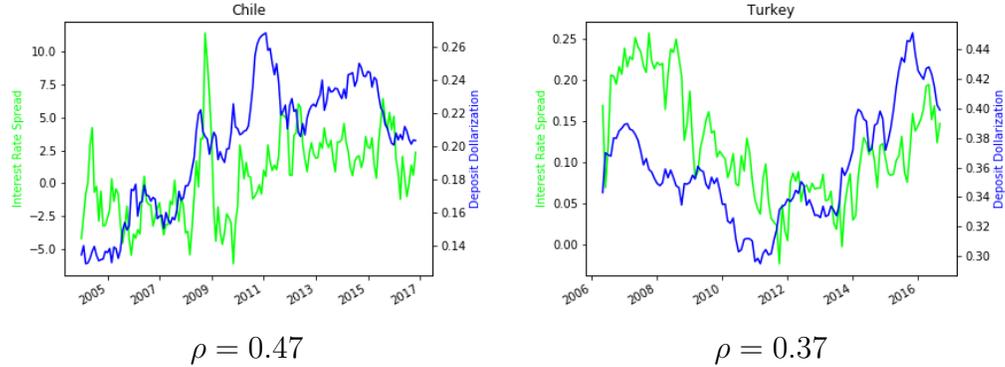


Figure 8: Deposit dollarization and interest rate spread
Source: Individual central banks, Survey of Expectations. Monthly data has been used.

Deposit and credit dollarization comove

Deposit and credit dollarization also correlate in time series. Figure 9 shows the time series movement of credit and deposit dollarization in example economies¹². Deposit and credit dollarization comove over long periods¹³. 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.

¹²In the Appendix, graphs of all countries in the dataset are listed.

¹³In short horizons, exchange rate movements can create a spurious correlation but we observe long periods where deposit and credit dollarizations comove.

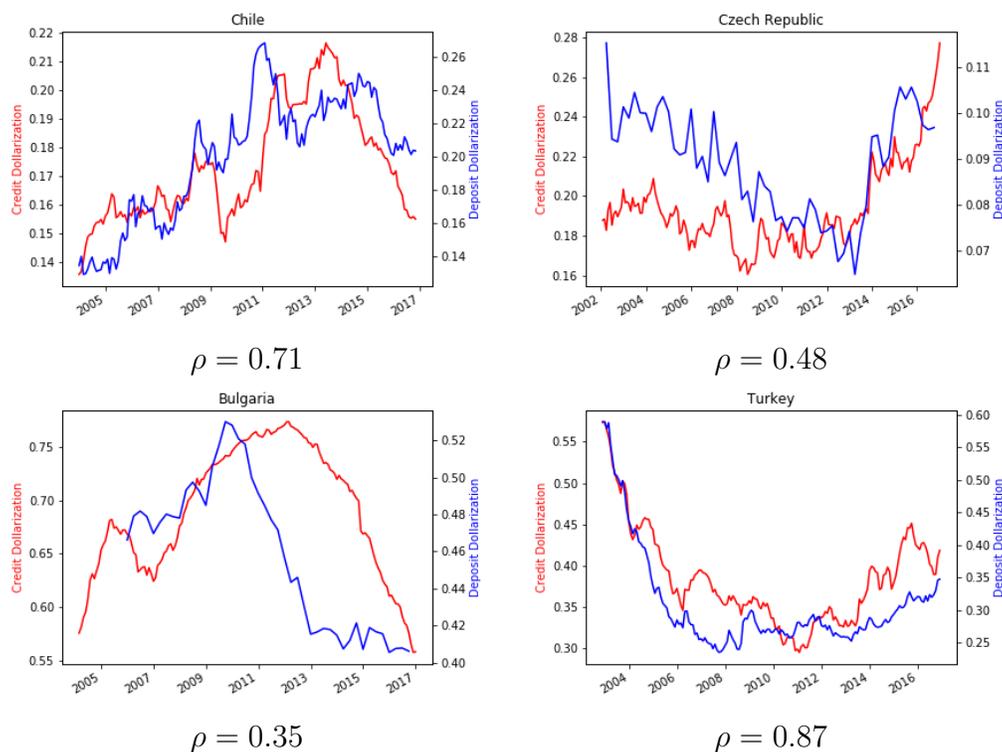


Figure 9: Credit and deposit dollarization in time series
Source: Individual central banks, ECB

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 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 economies¹⁴. I allow entrepreneurs in the model to choose endogenously the currency of borrowing. Foreign currency¹⁵

¹⁴See 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.

¹⁵This 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.

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 ($c_{f,t}$).

$$C_t = \left(\omega^{\frac{1}{\sigma}} c_{h,t}^{\frac{\sigma-1}{\sigma}} + (1-\omega)^{\frac{1}{\sigma}} c_{f,t}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (3)$$

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

$$P_t = \left(\omega p_{h,t}^{1-\sigma} + (1-\omega) S_t^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (4)$$

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_t^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,

$$\sum_{t=0}^{\infty} \beta^t \mathbb{E} \left(\frac{C_t^{1-\gamma}}{1-\gamma} - \frac{\xi}{1+\phi} l_{h,t}^{1+\phi} \right) \quad (5)$$

$$P_t C_t + \underbrace{d_t}_{\text{Home Asset}} + \underbrace{f_t}_{\text{Foreign}} = \underbrace{w_t l_{h,t}}_{\text{Labor}} + \underbrace{d_{t-1}}_{\text{Local Rate}} + \underbrace{f_{t-1} \frac{S_t}{S_{t-1}}}_{\text{ER Foreign Rate}} \underbrace{R_{t-1}^f}_{\text{Foreign Rate}} \quad (6)$$

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

$$\frac{C_t^{-\gamma}}{P_t} = \beta R_t \mathbb{E} \left(\frac{C_{t+1}^{-\gamma}}{P_{t+1}} \right) \quad (7)$$

$$\frac{C_t^{-\gamma}}{P_t} = \beta R_t^f \mathbb{E} \left(\frac{C_{t+1}^{-\gamma}}{P_{t+1}} \frac{S_{t+1}}{S_t} \right) \quad (8)$$

$$\xi l_{h,t}^\phi C_t^\gamma = \frac{w_t}{P_t} \quad (9)$$

4.2 Production Firms

Production firms produce home good according to the production function,

$$y_t = z_t K_t^\alpha L_t^{1-\alpha} \quad (10)$$

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,

$$L_t = l_{h,t}^\Omega l_{e,t}^{1-\Omega} \quad (11)$$

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

$$R_t^k = \mathbb{E} \left(\frac{z_{t+1} \alpha K_{t+1}^{\alpha-1} L_{t+1}^{1-\alpha} + Q_{t+1} (1 - \delta)}{Q_t} \right) \quad (12)$$

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 δ 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

$$K_{t+1} = (1 - \delta) K_t + I_t - \Phi \left(\frac{I_t}{K_t} \right) K_t \quad (13)$$

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

$$c_{xt} = S_t^\varphi x_t \tag{14}$$

where x_t is an exogenous demand, φ 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_t^f . Figure 10 summarizes the trade and production in the model.

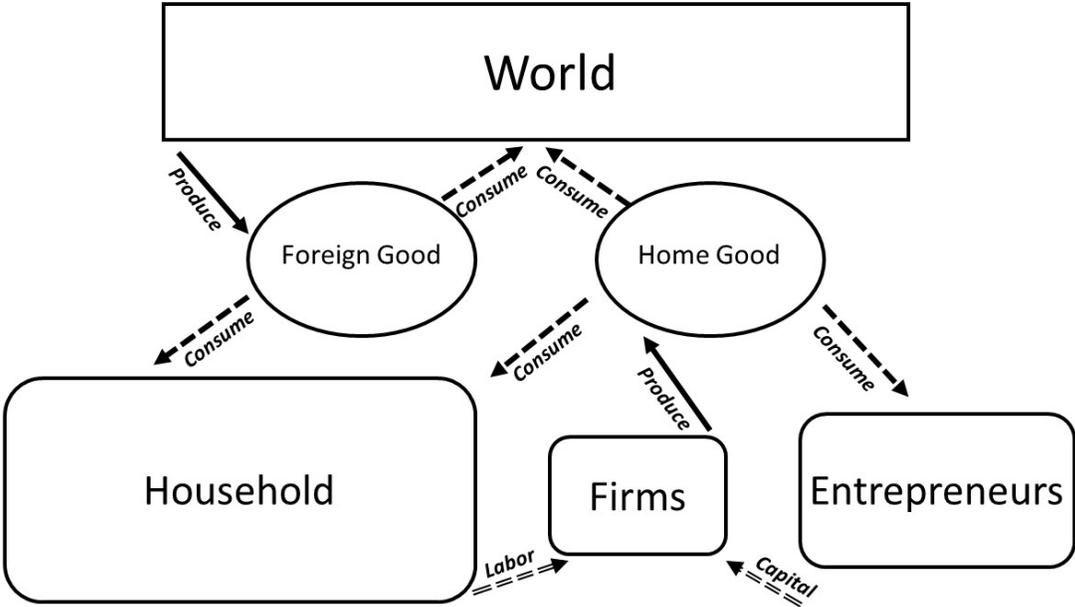


Figure 10: Goods market

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 economy¹⁶ through local interest rates R_t . Foreign banks intermediate in terms of foreign currency and are owned by risk neutral foreign investors¹⁷. They borrow at the exogenous interest rate R_t^f from foreign investors and the local household. Figure 11 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)). In Figure 20, I show plot loan and liability dollarizations in the data, it is apparent that the more banks have dollar liabilities, the higher proportion of dollar loans they extend. For simplicity, I 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.

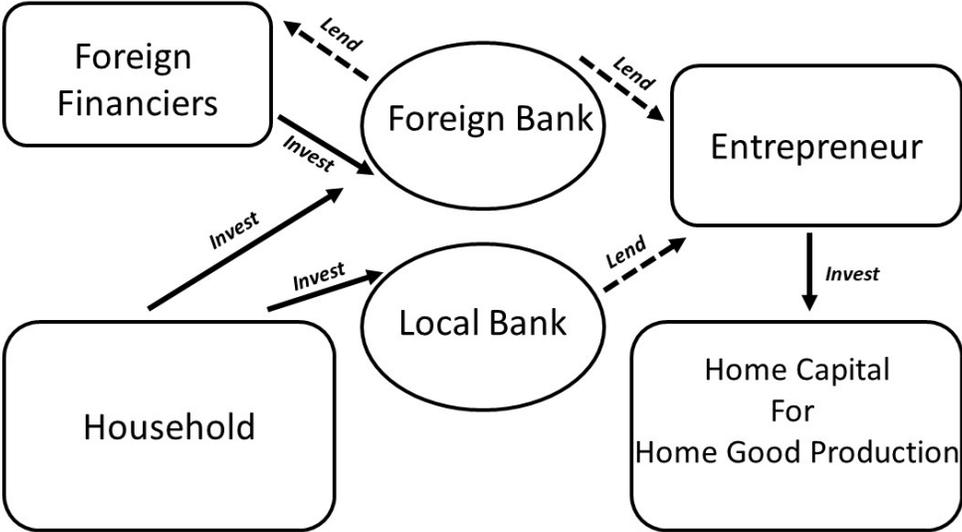


Figure 11: Financial markets in the model

¹⁶This is similar to Feldstein-Horioka puzzle (Feldstein & Horioka (1980)).
¹⁷This assumption is made because lending to entrepreneurs in foreign currency will typically carry aggregate risk.

