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FINANCIAL DOLLARIZATION IN EMERGING MARKETS: AN INSURANCE ARRANGEMENT*

By Husnu C. Dalgic

University of Mannheim, Germany

Households in emerging markets hold significant amounts of dollar deposits whereas firms have significant amount of dollar debt. Motivated by perceived dangers, policymakers consider regulations to limit dollarization. I draw attention to an important benefit of dollarization: it serves as an insurance arrangement in which firms provide income insurance. Emerging market exchange rates tend to depreciate in recessions so that households prefer holding deposits denominated in dollars. They effectively starve local financial markets of local currency; raising local interest rates over USD rates and causing entrepreneurs to borrow in dollars. This premium is the price paid by households for insurance.

1. INTRODUCTION

In many emerging markets (EMs), companies borrow substantial amounts in foreign currency, often denominated in dollars (see Figure 1).[1] This "credit dollarization" raises concerns for policymakers due to significant balance-sheet risks (Aoki et al., 2016). When the exchange rate depreciates, the interest payments on foreign debt increase, negatively impacting firms' balance sheets. This, in turn, affects investment, production, and, eventually, employment and wages. The prevailing explanation attributes the widespread credit dollarization to political instability and the perceived lack of commitment from central banks in emerging economies, leading to high and volatile domestic interest rates (BIS, 2014). What remains puzzling is the persistence of high credit dollarization levels despite considerable macroeconomic improvements in many emerging markets (Ize and Levy Yeyati, 2003).

In this article, I offer a complementary explanation for the prevalence of credit dollarization. In emerging economies, poor economic performance often coincides with exchange rate depreciations. To hedge against domestic income fluctuations, households invest in savings accounts in foreign currency, which appreciate precisely when domestic economic growth is low (Table 1). I propose that a significant portion of credit dollarization in emerging economies arises from an "insurance arrangement." As households prefer saving in foreign currency, it reduces the supply of local currency, leading to increased local interest rates and prompting firms to borrow in dollars. In this framework, households' foreign currency savings act as a

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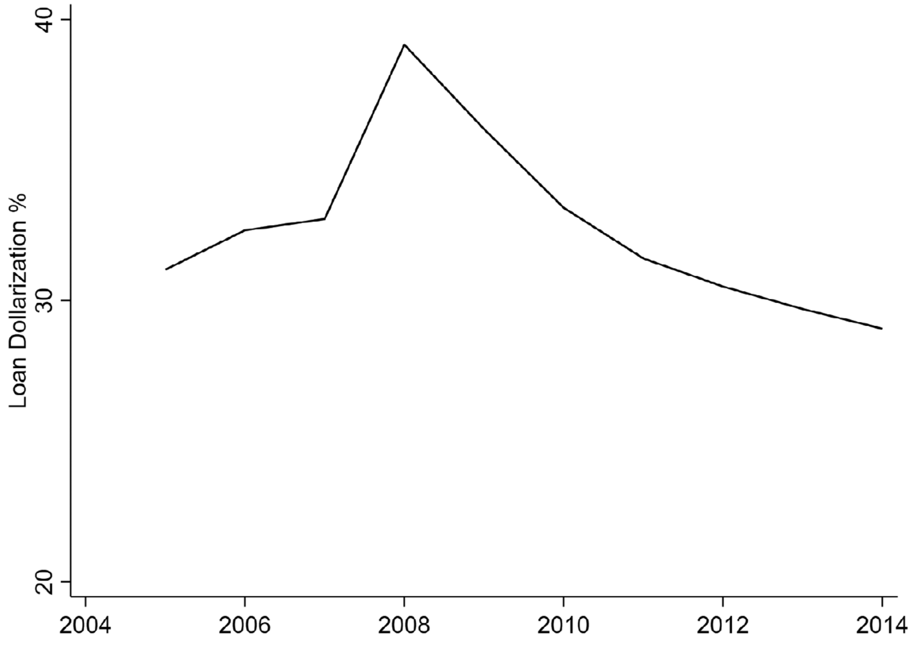
[1] Although the focus here is on the use of the dollar, it is worth noting that euro and Swiss Franc are also in the mix, as highlighted in Eren and Malamud (2022) and Gourinchas et al. (2022).



NOTES: The data source is IMF-Financial Soundness Indicators. The data consist 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. See Appendix Subsection A.8 for details.

FIGURE 1

LOAN DOLLARIZATION IN THE WORLD

TABLE 1
GDP/FX CORRELATION AND DOLLARIZATION

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

NOTE: Data source is World Bank. The data cover 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 have been reported for the subsets of countries exhibiting positive and negative correlation. A more detailed version of the data is reported in Figure 4. See Appendix Subsection A.8 for details.

hedge for income fluctuations, whereas firms benefit from lower borrowing costs. In essence, the origin of dollar credit in the economy lies in the dollar deposits provided by households.

I formalize the concept of dollarization as an "insurance arrangement" within a small open economy model with financial frictions, where local interest rates and exchange rates are endogenously determined, and dollarization endogenously arises. Households can choose to save by purchasing either peso or dollar assets (deposit dollarization), whereas entrepreneurs, who are subject to financial frictions (costly state verification [CSV]à la Gale and Hellwig, 1985 and Bernanke et al., 1999) can borrow in pesos or dollars (credit dollarization). Through portfolio choice, interest rate spread, and dollarization emerge endogenously in the model. The model addresses the primary concern about dollarization; entrepreneurs' balance sheets are negatively impacted by an exchange rate depreciation due to the mismatch between revenues (in pesos) and debt (in dollars). Simultaneously, it captures the insurance aspect of dollarization, the article's focal point. Following an exchange rate depreciation, the value of household savings in dollars rises, acting as insurance against the adverse effects. When households increase investments in dollar assets for hedging benefits, the supply of pesos decreases, leading to an endogenous increase in the spread between local and foreign interest rates.

Despite accepting lower interest rates on dollars, households are satisfied due to the income provided during low consumption periods. Conversely, firms, despite disliking exchange rate risks, are motivated to borrow in dollars because of higher local interest rates. In equilibrium, both firms and households make an interior portfolio choice, resulting in a portion of financial intermediation occurring in dollars. This article's contribution lies in the simultaneous endogenous emergence of deposit and credit dollarization, where dollar debt arises from households' inclination to invest in dollar assets.

My article makes a unique contribution by combining the insurance aspect of dollarization with considerations for financial stability. Unlike previous studies that mainly focus on the benefits of holding dollar assets for insurance purposes (such as Christiano et al., 2021 and Drenik et al., 2022) or the consequences of credit dollarization (such as Aoki et al., 2016 and Akinci and Queralto, 2018), my framework allows for a comprehensive analysis of the trade-off between "insurance" and "financial frictions." Using a small open economy real business cycle model that incorporates financial frictions and balance sheet effects resulting from exchange rate depreciations, my article sheds light on the complex dynamics of dollarization. Moreover, my model takes into account the specific characteristics of dollar credit in emerging market economies, where it is predominantly funded by local deposits through local banking systems. This differs from the assumptions made in previous studies, which overlooked the insurance aspect and assumed that dollar credit was primarily provided by foreigners.[2] By considering the endogenous generation of credit dollarization and its implications for both local residents and overall financial stability, my article offers a more realistic and nuanced understanding of the dynamics of financial dollarization.

This article connects with the notion of Global Financial Cycles (Miranda-Agrippino and Rey, 2020) and the USD's role as the global safe asset (Gopinath and Stein, 2021; Jiang et al., 2021; Gourinchas et al., 2022). Within my framework, the economy faces export demand shocks, foreign interest rate shocks (à la Neumeyer and Perri, 2005), and volatility shocks to these rates (à la Fernandez-Villaverde et al., 2011). The unique contribution lies in demonstrating that households in emerging markets can hedge against these global shocks through dollar-denominated deposits. In an emerging market with a countercyclical exchange rate, households opt for foreign currency assets, providing insurance against both local and global shocks. Consequently, nonfinancial firms in these markets turn to borrowing in dollars due to the limited availability of peso loans.

In my model, I abstract from the possibility for a banking crisis. In emerging markets, banks typically match the currency composition of their assets and liabilities through the loans they extend, minimizing the risk of currency mismatch in the banking sector. Extensive evidence supports the idea that the currency denomination of liabilities significantly shapes the currency composition of loan portfolios in emerging economies (Brown et al., 2014; Christiano et al., 2021). Empirical studies such as Christiano et al. (2021) find no substantial evidence linking domestic dollarization and banking crises in the data. Instead, they identify global uncertainty (Chicago Board of Exchange Volatility Index (VIX)) and external debt as predictors of banking crises. In contrast, Bocola and Lorenzoni (2020) illustrate how currency mismatch in the financial sector can trigger self-fulfilling bank runs and financial crises, viewing dollarization as a sunspot phenomenon leading to inherent financial instability. In my model, households predominantly employ dollar assets as insurance against external shocks, emphasizing the role of dollarization in shielding households from adverse external shocks.

A disproportionate share of cross-border flows is concentrated in USD, termed "currency bias" by Maggiori et al. (2020), indicating a preference among international investors for their own currencies. Emerging market economies face challenges in attracting local currency investment, as noted by Eichengreen et al. (2007). Motivated by these observations, I assume foreign investors are unwilling to provide peso loans to firms. Consequently, with only

[2] See Mimir and Sunel (2019), Cespedes et al. (2017), Aoki et al. (2016), Caballero and Krishnamurthy (2003), and Akinci (2021) among others.

households able to supply peso funds, household deposit dollarization reduces the peso supply in the banking system, raising local interest rates and prompting firms to borrow in dollars. The link between deposit and credit dollarization hinges on the absence of "currency bias." Recent literature highlights that sovereigns can borrow more in local currencies, leaving nonfinancial firms as the primary borrowers of dollars in emerging markets (Perez and Ottonello, 2016, Christiano et al., 2021 and Du and Schreger, 2022).

In the quantitative analysis, I calibrate the model to match Peru, a highly dollarized emerging market. With the calibrated model, I simulate a counterfactual economy in which households are restricted from holding substantial amounts of dollar assets. These policies aimed at reducing dollarization, while mitigating the balance-sheet effects of depreciations, have overall adverse effects on the economy. The primary reason for this is that such policies increase the economy's vulnerability to external shocks by reducing households' risk-sharing mechanisms. When I compare the baseline scenario to the counterfactual economy, where households' dollar holdings are converted into peso deposits, credit dollarization decreases by 60%. This reduction in credit dollarization leads to a 7.34% decline in investment volatility and a 2.76% reduction in exchange rate volatility. However, it also results in a 4.8% increase in consumption volatility and a marginal 0.1% reduction in household welfare (measured in consumption units). However, the result can be overturned if the entrepreneurs are more leveraged and preventing dollarization can actually be welfare improving. In the benchmark, leverage is calibrated to match the Peruvian data, 1.75. With a leverage of 2.4, I find that household welfare increases if dollarization is limited.

Welfare analysis does not encompass all potential impacts, as the policy of limiting dollarization may have broader economic consequences beyond my model's scope. In this article, I emphasize the overlooked benefits of dollarization as well as its recognized costs. Foreign currency credit forms a crucial insurance arrangement between firms and households. Restricting dollarization could disrupt this insurance, potentially leading to more significant economic consequences than policymakers anticipate.

