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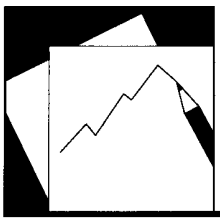

IMF Working Paper

Revisiting the Concept of Dollarization: The Global Financial Crisis and Dollarization in Low-Income Countries

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Revisiting the Concept of Dollarization: The Global Financial Crisis and Dollarization in Low-Income Countries

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Abstract

The economic literature has examined deposit dollarization in nominal terms, typically focusing on the ratio of foreign currency deposits to broad money. However, while private agent demand for foreign currency may remain unchanged in foreign currency terms, there could be large fluctuations in the dollarization ratio simply due to exchange rate movements. This paper proposes a new approach to measuring dollarization that removes these exchange rate effects, and demonstrates that beyond the variance of inflation and depreciation, the level of inflation and size of depreciation also matter for dollarization. While dollarization in nominal terms surged during the recent global financial crisis, there was a downward trend in real terms. Employing a set of econometric estimators, this paper investigates whether "real" dollarization during 2006–09 was associated with the crisis, and the role of initial macroeconomic conditions, quality of institutions, risk aversion, and prudential measures. We find that exchange rate appreciation and reductions in sovereign risk do moderate dollarization; but the results for global volatility have low statistical significance, perhaps because global shocks tend to preserve, to a large extent, relative attractiveness of foreign assets. Nonetheless, estimated impulse-response functions point to a large but short-lived positive impact of global volatility on dollarization, which could reflect economic agents heightened concerns about spillover effects of global uncertainty on the domestic economy.

JEL Classification Numbers: C33, E50, G01, G11, and G20.

Keywords: deposit dollarization, financial crisis, GMM, impulse response, flight to quality.

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Contents Page

I. INTRODUCTION

This paper proposes a new approach for analyzing dollarization that abstracts from the value-effect of exchange rate movements. The literature has focused on explaining the dollarization ratio in nominal terms, where foreign currency deposits (FCDs) are converted to local currency using the exchange rate and deflated by either broad money or total deposits (all in local currency terms). However, a key drawback of this approach is that exchange rate movements could lead to large changes in the dollarization ratio even with an unchanged stock of FCD. Indeed, to better understand economic agents' demand for FCD, it is important to remove the effect of exchange rate movements.

Deposit dollarization is defined in this paper as the share of foreign currency deposits in total domestic deposits in the banking system. To prevent an exchange-rate bias, we remove the effect of exchange rate changes on the share of foreign currency deposits in total deposits and derive "real" deposit dollarization. A "real" deposit dollarization index is computed by converting both foreign currency deposits and bank deposits to dollars and multiplying both (back to domestic currency) by a fixed base-year nominal exchange rate.

We then examine recent trends in 'real' deposit dollarization with a particular focus on demand for FCDs in low-income countries (LICs) during the recent Global Financial Crisis. The standard argument would be that during periods of volatility, deposit dollarization tends to increase as agents seek to hold FCDs as these are typically perceived as safer assets–the typical "flight to quality" argument. This would suggest that, although economic agents in many developing countries were wary about potential spillover or second-round effects of the recent global financial crisis they still opted to increase FCDs; in this case, flight to quality concerns outweigh home asset preference.

We investigate the channels through which global financial stress affects dollarization, and the extent to which policy interventions (including capital controls and other prudential measures, when used) can limit or dampen dollarization. Understanding what drives surges in dollarization is important, given that dollarization could weaken the monetary policy transmission mechanism. Since monetary instruments mainly impact domestic liquidity, high dollarization reduces the capacity of central banks to control liquidity that could fuel consumer price inflation, particularly as monetary policy instruments, in this event, principally affect only a shrinking share of domestic currency holdings.

Given that central banks cannot act as lender of last resort (LOLR) in foreign currency, high dollarization also reduces the capacity of central banks to stem a liquidity crisis, and exposes the financial system to liquidity and solvency risks. For domestic currency deposits, the central bank could step in as LOLR since it can create domestic currency in the event of emergency, albeit with possible inflationary effects if non-sterilized. For FCDs, strictly limited international reserves are the only buffer that exists to stem a liquidity crisis. So bank runs on foreign currency deposits have much more serious consequences.

The paper focuses on LICs using monthly data spanning 2006–09. Trends in dollarization in LICs vary depending on whether it is defined in nominal or real terms. While dollarization in nominal terms surged in LICs during the Global Financial Crisis, it maintained a downward trend in real terms. For Emerging Markets (EMs), dollarization generally surged during the crisis but was higher in nominal terms. Overall, these findings suggest that exchange rate movements play an important role, with domestic currency depreciations raising the dollarization ratio even before economic agents change behavior in response to the depreciation.

Analysis of recent trends suggests that beyond the variance of inflation and depreciation (as suggested by recent literature) the level of inflation and size of depreciation also affect dollarization. This suggests that it is important to examine the level of inflation and depreciation to better understand the evolution of dollarization.

We estimate a simple linear relationship between our real dollarization index and identified factors, applying a panel system GMM estimator. We also apply the fixed effects estimator with autoregressive disturbances. Further, we estimate impulse response functions and derive variance decompositions to identify the dynamic response of (changes in) dollarization due to shocks from identified variables to quantify the relative importance of each of the shocks as a source of variation in dollarization. The results from the system GMM and the fixed effects (with AR (1) disturbances) estimators are broadly similar, indicating that our estimates do not suffer from explanatory variable endogeneity bias under the latter estimator.

Specifically, we find that deposit dollarization among LICs during the sample period was driven largely by changes in relative prices, exchange rate movements, global volatility (measured by Chicago Board Options Exchange Volatility Index, the VIX) and institutional factors. Exchange rate depreciation is associated with a surge in dollarization, while a rise in VIX helps contain it. Our findings on the effect of the exchange rate regime are statistically insignificant but consistent with the Calvo-Reinhart-type fear-of-floating effects. These findings are broadly robust to alternative estimation approaches, with the exception of the VIX. We find that an increase in global risk aversion reduces real dollarization, albeit with low economic impact using the fixed effects estimator, while the results from the system GMM estimator are not statistically significant. Impulse response analysis, using panel vector autoregression (PVAR), yielded results that indicate that shocks to VIX, relative prices and exchange rate have strong, significant but short-lived impact on real dollarization. The findings of a positive, albeit short-term, relationship between the VIX and dollarization suggests that in the face of global financial volatility, domestic residents increased their dollar holdings due to uncertainty about the spillover effects of the crisis—flight-to-quality outweighs home asset preference.