4.5 Entrepreneurs

In the model, entrepreneurs operate the capital for the Home good production. Following Bernanke et al. (1999), entrepreneurs are modeled as separate households; they are risk neutral, maximize life time income and they are subject to financial frictions. This particular formulation introduces two important pieces to the model. First, financial frictions bring about risk-averse type behavior by entrepreneurs, which is crucial for generating risk premium and interest spread. Second, financial accelerator in the model generate balance sheet effects that are central to the discussions on dollarization (Aoki et al. (2016); Chui et al. (2015)).

Each entrepreneur has net worth N_i , which can be used as collateral to borrow more. Even though all entrepreneurs are ex-ante identical, each entrepreneur operates capital with efficiency ω_i . Given the return to capital R_t^k , an entrepreneur gets a return of $\omega_i R_t^k$. The realization of ω_i depends on the distribution function $\omega_i \sim F(\omega)$ where $\mathbb{E}(\omega_i) = 1$. They are subject to a particular financial friction, Costly State Verification, introduced by Townsend (1979). In particular, banks can observe efficiency ω_i only after paying a monitoring cost μ 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 and the interest rate offered by the foreign bank reflects the exchange rate risk as well. 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_t^f, L_t^l) for foreign and local borrowing, respectively, which become two equilibrium contracts offered by banks ($R_{b,t}^l, L_t^l$) for local and ($R_{b,t}^f, L_t^f$) for foreign borrowing. Given the level of leverage, the interest rate uniquely determines default cutoff for two types of borrowing ($\bar{\omega}_t^l, \bar{\omega}_t^f$), 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,

$$\max_{\theta_t, \bar{\omega}_t^l, \bar{\omega}_t^f} R_t^k N_t \left([1 - \Gamma^l(\bar{\omega}_t^l)] L_t^l (1 - \theta_t) + \theta_t \mathbb{E} \left[1 - \Gamma^f(\bar{\omega}_t^f \frac{S_{t+1}}{S_t}) \right] L_t^f \right) \quad (15)$$

$R_t^k [1 - \Gamma(\cdot)]$ denotes the expected return to the entrepreneur of borrowing and $\Gamma(\cdot)$ is the expected payment to the bank given the default cutoff¹⁸. Since the bank interest rate uniquely determines a default cutoff, entrepreneurs choose,

- $(R_{b,t}^l, L_t^l)$ Interest rate and leverage for local borrowing
- $(R_{b,t}^f, L_t^f)$ Interest rate and leverage for foreign borrowing
- θ_t amount of net worth used as collateral for foreign borrowing

where, $N_t(1 - \theta_t)(L_t^l - 1)$ is the amount raised through local sources and $N_t\theta_t(L_t^f - 1)$ 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

$$\frac{N_t\theta_t(L_t^f - 1)}{N_t\theta_t(L_t^f - 1) + N_t(1 - \theta_t)(L_t^l - 1)} \quad (16)$$

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

$$Q_t K_{t+1} = N_t\theta_t L_t^f + N_t(1 - \theta_t)L_t^l \quad (17)$$

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 θ_t implies¹⁹,

$$[1 - \Gamma(\bar{\omega}_{lt})] L_{lt} = \mathbb{E} \left[1 - \Gamma \left(\bar{\omega}_{ft} \frac{S_{t+1}}{S_t} \right) \right] L_{ft} \quad (18)$$

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.

¹⁸This function is explicitly defined in the Appendix

¹⁹Two other first order constraints are derived in the Appendix

A depreciation will increase the default rates and the payments of the entrepreneurs who borrowed from 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.

$$R_t \mathbb{E} \left[\frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \right] = R_t^f \mathbb{E} \left[\frac{u'(C_t)/P_t}{u'(C_{t+1})/P_{t+1}} \frac{S_{t+1}}{S_t} \right] \quad (19)$$

The deviation in expected interest rates will come from the covariance between expected exchange rate depreciation 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.

$$[1 - \Gamma(\bar{\omega}_{lt})] L_{lt} = \mathbb{E} \left[1 - \Gamma \left(\bar{\omega}_{ft} \frac{S_{t+1}}{S_t} \right) \right] L_{ft} \quad (20)$$

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. Higher risk means that the probability of default goes up and expected monitoring costs rise. Since the banks operate on zero profit condition, expected monitoring costs are reflected to the contract that the entrepreneurs face, which makes the function $(1 - \Gamma(\cdot))L(\cdot)$ concave. Concavity of the objective function makes risk neutral entrepreneurs act as if they are risk averse. 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 conditions²⁰.

- 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

$$d_t = N_t(1 - \theta_t) (L_t^l - 1) \quad (21)$$

- Current account identity implies that trade surplus needs to be equal to the change in net investment position (Current Account - Capital Account = 0),

$$\text{Current Account} : \frac{c_{xt}}{S_t} - c_{ft} \quad (22)$$

$$\text{Capital Account} : \underbrace{\left(\frac{f_t}{S_t} - \frac{f_{t-1}}{S_{t-1}} R_t^f \right)}_{\text{Household net foreign investment}} - \underbrace{\left[\theta_t \frac{N_t}{S_t} (L_t^f - 1) - \theta_{t-1} \frac{N_{t-1}}{S_{t-1}} (L_{t-1}^f - 1) R_{t-1}^f \right]}_{\text{Entrepreneur net foreign borrowing}} - \underbrace{\Pi_t^b}_{\text{Foreign Bank Profit}} \quad (23)$$

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

- Market clearing for home good

$$c_{h,t} + c_{e,t} + c_{x,t} + I_t + M_t + \Pi_t^b S_t = z_t K_t^\alpha L_t^{1-\alpha} \quad (24)$$

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

$$M_t = R_{t-1}^k N_{t-1} \left(\mu G(\bar{\omega}_{l,t-1}) L_{t-1}^l (1 - \theta_{t-1}) + \mu G(\bar{\omega}_{f,t-1}) \frac{S_t}{S_{t-1}} L_{t-1}^f \theta_{t-1} \right) \quad (25)$$

4.8 Shocks in the model

The economy is subject to the following shocks:

²⁰Due to Walras' Law, financial market clearing and current account identity implies market clearing for home good.

- 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. Hassan (2013) and Martin (2013) discuss how this shock could generate interest rate spread between emerging markets and developed economies.
- 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 (σ_{Rt}), 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

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)). ξ 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 ($P = 1$). 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 framework²¹. 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 $(1 - \Omega) = 0.09$. 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)). 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. Table 8 lists all the parameter choices.

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 literature²². 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.

²¹See Bernanke et al. (1999); Gertler et al. (2007); Faia (2007)

²²I 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 12 and 13 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 9 and Figure 8.

Moment	Model	Bulgaria	Chile	Peru	Hungary	Turkey
Std IO	3.25%	3.52%	2.16%	3.76%	3.22%	4.24%
Std RER	4.25%	6.85%	4.15%	4.43%	2.34%	7.09%
Corr(FC Deposit, FC Credit)	0.58	0.35	0.71	0.34	0.46	0.43
Corr(FC Deposit, Spread)	0.71	0.33	0.47	0.27	0.19	0.37

Table 2: Moments from the model

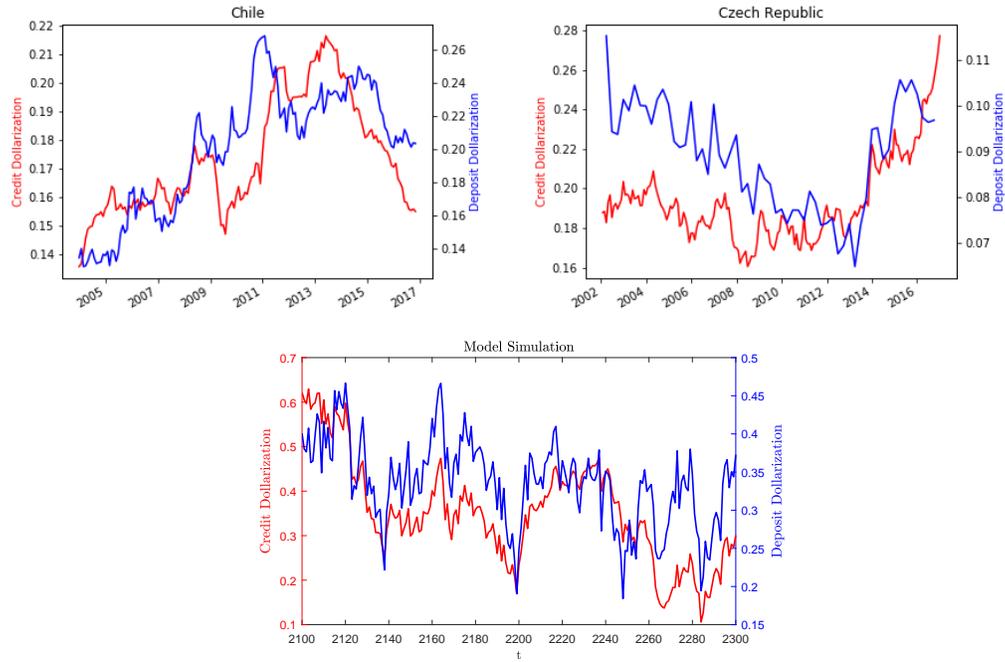


Figure 12: Data vs Model: Credit and deposit dollarization

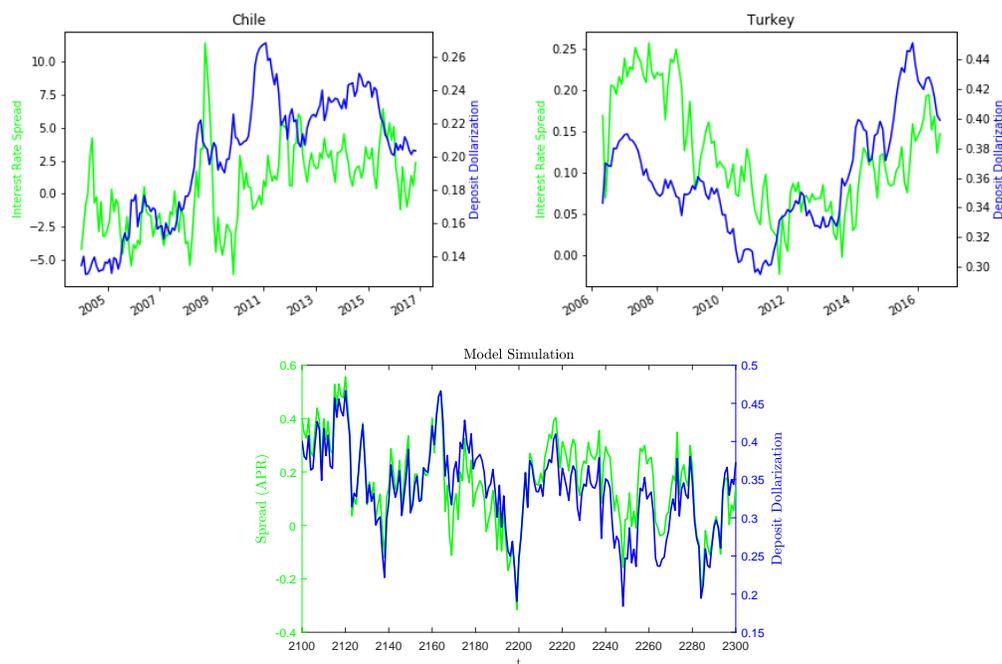


Figure 13: Data vs. Model: Deposit dollarization and expected interest rate spread

6.2 Deposit dollarization is negatively related to 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. Here, I want to move the covariance between consumption and exchange rate to see whether the model responds as predicted. In order to change the covariance between consumption and exchange rate, I change the volatility of the foreign interest rate $\sigma_R \in [0, 0.005]$ ²³. 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

²³The results do not rely on the particular shock that I use, any shock which moves the covariance will yield the same results.

currency savings to hedge. Figure 14 shows the relation between consumption and exchange rate covariance and dollarization. The model is able to capture the main trend in the data.