2. EMPIRICAL FACTS

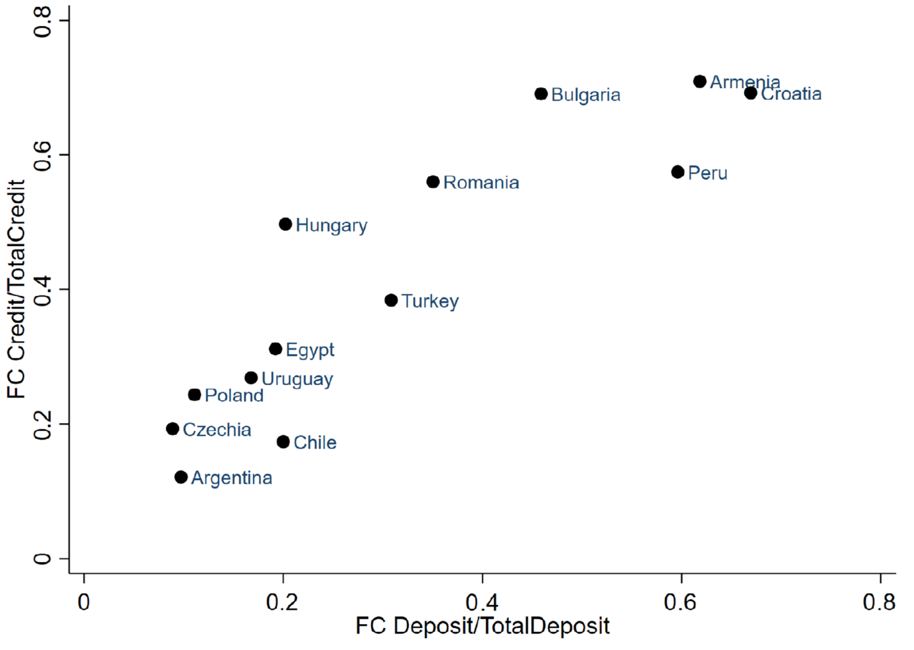
In this section, I present certain important facts about dollarization in emerging economies. I obtain annual deposit dollarization data from Yeyati (2006). I gather monthly deposit dollarization, credit dollarization, deposit and credit interest rates from individual central banks[3] as well as European Central Bank (ECB) for EU members.[4] To account for international dollar borrowing by firms, I use Bank for International Settlements (BIS) data for international security issuance. For Chile and Turkey, I use central bank survey of expectation data to construct expected real interest spread. To construct average interest rate spread, I obtain daily spot and forward currency rates from The World Markets/Reuters (WMR) quotes on Datastream. In Online Appendix Subsection A.8, I provide details on data sources. In each section, the number of countries is limited to data availability.

2.1. *Deposit and Credit Dollarization are Significant and Correlated.* Credit and deposit dollarization are positively correlated across countries. Figure 2 shows that in countries with high deposit dollarization, we also see high credit dollarization. In some countries, we see more than 40% of financial intermediation taking place in a foreign currency.

2.2. *Most Foreign Currency Credit is Supplied Locally.* In emerging market economies, a significant portion of financial intermediation takes place in a foreign currency. This trend is evident in Figure 2, in many countries, close to 50% of credit to nonfinancial firms is

[3] Argentina, Armenia, Chile, Egypt, Peru, Turkey, and Uruguay.

[4] Bulgaria, Croatia, Czechia, Hungary, Romania, and Poland. I use the generalized term "dollarization" yet it refers to any major currency. In emerging Europe, it is likely to be the euro or the Swiss franc.



SOURCE: Individual central banks, European Central Bank (ECB). Reported numbers are the averages of 2005–17. Total Credit (Deposit) is the amount of credit extended (deposits issued) by banking systems to local residents, Foreign currency (FC) Credit (Deposit) is the portion that is denominated in a foreign currency. See Appendix Subsection A.8 for details.

FIGURE 2

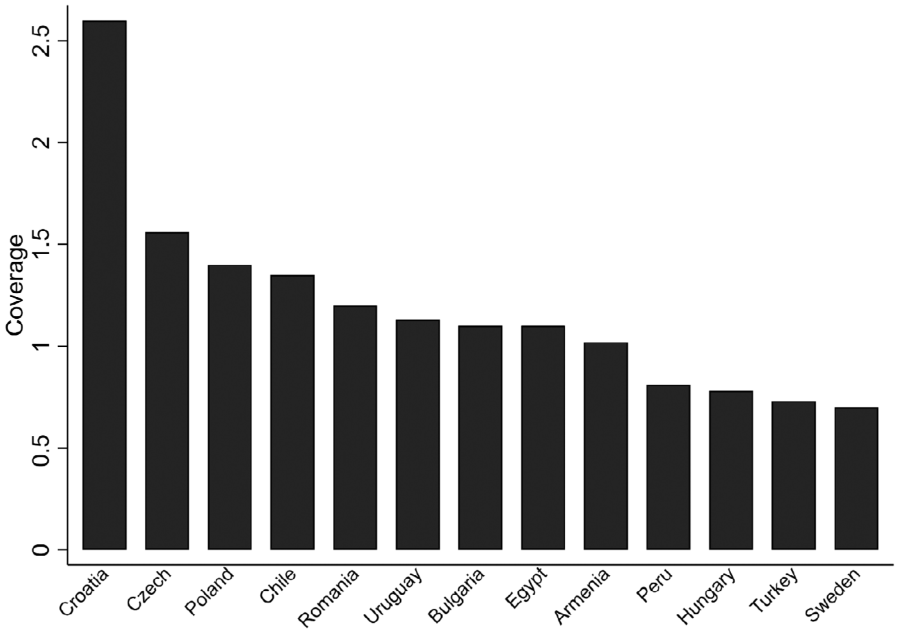
AVERAGE CREDIT AND DEPOSIT DOLLARIZATION ACROSS SELECTED COUNTRIES

denominated in foreign currency, alongside approximately half of household savings being held in a foreign currency. Notably, Christiano et al. (2021) show that financial dollarization in emerging markets primarily functions as an intranational insurance mechanism, as the amount of dollar credit closely aligns with the amount of dollar deposits. Consequently, it becomes apparent that household foreign currency deposits largely finance foreign currency credit extended to nonfinancial firms. As a result, when the exchange rate depreciates, firms face increased financial costs while many residents simultaneously benefit from their dollar savings. This dynamic establishes an internal insurance mechanism that effectively distributes income between saver and borrower residents. Figure 3 further supports these findings, illustrating the ratio of household dollar deposits to dollar credit for nonfinancial firms in major emerging economies between 2005 and 2017. Notably, this ratio surpasses 70% across all economies, with emerging Europe displaying a substantially higher ratio exceeding 1.

2.3. *Deposit Dollarization Provides Hedging against Business-Cycle Fluctuations.* I argue that one of the underlying reasons behind deposit dollarization is hedging motive. To find out the correlation between GDP and exchange rate in each country, I run the following regression for each country in my data set:

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

Figure 4 plots average dollarization against each country β. In emerging economies, exchange rate depreciations are associated with lower growth. Figure 4 presents the evidence



SOURCE: Individual central banks, European Central Bank (ECB), BIS. Reported numbers are the averages of year 2005–17. Dollar deposit is defined as foreign currency deposit held at financial institutions by residents. Dollar credit data include foreign currency credit extended to nonfinancial firms by banks as well as FC security issuances obtained from BIS. See Appendix Subsection A.8 for details.

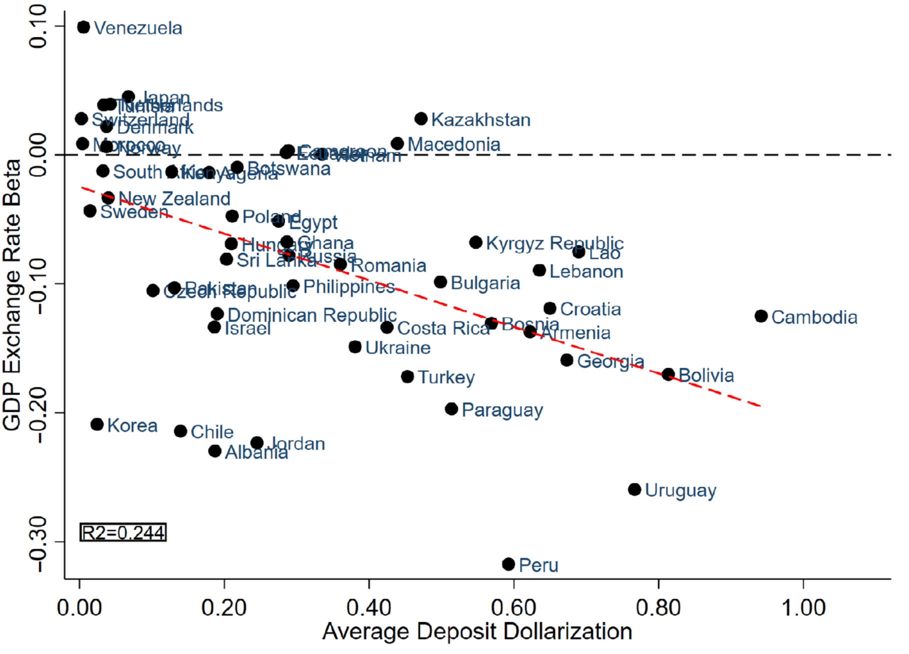
FIGURE 3

RATIO OF FC DEPOSITS TO FC CREDIT (2005–17)

for this fact. In economies with high dollarization, the comovement between real GDP growth and exchange rate depreciations[5] is typically negative. On the other hand, in developed economies where we do not observe dollarization, the covariance is either close to zero or positive. Christiano et al. (2021) uncover several more determinants of dollarization such as past inflation, institutions, and foreign debt. I show in Appendix Figure A2, that dollarization is correlated with inflation volatility but not real exchange volatility.

2.4. *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 the insurance motive discussed in Subsection 2.3, 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. Data are taken from Reuters/WMR quotes on Datastream and cover the period 2004–17. For Bulgaria, Croatia, Hungary, Romania, and Poland, the euro is taken as the benchmark; for others USD is the benchmark.

[5] Here, exchange rate is defined as the nominal dollar exchange rate (LCU per USD) divided by the CPI of that economy.



NOTES: Data source is the World Bank, Yeyati (2006). The data cover the years 1994–2018. GDP/exchange rate β has been calculated separately for each country from available time series. The Beta coefficient is calculated as the regression coefficient of the log deviation of real GDP on the log deviation of the real exchange rate. GDP is defined as GDP (Constant Local Currency Unit (LCU)). Exchange rate is defined as "Official exchange rate (LCU per US$, period average) divided by "Consumer price index (2005 = 100)." The data cover the period 1995–2017. See Appendix Subsection A.8 for details.

FIGURE 4

CORRELATION BETWEEN CHANGE IN GDP AND EXCHANGE RATE

I assume that covered interest rate parity holds.[6] I denote S_t as the spot exchange rate and F_t as the forward rate. Covered interest parity (CIP) implies that returns domestic interest rate has to be equal to a hedged foreign position:

$$R_t = \frac{F_t}{S_t} R_t^f. \tag{1}$$

Return to holding local currency is

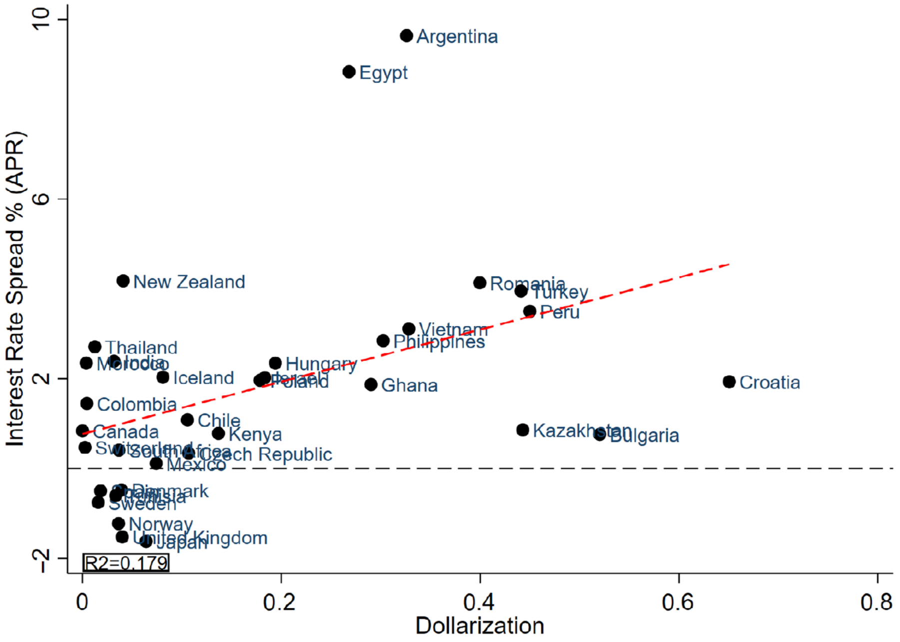
$$R_t - \frac{S_{t+1}}{S_t} R_t^f.$$

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

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

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 5).[7]

[6] Otherwise, there would 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,



NOTES: Data source is Yeyati (2006) and Reuters/WMR quotes on Datastream. The data cover the years 2004–17. 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. See Appendix Subsection A.8 for details.