The rest of the paper is organized as follows. Section II discusses the measurement of deposit dollarization, and Section III compares deposit dollarization using the traditional approach

and the new concept of "real" dollarization, and examines recent trends in dollarization. Section IV reviews the literature on dollarization and outlines the contributions of this paper to the literature. Section V outlines the theoretical model that informs our approach—a version of the portfolio balance model, while section VI presents the estimated panel econometric models and summarizes our empirical results. Section VII concludes the paper with a summary of the findings and a discussion of policy implications.

II. MEASURING DEPOSIT DOLLARIZATION

Dollarization can take various forms, including transacting, storing financial assets/liabilities and/or indexing prices in foreign currency—usually in dollars. Since monetary authorities are usually not able to perfectly monitor foreign currency circulating in their economies, it is difficult to obtain an accurate measure of foreign currency transactions ("payments dollarization").

The literature has typically computed the deposit dollarization ratio in nominal terms as a ratio of FCDs to broad money or total deposits.[2] Data on FCDs and other monetary aggregates including broad money are typically compiled by the Central Bank and presented in local currency terms. However, unlike domestic currency or deposits that are in local currency, the FCDs are in different foreign currencies but are converted to local currency terms. However, exchange rate movements could lead to big swings in the dollarization ratio even with constant stock of FCDs in foreign currency terms. For example, if there are 70 units of FCD and 30 units of local currency deposits (LCD) and the currency depreciates by 10 percent, the FCD goes up from 70 to 77 units in local currency terms. Since the LCD remain unchanged, there are now 107 units and the share of FCD in total is 77/107 = 72 percent, although nothing has happened to the amount of dollar foreign exchange holdings. This simple example supports the need to adjust foreign exchange holdings for exchange rate changes.

We argue that dollarization should be measured in "real" terms by abstracting exchange rate movements, and that it is important to consider the impact of identified drivers of the exchange rate adjusted FCD ratio. The "real" deposit dollarization indicator is derived as a constant-exchange rate indicator, $adj.FCD_t \Big/ (adj.FCD_t + LCD_t)$ where adjusted FCD is derived as $(FCD_t/NER_t * NER_{t==2000})$; NER is the nominal exchange rate (local currency per dollar). While the usage of the term "real" dollarization differs from its usage by Ize and Yeyati (2003) as "the extent to which prices and wages are denominated in foreign currency and as measured by the pass-through coefficient of exchange rate changes on prices, being moderate," it is consistent with Garcia-Escribano and Sosa (2011) who compute deposit and credit dollarization at constant exchange rates.

[2] See for example Honohan *et. al.* (2005) and Reinhart *et. al.* (2003).

In addition, we argue that the dollarization ratio should be measured using deposits as opposed to broad money. Estimates of deposit dollarization using broad money do not adequately measure economic agents' preference for foreign currency. For example, using broad money makes it difficult to ascertain whether the reported dollarization ratio reflects preference for deposits or currency. It also suffers from likely measurement errors, due to paucity of data on foreign currency in circulation.[3] In contrast, with our measure (using total deposits as the denominator)[4] a high share of deposit dollarization implies that residents consider the relative preference for holding deposits in foreign currency versus domestic.

III. Recent Trends In Deposit Dollarization

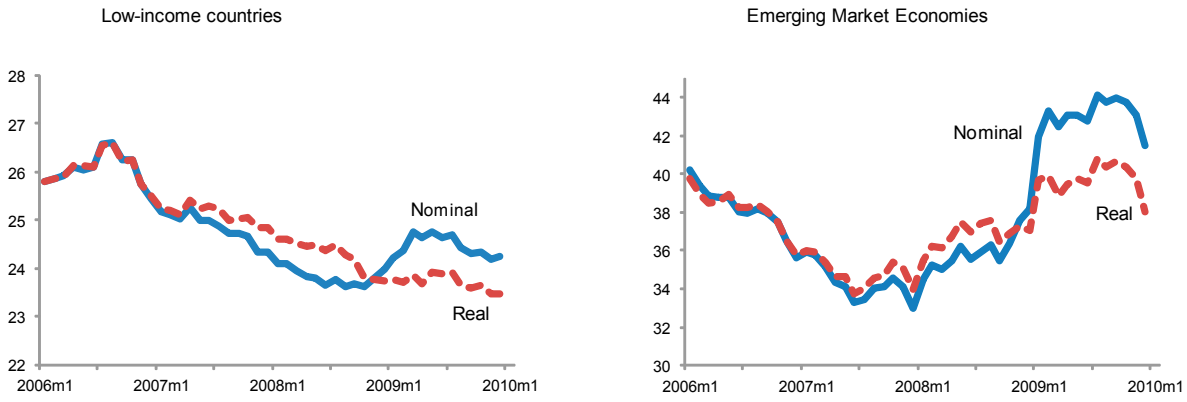
Analysis of the trends in deposit dollarization ratio indicate differing patterns depending on whether it is computed in "real" or nominal terms (Figure 1). Specifically, there was a surge in the dollarization ratio in nominal terms during the global financial crisis. In contrast, the ratio computed in real terms points to a continued decline in dollarization in LICs while a smaller increase than in nominal terms is observed for EMs. At the same time, "real" dollarization was less volatile (i.e. showing lower swings) than when measured in nominal terms (Figure 3). While the observed decline in "real" dollarization in LICs was more accentuated, the increase in EMs was relatively dampened/moderated (Figure 1). The list of countries included in the analysis is presented in Appendix Table A1.

The finding that dollarization (both in levels and percent changes) is lower in "real" terms is attributable to the large exchange rate depreciations that some countries experienced during the crisis. In many of the countries considered, despite the gradual correction, the exchange rates remain more depreciated and volatile than in the pre-crisis period, resulting in the exchange rate being typically lower than in the base year. For example, the large increase in dollarization ratios in Ghana and Zambia during the global financial crisis is partly explained by large exchange rate movements (Figure 2).

[3] Since we do not have an accurate estimate of foreign currency circulating in an economy at any point in time, the denominator is likely to be biased as well. Further, the ratio will be biased by other factors, including domestic agents' preference to hold currency and therefore not reflect a clear picture of preference for holding foreign currency deposits over domestic deposits. See Savastano (1996) for more details.