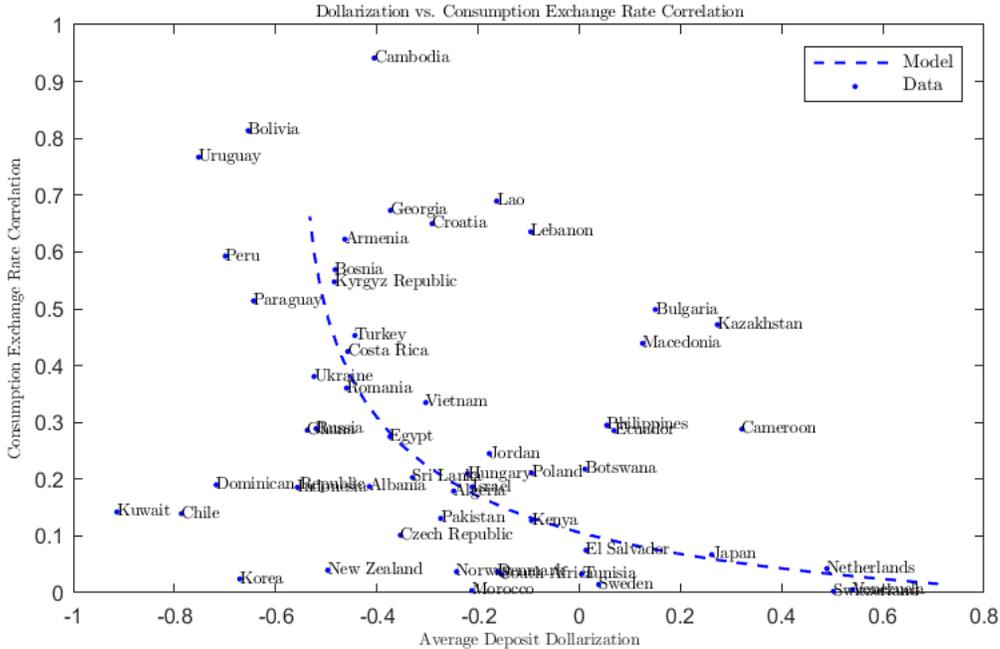


Figure 14: Deposit dollarization and correlation between consumption and exchange rate

6.3 Credit and deposit dollarization are linked

In the model, steady state deposit and credit dollarizations are linked. Figure 15 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.

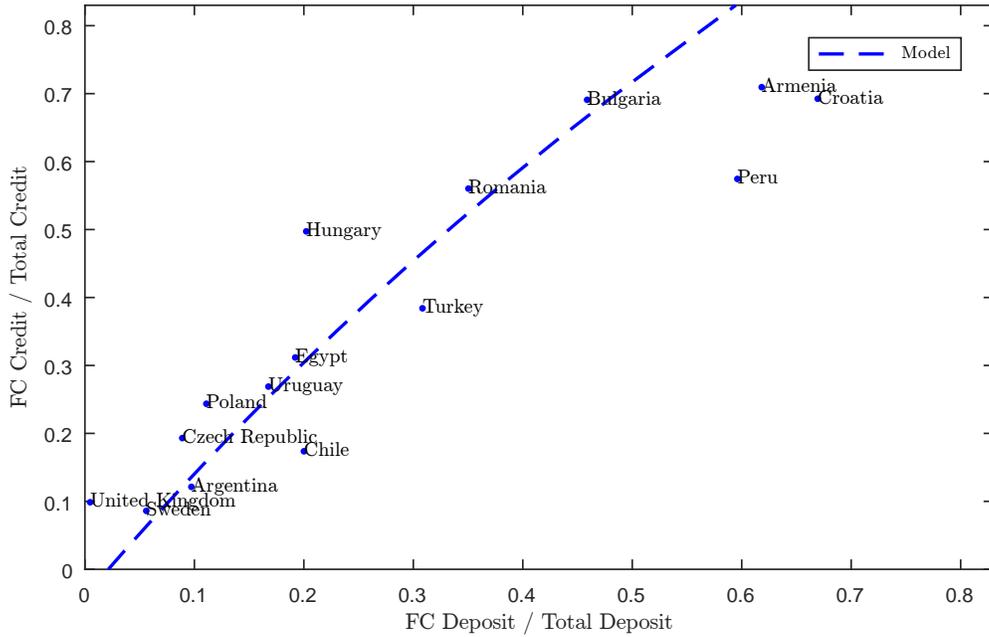


Figure 15: Deposit and credit dollarization in the steady state

6.4 Interest Spread is negatively related to consumption-exchange rate correlation

The model generates endogenous interest spread that is related to the covariance between consumption and exchange rate movements. Figure ?? shows the steady state interest rate spread as a function of consumption-exchange rate correlation generated by the model as well as the counterpart in the data. Even though the spreads are much higher in the data, the model captures the fact that the spread is higher in economies with more negative correlation.

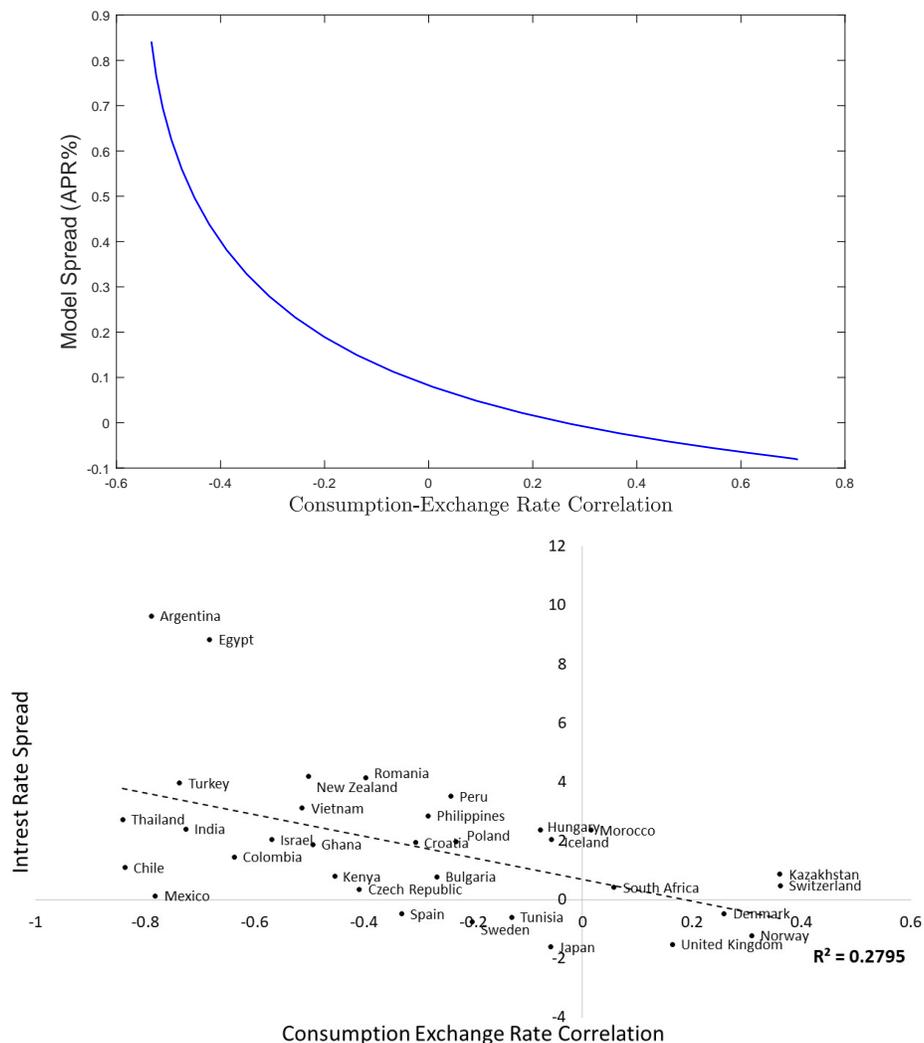


Figure 16: Interest Rate Spread and Consumption ER Correlation

Note: Data source is Yeyati (2006) and Reuters/WMR quotes on Datastream . The data covers years from 2004 to 2017. Average spread is calculated as the mean return from local interest rate minus exchange rate adjusted dollar(euro) interest rate, where local interest rate is calculated using derivative prices.

6.5 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.

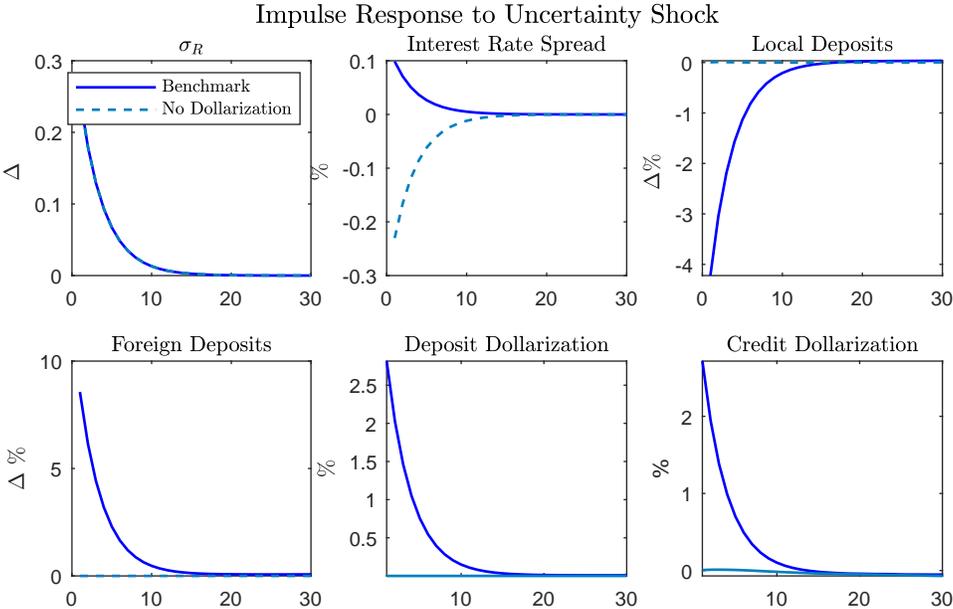


Figure 17: Impulse response to uncertainty shock

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.

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 19 and 20 have a similar purpose. Even in the absence of deposit dollarization, foreign currency credit channel causes a depreciation via equation 20²⁴. 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 26 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.

$$\overbrace{P_t}^{\text{Trade}\uparrow} C_t + d_t + f_t = \overbrace{w_t l_{h,t}}^{\text{Balance Sheet}\downarrow} + d_{t-1} R_{t-1} + f_{t-1} \overbrace{\frac{S_t}{S_{t-1}} R_{t-1}^f}^{\text{Insurance}\uparrow} \quad (26)$$

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 19 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

$$\begin{aligned} R_t \mathbb{E} \left[\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t} \right] &= R_t^f \mathbb{E} \left[\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t} \frac{S_{t+1}}{S_t} \right] \\ &= \mathbb{E} \left[\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t} \right] \mathbb{E} \left[R_t^f \frac{S_{t+1}}{S_t} \right] + \text{cov} \left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}, R_t^f \frac{S_{t+1}}{S_t} \right) \\ \mathbb{E} \left[R_t - R_t^f \frac{S_{t+1}}{S_t} \right] &= \text{cov} \left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}, R_t^f \frac{S_{t+1}}{S_t} \right) / \mathbb{E} \left[\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t} \right] \end{aligned} \quad (27)$$

Expected interest spread is related to the covariance between marginal utility and

²⁴The 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.

exchange rate. An increase in the uncertainty increases the covariance and leads to expected interest rate difference.