FIGURE 5

AVERAGE INTEREST RATE SPREAD AND AVERAGE DEPOSIT DOLLARIZATION

2.5. *Interest Rate Spreads Comove 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:[8]

$$\text{Real Spread} = R_t^l \frac{P_t}{P_{t+1}^e} - R_t^f \frac{P_t}{P_{t+1}^e} \frac{S_{t+1}^e}{S_t}, \tag{3}$$

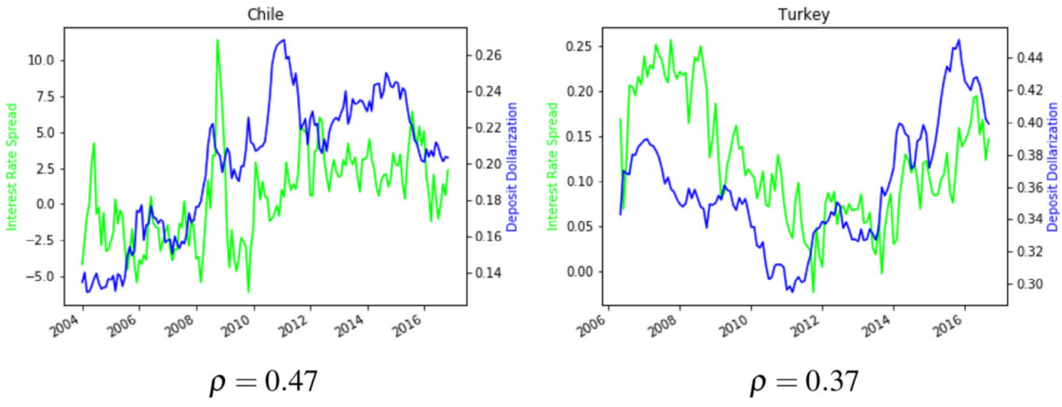
where R_t^l and R_t^f are average local currency and foreign currency deposit interest rates, P_t is Consumer Price Index (CPI), and S_t is dollar exchange rate. P_{t+1}^e and S_{t+1}^e denote CPI and exchange rate expectations for 12 months ahead, respectively. Comovement between credit dollarization and interest rates in Figure 6 supports the view that firms follow the cheaper source of funding. On the other hand, households switching to saving in foreign currency coincides with an increase in local interest rates. This lends to the view that the underlying reason for deposit dollarization is not relative interest rates.

2.6. *Deposit and Credit Dollarization Comove.* Deposit and credit dollarization correlate also in time series. Figure 7 shows the time-series movement of credit and deposit

violations of covered interest rate parity are observed (Sushko et al., 2016; Amador et al., 2019). According to Du et al. (2018), the source of CIP is the convenience yield of the U.S. Treasuries.

[7] Average interest rate spread can be due to the high risk that these emerging markets carry. In Appendix Figure A4, I plot the Sharpe ratio instead of average return. Highly dollarized economy local asset returns are higher, even after adjusted by the standard deviation of the returns.

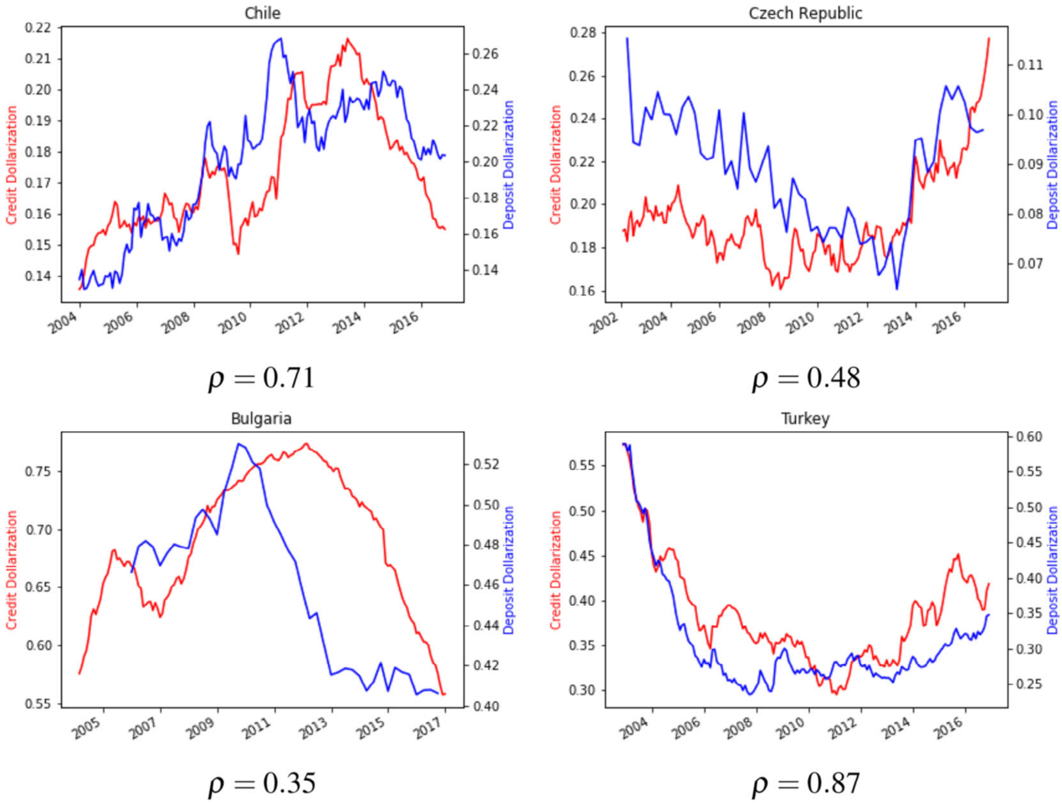
[8] Chile and Turkey publish 12 month-ahead exchange rate and CPI expectations. In Appendix Subsection A.1.6, I plot dollarization against the raw interest rate difference between local currency and dollars. In periods when there is high dollarization, local currency interest rates tend to be high.



SOURCE: Individual central banks, Survey of Expectations. Interest rate spread is the expected difference between local currency and dollar returns. Expectations are calculated using median expectation in the survey. Monthly data have been used. See Appendix Subsection A.8 for details.

FIGURE 6

DEPOSIT DOLLARIZATION AND INTEREST RATE SPREAD



SOURCE: Individual central banks, ECB. Deposit dollarization is defined as the ratio of foreign currency denominated deposits as a share of total deposit. Credit dollarization is defined as the foreign currency denominated credit as a share of total credit in the nonfinancial sector. See Appendix Subsection A.8 for details.

FIGURE 7

CREDIT AND DEPOSIT DOLLARIZATION IN TIME SERIES dollarization in example economies.[9] Deposit and credit dollarization comove over long periods.[10] The interest rate spread also follows the same trend, which indicates that as households switch to foreign currency deposits, interest rates go up which pushes firms to borrow more in dollars.

3. THE MODEL

The model is based on a standard small open economy model with two goods (home good and foreign good). Exchange rate, defined as the price of foreign good in terms of home good, is determined endogenously within the model. Endogenous local interest rates clear local financial markets. To capture balance-sheet effects of exchange rate, the model features financial frictions that are based on the CSV mechanism from Gale and Hellwig (1985) and Bernanke et al. (1999),[11] and endogenous loan denomination choice by entrepreneurs.

The model includes two assets. Peso asset promises a fixed amount of home good in the next period. Similarly, the dollar asset holder receives a fixed amount of foreign good in the next period. In terms of consumption, which is composed of home good and foreign good; both assets are risky.

The model features three inefficiencies: (i) Incomplete asset markets—agents have access to only the two assets described above, and the peso asset is traded only among residents. To obtain insurance, households can purchase the dollar asset, whose returns are negatively correlated with consumption. Since foreigners do not have access to the peso asset, entrepreneurs must borrow in dollars if peso savings are insufficient for investment. (ii) CSV results in inefficiently low investment because entrepreneur borrowing is restricted by their net worth. (iii) Investment adjustment costs make volatile investment expensive, as adjusting investment requires spending resources. It is evident how these three inefficiencies interact, making dollarization potentially inefficient. In the absence of complete markets, entrepreneurs must borrow in dollars since peso supply is limited due to households' preference to save in dollars. However, dollar borrowing is risky because returns are in terms of the home good. Therefore, exchange rate fluctuations lead to volatile net worth due to balance-sheet effects, making investment more volatile, and volatile investment is costly due to investment adjustment costs. As a result, dollarization can amplify shocks, specifically those leading to lower output and a higher exchange rate. On the other hand, dollar savings of households can still serve as a cushion against these shocks.

3.1. *Households.*

I consider a standard small open economy that is populated by a representative household. Consumption good is a composite good of home good ($c_{h,t}$) and foreign good($c_{f,t}$):

$$C_t = \left(\omega^{\frac{1}{\sigma}} c_{h,t}^{\frac{\sigma-1}{\sigma}} + (1-\omega)^{\frac{1}{\sigma}} c_{f,t}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{4}$$

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:

$$P_t = \left(\omega p_{h,t}^{1-\sigma} + (1-\omega) S_t^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \tag{5}$$

[9] See Appendix Subsection A.1.7 for more countries.

[10] There is a possible limitation to consider regarding Figures 6 and 7, as their correlation could be influenced by short-term fluctuations in the exchange rate. In Appendix Subsection A.1.5, I generate Figures 6 and 7 by employing a fixed exchange rate to determine the value of FC deposit and credit.

[11] The CSV mechanism has also been applied previously in the context of open economies. See Christiano et al. (2011) for a review. In particular, Faia (2007) and Akinci (2021) show that CSV-type financial frictions amplify 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.

where price of home good is fixed $p_{h,t} = 1$. S_t denotes the relative price of foreign good; I refer to S_t as exchange rate throughout the article. Households have access to two one-period assets. The first is the "dollar asset," which pays out R_t^f units of foreign good at $t+1$, where R_t^f is the exogenous dollar interest rate faced by this small open economy. The second asset is the "peso asset," which pays R_t units of home good at $t+1$. Local interest rate, R_t is determined endogenously in equilibrium. Households also lend labor $(l_{h,t})$ with Frisch elasticity ϕ to production firms at the competitive wage rate w_t. Representative household maximizes lifetime utility subject to the budget constraint:

$$\max_{\{C_t, d_t, f_t, l_{h,t}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \mathbb{E}\left(\frac{C_t^{1-\gamma}}{1-\gamma} - \frac{\xi}{1+\phi} l_{h,t}^{1+\phi}\right) \text{ s.t.} \tag{6}$$

$$P_t C_t + \overbrace{d_t}^{\text{Peso Asset}} + \overbrace{f_t}^{\text{Dollar Asset}} + \Phi(d_t, f_t, \bar{d}, \bar{f}) = \overbrace{w_t l_{h,t}}^{\text{Labor}} + d_{t-1} \overbrace{R_{t-1}}^{\text{Local Rate}} + f_{t-1} \overbrace{\frac{S_t}{S_{t-1}}}^{\text{ER}} \overbrace{R_{t-1}^f}^{\text{Foreign Rate}} + \pi_t, \tag{7}$$

where C_t and P_t are consumption (Equation (4)) and the price of the consumption basket (Equation (5)), respectively. $\Phi(\cdot)$ denotes costs of deviating from the target portfolio $(\bar{d}, \bar{f})$. In many emerging economies, households hold savings in both local and foreign currencies; the model captures this behavior by allowing households to hold peso and dollar assets. I refer to the ratio $\frac{f_t}{f_t+d_t}$ as "deposit dollarization." The first-order conditions of the household maximization problem are

$$\frac{C_t^{-\gamma}}{P_t}\left(1 + \Phi'_{d_t}(\cdot)\right) = \beta R_t \mathbb{E}\left(\frac{C_{t+1}^{-\gamma}}{P_{t+1}}\right), \tag{8}$$

$$\frac{C_t^{-\gamma}}{P_t}\left(1 + \Phi'_{f_t}(\cdot)\right) = \beta R_t^f \mathbb{E}\left(\frac{C_{t+1}^{-\gamma}}{P_{t+1}} \frac{S_{t+1}}{S_t}\right), \tag{9}$$

$$\xi l_{h,t}^{\phi} C_t^{\gamma} = \frac{w_t}{P_t}. \tag{10}$$

3.2. *Production Firms.* Production firms produce home good according to the production function:

$$y_t = z_t K_t^{\alpha} L_t^{1-\alpha}. \tag{11}$$

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

$$L_t = l_{h,t}^{\Omega} l_{e,t}^{1-\Omega}, \tag{12}$$

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

$$R_t^k = \mathbb{E}\left(\frac{z_{t+1}\alpha K_{t+1}^{\alpha-1} L_{t+1}^{1-\alpha} + Q_{t+1}(1-\delta)}{Q_t}\right), \tag{13}$$