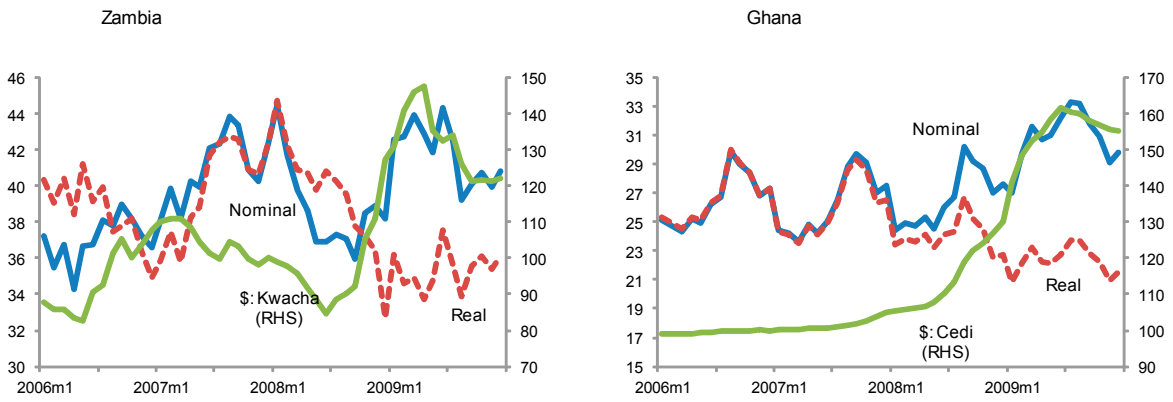
[4] In this definition, only deposits captured in broad money, and therefore expected to affect aggregate demand, are included.

Figure 1. Trends in Deposit Dollarization, 2006m1-2009m12
(In percent)



Source: IMF International Financial Statistics (IFS) database.

Figure 2. Ghana and Zambia: Trends in Deposit Dollarization, 2006m1-2009m12
(In percent)

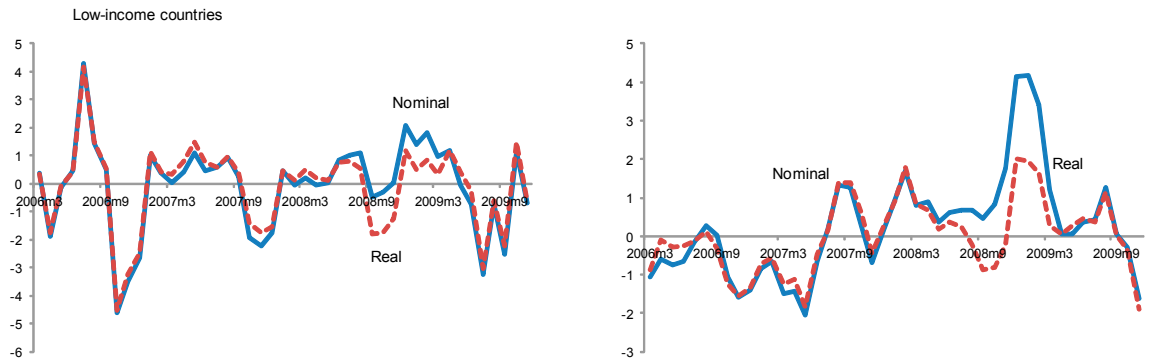


$ per Kwacha rebased to 100 in 2006m10

$ per Cedii rebased to 100 in 2006m10

Source: IMF International Financial Statistics (IFS) database.

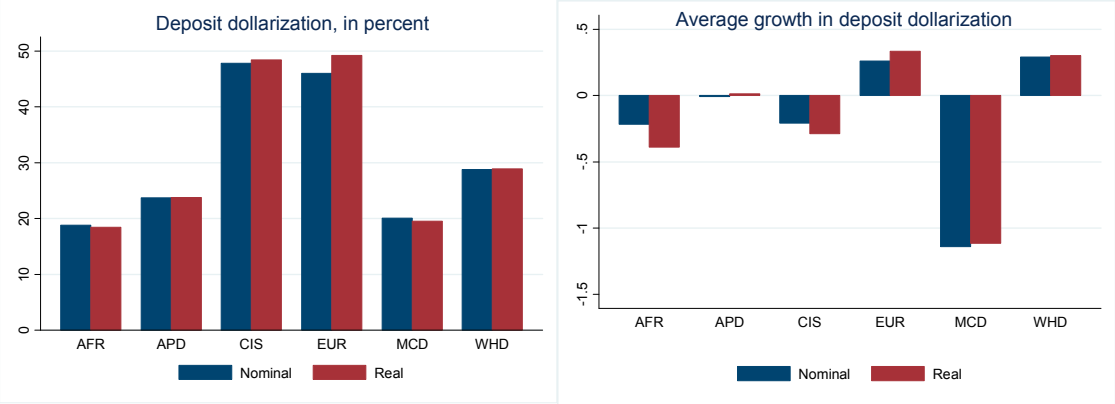
Figure 3: Surge in Deposit Dollarization, 2006m3-2009m11
(Percent change, three-month moving average)



Source: IMF International Financial Statistics (IFS) database.

Further, visual analysis suggests that regional characteristics and institutional factors could help explain the deposit dollarization. Sub-Saharan Africa (SSA) and Middle East and Central Asian LICs have the lowest deposit dollarization ratios (real and nominal) but also the largest declines during the financial crisis (Figure 4).[5]

Figure 4. LICs: Deposit Dollarization, by Region, 2006m1-2009m12



Source: IMF International Financial Statistics (IFS) database and author's estimates.

Scatter plots suggest that the surge in dollarization in LICs is negatively correlated with global volatility, the VIX (Figure 5). Specifically, Figure 5 provides a comparison of the relationship between dollarization growth (both real and nominal) and the VIX for LICs and EMs. While there is a negative correlation for the entire LIC sample, a closer analysis of the relationship for select LICs (e.g., Zambia, Nigeria, Kenya and Ghana) suggests some heterogeneity across countries, even for those that had greater access to capital markets (Figures 5 and 6). There is no clear relationship between dollarization and the VIX in emerging market economies (Figure 5).

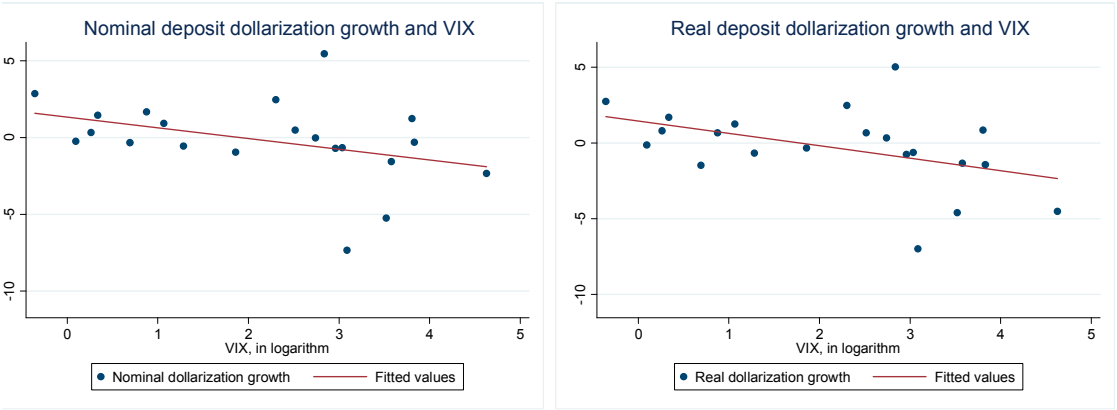
The negative relationship suggests that when global volatility increases, deposit dollarization declines, which somewhat seemingly contradicts conventional wisdom of flight to quality but could be due to heightened home asset preference during global uncertainty. However, many LICs were not directly exposed to the global financial crisis and have limited financial integration. Another plausible explanation for this finding could be that domestic economic agents had less information about spillover effects of the financial crisis and thus did not adjust their balances. However, this explains the absence of a positive relationship and not of the negative. This could reflect the impact of global shortage of U.S. dollars and could have contributed to outflows. The impact took many channels including curtailing of private capital flows (e.g., in Uganda and Zambia); capital flight and portfolio inflow reversals in

[5] The average surge in deposit dollarization is computed by taking the average during periods when the dollarization growth rate was increasing (i.e., greater than zero percent).