8 Policy Experiments

8.1 Preventing Foreign Currency Deposits

I argue that household dollarization acts as a hedge against exchange rate risks but policy makers argue that dollar savings by households create mismatch in the non-financial system which increase credit dollarization and cause “balance sheet effects” in economic downturns. Hence, a plausible policy to prevent credit dollarization might be preventing household to save in dollars, as policy makers think. Here, I evaluate the effects of a tax on dollar savings. Table 3 summarizes the nature of dollarization in three economies. First one is the benchmark economy which is calibrated to match average dollarization in an emerging country. The second economy is the one with imposed tax on dollarization: “policy economy”. The third economy is the one in which risk neutral international investors can invest in local assets directly. In this ‘International Investors’ economy, uncovered interest rate parity holds ($R_t = R_t^f \mathbb{E} \left(\frac{S_{t+1}}{S_t} \right)$).

	Benchmark	Tax on Dollar Deposits	International Investors
Deposit Dollarization	33.6%	7.68%	100%
Credit Dollarization	43.7%	17.2%	0%

Table 3: Dollarization in three economies

Note: First column represents average dollarization in an emerging economy, the second column is the outcome after introducing tax on dollarization and the third column is the hypothetical economy where international investors can freely invest in local assets. I impose a quadratic tax that targets 0 non-stochastic steady state dollarization. Precise tax is $10^{-3} f^2$.

As a comparison, tax on dollar deposits in the benchmark economy significantly reduce both credit and deposit dollarization (Table 3). The steady state outcomes of the economy with imposed taxes on dollarization can be seen in Table 7. In equilibrium, in response to taxes on dollarization, local interest rates increase to induce households to save more pesos. Higher interest rates lead to a decline in investment, capital and production and wages. Lower wages lead to lower income for both entrepreneurs and households. The welfare loss is 0.42% in the economy after the implementation of the policy. (In Appendix Figure 25, I show the response of the economy in the short run.)

	Tax on Dollar Deposits	International Investors
Δ Welfare (In C-units)	-0.42%	16%
$\% \Delta \text{cov}(\Delta C, \Delta S) $	58.62%	-61.3%
Δ Capital	-0.53%	24.4%
Δ Total Saving	5.32%	-11.02%
Δ Entrepreneur Net Worth	-1.81%	10.6%

Table 4: Change in Welfare and other quantities compared to the benchmark economy

Note: The comparison is made with respect to the benchmark economy as reported in Table 3. The tax rate imposed is a quadratic tax that targets 0 non-stochastic steady state dollarization. Precise tax is $10^{-3}f^2$. To generate

International Investors economy, I impose $R_t^L = R_t^F \mathbb{E} \left(\frac{S_{t+1}}{S_t} \right)$

Another outcome of introducing tax on dollar deposits is that trade balance improves from 0.26% to 0.74% (Table 5). Since the households lose their hedge, they save more to compensate. Increased savings and decreased consumption means that the economy imports less and increases trade surplus.

	Trade Balance (% of C)
Baseline	0.26%
Tax on Dollar Deposits	0.74%
International Investors	-14.46%

Table 5: Trade Balance in three economies

Mechanism: Response to Tax on Dollarization

The channel through which preventing dollarization causes welfare loss stems from the adjustment in the local interest rate. Here, I show how local interest rates rise in response to tax on dollarization. In response to tax on dollarization, households convert dollar savings into pesos which is channeled to the entrepreneurs. Households are worse off after the tax because they lose access to the asset that provides income insurance. To compensate, households save more in pesos due to precautionary saving motive. However, the precautionary motive is dampened by the fact that the peso bond is now riskier. Euler equation in Eq 28 shows that as households lose access to dollars, covariance between consumption and price level (due to exchange rate) becomes more negative, which means that households demand higher yield to carry the exchange rate risk.

$$\beta^{-1}R_t^{-1} = \underbrace{\mathbb{E}\left(\frac{u'(C_{t+1})}{u'(C_t)}\right)}_{\text{Precautionary Motive}} \mathbb{E}\left(\frac{P_t}{P_{t+1}}\right) + \underbrace{\text{cov}\left[\frac{u'(C_{t+1})}{u'(C_t)}, \frac{P_t}{P_{t+1}}\right]}_{\text{Price level risk}} \quad (28)$$

An additional force which raises interest rates is that firms increase their demand for peso loans as households lose access to dollar accounts. Households get insurance from dollarization by selling dollars as a response to external shocks, which stabilizes the exchange rate and helps entrepreneurs borrow in dollars cheaper. Figure 18 shows that higher household dollars as a share of firm dollar credit is associated with lower exchange rate volatility.

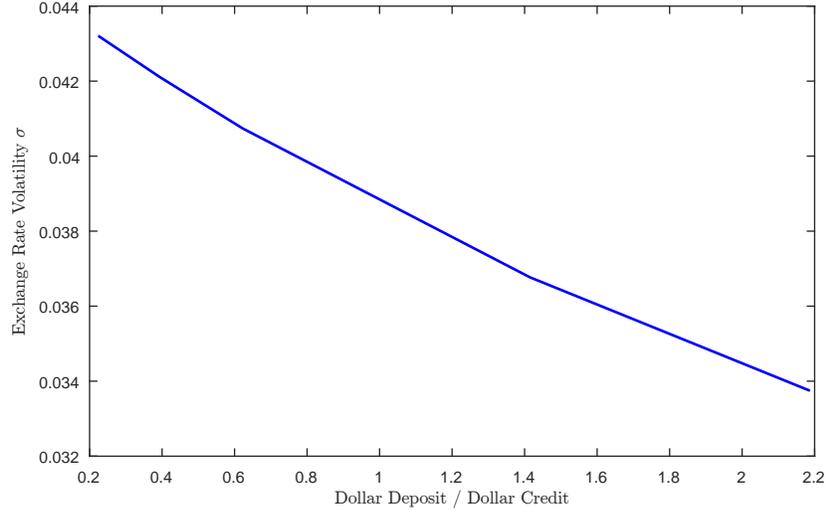


Figure 18: Exchange rate volatility and household dollarization

8.2 Preventing Foreign Currency Credit

As policy makers are worried about high credit dollarization, a standard response might be a tax on foreign currency borrowing. Table 6 reports average dollarization in the benchmark economy and in the economy after imposing tax on credit dollarization. We see that policy makers wish is realizes; i.e. credit dollarization drops. Although, the consumption increases after the tax, entrepreneurs net worth as well as the capital in the long run decreases significantly. In Table 7, I report the changes in outcomes and we see that the drop in capital is 5%.

	Benchmark	Tax on Dollar Credits
Deposit Dollarization	33.6%	25.25%
Credit Dollarization	43.7%	20%

Table 6: Dollarization in three economies

Note: First column represents average dollarization in an emerging economy, the second column is the outcome after introducing tax on credit dollarization. I implement a quadratic tax to target 50% decline in credit dollarization, tax is remitted back to entrepreneurs.

	Tax on FC credit
Δ Consumption	0.7%
Δ Real Interest Rates	1.4%
Δ Net Worth	-4.5%
Δ Capital	-5%

Table 7: Welfare gains of tax on foreign currency credit

Note: The comparison is made with respect to the benchmark economy as reported in Table 6

The channel through which tax on credit dollarization leads low long run capital is similar to tax on deposit dollarization, i.e. through the effect on local interest rates. 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 which raises interest rates even more in order to push households to save and provide local currency credit to the firms. The end result from the firm side is higher interest rates, lower net worth 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. The result from the household side is higher (“induced”) saving rate which eventually increases consumption in the long run.

9 Balance Sheet Effects after “Depreciation”

Policy makers are worried about “balance sheet effects” following a depreciation because firms profits decline in economic downturns due to the fact that their revenues are in local currency but their debt is in foreign currency. I argue that due to the “insurance

arrangement”, households gain extra income during economic downturns thanks to their foreign currency savings. In this section, I evaluate the effect of a possible “exchange rate shock”. I find that “insurance effect” dominates “balance sheet effects” because some of the shock is absorbed by entrepreneurs’ net worth.

Here, I take two economies and show the effect of an increase in foreign interest rates. One economy is the benchmark economy with “dollarization”, the other economy is an economy with “no dollarization”. Neumeyer & Perri (2005) argue that movements in international interest rates are an important source of volatility in emerging economies. Figure 19 shows the response of two economies to an increase in foreign interest rates. 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 with 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 households can afford to save more to recapitalize the entrepreneurs, which results in higher leverage offered by the banks in the benchmark economy.

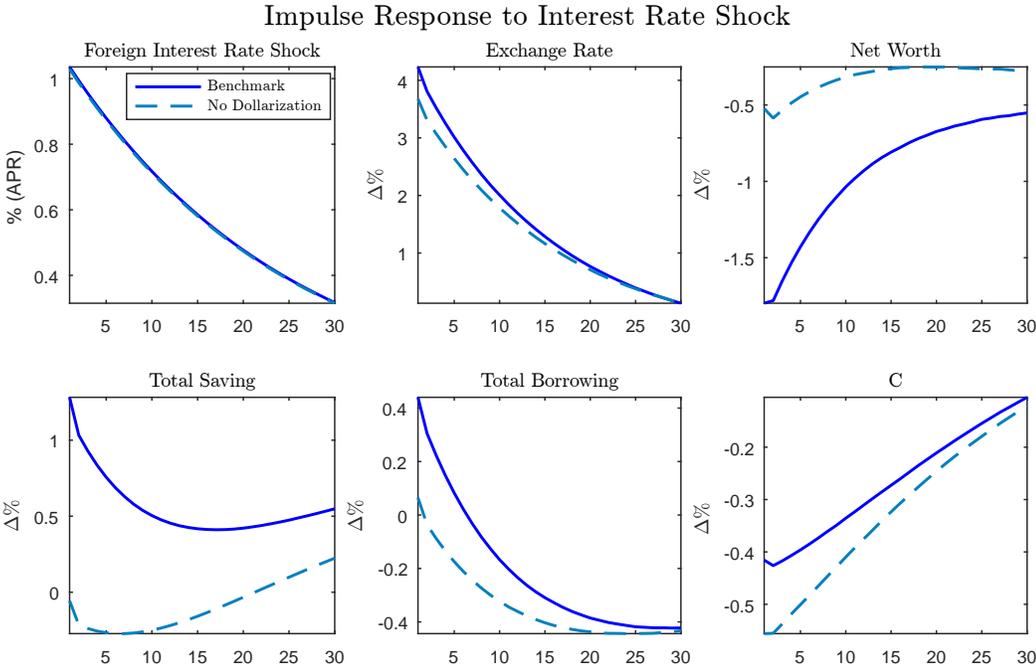


Figure 19: Impulse response to foreign interest rate shock

10 Conclusion

Significant amount of financial intermediation in emerging economies takes place in foreign currency, and this has been considered as a source of fragility in the financial system. Firms' foreign currency borrowing is thought to cause "balance sheet effects" in economic downturns since exchange rate tend to depreciate during downturns in these economies. In this paper, I show that part of foreign currency use can be explained by the "insurance arrangement", through which households save in foreign currency in order to hedge themselves against economic downturns because of the same reason: i.e. exchange rate tend to depreciate in downturns and households' foreign currency saving gain in value exactly when they face a negative income shock. I show that: 1-Part of "high dollarization" in emerging economies can be explained by "insurance arrangement", 2- "Dollarization" might not be as bad as policy makers think because the gain through "insurance arrangement" dominates the loss from "balance sheet effects".