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

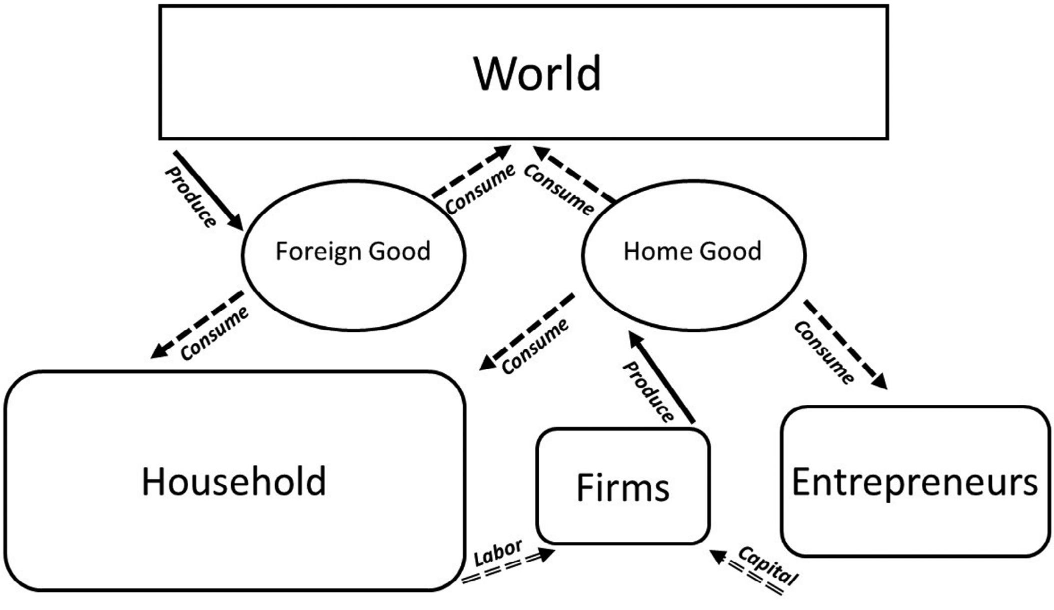


FIGURE 8

GOODS MARKET

period, households buy back the capital from entrepreneurs. Capital evolves according to

$$K_{t+1} = (1-\delta)K_t + I_t - \psi\left(\frac{I_t}{I_{t-1}} - 1\right)^2 K_t \tag{14}$$

with quadratic investment adjustment costs.

3.3. *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}), and their consumption demand is given by

$$c_{xt} = S_t^{\varphi} x_t, \tag{15}$$

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 8 summarizes the trade and production in the model.

3.4. *Banks.* In the model, there are two types of banks: local and foreign. Local banks are owned by households and they intermediate the peso asset. Following Eichengreen et al. (2007), I assume that local banks can borrow only from households. This means that foreign investors do not have access to financial intermediation in terms of the peso asset. Recent empirical observation by Maggiori et al. (2020) verifies that this assumption is reasonable. Local financial markets need to then clear within the small open economy[12] through local interest rates R_t. Foreign banks intermediate in terms of the dollar asset and are owned by risk-neutral foreign investors. They borrow at the exogenous interest rate R_t^f from foreign investors and local households. Figure 9 shows the financial sector in the economy.

[12] This is similar to the Feldstein–Horioka puzzle (Feldstein and Horioka, 1980).

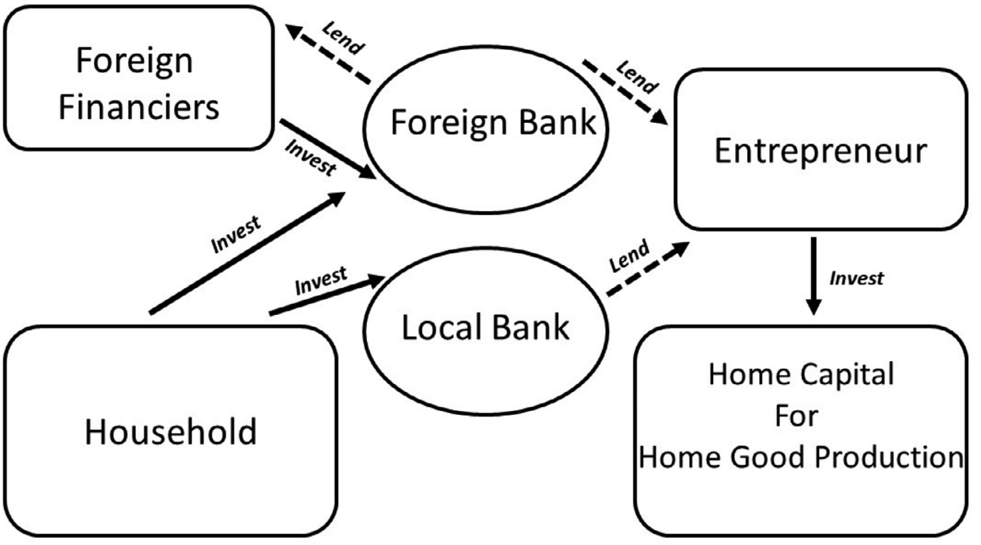


FIGURE 9

FINANCIAL MARKETS IN THE MODEL

Another important assumption is that the banks have to balance peso and dollar asset positions separately; they need to match the denomination of their liabilities and loans. Many studies verify that emerging market banks do not carry currency mismatch due to regulation or risk management (Brown et al., 2014; Keller, 2019; Dalgic, 2020). In Appendix Figure A1, I plot loan and liability dollarizations using IMF Financial Soundness Indicators 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 the bank zero profit condition separately, which means that banks do not extend loans from which they know they would experience a loss. One implication of this assumption is that monitoring costs are paid by foreign banks in case entrepreneurs default on dollar debt. In Appendix Subsection A.4, I show that these costs are not large in the benchmark equilibrium.

I assume that the peso asset is traded only among residents. Recent literature documents that while foreigners invest more and more in local currency denominated government debt, nonfinancial firm external debt is overwhelmingly denominated in dollars (Chui et al., 2015 and Du and Schreger, 2022). In the absence of this assumption, risk-neutral foreigners will provide insurance to the economy by borrowing in dollars and lending in pesos. Maggiori and Gabaix (2015) show that financial constraints can lead to limited participation of foreigners into peso market. Christiano et al. (2021) argue that frictions need to be too high to generate the observed patterns in international flows. Instead, they argue that emerging market exchange rates typically comove negatively with global financial conditions such that EM currency assets have poor insurance properties for foreign investors, which leads to limited participation of foreigners (Lustig and Verdelhan, 2007).

3.5. *Entrepreneurs.* In the model, entrepreneurs operate the capital for home good production. Following Bernanke et al. (1999), entrepreneurs are modeled as separate households; they are risk-neutral, maximize life-time income, and 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 (Chui et al., 2015; Aoki et al., 2016). Existing data present mixed views on the strength of these effects. Whereas Bleakley and Cowan (2008), Dalgic (2020), and Christiano et al. (2021) find them to be weak, Aguiar (2005) identifies strong effects for short-term dollar debt but not for long-term dollar debt. Kim et al. (2015) reveal that, post-Asian Crisis in Korea, smaller firms with dollar debt reduced investment more than larger firms. The perceived low impact of balance sheet effects is attributed to selection, as firms capable of handling depreciation risk are the ones borrowing in dollars. Dollar debt is primarily taken on by larger firms, exporters (Dalgic, 2020), and more productive firms (Salomao and Varela, 2022). Nonfinancial firms with dollar debt are typically not highly leveraged (Dalgic, 2020; Christiano et al., 2021).

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 $\omega_i R^k$. The realization of ω_i is i.i.d. with the distribution function $\omega_i \sim F(\omega)$ where $\mathbb{E}(\omega_i) = 1$. They are subject to a particular financial friction, CSV, 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 and Hellwig (1985) show that the optimal contract in this environment is a debt contract and the entrepreneur is monitored only if the entrepreneur declares bankruptcy. The bank offers a menu of contracts that specify an interest rate and leverage.[13] 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 dollar asset and peso asset borrowing, respectively. Given the level of leverage, the interest rates uniquely determine default cutoffs for two types of borrowing $(\bar{\omega}_{t+1}^l, \bar{\omega}_{t+1}^f)$, 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 the two sources of borrowing. Entrepreneurs are subject to limited liability, they are only responsible for the amount of net worth they pledge to each source of funds. Combined with the linearity of the objective function, the model rules out cross-subsidization. Default decisions on dollar loans are not affected by default decisions on peso loans, which makes computation much easier.

3.5.1. *Entrepreneur choice and capital.* This section presents the entrepreneur problem: [14] Entrepreneurs maximize expected profit denominated in home good

$$(16)\quad \max_{\theta_t, \bar{\omega}_{t+1}^l, \bar{\omega}_{t+1}^f} N_t \left(\mathbb{E}\left[R_{t+1}^k [1 - \Gamma(\bar{\omega}_{d,t+1})]\right] L_t^d (1-\theta_t) + \theta_t \mathbb{E}\left[R_{t+1}^k \left[1 - \Gamma(\bar{\omega}_{f,t+1} \frac{S_{t+1}}{S_t}) \right] \right] L_t^f \right).$$

$R_t^k[1 - \Gamma(\cdot)]$ denotes the expected return to the entrepreneur of borrowing and $\Gamma(\cdot)$ is the expected payment to the bank given the default cutoff.[15] Since the bank interest rate uniquely determines a default cutoff, entrepreneurs choose, interest rate and leverage for (i) peso $(R_{b,t}^l, L_t^d)$ and (ii) dollar $(R_{b,t}^f, L_t^f)$ asset borrowing, and (iii) the amount of net worth used as collateral for dollar asset borrowing (θ_t). Credit dollarization in the model is equal to

$$(17)\quad \frac{N_t \theta_t \left(L_t^f - 1\right)}{N_t \theta_t \left(L_t^f - 1\right) + N_t (1-\theta_t)\left(L_t^d - 1\right)},$$

[13] In this model, a standard debt contract is not necessarily the optimal contract as in Gale and Hellwig (1985).
[14] Derivation in detail in Appendix Subsection A.2.
[15] This function is explicitly defined in Appendix Subsection A.2.

where $N_t(1-\theta_t)(L_t^d - 1)$ is the amount raised through issuing the peso asset and $N_t\theta_t(L_t^f - 1)$ through the dollar asset. Similar to deposit dollarization, I denote "credit dollarization" as the portion of credit funded by foreign sources. Then, the entrepreneur buy capital with the fund they raised,

$$Q_t K_{t+1} = N_t\theta_t L_t^f + N_t(1-\theta_t)L_t^l. \tag{18}$$

Since entrepreneurs are risk-neutral, in equilibrium they are indifferent about the source of borrowing. The first-order condition for the entrepreneur maximization problem with respect to θ_t implies,[16]

$$\mathbb{E}_t[1-\Gamma(\bar{\omega}_{d,t+1})]L_t^d = \mathbb{E}_t\left[1-\Gamma\left(\bar{\omega}_{f,t+1}\frac{S_{t+1}}{S_t}\right)\right]L_t^f. \tag{19}$$

3.6. *Saving and Debt Denomination.* In the model, two equations determine the choice of denomination and the interest rate spread. The first is the entrepreneur choice (Equation (19)). The second is Equation (20),[17] which combines two Euler equations (Equations (8) and (9)).

$$\mathbb{E}_t\left[\frac{u'(C_t)}{u'(C_{t+1})}R_t\frac{P_t}{P_{t+1}}\right] - \epsilon(d_t - \bar{d}) = \mathbb{E}_t\left[\frac{u'(C_t)}{u'(C_{t+1})}R_t^f\frac{S_{t+1}/P_{t+1}}{S_t/P_t}\right] - \epsilon(f_t - \bar{f}). \tag{20}$$

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 model, entrepreneurs act as if they are risk-averse as a result of financial frictions. In the equilibrium, entrepreneurs are indifferent between borrowing in two sources.