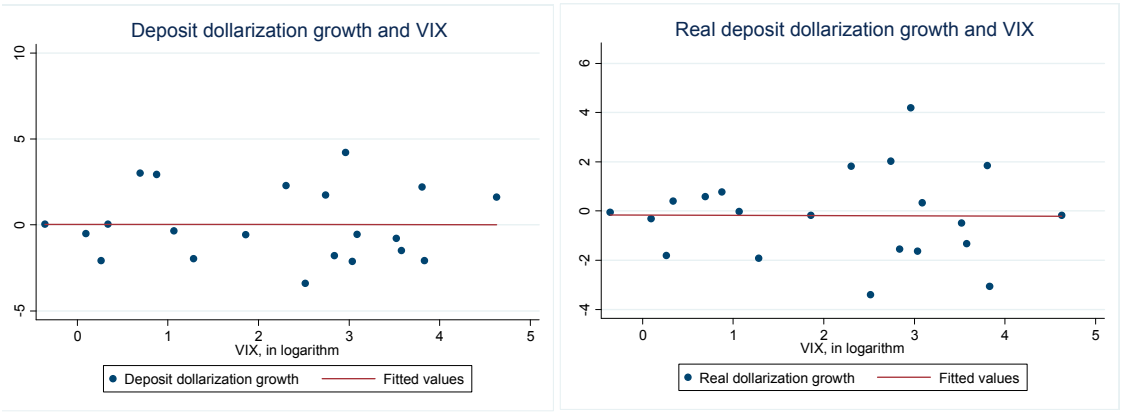
foreign-owned banks—even in countries with capital account restrictions—and reflecting this, a drop in trade of local debt by foreign investors, a collapse in trade financing and stock markets.[6]

Figure 5. LICs and EMs: Deposit Dollarization Growth and Global Risk Aversion, 2006m1-2009m12

Low-income countries



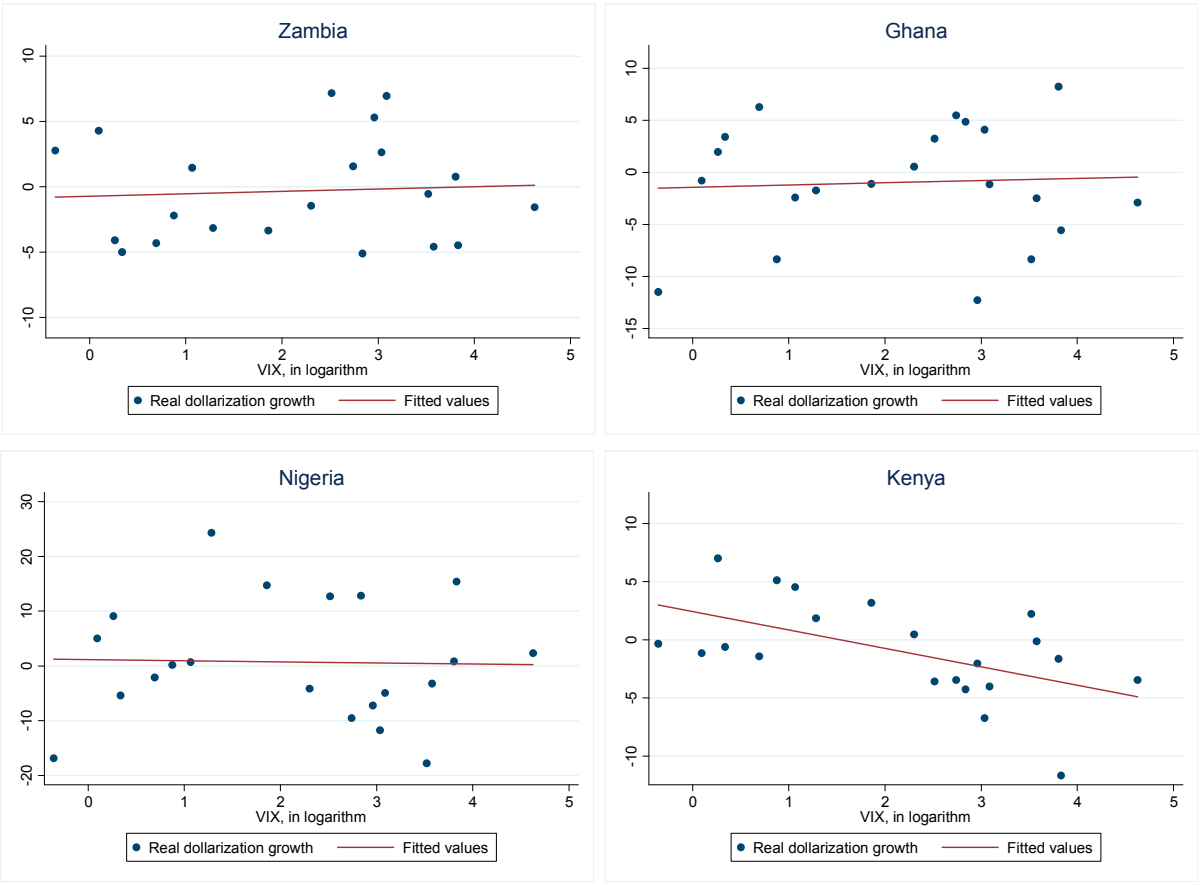
Emerging market economies



Source: IMF International Financial Statistics (IFS) database, Chicago Board Options Exchange (CBOE) Volatility Index, and author's estimates.

[6] The Emerging Markets Trading Association (EMTA) reports that between Q2 and Q3 of 2008, local debt trade by foreign investors declined by 71 percent in LICs compared to only 22 percent for EMs. In addition, LICs volume of trade financing dropped by 18 percent in the last quarter of 2008, while the Merrill Lynch Africa Lions index, which tracks 15 African countries, declined by almost 70 percent during March–December 2008. See IMF, 2009.