The main empirical facts that we observe globally are as follows: 1- Credit and deposit dollarization are correlated in the cross section and comove across time. 2- Higher dollarization is associated with higher interest rate spread both in the cross section and across time. 3- Dollarization is higher in economies where the correlation between consumption and exchange rate movements is negative.

I formalize the idea of dollarization as an "insurance arrangement" in the context of a small open economy model with financial frictions where local interest rate and exchange rate are endogeneously determined and dollarization endogeneously emerges. The model features the main concern about dollarization, i.e. that the balance sheets of entrepreneurs are adversely affected by exchange rate depreciations due to the mismatch between the denomination of revenues and debt. At the same time, the model also captures the insurance aspect of dollarization, i.e. following an exchange rate depreciation, the value of household savings in foreign assets increases, providing insurance against the adverse effects of this depreciation.

I show that preventing dollarization through either imposing tax on credit or deposit dollarization have counterproductive results. These policies breaks down the "insurance arrangement" and leads to welfare loss and lower capital in the long run. Moreover,

the economy with restricted dollarization becomes more vulnerable to foreign shocks since households hedging mechanism, the “insurance arrangement” is broken down. On the other hand, these policies improve trade balance due to higher saving rates by the households. Policymakers should be aware of the costs of macroprudential reforms to limit dollarization.

References

- Aguiar, M. (2005). Investment, devaluation, and foreign currency exposure: The case of Mexico. *Journal of Development Economics*, 78(1), 95–113.
- Alp, B. & Yalcin, C. (2015). Turkiye’de sirketlerin borc dolarizasyonu ve buyume performansi. *Central Bank of Republic of Turkey Working Paper*.
- Alper, C. E., Ardic, O. P., & Fendoglu, S. (2009). The economics of the uncovered interest parity condition for emerging markets. *Journal of Economic Surveys*, 23(1), 115–138.
- Amador, M., Bianchi, J., Bocola, L., & Perri, F. (2017). *Exchange Rate Policies at the Zero Lower Bound*. Working Paper 23266, National Bureau of Economic Research.
- Aoki, K., Benigno, G., & Kiyotaki, N. (2016). *Monetary and Financial Policies in Emerging Markets*. Working paper.
- Bacchetta, P. & Benhima, K. (2015). The Demand For Liquid Assets, Corporate Saving, And International Capital Flows. *Journal of the European Economic Association*, 13(6), 1101–1135.
- Bacchetta, P., Benhima, K., & Kalantzis, Y. (2013). Capital Controls with International Reserve Accumulation: Can This Be Optimal? *American Economic Journal: Macroeconomics*, 5(3), 229–262.
- Backus, D., Kehoe, P. J., & Kydland, F. E. (1993). *International Business Cycles: Theory and Evidence*. NBER Working Papers 4493, National Bureau of Economic Research, Inc.
- Bahadir, B. & Gumus, I. (2016). Credit decomposition and business cycles in emerging market economies. *Journal of International Economics*, 103(C), 250–262.

- Bahadir, B. & Lastrapes, W. D. (2015). Emerging market economies and the world interest rate. *Journal of International Money and Finance*, 58(C), 1–28.
- Banerjee, A. & Singh, M. (2006). *Testing Real Interest Parity in Emerging Markets*. IMF Working Papers 06/249, International Monetary Fund.
- Bassetto, M. & Galli, C. (2017). *Is Inflation Default? The Role of Information in Debt Crises*. Discussion Papers 1715, Centre for Macroeconomics (CFM).
- Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor & M. Woodford (Eds.), *Handbook of Macroeconomics*, volume 1 of *Handbook of Macroeconomics* chapter 21, (pp. 1341–1393). Elsevier.
- BIS (2014). *84th BIS Annual Report*. Technical report, Bank Of International Settlements.
- Bleakley, H. & Cowan, K. (2008). Corporate dollar debt and depreciations: Much ado about nothing? *The Review of Economics and Statistics*, 90, 612–626.
- Bocola, L. & Lorenzoni, G. (2017). *Financial Crises and Lending of Last Resort in Open Economies*. Staff Report 557, Federal Reserve Bank of Minneapolis.
- Borio, C., McCauley, R. N., McGuire, P., et al. (2017). Fx swaps and forwards: missing global debt? *BIS Quarterly Review*, (pp.37).
- Braggion, F., Christiano, L. J., & Roldos, J. (2009). Optimal monetary policy in a [‘]sudden stop’. *Journal of Monetary Economics*, 56(4), 582–595.
- Brillembourg, A. & Schadler, S. M. (1979). A model of currency substitution in exchange rate determination, 1973-78. *Staff Papers (International Monetary Fund)*, 26(3), 513–542.
- Brown, M., Kirschenmann, K., & Ongena, S. (2014). Bank Funding, Securitization, and Loan Terms: Evidence from Foreign Currency Lending. *Journal of Money, Credit and Banking*, 46(7), 1501–1534.
- Bruno, V. & Shin, H. S. (2015). Capital flows and the risk-taking channel of monetary policy. *Journal of Monetary Economics*, 71(C), 119–132.

- Burnside, C., Eichenbaum, M., & Rebelo, S. (1999). *Hedging and Financial Fragility in Fixed Exchange Rate Regimes*. NBER Working Papers 7143, National Bureau of Economic Research, Inc.
- Burnside, C., Eichenbaum, M. S., & Rebelo, S. (2011). Carry trade and momentum in currency markets. *NBER Working Paper No. 16942*.
- Calvo, G. A. & Reinhart, C. M. (2002). Fear of Floating. *The Quarterly Journal of Economics*, 117(2), 379–408.
- Catao, L. & Terrones, M. (2016). *Financial De-Dollarization; A Global Perspective and the Peruvian Experience*. IMF Working Papers 16/97, International Monetary Fund.
- Christiano, L. J., Gust, C., & Roldos, J. (2004). Monetary policy in a financial crisis. *Journal of Economic Theory*, 119(1), 64–103.
- Christiano, L. J., Trabandt, M., & Walentin, K. (2011). Introducing financial frictions and unemployment into a small open economy model. *Journal of Economic Dynamics and Control*, 35(12), 1999–2041.
- Chui, M., Kuruc, E., & Turner, P. (2015). A new dimension to currency mismatches in the emerging markets: nonfinancial companies. *BIS Working Paper*, 550.
- Dalgic, H. C., Kabas, G., & Luo, V. X. (2017). Emerging market corporate dollar debt. does firm heterogeneity matter?
- Du, W., Pflueger, C. E., & Schreger, J. (2016). *Sovereign debt portfolios, bond risks, and the credibility of monetary policy*. Technical report, National Bureau of Economic Research.
- Eichengreen, B., Hausmann, R., & Panizza, U. (2003). *Currency Mismatches, Debt Intolerance and Original Sin: Why They Are Not the Same and Why it Matters*. NBER Working Papers 10036, National Bureau of Economic Research, Inc.
- Eren, E. & Malamud, S. (2018). *Dominant Currency Debt*. CEPR Discussion Papers 13391, C.E.P.R. Discussion Papers.
- Faia, E. (2007). Finance and international business cycles. *Journal of Monetary Economics*, 54(4), 1018–1034.

- Feldstein, M. & Horioka, C. (1980). Domestic Saving and International Capital Flows. *Economic Journal*, 90(358), 314–329.
- Fernandez-Villaverde, J., Guerron-Quintana, P., Rubio-Ramirez, J. F., & Uribe, M. (2011). Risk Matters: The Real Effects of Volatility Shocks. *American Economic Review*, 101(6), 2530–2561.
- Ferreira, A. L. & Leon-Ledesma, M. A. (2007). Does the real interest parity hypothesis hold? evidence for developed and emerging markets. *Journal of International Money and Finance*, 26, 364–382.
- Gale, D. & Hellwig, M. (1985). Incentive-compatible debt contracts: The one-period problem. *Review of Economic Studies*, 52(4), 647–663.
- Gertler, M., Gilchrist, S., & Natalucci, F. M. (2007). External Constraints on Monetary Policy and the Financial Accelerator. *Journal of Money, Credit and Banking*, 39(2-3), 295–330.
- Giovannini, A. & Turtelboom, B. (1992). *Currency Substitution*. NBER Working Papers 4232, National Bureau of Economic Research, Inc.
- Goldberg, L. S. (2010). Is the international role of the dollar changing? *Current Issues in Economics and Finance*, 16(Jan).
- Gopinath, G. & Stein, J. C. (2018). *Banking, Trade, and the making of a Dominant Currency*. NBER Working Papers 24485, National Bureau of Economic Research, Inc.
- Gourinchas, P.-O., Rey, H., & Govillot, N. (2010). *Exorbitant Privilege and Exorbitant Duty*. IMES Discussion Paper Series 10-E-20, Institute for Monetary and Economic Studies, Bank of Japan.
- Gručić, B. & Wooldridge, P. (2013). Who is issuing international bonds denominated in emerging market currencies? *BIS Quarterly Review*, (pp. 22–3).
- Gumus, I. & Taspinar, Z. T. (2015). Real exchange rate volatility and business cycles in emerging market economies. *Economics Letters*, 134(C), 127–129.
- Hassan, T. A. (2013). Country size, currency unions, and international asset returns. *THE JOURNAL OF FINANCE*, (pp. 2269–2308).

- Hausmann, R. & Panizza, U. (2003). On the determinants of original sin: an empirical investigation. *Journal of International Money and Finance*, 22, 957–990.
- Keller, L. (2017). Capital controls and misallocation in the market for risk : Bank lending channel.
- Maggiore, M. & Farhi, E. (2016). *A Model of the International Monetary System*. Working Paper 395921, Harvard University OpenScholar.
- Maggiore, M., Neiman, B., & Schreger, J. (2017). International currencies and capital allocation.
- Martin, I. (2013). The forward premium puzzle in a two-country world. *Working Paper*.
- Mecagni, Mauro, e. a. (2015). Dollarization in sub-saharan africa: Experiencie and lessons. *International Monetary Fund*.
- Miles, M. A. (1978). Currency substitution, flexible exchange rates, and monetary independence. *American Economic Review*, 68(3), 428–36.
- Neanidis, K. C. & Savva, C. S. (2009). Financial dollarization: Short-run determinants in transition economies. *Journal of Banking & Finance*, 33(10), 1860–1873.
- Neumeier, P. A. & Perri, F. (2005). Business cycles in emerging economies: the role of interest rates. *Journal of Monetary Economics*, 52(2), 345–380.
- Perez, D. & Ottonello, P. (2016). *The Currency Composition of Sovereign Debt*. 2016 Meeting Papers 596, Society for Economic Dynamics.
- Reinhart, C. M. & Kaminsky, G. L. (1999). The Twin Crises: The Causes of Banking and Balance-of-Payments Problems. *American Economic Review*, 89(3), 473–500.
- Rey, H. (2013). Dilemma not trilemma: the global cycle and monetary policy independence. *Proceedings - Economic Policy Symposium - Jackson Hole*, (pp. 1–2).
- Schmitt-Grohe, S. & Uribe, M. (2003). Closing small open economy models. *Journal of International Economics*, 61(1), 163–185.
- Schreger, J. & Du, W. (2014). *Sovereign Risk, Currency Risk, and Corporate Balance Sheets*. Working Paper 209056, Harvard University OpenScholar.