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.[18]

3.7. *Equilibrium Conditions.* Exchange rate (S_t) and local interest rate (R_t) are determined endogenously with the following equilibrium conditions:

- Peso asset market clears within the small open economy, which means that peso asset borrowing needs to be equal to household peso asset savings

$$d_t = N_t(1-\theta_t)\left(L_t^d - 1\right) \tag{21}$$

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

[16] Two other first-order constraints are derived explicitly in Appendix Subsection A.2.

[17] The cost of deviating from the target portfolio, $\Phi(d_t, f_t, \bar{d}, \bar{f}) = 0.5\epsilon(d_t - \bar{d})^2 + 0.5\epsilon(f_t - \bar{f})^2$ such that the derivatives with respect to d_t and f_t are $\epsilon(d_t - \bar{d})$ and $\epsilon(f_t - \bar{f})$, respectively.

[18] In Appendix Subsection A.3, I show that in the absence of financial frictions, UIP would hold; the model would not feature interest rate spread between dollar and peso assets.

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

$$\text{Capital Account}: \underbrace{\left(\frac{f_t}{S_t} - \frac{f_{t-1}}{S_{t-1}} R^f_{t-1}\right)}_{\text{Household net foreign investment}} - \underbrace{\left[\theta_t \frac{N_t}{S_t}\left(L^f_t - 1\right) - \theta_{t-1}\frac{N_{t-1}}{S_{t-1}}\left(L^f_{t-1} - 1\right) R^f_{t-1}\right]}_{\text{Entrepreneur net foreign borrowing}}$$

(23) $$- \underbrace{\Pi^b_t}_{\text{Foreign Bank Profit}}.$$

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

- Market clearing for home good

(24) $$c_{h,t} + c_{e,t} + c_{x,t} + I_t + M_t + \Pi^b_t S_t = z_t K^\alpha_t L^{1-\alpha}_t,$$

where $c_{h,t}\, c_{e,t},\ c_{x,t}$ are home good consumption demand by the household, entrepreneurs, and foreigners, respectively, and M_t is the monitoring costs.[19]

3.8. *Shocks in the Model.* The economy is subject to the following shocks. Each shock follows AR(1) process. For each shock $j \in \{z, x, R_f, \sigma_{Rf}\}$, ρ_j denotes the persistence; innovations $e_{j,t}$ follow standard Gaussian distribution, and σ_j denotes the standard deviation of each shock.

- Technology shock, z_t, works mainly 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 output, and an exchange rate depreciation.

(25) $$\log(z_t) = \log(\mu_z)(1 - \rho_z) + \rho_z \log(z_{t-1}) + \sigma_z e_{z,t}$$

- 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 (2011) show that small economies face trade shocks coming from large countries (but not vice versa), which makes their bonds riskier and drives up interest rate spreads. Similarly, Richmond (2019) makes a similar argument for countries that are not central to world trade network, which face trade shocks from central economies.

(26) $$\log(x_t) = \log(\mu_x)(1 - \rho_x) + \rho_x \log(x_{t-1}) + \sigma_x e_{x,t}.$$

- Foreign interest rate shock, R^f_t, can also be considered as external premium shock similar to Gertler et al. (2007). Neumeyer and Perri (2005) argue that foreign interest rate shock is an important driver of emerging economy business cycles; due to intertemporal substitution, large variations in R^f_t make household consumption and current account more volatile. In my model, by making exchange rate more volatile, R^f_t shocks also trigger balance-sheet effects and make investment more volatile. I argue that households

[19] See Appendix Subsection A.11 for derivation.

TABLE 2
INTERNALLY ESTIMATED PARAMETERS

Parameter		Value
σ_z	% Std Dev ϵ_z	1.72
σ_x	% Std Dev ϵ_x	3.52
ψ	Capital adjustment	0.96
γ_e	Entrepreneur survival	0.99
$\bar{d}$	Target Peso assets	2.01
$\bar{f}$	Target Dollar assets	1.62
μ_x	Mean export demand	0.17
Ω	Household share of labor	0.999

can protect themselves from foreign interest rate shock by holding foreign assets. Foreign interest shock is subject to stochastic volatility shocks,

$$R_t^f = \bar{R}_f(1-\rho_{Rf}) + \rho_{Rf}R_{t-1}^f + exp(\sigma_{R,t})\sigma_{Rf}\epsilon_{Rf,t}. \tag{27}$$

- 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. The shock process is

$$\sigma_{R,t} = \rho_{\sigma_R}\sigma_{R,t-1} + \sigma_{\sigma_R}\epsilon_{\sigma_R,t}. \tag{28}$$

4. MODEL PARAMETERIZATION

I use quarterly discount factor $\beta = 0.9951$, which corresponds to a 2% steady-state annual interest rate. Elasticity of intertemporal substitution is 0.5, which implies $\gamma = 2$. Home bias in consumption is set $\omega = 0.7$, which is the average import/consumption ratio in emerging economies (Camara et al., 2023). Elasticity of intratemporal substitution is set to $\sigma = 1.5$ (Backus et al., 1993; Faia, 2007). In a similar open economy model, Christiano et al. (2011) estimates inverse elasticity of labor $(1+\phi) = 7.7$. This number is high compared to estimates from the U.S. 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 hours in the nonstochastic steady state is equal to one-third. Share of capital in production is $\alpha = 0.33$. Depreciation rate is $\delta = 0.025$. I set the elasticity of exports to the exchange rate (φ) to 1. High elasticity makes exports react more to exchange rate movements and reduces the impact on the economy, making dollar deposits less useful. In Subsection 6.2, I show that a higher elasticity would have made preventing deposit dollarization less painful. Entrepreneur efficiency follows lognormal distribution with standard deviation $\sigma_e = 0.26$, and the losses in case of bankruptcy is $\mu_e = 0.12$ (Faia, 2007; Gertler et al., 2007). All shocks follow AR(1) process. Foreign interest rate shock process is estimated using Emerging Market Bond Index (EMBI) spread index as in Fernandez-Villaverde et al. (2011). I add risk-free rate taken from the Ken French data set to the EMBI spread. I fit an Autoregressive and Generalized autoregressive conditional heteroskedasticity (AR(1)-GARCH(1,1)) model on the dollar interest rate and estimate Equations (27) and (28).[20] The estimated average standard deviation is 20 basis points, very similar to the estimated values in the literature (Neumeyer and Perri, 2005; Fernandez-Villaverde et al., 2011).

I estimate a subset of parameters within the model to fit quarterly Peruvian data. Table 2 lists the estimated parameters and Table 3 lists the model and data moments for the calibration targets as well as the untargeted moments. Overall, the model fits the levels well but

[20] See Appendix Subsection A.6 for the details of estimation.

TABLE 3
CALIBRATION TARGETS

Target	Data	Model
$\sigma(Y/P)$	0.74%	2.21%
$\sigma(I/P)$	6.09%	6.04%
$\sigma(NX/Y)$	0.95%	1.21%
$\sigma(S/P)$	1.73%	1.94%
Leverage	1.75	1.75
$\rho(S/P, Y/P)$	−0.20	−0.20
Deposit dollarization ($\frac{f}{d+f}$)	0.47	0.48
Credit dollarization ($\frac{b_f}{b_l+b_f}$)	0.53	0.52
Dollar borrowing share ($\frac{b_f}{f}$)	1.15	1.15
Untargeted moments	Data	Model
$\sigma(C)$	1.10%	1.25%
$\rho(C, S/P)$	−0.07	−0.34
$\rho(Y/P, NX/Y)$	0.04	−0.24
$\rho(Y/P, I/P)$	0.55	0.79
$\rho(NX/Y, I/P)$	−0.57	−0.53
$\sigma(\frac{f}{d+f})$	1.21%	2.75%
$\sigma(\frac{b_f}{b_l+b_f})$	0.54%	2.57%

SOURCE: Quarterly nominal GDP, investment, net export, nominal exchange rate, CPI, and dollarization data are taken from the Central Bank of Peru Web site. Data are between 2000Q1 and 2019Q4, seasonally adjusted using X13 methodology and HP-filtered. All data are deflated using Metropolitan Lima CPI ("Indice de precios Lima Metropolitana (Ãndice 2009 = 100) - Indice de Precios al Consumidor (IPC)"). The ratio of dollar credit/dollar deposits is taken from Christiano et al. (2021). The data include BIS corporate dollar-denominated security issuances (see Appendix Subsection A.8). The correlation between GDP and exchange rate is also taken from Christiano et al. (2021). Firm leverage numbers are estimated using Peruivan firm-level data (2000–14) used by Ramírez-Rondán (2019) and Christiano et al. (2021).

overestimates the volatility of output. Since the productivity shock is the only shock in the model that delivers positive comovement between the output and the exchange rate, I estimate a high σ_z (standard deviation of the productivity shock) which fits the correlation but delivers a somewhat more volatile output.[21] The model can match credit and deposit dollarization in Peru as well as the ratio of dollar credit divided by dollar deposits. The estimated parameter for investment adjustment costs (ψ) is around 1 (somewhat lower than but close to Christiano et al., 2005). Crucially, the model is able to match the leverage of nonfinancial firms in Peru (1.75). A relatively low leverage ratio in nonfinancial firms, where the dollar debt is concentrated, limits the financial amplification of the exchange rate movements (similarly, the average leverage of nonfinancial firms calculated by Dalgic, 2020, using Turkish data is 2.04). I show in Subsection 6.2 that a higher leverage ratio might rationalize macroprudential policies to limit dollarization.

In terms of untargeted moments, the model delivers the standard deviation of consumption but misses the observation that in emerging markets, consumption tends to be more volatile than output (Akinci, 2021). In the model, net exports are highly countercyclical whereas in the data they are somewhat acyclical, likely driven by commodity exports, which I do not include in the model. The model can deliver the negative comovement between net exports and investment. The model generates too much negative correlation between consumption and the exchange rate. In the model, dollarization is more volatile than the data.

The model can generate endogenous interest spread but the magnitude of the spread generated is small compared to the data. Two equations ((20) and (19)) pin down the interest rate spread in the model. Lustig and Verdelhan (2007) show that the standard preferences are unable to quantitatively match the country spread. In the data, most dollar credit is extended

[21] In Appendix Subsection A.7, productivity and export volatility of similar countries are estimated and compared to the model.