Figure 6. Selected Countries: Deposit Dollarization Growth and Global Risk Aversion, 2006m1-2009m12

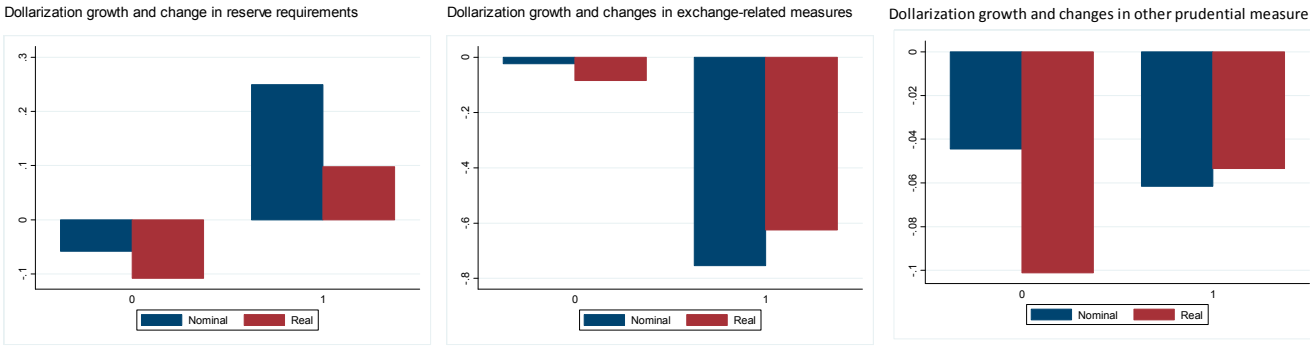


Source: IMF International Financial Statistics (IFS) database, Chicago Board Options Exchange (CBOE) Volatility Index, and author's estimates.

Changes in prudential measures during the global financial crisis had significant effects on dollarization in low-income countries (Figure 7). While dollarization ratios declined in both LICs that introduced changes exchange rate-related measures and those that changed other prudential measures, there was a bigger decline in real terms for those that introduced changes in the former. However, this is an instantaneous relationship and does not capture the dynamic effects of changes in prudential measures; neither does it distinguish between an increase or decrease in trend.[7] Many developing countries introduced controls on lending locally in foreign currency and raised reserve requirements at the onset of the global financial crisis to build resilience against these external financial shocks, but most countries removed these controls shortly thereafter (Figure 8). Indeed, examination of country practices regarding current and capital controls indicates that changes to these, as well as controls of foreign exchange accounts permitted domestically, were the most commonly adopted during the period.

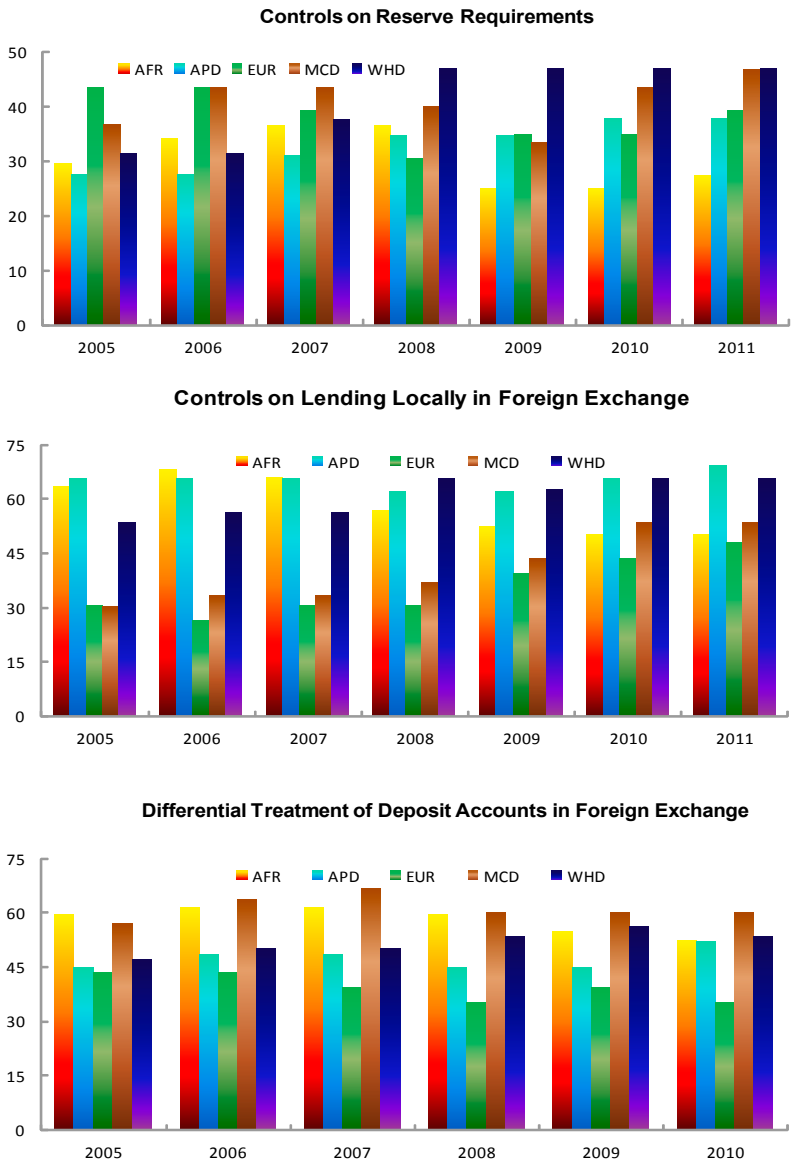
[7] Reserve requirements require banking institutions to hold a fraction of their deposit liabilities at the Central Bank in the form of cash or highly liquid sovereign paper. The regulation usually specifies the size of the requirement according to currency denomination (domestic or foreign currency) and maturity.

Figure 7. LICs: Deposit Dollarization Growth and Change in Prudential Measures, 2006m1-2009m12



Source: IMF International Financial Statistics (IFS) and IMF ARAER databases and authors' estimates.