- Sushko, V., Borio, C., McCauley, R. N., & McGuire, P. (2016). *The failure of covered interest parity: FX hedging demand and costly balance sheets*. BIS Working Papers 590, Bank for International Settlements.
- Townsend, R. M. (1979). Optimal contracts and competitive markets with costly state verification. *Journal of Economic Theory*, 21(2), 265–293.
- Varela, L. & Salomao, J. (2018). *Exchange Rate Exposure and Firm Dynamics*. The Warwick Economics Research Paper Series (TWERPS) 1157, University of Warwick, Department of Economics.
- Yeyati, E. L. (2006). Financial dollarization: evaluating the consequences. *Economic Policy*, 21(45), 61–118.

A Appendix

A.1 Figures

A.1.1 Deposit and Loan Dollarization

I replicate Figure 4 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).

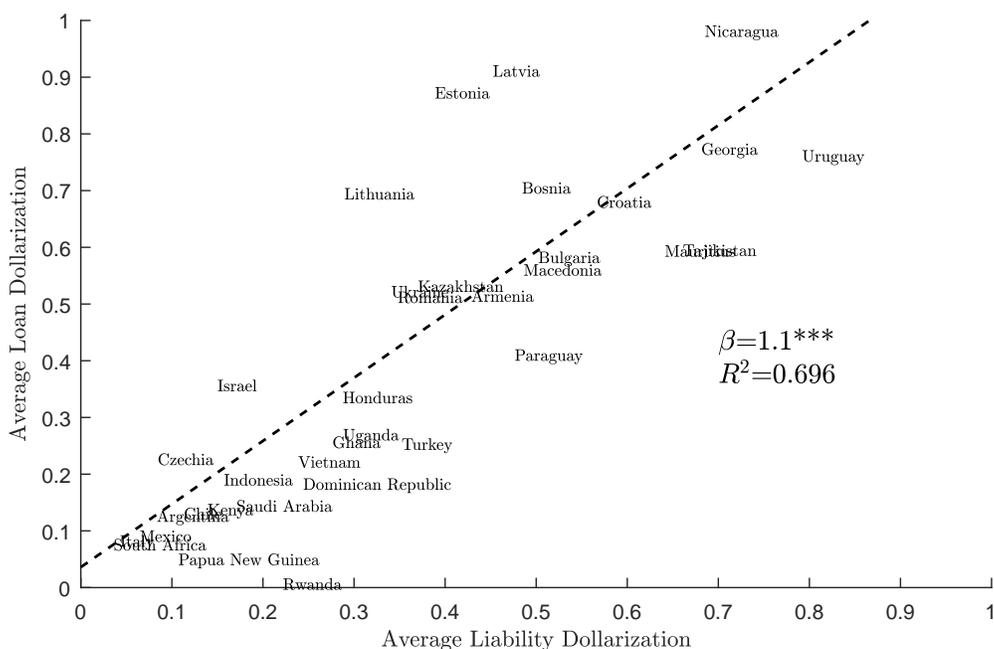


Figure 20: Average Deposit and Loan Dollarization (2004-2008)

A.1.2 Dollarization vs Inflation and Real Exchange Rate (RER) Volatility

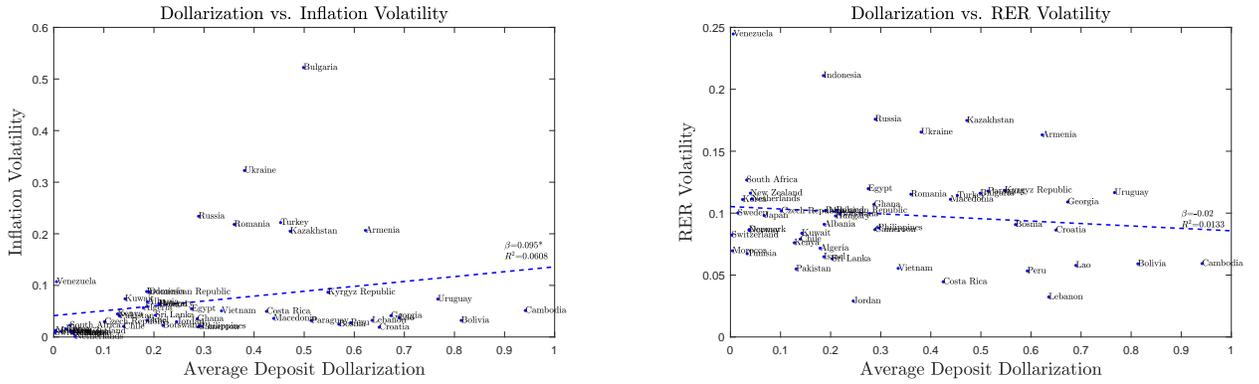


Figure 21: Dollarization vs Inflation and RER Volatility

A.1.3 Deposit Dollarization and Interest Rates

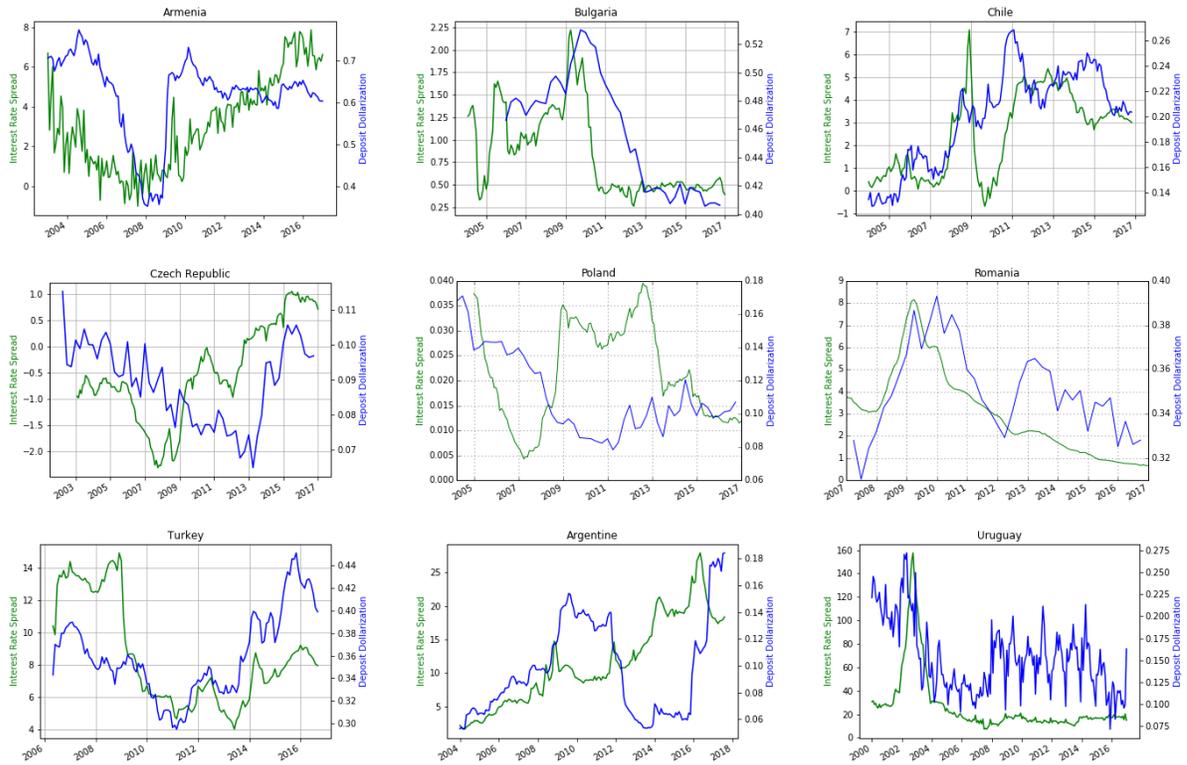


Figure 22: Deposit Dollarization and Interest Rates

A.1.4 Credit and Deposit Dollarization

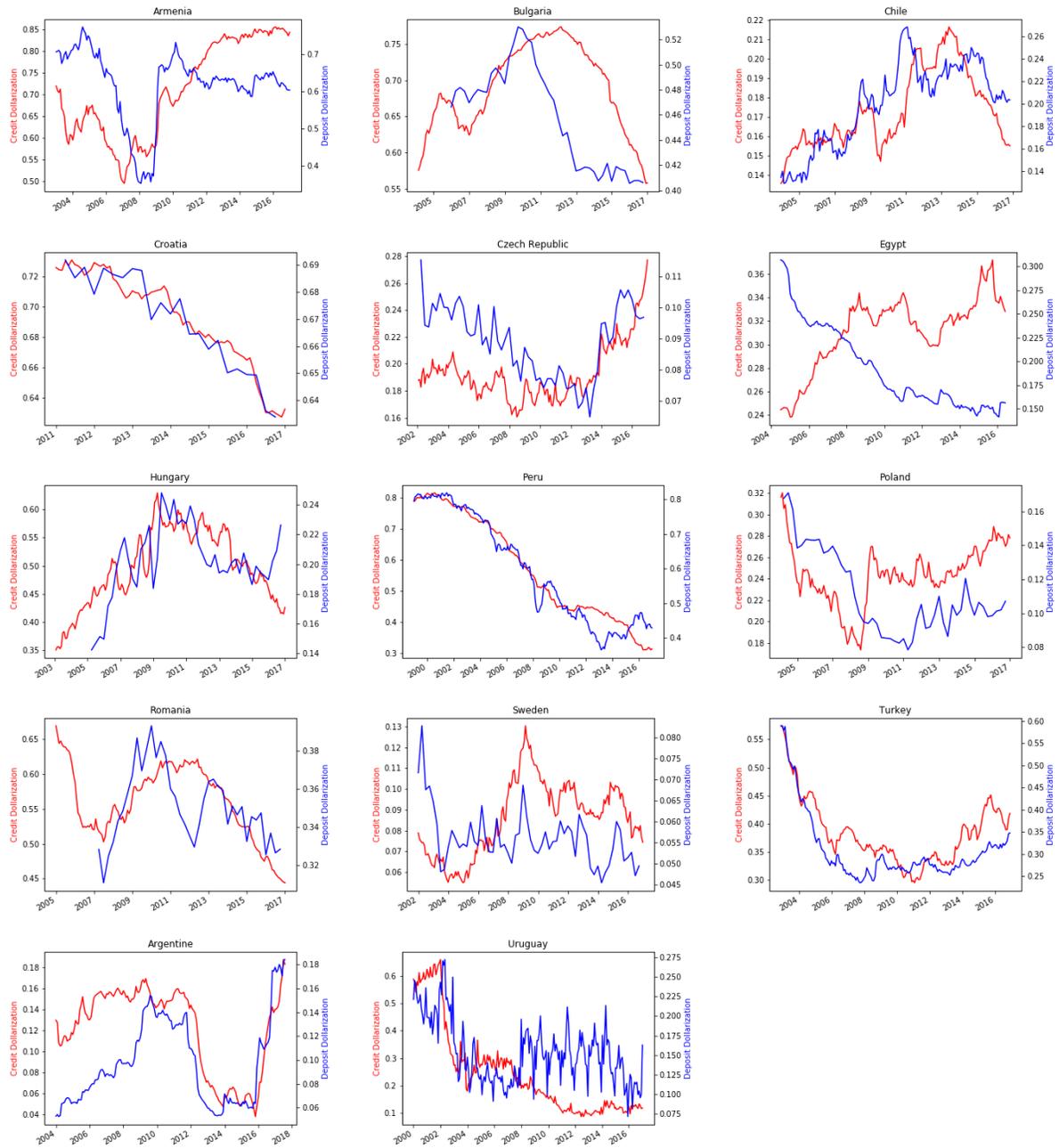


Figure 23: Credit and Deposit Dollarization

A.2 Derivations

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 ω . ω is distributed according to cdf $F(\omega)$.