TABLE 4
LIST OF PARAMETERS

Parameter	Value	Explanation	
β	$(1.02)^{-1/4}$	Discount factor	Steady-state 2% annual rate
R	$1/\beta$	Steady-state interest rate	
ω	0.7	Home bias	Import/Consumption
σ	1.5	CES elasticity	Faia (2007), Backus et al. (1993)
γ	2	Risk aversion	Neumeyer and Perri (2005) Fernandez-Villaverde et al. (2011)
ϕ	7.7	Inverse Frisch elasticity	Christiano et al. (2011)
ψ	0.96	Capital adjustment cost	Estimated
$\bar{d}$	2.01	SS level of local assets	Estimated
$\bar{f}$	1.62	SS level of foreign assets	Estimated
$L^f = L^l$	1.75	Steady-state leverage	Peru firm-level data
Ω	0.999	Household share of labor	Estimated
γ_e	0.99	Entrepreneur survival prob.	Estimated
α	0.33	Capital share	
φ	1	Elasticity of export demand	Estimated
σ_e	0.26	Entrepreneur cross section sdev	Faia (2007), Gertler et al. (2007)
μ	0.12	Monitoring cost	Faia (2007), Gertler et al. (2007)
$F(\cdot)$	Lognormal	Entrepreneur distribution	Faia (2007), Gertler et al. (2007) Christiano et al. (2011)
ρ_R	0.98	Interest rate shock persistency	EMBI spreads
σ_R	0.0025	Interest rate shock	Fernandez-Villaverde et al. (2011)
μ_x	0.17	Mean export demand shock	Estimated
μ_z	1	Mean productivity shock	
ρ_z, ρ_x	0.95	Shock persistence	
σ_z	1.72%	Technology shock	Estimated
σ_x	2.52%	Export shock	Estimated
$\sigma_{\sigma R}$	0.28	Interest rate volatility shock	EMBI spreads
$\rho_{\sigma R}$	0.86	Volatility shock persistence	EMBI spreads

by local banks. Therefore, from the entrepreneur side, the model uses the same set of parameters for both dollar and peso borrowing. To get realistic spreads, the model requires either extreme parameters[22] or different financial friction parameters for dollar and peso loans (Akinci and Queralto, 2018).

I use third-order perturbation around the nonstochastic steady state to solve the model. Third-order approximation allows for the stochastic steady state to deviate from the nonstochastic steady state. Similarly it can allow for interest rate spread. Fernandez-Villaverde et al. (2011) and Fernandez-Villaverde and Guerron-Quintana (2020) show that this method allows analyzing the effects of uncertainty shocks. To ensure stationary portfolios, I use quadratic portfolio adjustment costs, which is standard in the literature.[23] Table 4 shows all the parameters in the model.

5. RESULTS

In this section, I show that the model is able to generate several facts in the data. In Subsection 5.1, I show that the model generates the comovement of interest rate spreads, credit and deposit dollarizations observed in the data (Figures 6 and 7). Whenever households save more in dollars, this drives up the interest rate spread and pushes entrepreneurs to borrow more in dollars. In Subsection 5.2, I discuss how dollarization is determined in the model. I show that the model generates higher dollarization whenever the exchange rate is more countercyclical (measured by consumption) as in the data, I plot Figure 12(a) which is the

[22] See Appendix Subsection A.3.

[23] I use adjustment cost parameter $\epsilon = 1e-3$. See Schmitt-Grohe and Uribe (2003) for a review of other means to ensure stationarity.

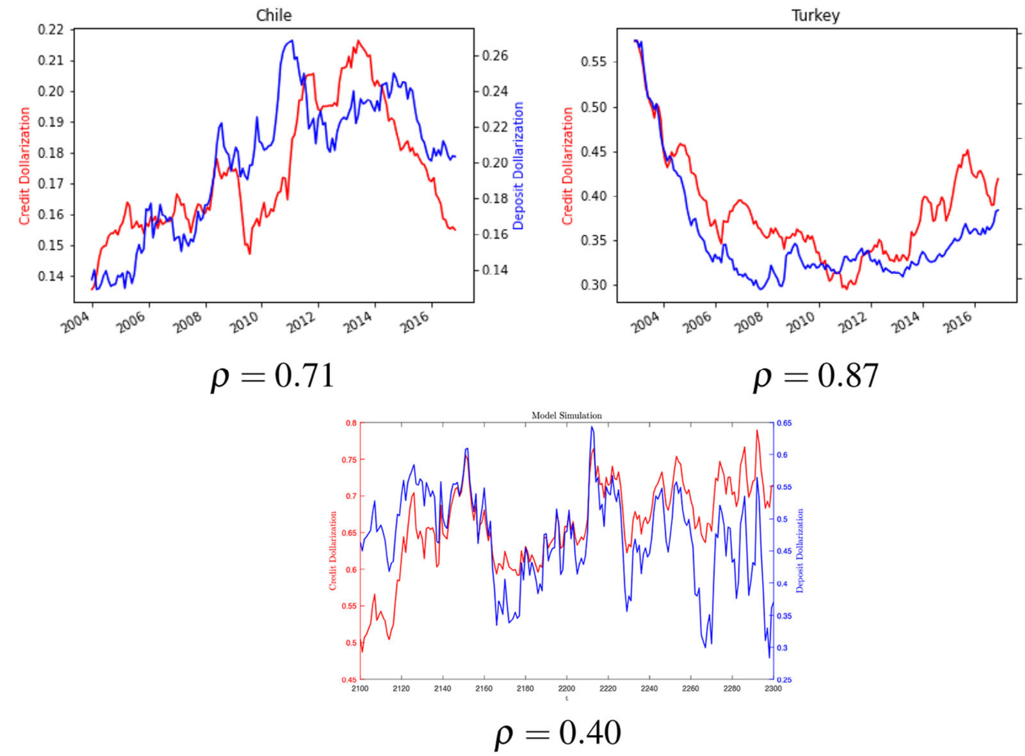


FIGURE 10

DATA VERSUS MODEL: CREDIT AND DEPOSIT DOLLARIZATION

consumption equivalent of Figure 4. In Subsection 5.3, I show that when the economy is shocked with an uncertainty shock, households respond by switching their portfolios from pesos to dollars, which raises domestic interest rates and pushes firms to borrow more in dollars. Uncertainty shocks lower investment significantly but do not affect consumption much (Figure 13).

5.1. *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 as in the data, and the interest rate spread moves with them. Figures 10 and 11 show an example simulation where deposit and credit dollarizations move together. Higher expected interest rate spread is associated with higher dollarization. Note that the simulations look remarkably similar to the data in Figures 6 and 7.

5.2. *Determinant of Dollarization.* In the nonstochastic steady state, deposit dollarization is equal to $\frac{\bar{f}}{\bar{d}+\bar{f}}$ and is pinned down by the parameter choice. However, in the stochastic steady state, dollarization varies due to the nonlinear nature of the model. In the model, any shock that implies a negative covariance between consumption and exchange rate, which translate into positive covariance between marginal utility and the exchange rate; increases demand for dollar assets, which can be seen from the Euler equation,

$$(29)\quad \left(1+\epsilon\overbrace{(f_t-\bar{f})}^{\text{Dollarization}\uparrow\uparrow}\right)=\beta\mathbb{E}_t\left(R_t^f\frac{S_{t+1}}{S_t}\right)\overbrace{\mathbb{E}_t\left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}\right)}^{\text{Precautionary motive}}+\overbrace{cov\left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t},R_t^f\frac{S_{t+1}}{S_t}\right)}^{\text{Covariance Risk}\uparrow\uparrow}.$$

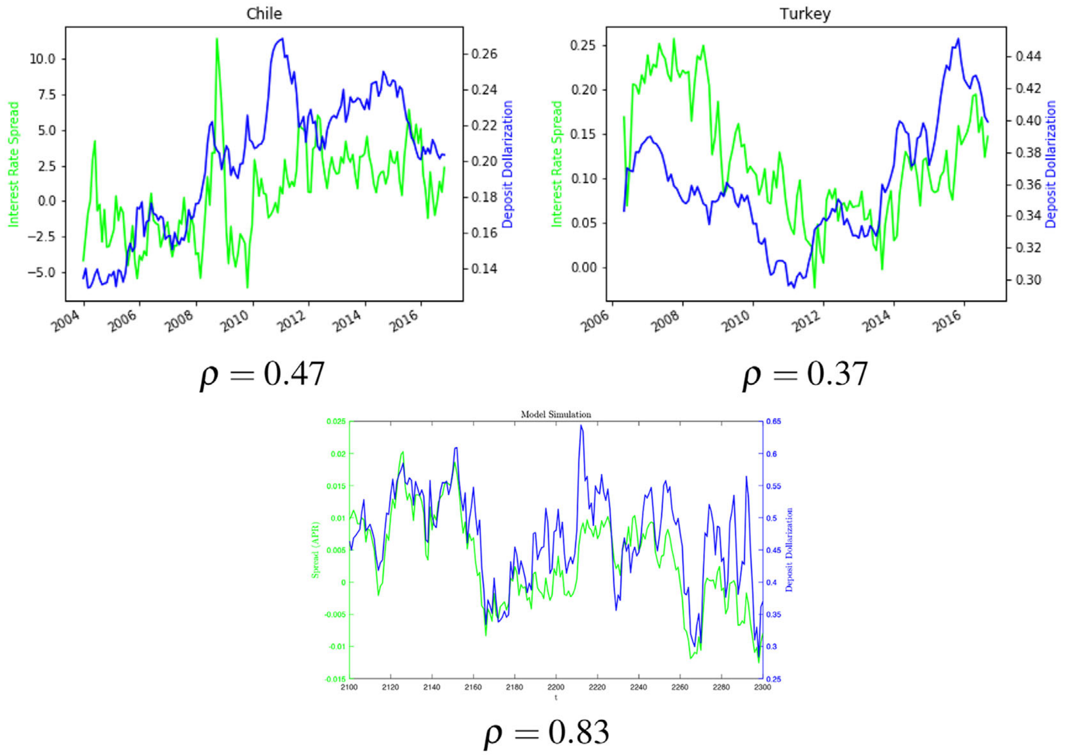


FIGURE 11

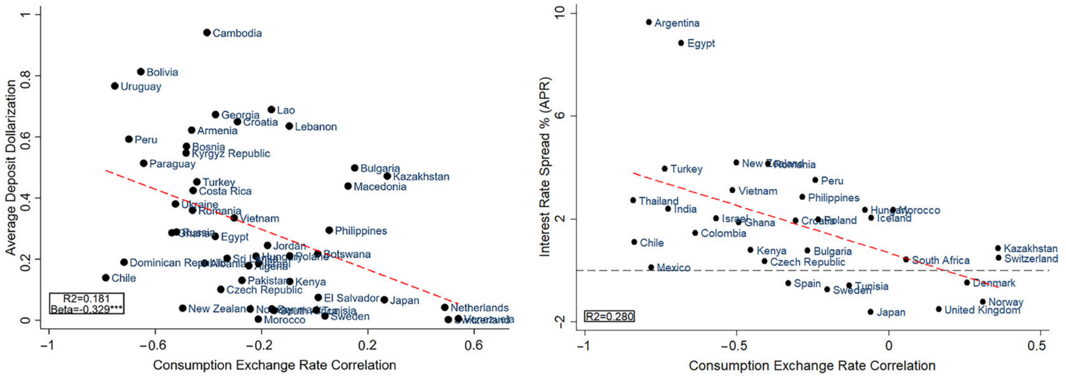
DATA VERSUS MODEL: DEPOSIT DOLLARIZATION AND EXPECTED INTEREST RATE SPREAD

The presence of high covariance risk contributes to an increase in dollar savings for two primary reasons.[24] First, high covariance risk amplifies consumption volatility, leading to higher savings due to precautionary motives. More importantly, if the covariance between marginal utility and the exchange rate is positive and substantial, holding dollar savings becomes advantageous as it offers effective insurance, thereby further driving up dollar savings. Credit dollarization in the model is determined through equilibrium conditions. Entrepreneurs choose the amount to borrow in pesos and in dollars to maximize Equation (16), leverage choice determines credit dollarization in Equation (17). At the margin, entrepreneurs are indifferent between borrowing in pesos or in dollars according to Equation (19). Peso market clearing condition (Equation (21)) connects peso savings and peso borrowing, whereas dollar borrowing can be from local sources as well as from foreign sources if the amount of dollar savings are less than the amount of dollar credit demanded.

Equation (30) combines the Euler equations for dollar and peso assets. When covariance risk increases, the interest rate spread can partially absorb this risk by allowing both the spread and dollarization to increase. This ensures that Equation (30) holds with higher covariance risk.

$$\text{(30)} \quad \epsilon\left(\overbrace{(f-d)-(\bar{f}-\bar{d})}^{\text{Dollarization}\uparrow\uparrow}\right) = \overbrace{cov\left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}, R_t^f \frac{S_{t+1}}{S_t}\right)}^{\text{Covariance Risk}\uparrow\uparrow} - \overbrace{\left(R_t - \mathbb{E}_t\left(R_t^f \frac{S_{t+1}}{S_t}\right)\right)}^{\text{Spread}} \overbrace{\mathbb{E}_t\left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}\right)}^{\text{Precautionary motive}}.$$

[24] In Appendix Subsection A.7, I show how each shock in the model contributes to the covariance risk, dollarization, and the interest rate spread.