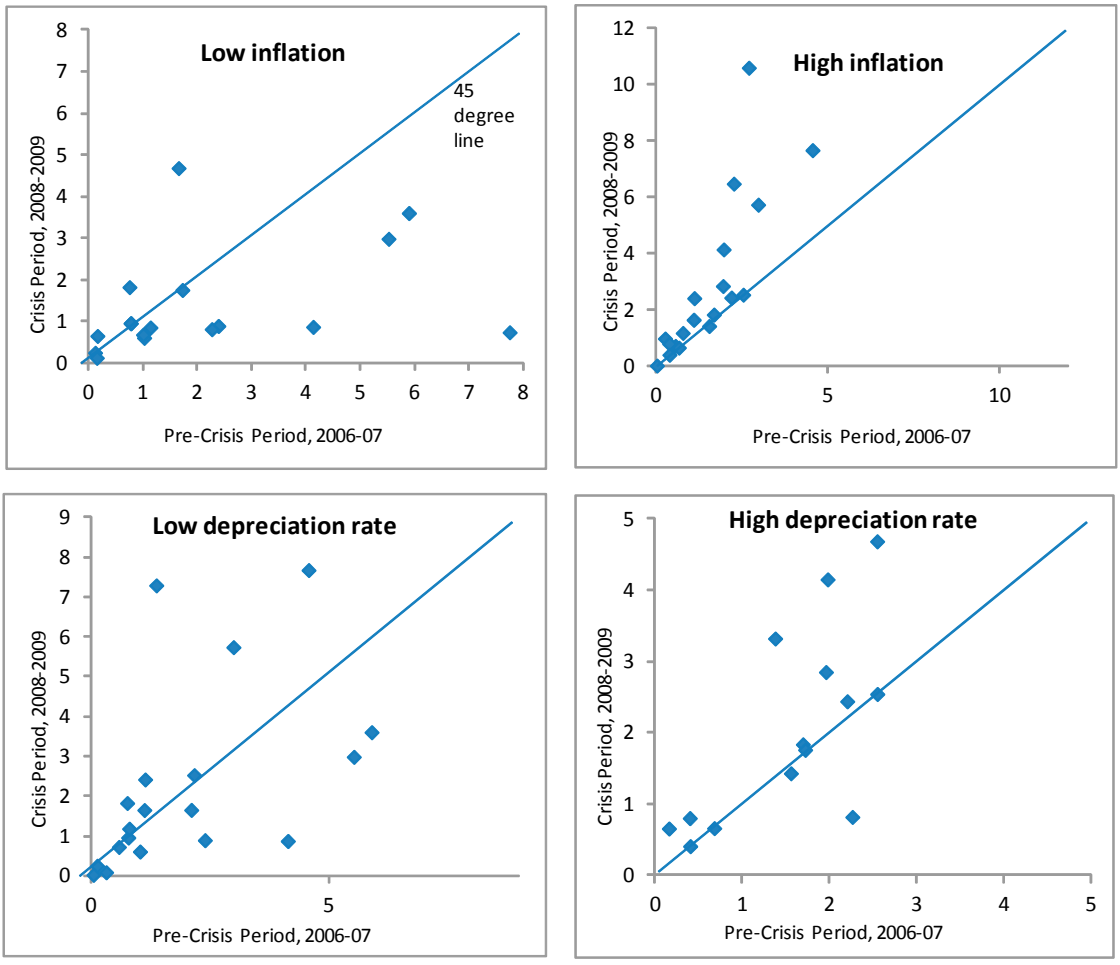
Figure 8. Current and Capital Account Controls, 2005-2011
(Percent of Countries)



Sources: IMF AREAER database; and staff estimates

Visual analysis suggests that beyond the variance of inflation and depreciation (as suggested by the literature) the level of inflation and size of depreciation also affect (nominal) dollarization (Figure 9). Countries that had high inflation or depreciation rate prior to the global financial crisis experienced an increase in the variance of dollarization during the crisis. In contrast, countries that went into the crisis with lower inflation tended to experience a reduction in the variance of dollarization. The findings for low dollarization suggest that it remains broadly unchanged except for a few outliers. In addition, the analysis suggests that countries that started off with high depreciation or inflation tended to experience a bigger increase in the variance of dollarization. This suggests that it is important to examine the level of inflation and depreciation to better understand the evolution of dollarization.

Figure 9: Variance of Nominal Dollarization, by inflation and depreciation
(Standard deviation of dollarization)



Source: IFS database, IMF, and author calculations

Notes: Standard deviation is computed by country for pre-crisis (2006-07) and crisis (2008-09) periods.
1/A country is included in the high inflation (depreciation rate) sample if its median monthly inflation (depreciation) in 2006 is higher than the sample median.
2/ In the low inflation case and also low depreciation rate: Armenia is excluded from the chart, it is an outlier with a deviation of about 10 percent pre-crisis and about 15 percent therafter.

IV. LITERATURE REVIEW

The causal factors discussed in the literature that relate to the short-run drivers of dollarization could be grouped into five broad categories:

- *Price movements that affect store of value:* Concerns about loss in value of financial assets lead residents to hold a large proportion (or all) of these assets in foreign currency. A variety of models have been developed to explain this economic behavior. The main thrust of the results from these models is that inflation and/or exchange rate depreciation reduce the real value of financial assets, and therefore if residents (households/banks) expect either of these to occur they may choose to hedge this risk by holding their assets in foreign currency.[8] Ize and Levy-Yeyati (2003, 2005) highlight the importance of the relative volatility of inflation and the exchange rate.

- *Relative rates of return:* Some studies have pointed to the role that spreads between domestic and foreign interest rates could play in economic agents' decision to switch demand between local and foreign currency holdings. However, to the extent that these differentials partly reflect expectations of exchange rate movements, these two factors (interest rate spreads and exchange rate movements) could be interrelated, as consistent with uncovered interest parity.[9]

- *Institutions and policy credibility:* Concerns about potential collapse of the financial system and exchange rate regime as well as the possibility of debt default could increase dollarization. Ize and Parrado (2002) note that the preference for holding foreign currency could be determined by expectations about how monetary policy would be conducted in the event of a collapse of a fixed exchange rate regime regardless of the probability of the collapse occurring.[10] Institutional factors including political, the legal and even the cultural environment as well as the level of fiscal discipline are also be important factors.[11] Concerns about fiscal sustainability could affect the expected probability of a devaluation arising from plausible monetization of the fiscal deficit.[12] In addition, if residents believe that the government would provide a bailout in the event of a sharp depreciation of the domestic currency they may

[8] See Rennhack and Nozaki (2006) on the role of asymmetric exchange rate policy in asset portfolio choice.

[9] See for example, Basso, Calvo-Gonzalez, and Jurgilas (2011), Savastano (1996) and Sahay and Vegh (1996).

[10] See also Jeanne (2003) and Calvo and Guidotti (1989) for additional examples of implications of lack of monetary credibility on dollarization.

[11] For example, Nicolo, Honohan, and Ize (2005) suggest that shifting from highly restrictive to completely unrestricted or liberal political system increases uncertainty and risk, and induces shifts in agent portfolios in favor of foreign assets.