A.2.1 Entrepreneur Problem

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

$$\begin{aligned} R^k A_t \hat{\omega} &= R_t^b B_t \frac{S_{t+1}}{S_t} \\ \hat{\omega} &= \frac{R_t^b B_t D_{t+1}}{R^k A_t} = \bar{\omega} D_{t+1} \end{aligned}$$

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

$$\begin{aligned} \bar{\omega} &= \frac{R_t^b L_t - 1}{R^k L_t} \\ \mathbb{E} \left[\frac{\int_{\bar{\omega} D}^{\infty} R^k A_t \omega - R_t^b B_t D_{t+1} dF(\omega)}{N_t R_t^f \mathbb{E}(D_{t+1})} \right] \\ \mathbb{E} \left[\frac{\int_{\bar{\omega} D}^{\infty} R^k A_t \omega - R^k A_t \bar{\omega} D_{t+1} dF(\omega)}{N_t R_t^f \mathbb{E}(D_{t+1})} \right] \\ \mathbb{E} \left[\frac{\int_{\bar{\omega} D}^{\infty} (\omega - \bar{\omega} D_{t+1}) R^k A_t dF(\omega)}{N_t R_t^f \mathbb{E}(D_{t+1})} \right] \\ \mathbb{E} \left[\int_{\bar{\omega} D}^{\infty} (\omega - \bar{\omega} D_{t+1}) dF(\omega) \right] \frac{R^k}{R_t^f \mathbb{E}(D_{t+1})} L_t \\ \mathbb{E}([1 - \Gamma(\bar{\omega} D_{t+1})]) \frac{R^k}{R_t^f \mathbb{E}(D_{t+1})} L_t \end{aligned}$$

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

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.

$$\begin{aligned} \mathbb{E} \left[\frac{1}{S_{t+1}} \left((1 - F(\bar{\omega} D_{t+1})) R_t^b B_t D_{t+1} + (1 - \mu) \int_0^{\bar{\omega} D} \omega dF(\omega) R^k A_t \right) \right] \\ = \mathbb{E} \left[\frac{1}{S_{t+1}} R_t^f B_t D_{t+1} \right] \end{aligned}$$

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

$$\mathbb{E} \left[\frac{1}{S_{t+1}} \left((1 - F(\bar{\omega} D_{t+1})) \bar{\omega} D_{t+1} + (1 - \mu) \int_0^{\bar{\omega} D} \omega dF(\omega) \right) \right] = \mathbb{E} \left[\frac{R_t^f B_t}{R^k S_t A_t} \right]$$

$$\frac{\mathbb{E} \left[\frac{S_t}{S_{t+1}} \left((1 - F(\bar{\omega} D_{t+1})) \bar{\omega} D_{t+1} + (1 - \mu) \int_0^{\bar{\omega} D} \omega dF(\omega) \right) \right]}{\frac{R_t^f}{R^k}} = \frac{L_t^f - 1}{L_t^f}$$

$$L_t^f = \frac{1}{1 - \frac{R^k}{R_t^f} \mathbb{E} \left(\frac{1}{D_{t+1}} (\Gamma(\bar{\omega} D_{t+1}) - \mu G(\bar{\omega} D_{t+1})) \right)}$$

A.2.3 Entrepreneur Choice

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

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

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

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,

$$\max_{\theta} R_t^k N_t \left([1 - \Gamma^d(\bar{\omega}^d)] L_t^d (1 - \theta) + \theta \mathbb{E} [1 - \Gamma^f(\bar{\omega}^f D_{t+1})] L_t^f \right)$$

Now, it is apparent that the entrepreneur will choose a corner solution unless in equilibrium both options yield the same revenue. Then the local interest rate will adjust to make sure that happens. In the equilibrium calibration, dollar borrowing will have lower interest rate with lower leverage (higher collateral).

A.2.5 Risk Aversion

Entrepreneurs are by nature risk neutral. However, due to the nature of the financial contract that they face, they care about risk. In particular, the objective function that they maximize, $[1 - \Gamma(\bar{\omega})] L$, is concave. For an individual entrepreneur, higher risk means that she is more likely to default, which means more monitoring costs paid by banks in expectation. Since banks operate on zero profit condition, expected monitoring costs are charged back to the entrepreneur. Then, in order to take on exchange rate risk by borrowing in dollars, entrepreneurs require an interest rate spread. Figure 24 shows the required interest rate spread for dollar borrowing as a function of the volatility of exchange rate. Then, the model can admit risk premium as households are willing invest in dollars at lower interest rates and entrepreneurs accept dollar borrowing only at lower rates.

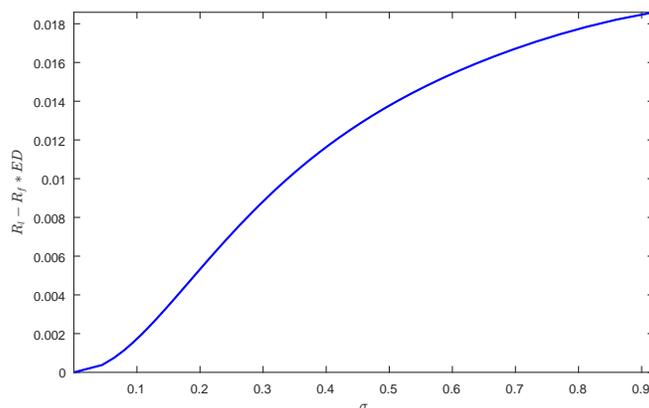


Figure 24: Interest rate spread entrepreneurs require to borrow in dollars as a function of the volatility of exchange rate

A.2.6 International Investors

I relax the 'Original Sin' assumption and allow risk-neutral international investors with deep pockets to invest in local assets directly. The interest spread basically disappears ($R_t = R_t^f \mathbb{E} \frac{S_{t+1}}{S_t}$) since any expected spread will attract more investment until the spread disappears. In 27, I show that interest spread is a function of the covariance between consumption and exchange rate. If the spread is zero, household will invest only in dollars unless the covariance is zero. Since entrepreneurs require interest rate spread to borrow in dollars, they will only borrow in pesos in the absence of a spread. Then, in the version of the model where there are risk neutral, deep-pocket international investors, the economy is characterized by 100% deposit dollarization and no credit dollarization. Households save in dollars to hedge against income fluctuations and entrepreneurs borrow only in pesos. The investors intermediate between them and bear the exchange rate risk.

A.3 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)²⁵. World Bank data is used for real GDP, nominal exchange

²⁵Kindly provided by the author.

rate and CPI. For the real exchange rate, BIS data is used. If BIS data is not available, World Bank data is used.

A.4 Impulse Response to Shocks

A.4.1 Short-run Response of the Economy to a Tax on Dollar Deposits

Figure 25 shows the short-run response of the economy to an unanticipated tax on dollar deposits. Dollarization falls immediately but due to capital adjustment costs, capital and savings adjust slowly.