(a) Dollarization (b) Interest Rate Spread

NOTES: Data source is the World Bank, Yeyati (2006), and Reuters/WMR quotes on Datastream. Dollarization data cover the years 1994–2018, interest rate spread data cover the years 2004–17. Consumption/Exchange rate correlation has been calculated separately for each country from available time series as the correlation coefficient of the log deviation of real consumption on the log deviation of the real exchange rate. Consumption is defined as Consumption (Constant LCU). Exchange rate is defined as "Official exchange rate (LCU per US$, period average) divided by "Consumer price index (2005 = 100)." 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. See Appendix Subsection A.8 for details.

FIGURE 12

CONSUMPTION-EXCHANGE RATE CORRELATION VERSUS DOLLARIZATION AND INTEREST RATE SPREADS

Figures 12(a) and 12(b) depict the covariance between consumption and the exchange rate in relation to dollarization and interest rate spreads. The data align with the model's conclusion that the comovement of consumption and the exchange rate plays a significant role in influencing dollarization.

5.3. *Macroeconomic Uncertainty Increases Dollarization through Household Insurance Motive.* In the model, deposit dollarization helps households hedge against uncertainty coming from external shocks. In the following exercise, I increase the standard deviation of the foreign interest rate shock (similar to Fernandez-Villaverde et al., 2011). I set the shock to be two-standard-deviation increase in stochastic volatility, which almost doubles the volatility of the foreign interest rate shock. High uncertainty pushes households to shift their portfolio from peso assets to dollar assets, which provides hedging in the presence of increased uncertainty. Households increase holding of dollar assets by almost 10% whereas decreasing peso asset by a similar amount. Demand for dollar assets creates exchange rate depreciation and raises the interest rate spread. Depreciation and high uncertainty lowers investment significantly by around 0.5% but consumption is not much affected. High spreads pushes firms to borrow more in dollars and thus we observe high global uncertainty leading to higher dollarization.

To see how an increase in uncertainty affects interest rate spread, let us rewrite the Euler equations,

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

(31)
$$R_t - \mathbb{E}_t\left(R_t^f \frac{S_{t+1}}{S_t}\right) = \frac{cov\left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}, R_t^f \frac{S_{t+1}}{S_t}\right) - \epsilon((f-d)-(\bar{f}-\bar{d}))}{\mathbb{E}_t\left(\frac{u'(C_{t+1})/P_{t+1}}{u'(C_t)/P_t}\right)}.$$

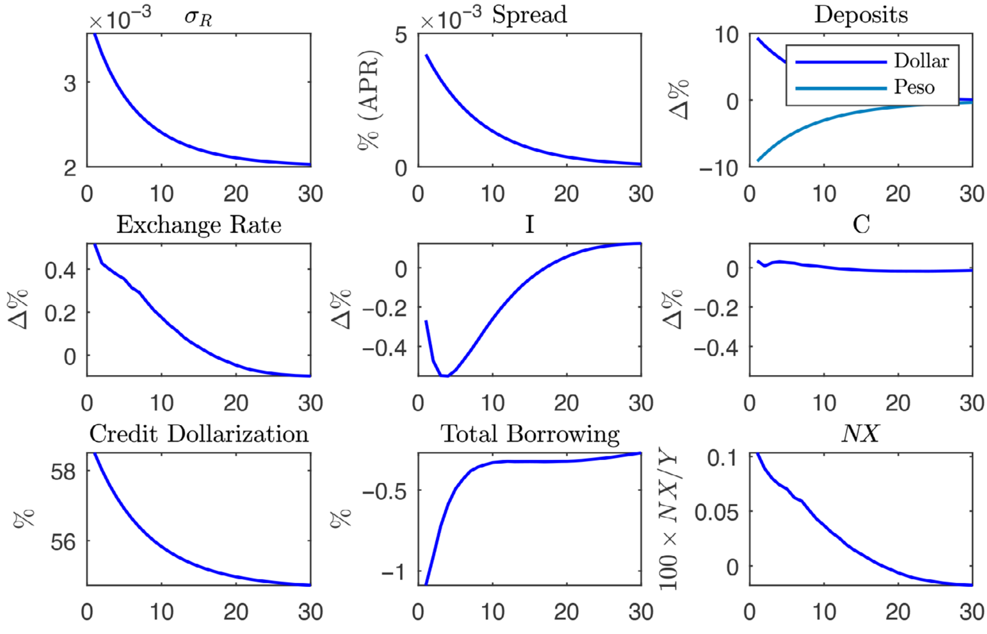


FIGURE 13

IMPULSE RESPONSE TO UNCERTAINTY SHOCK

Expected interest spread is related to the covariance between marginal utility and the exchange rate and the portfolio composition. An increase in uncertainty increases the covariance and leads to an expected interest rate difference although some of the spread is absorbed by the portfolio adjustment costs. Equation (31) is similar to that in Lustig and Verdelhan (2007) except that it reflects domestic risk as opposed to U.S. consumption risk.

Note that other things being equal, a more volatile exchange rate increases the covariance between returns of dollar assets and the marginal utility. Even though dollar assets become riskier (due to a more volatile exchange rate), dollar demand rises because the volatility raises the covariance between marginal utility and the exchange rate, that is, the asset pays off even more when the marginal utility is high.

5.3.1. *Mechanism.* International interest rate risk has been noted to be an important driver of emerging market business cycles (Neumeyer and Perri, 2005; Gertler et al., 2007).

An increase in foreign interest rates triggers a Dornbusch-like depreciation in the local exchange rate. In a classical model where Uncovered Interest Rate Parity (UIP) holds, depreciation comes from the parity condition. Equations (20) and (19) in this model serve a similar purpose. Even without deposit dollarization, the foreign currency credit channel induces depreciation through Equation (19). Entrepreneurs are indifferent to borrowing from either source. A rise in foreign interest rates does not directly impact local currency borrowing but elevates the cost of funds from abroad. To maintain equilibrium, the exchange rate depreciates. Equation (32) shows various effects of exchange rate depreciation on the household. The cost of imported goods rises, escalating the price level (income). This shift in the relative price of foreign goods is unfavorable for households, being net buyers of foreign goods and net sellers of domestic goods. The second channel operates through balance-sheet effects. Post-depreciation, entrepreneurs face increased interest rate costs if they borrowed in foreign currency. Reduced net worth results in diminished investment, leading to lower production and wages. At the same time, dollar deposits provide a perfect hedge against foreign interest rate

TABLE 5
BENCHMARK AND POLICY ECONOMIES

Variable	Benchmark	Policy
Deposit dollarization $\left(\frac{f}{f+d}\right)$	0.48	0.13
Credit dollarization $\left(\frac{b_f}{b_f+b_l}\right)$	0.52	0.22
External borrowing ratio $\left(\frac{b_f}{f}\right)$	1.15	1.91
Trade balance $\left(100 * \frac{NX}{Y}\right)$	0.15	0.23
$\rho\left(\frac{Y_t}{P_t}, \frac{S_t}{P_t}\right)$	−0.20	−0.19

NOTE: First column represents average dollarization in an emerging economy and the second column is the outcome after introducing the policy to limit dollarization.

risk because its returns are high when foreign interest rates are high and the exchange rate depreciates.

$$\overbrace{P_t}^{\text{Income}\uparrow} C_t + d_t + f_t = \overbrace{w_t l_{h,t}}^{\text{Balance Sheet}\downarrow} + d_{t-1}R_{t-1} + f_{t-1}\overbrace{\frac{S_t}{S_{t-1}}R^f_{t-1}}^{\text{Insurance}\uparrow}. \tag{32}$$

6. POLICY EXPERIMENT

In this section, I evaluate the impact of restricting deposit dollarization in emerging markets. Policymakers in these economies are concerned about imbalances caused by household dollarization in the banking system, specifically credit dollarization it induces, leading to potential "balance-sheet effects" during economic downturns. Therefore, a plausible policy to curb credit dollarization involves discouraging households from saving in dollars, thereby aiding firms in obtaining local currency loans. I propose a policy that converts all household savings into pesos at the current exchange rate and compare it to the benchmark.[25] In the new economy, the level of dollar deposits in the nonstochastic steady state is reduced to zero ($\bar{f}^* = 0$), and peso deposits equal the total deposits in the benchmark ($\bar{d}^* = \bar{f} + \bar{d}$). Although households can still hold dollar deposits in the stochastic steady state, portfolio adjustment costs limit substantial accumulation. The welfare insights presented may not cover all potential impacts; that limiting dollarization could have broader economic consequences beyond the model's scope. Nevertheless, results suggest that policymakers consider the insurance role of dollar deposits along with potential costs when contemplating macroprudential reforms to limit dollarization.

Table 5 summarizes the degree of dollarization in benchmark and policy economies. The benchmark economy is calibrated to match Peru's average dollarization, whereas the policy economy introduces measures to restrict dollarization. The results suggest that limiting dollar deposits reduces welfare at the current calibration. However, I demonstrate in Subsection 6.2 that limiting dollarization can increase welfare if the nonfinancial system is more leveraged.

The steady-state outcomes of the policy economy can be seen in Table 6. The policy manages to reduce both deposit and credit dollarization as well as exchange rate volatility. Lower credit dollarization lowers the investment volatility (−7.24%). However, consumption volatility goes up significantly (4.8%) since households lose the asset that protects them against income fluctuations. Higher consumption volatility lowers welfare (−0.1% in consumption units). Consumption goes up slightly as savings decline with slightly lower interest rates.

[25] In practice, forceful conversion of dollar deposits has been used multiple times, often associated with sovereign defaults and banking crises (Arellano et al., 2016), such as the forced conversion of dollar credit and deposits in Argentina in 2001. Other measures to discourage deposit dollarization include Mexico which prohibits dollar deposits and Peru, which imposes a high reserve requirement for dollar deposits.

TABLE 6
CONSEQUENCES OF A TAX OF DOLLAR DEPOSITS

Variable	Δ Change
Consumption (C)	−0.06%
Consumption volatility ($\sigma(C)$)	4.80%
Investment volatility ($\sigma(I)$)	−7.24%
Exchange rate volatility ($\sigma(S/P)$)	−2.76%
Exchange rate (S)	0.34%
Local interest rate (R)	−0.07 (% Annual Percentage Point (APR))
Spread ($R - \mathbb{E}\Delta SR_f$)	−0.0006 (%APR)
Total savings ($d + f$)	−0.01%
Capital (K)	0.10%
Net worth (N)	−2.83%
Net worth volatility ($\sigma(N)$)	−31.59%
Welfare (ΔU)	−0.10%

NOTE: The comparison is made with respect to the benchmark economy as reported in Table 5.

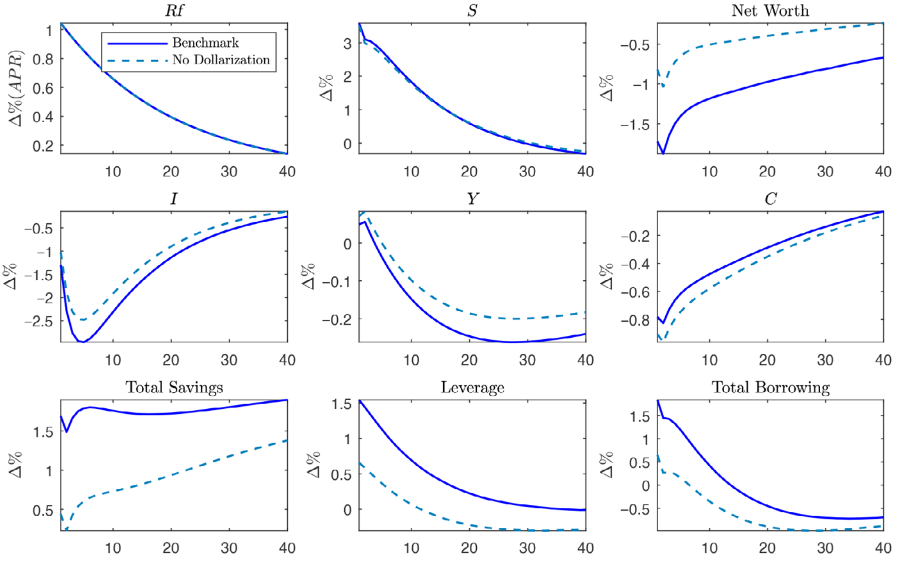


FIGURE 14

IMPULSE RESPONSE TO FOREIGN INTEREST RATE SHOCK

Entrepreneurs also lose from the policy since their net worth goes down (−2.83%) but their net worth volatility also goes down (−31.59%).