[12] See Aizenman *et. al.* (2005), Doblas-Madrid (2009), and Honig (2009).

borrow in foreign currency and not internalize the currency risk, thus leading to higher dollarization.[13]

- *Macroprudential tools:* More recently, the literature has explored the role of macroprudential measures to reduce the incentive for banks to borrow externally when domestic interest rates are raised (e.g., capital controls, reserve requirements and other prudential measures).[14]

V. THE THEORETICAL MODEL

Models of currency substitution or dollarization (particularly, of deposit dollarization) have as a basis some aspect of a portfolio balance model as discussed for example in Kouri (1976), Calvo and Rodrguez (1977) and Branson and Hendersen (1985). Following the lead of these researchers, suppose wealth can be held in the form of domestic money, domestic bonds and foreign bonds denominated in foreign currency, such that the demand for foreign bonds is an implicit demand for foreign currency, then dollarization (deposit dollarization) would be driven by factors similar to those that drive the choice of an optimal portfolio. These factors include (i) expected movements in the value of the domestic currency, which may be sparked by fiscal and (or monetary) policy or by changes in expectations or confidence, (ii) perceptions of changes in sovereign risk, and (iii) real/technology shocks.

Following the portfolio balance approach, we discuss dollarization in the context of a simple rational expectations form of the model in equations (1)–(5) below.

$$W_t = M_t + B_t + s_t F_t \tag{1}$$

$$M_t = m(r_t, r_t^* + E[\Delta s_t] + \rho_t) W_t, \quad \mathrm{m_r} < 0,\ m_{r^* + E[\Delta s] + \rho} < 0, \tag{2}$$

$$B_t = b(r_t, r_t^* + E[\Delta s_t] + \rho_t) W_t, \quad \mathrm{b_r} > 0,\ \mathrm{b}_{r^* + E[\Delta s] + \rho} < 0 \tag{3}$$

$$sF_t = f(r_t, r_t^* + E[\Delta s_t] + \rho_t) W_t, \quad f_{\mathrm{r}} < 0, f_{r^* + E[\Delta s] + \rho} > 0 \tag{4}$$

$$\dot{F}_{\mathrm{t}} = n(\frac{s_t}{p_t}, \mathrm{Z_t}) + r_t^* F_t \qquad n_{\frac{s}{p}} > 0,\ n_z > 0 \tag{5}$$

[13] See McKinnon and Pill (1999), Dooley (2000), Schneirder and Tornell (2004); Burnside, Eichenbaum and Rebelo (2001, 2004); Aghion, Bacchetta and Banerjee (2001), and Chamon (2001).

[14] For a detailed overview of recent experiences with prudential policies, see IMF (2011a) and Terrier *et al* (2011).

Equations (1) — (5) above show that the net wealth of the private sector could be expressed as the sum of domestic money (M_t), bonds (B_t), and foreign bonds (F_t) denoted in foreign currency; s_t is the domestic price of foreign exchange. By definition, the current account balance denotes the rate of accumulation of foreign assets over time (equation 5). Domestic and foreign interest rates are denoted by r_t and r_t^*, respectively, $E[\Delta s_t]$ is the expected depreciation of the domestic currency, while ρ_t is used here to represent sovereign risk that may arise as a result of increased uncertainty about economic policy actions generally or simply from increases in risk as reflected in higher domestic interest rates. The variables are all in levels. In equation (5), domestic net savings ($n(.)$) is specified to be a function of the real exchange rate ($^{S_t}/_{p_t}$) and real/technology shocks (Z_t).

As specified, real exchange depreciations increase net savings (or the current account balance); just as real shocks do. The solution of this rational expectations specification yields, among others, the result that with constant exchange rate expectations—i.e., for $E[\Delta s_t] = 0$—expansive monetary policy and exchange rate depreciations increase demand for foreign assets – and hence the demand for foreign currency. Positive real or technology shocks that appreciate the domestic currency also reduce the demand for foreign assets – and reduce dollarization. Further, increases in sovereign risk (ρ_t) feed a flight to quality, increasing demand for foreign assets. These results can be obtained by deriving equilibrium demand schedules for the three assets in an exchange rate-foreign assets plane as follows.

Holding r_t^* and ρ_t constant and totaling differentiating equations (2) and (4) yields differential equations for the shares of money and foreign currency as

$$\begin{aligned} d(\frac{M}{W}) &= m_r dr + m_s ds \\ d(\frac{sF}{W}) &= f_r dr + f_s ds \end{aligned} \tag{6}$$

which can be solved for ds_t and dr_t as functions of relative shares of domestic and foreign assets in agents' portfolio. Thus, from the solution of equations (1) – (4), we can express the expected change in the exchange rate as a function of relative shares of assets:

$$E[\Delta s_t] = \phi(\frac{sF}{W}, \frac{M}{W}), \quad \text{where } \phi_1 > 0 \text{ and } \phi_2 < 0. \tag{7}$$

Equations (5) and 7) are dynamic equations that can be solved for the equilibrium levels and F (foreign currency) and s (the exchange rate). To obtain slopes of the respective loci for F and s in (F, s) space, we totally differentiate these equations, given $\dot{F} = 0$ and $E[\Delta s_t] = 0$ as follows:

$$\left.\frac{ds}{dF}\right|_{E[\Delta s_t]=0} = -\frac{s_t}{F_t} \quad \text{and} \quad \left.\frac{ds}{dF}\right|_{\dot{F}=0} = -\frac{r_t^*}{n_{s/p}} \tag{8}$$

Given these slopes and the behavior of foreign assets holdings and the exchange rates off their respective loci, saddle point equilibrium requires that $-s_t/F_t$ be less than $-r_t^* / n_{s/p}$ — this is the Marshall-Lerner condition, requiring that $s_t n_{s/p} / n$ be greater than one.

The equilibrium paths for F and S (given that the Marshall-Lerner condition holds) are depicted in Figures 10 and 11 below.