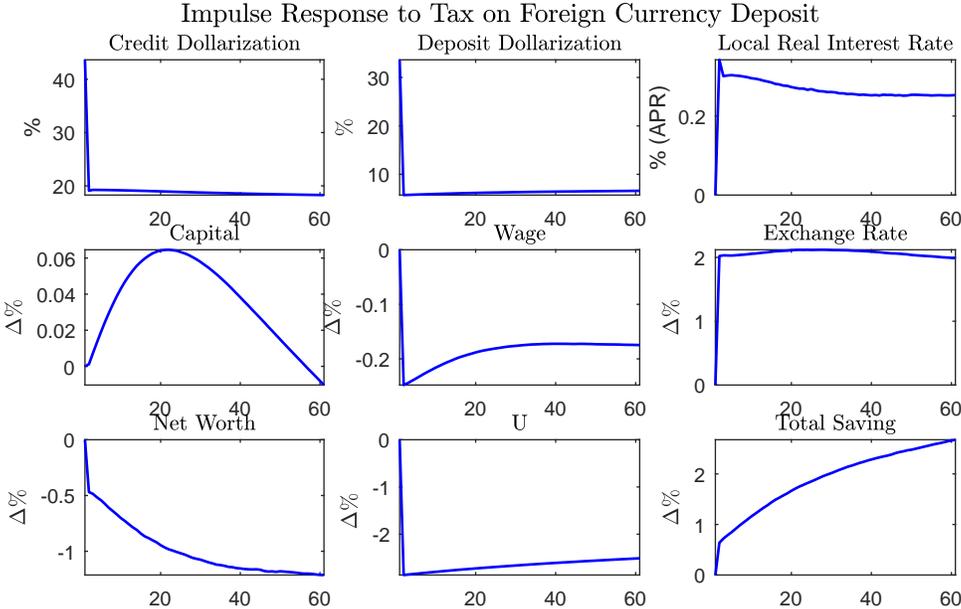


Figure 25: Impulse response to tax on FC deposit

A.4.2 Positive Technology Shock

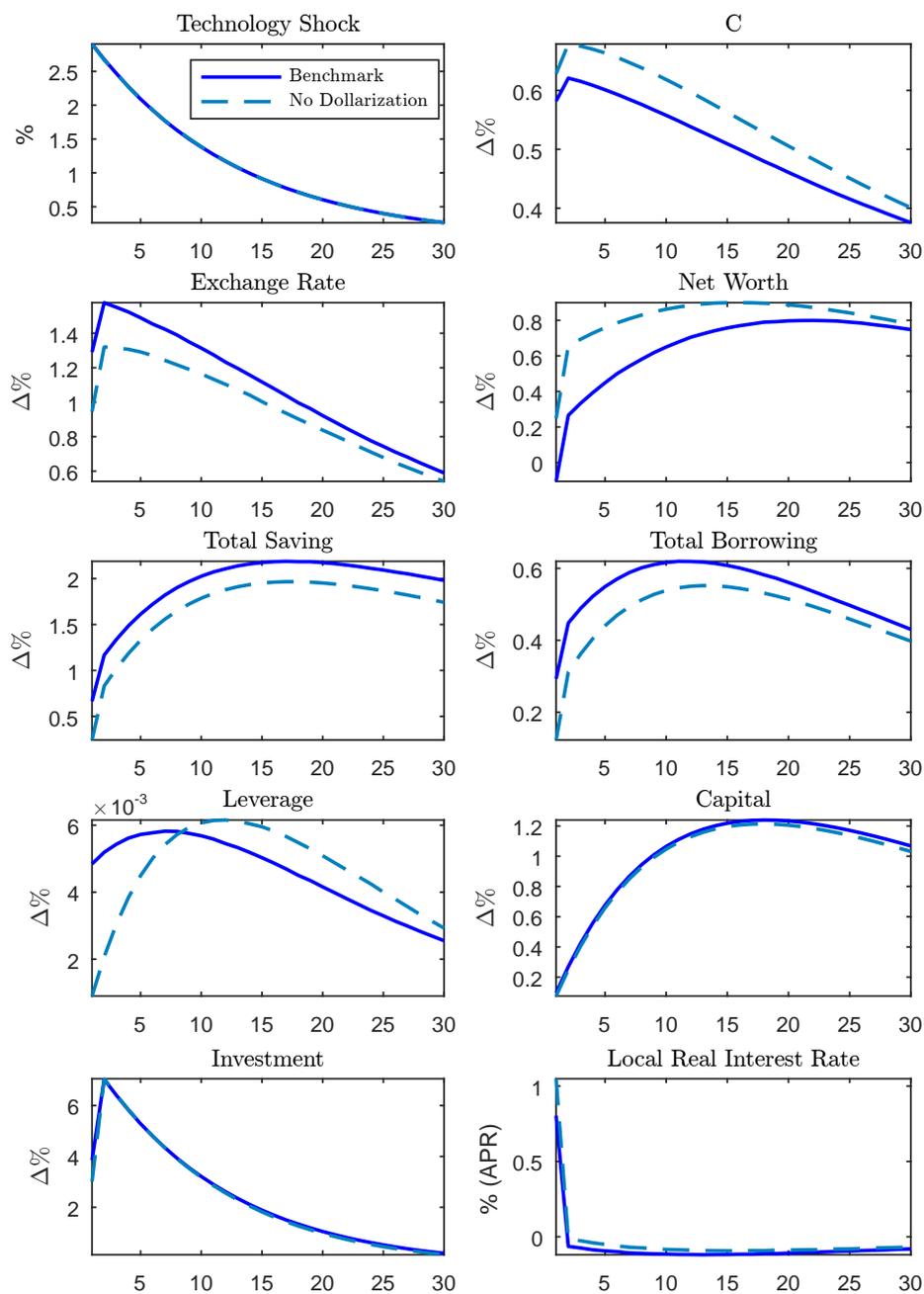


Figure 26: Impulse response to technology shock

A.4.3 Positive Export Shock

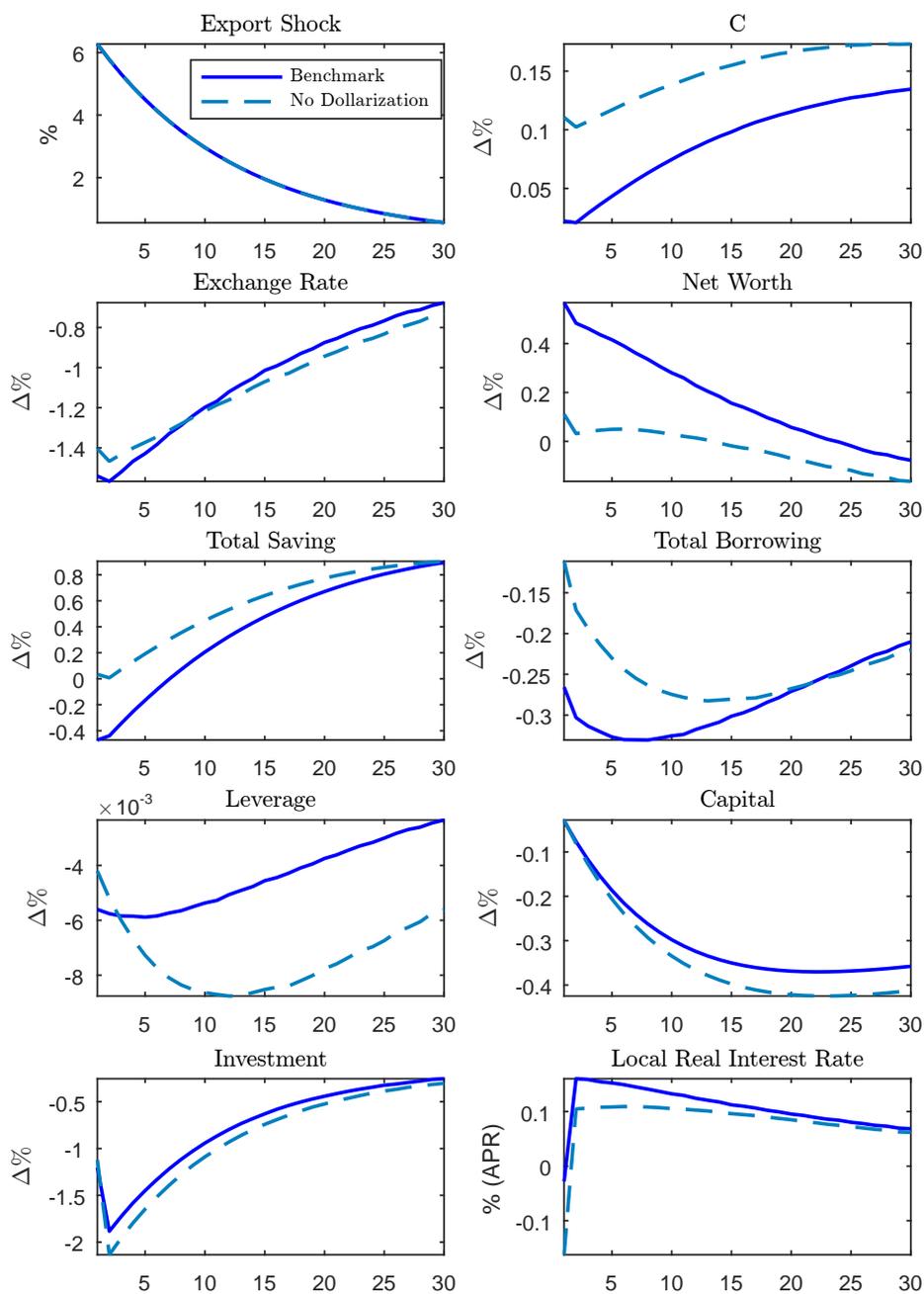


Figure 27: Impulse response to export shock

A.4.4 Uncertainty Shock

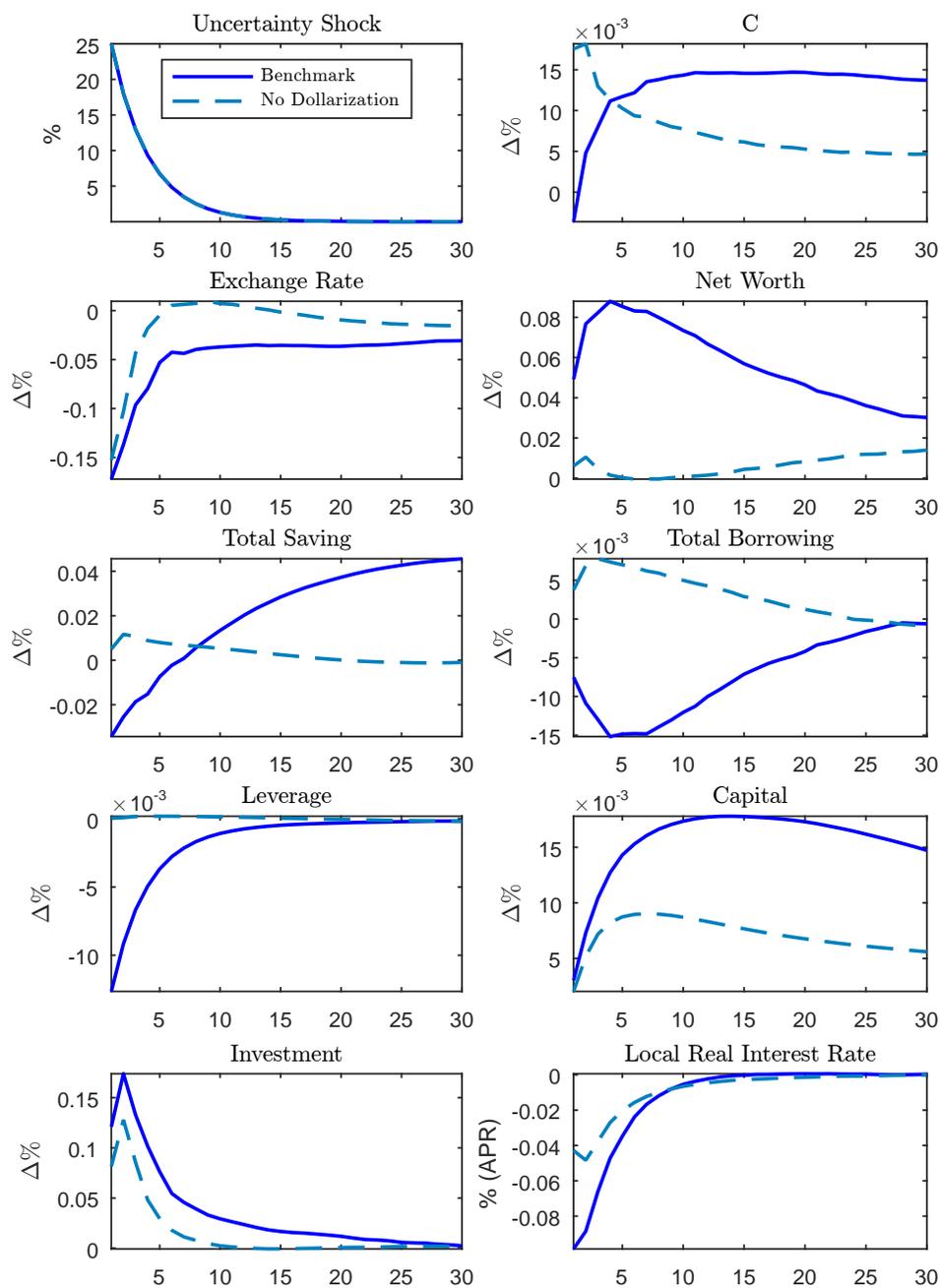


Figure 28: Impulse response to export shock

A.5 Model Parameters

Parameter	Value	Explanation
β	$(1.03)^{-1/4}$	Discount factor
R	$1/\beta$	Steady state interest rate
ω	0.7	Home Bias
σ	1.5	CES elasticity
γ	5	Risk aversion
$\phi - 1$	7.7	Inverse Frisch elasticity
\bar{d}	13.3	SS level of local assets
\bar{f}	4.45	SS level of foreign assets
$L^f = L^l$	2.04	Steady state leverage
α	0.36	Capital Share
φ	1	Elasticity of export demand
σ_e	0.26	Entrepreneur cross section sdev
μ	0.12	Monitoring cost
$F(\cdot)$	Lognormal	Entrepreneur distribution
ρ_R	0.96	Interest rate shock persistence
σ_R	0.0025	Interest rate shock
σ_z	0.08	Technology shock
σ_x	0.04	Export shock
$\sigma_{\sigma R}$	0.25	Interest rate volatility shock
$\rho_{\sigma R}$	0.72	Volatility shock persistence
		Steady state 3% annual rate
		Import/Consumption
		Faia (2007), Backus et al. (1993)
		Neumeyer & Perri (2005)
		Fernandez-Villaverde et al. (2011)
		Christiano et al. (2011)
		Deposit dollarization: 33%
		Credit dollarization: 41%
		Dalgic et al. (2017)
		Gertler et al. (2007); Aoki et al. (2016)
		Faia (2007); Gertler et al. (2007)
		Faia (2007); Gertler et al. (2007)
		Faia (2007); Gertler et al. (2007)
		Christiano et al. (2011)
		Data, Fernandez-Villaverde et al. (2011)
		Fernandez-Villaverde et al. (2011)
		Output Volatility 3%
		RER Volatility 3.8%
		VIX Index
		VIX Index

Table 8: List of parameters