Another outcome of introducing the policy to prevent dollar deposits is that trade balance improves from 0.15% to 0.23% (Table 5). Total savings go down and entrepreneur net worth declines; hence, the economy ends up borrowing more and to compensate that trade balance has to go up through Equations (22) and (23).

6.1. *Balance-Sheet Effects versus Insurance.* An important concern regarding dollarization is "balance-sheet effects" that follow an exchange rate depreciation because firm revenues are in local currency but their debt is in foreign currency. Figure 14 plots responses of a "dollarized" benchmark economy and a "nondollarized" policy economy to an increase in foreign interest rates. Both economies experience reduced consumption and exchange rate depreciation. The dollarized economy witnesses a nearly 2% collapse in entrepreneur net worth, resulting in a 3% investment decline and a more significant decline in output (−0.25%

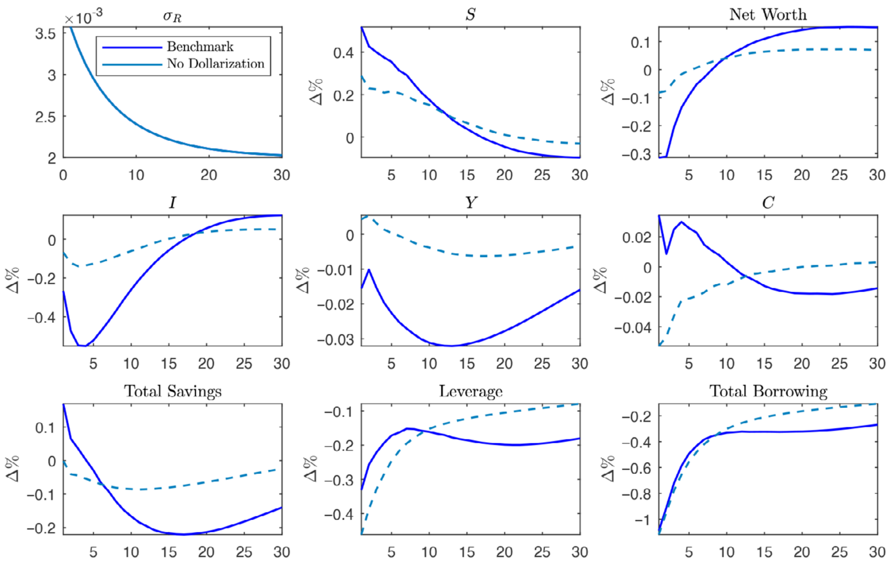


FIGURE 15

IMPULSE RESPONSE TO VOLATILITY SHOCK

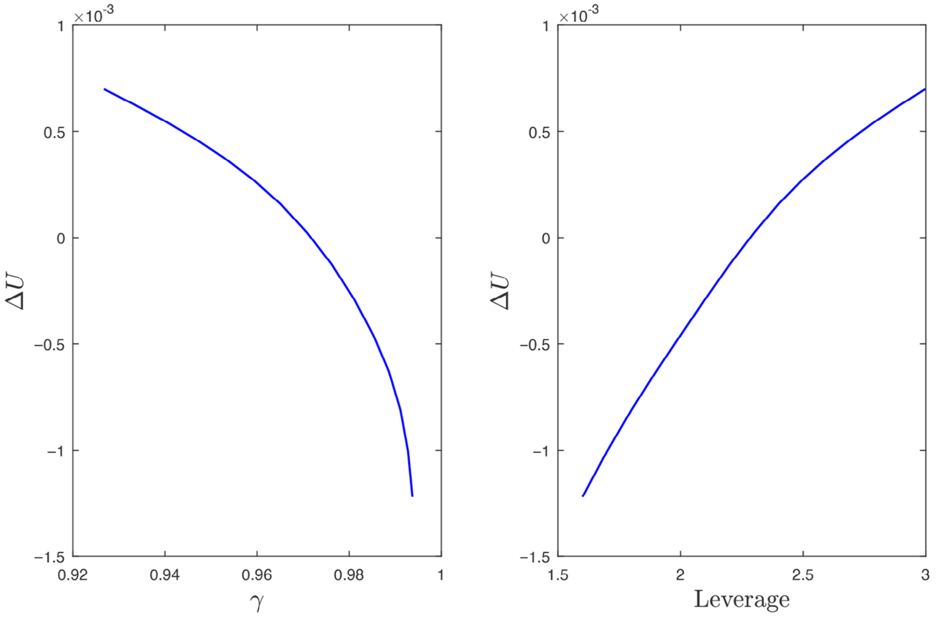
vs. −0.2%). But the depreciation benefits household wealth due to dollar savings, so that consumption is less affected. Dollarized economy sees an increase in borrowing, mostly financed by increased domestic savings. Conversely, the savings increase in the nondollarized economy does not compensate for the net worth decline, causing a drop in borrowing.[26]

I repeat the exercise with a two-standard deviation shock to the foreign interest rate volatility ($\sigma_{R,t}$). Figure 15 displays the responses of the two economies. Investment and output decline more in the dollarized economy due to balance-sheet effects, whereas consumption increases slightly (0.04%) compared to a slight decline (−0.05%) in the nondollarized economy. Both economies experience a 1% decrease in total borrowing, but in the dollarized economy, savings initially rise, indicating a shift from local to foreign assets.

Notably, both economies see reduced leverage following an increase in uncertainty, leading to capital outflows during periods of high global uncertainty, aligning with Bruno and Shin (2013), which links high VIX to low global capital flows.

6.2. *Robustness.* In the previous section, I show that limiting dollarization reduces household welfare in the benchmark setting. However, this section investigates whether, under different parameters, limiting dollarization can actually enhance welfare. Initially, I explore how variations in steady-state leverage affect the outcomes by altering the parameter γ_e (entrepreneur survival rate). Lower γ_e prompts more entrepreneurs to retire, reducing net worth and boosting borrowing relative to net worth, resulting in higher leverage. To ensure comparability, I adjust portfolio targets ($\bar{d}$ and $\bar{f}$) to maintain the same levels of dollarization as the benchmark economy. In Figure 16, it is evident that the welfare gains from limiting dollarization increase monotonically with higher leverage in the nonfinancial system. Notably, household welfare improves when dollarization is prevented with leverage above 2.4 in the current parameters. In practice, Peru exhibits a leverage of 1.75, and Turkey's is 2.04 (Dalgic, 2020). This finding reconciles with Bocola and Lorenzoni (2020), where they suggest that dollarization in highly leveraged banking systems can have adverse consequences. Finally, Figure 17(b)

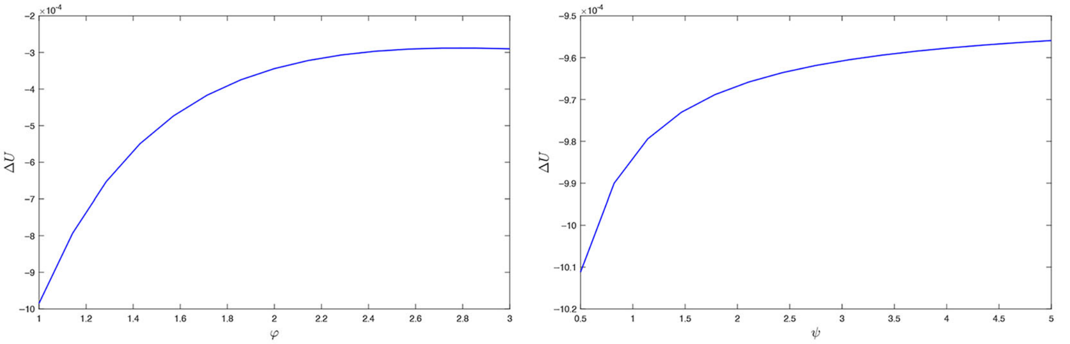
[26] In Appendix Subsection A.10, I emphasize that balance-sheet effects are more pronounced in highly leveraged economies, leading to even lower investment. This highlights the impact of leverage, and low leverage in emerging market nonfinancial systems helps them withstand exchange rate fluctuations.



NOTES: For every level of leverage, I calculate $(\gamma_e, \bar{d}, \bar{f})$ to also target the benchmark credit and deposit dollarization in the stochastic steady state to assure that the economies are comparable with respect to dollarization; however, in each economy, the leverage of the entrepreneurs is different.

FIGURE 16

WELFARE GAINS FOR LIMITING DOLLARIZATION AS A FUNCTION OF STEADY-STATE LEVERAGE



(a) Changing export demand elasticity

(b) Changing investment adjustment costs

FIGURE 17

WELFARE GAINS FOR LIMITING DOLLARIZATION

shows how high investment adjustment costs decrease (slightly) welfare losses associated with limiting dollarization. The downside of credit dollarization is that it makes investment more volatile and high investment adjustment costs lead to more resources spent due to volatile investment. In summary, while limiting dollarization reduces welfare in the benchmark setting, it can enhance welfare in economies with increased financial amplification due to either higher leverage or higher investment adjustment costs.

Similarly, Figure 17(a) illustrates how altering export demand elasticity affects the welfare gains of dollarization. Lower elasticities result in greater welfare losses as exports fail to respond to exchange rate fluctuations. In contrast, higher elasticities indicate robust expenditure switching, countering adverse economic effects caused by exchange rate fluctuations. In economies with slow export responses to exchange rate changes, lower elasticity, as suggested by recent research (Gopinath et al., 2020), is more relevant, aligning with findings in emerging markets (Akinci, 2021; Camara et al., 2023).

7. CONCLUSION

In emerging economies, a substantial portion of financial intermediation occurs in foreign currency, often viewed as a financial system vulnerability. Foreign currency borrowing by firms is believed to trigger "balance sheet effects" during economic downturns when exchange rates depreciate. However, this article argues that a significant portion of foreign currency use can be attributed to an "insurance arrangement," where households save in foreign currency to hedge against economic downturns. This is because foreign currency savings gain value precisely when households face negative income shocks. The article suggests that: (i) the "insurance arrangement" explains "high dollarization" in emerging economies, and (ii) "dollarization" may not be as detrimental as policymakers fear, as gains from the "insurance arrangement" outweigh losses from "balance sheet effects."

The main empirical facts that we observe are as follows: (i) credit and deposit dollarization are correlated in the cross section and comove across time; (ii) higher dollarization is associated with higher interest rate spread both in the cross section and across time, and (iii) dollarization is higher in economies where the correlation between consumption and exchange rate movements is negative.

The article formalizes the concept of dollarization as an "insurance arrangement" in a small open economy model with financial frictions, where local interest rates and exchange rates are endogenously determined, and dollarization emerges endogenously. The model addresses the concern that entrepreneurs' balance sheets are adversely affected by exchange rate depreciations due to revenue and debt denomination mismatch. Simultaneously, it captures the insurance aspect of dollarization, where an exchange rate depreciation boosts the value of household savings in foreign assets, providing insurance against the adverse effects of depreciation.

I show that restricting dollarization, particularly deposit dollarization, has counterproductive outcomes. Such policies disrupt the "insurance arrangement," resulting in welfare loss and increased consumption volatility, despite lowering exchange rate and investment volatility. In addition, an economy with restricted dollarization becomes more susceptible to foreign shocks, as the household hedging mechanism, the "insurance arrangement," breaks down. However, in highly leveraged economies, limiting dollarization may have more positive effects by stabilizing investment. Certain important aspects of dollarization are not included in the model, such as effects on inequality or interaction with monetary policy. Overall, this article suggests that policymakers should take into account the insurance role of dollar deposits alongside potential costs when considering macroprudential reforms to limit dollarization.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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