Figure 10. Saddle Path in S-F Space

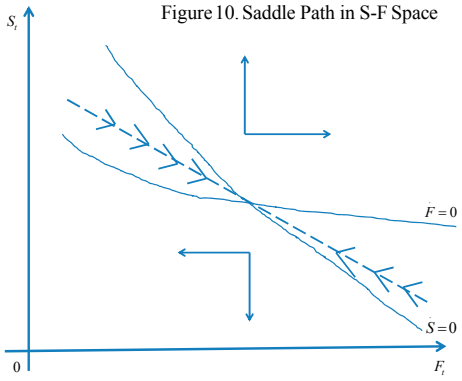
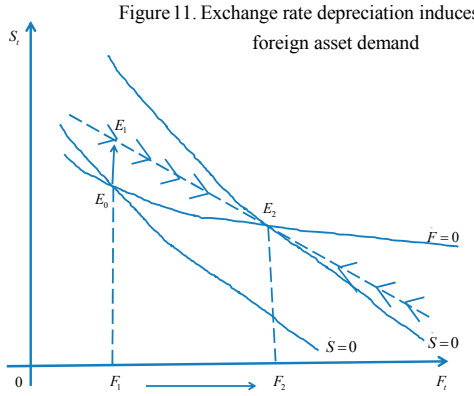


Figure 11. Exchange rate depreciation induces foreign asset demand



Note that, while exchange rate depreciation (i.e. when the domestic value of foreign currency declines) increases foreign currency demand (i.e. a movement along the $\dot{F}=0$ schedule),

(i) Positive real shocks would shift the foreign currency demand schedule upwards, reducing demand for foreign exchange;

(ii) Unanticipated expansionary monetary policy that shifts the expected depreciation schedule upwards – appreciating the domestic currency, initially – would require an offsetting exchange rate depreciation (or an increase in foreign asset holdings or dollarization) to hold $E[\Delta s_t]$ constant (Figure 11); and

(iii) Heightened uncertainty (i.e. increases in ρ_t) either about the course of short-term economic policies or about general prospects of the economy drives foreign currency demand as a safe haven for preserving wealth.

In addition to the factors explained above, it is noteworthy from the literature review that the economic policy environment (the monetary policy, prudential measures and exchange rate regime) and quality of government institutions matter in the overall economic agent decision

to hold foreign currency denominated assets; these variables are included in our empirical estimations in the sections that follow.[15]

VI. THE EMPIRICAL APPROACH AND RESULTS

Drawing on the theoretical model outlined above, we specify a dynamic linear model of the form

$$\begin{aligned} \ln y_{it} &= \alpha \ln RR_{it} + \beta \ln S_{it} + \gamma \ln VIX_{it} + \delta X_{it} + u_{it} \\ u_{it} &= \eta_i + v_{it} \end{aligned} \tag{9}$$

where y_{it} denotes our real deposit dollarization index, as defined above; RR_{it} denotes expected real returns (or an indicator, such as inflation, that affects real returns) on domestic assets relative to dollar-denoted assets; S_{it} denotes the exchange rate (defined as US dollar per domestic currency, so that an increase denotes domestic currency appreciation); VIX_{it} is a measure of global risk aversion or uncertainty; X_{it} is a set of controls (including exchange rate regime, prudential requirements, and quality of institutions); η_i is country-specific, unobservable, fixed effects; and v_{it} is serially uncorrelated errors.

The baseline model is the fixed effects estimator with autoregressive disturbances in a first estimation of the model, which is complemented with a system GMM estimator and panel Vector AutoRegression (PVAR). The fixed effects model is simpler and outperforms other models, assuming that normality conditions are satisfied.[16] However, since tests suggest that the dependent variable could be correlated with the error term (i.e., implying endogeneity of explanatory variables), the results from the fixed effects model could be biased. To address this potential endogeneity bias, we apply the Arellano and Bond (1991) system GMM estimator using as instruments appropriately lagged levels of the dependent variable and the predetermined variables. To investigate the short-term dynamics of the dependent variable to perturbations in the predetermined variables, we run panel VARs and estimate impulse-response functions and variance decompositions.

A description of the explanatory variables used in equation (9) above is presented in five broad categories in Box 1 below. Variable descriptions and summary statistics for LICs are

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[15] Indeed, Ize and Yeyati (2005) admit that "at any rate, minimum variance portfolio (MVP) explains only a limited share of dollarization in cross-country estimates of financial dollarization"; and this statement probably applies to the portfolio balance model, and perhaps all other models, as well.

[16] We assume the following: (i) explanatory variables (x_{it}), so that $E[x_{it}v_{it}] = 0$; (ii) correlated individual effects, such that $E[x_{it}\eta_i] \neq 0$; and (ii) strict exogeneity, such that $E[x_{it}v_{is}] = 0, \textit{for all } s,t.$

available in Appendix Tables A2 and A3, respectively. The empirical analysis focuses on the LICs (see Appendix Table A1).[17]

Box 1. Determinants of Surge in Deposit Dollarization

- Macroeconomic variables
  - Returns/Price differential or relative returns/prices
  - Exchange rate: depreciation (level and volatility), exchange market pressure
- Institutions
  - Bureaucracy quality (e.g., International Country Risk Guide (ICRG))
  - Entrepreneurial quality (e.g., Kauffman index of entrepreneurial activity (KIEA))
- Prudential measures
  - Reserve requirements
  - Net open positions and other exchange related measures
  - Other prudential requirements.
- Flight to quality:
  - Global risk aversion (VIX)
- Controls:
  - Level of dollarization
  - Exchange rate regime

The empirical results presented in Table 1 below suggest the following[18]:

- **Exchange rate appreciation tends to moderate deposit dollarization (Table 1).** Specifically, a one-percent appreciation in the exchange rate is associated with a 0.09–0.2 percent decrease in the real deposit dollarization ratio. These results are strongly significant and robust to model specifications and estimation approaches. A related finding supports the Calvo-Reinhardt fear-of-floating effect; specifically, countries that operated more flexible exchange rate regimes tended to experience lower dollarization, although the elasticity is not statistically significant, possibly because the effects of exchange rate regime is captured by exchange rate changes.

- **Increase in global risk aversion reduces real dollarization.** A ten percent increase in the VIX index induces a statistically significant 0. 1 percent decline in real dollarization. However, its low economic impact suggests that it is not a very important determinant of real dollarization. Moreover, the results are sensitive to the estimation strategy and are insignificant under system GMM but significant in the PVAR (see related discussions below).

[17] Only countries that report data on dollarization are included; countries with no deposit dollarization (e.g., Benin and Cameroun) are excluded. LICs are identified from the list of countries deemed eligible for concessional financing from the IMF's Poverty Reduction and Growth Trust (PRGT) as at April 8, 2013.

[18] For brevity, only the final results from the fixed effects and system GMM are presented. Alternative model specifications (e.g., including lagged dependent variable in levels and results from other prudential measures) are not shown.

Table 1. Panel Econometric Estimates of Real Dollarization in Low-Income Countries, 2006-09

Dependent variable: log. of real dollarization indicator		
Explanatory variables:	Fixed Effects *(with AR(1) disturbances)*	System GMM *(t-2)*
1. Macroeconomic variables		
Log. relative prices	0.1638**	0.1405*
	(0.0320)	(0.0680)
Log. exchange rates	-0.2226***	-0.0946***
	(0.0000)	(0.0020)
2. Institutions		
Kauffman's entrepreneurial activity indicator (KIEA)	0.1547***	0.2576***
	(0.0050)	(0.0000)
International Country Risk Guide (ICRG)	0.0106***	0.0181***
	(0.0000)	(0.0000)
3. Prudential measures		
Exchange rate related measures	-0.0205	0.8230
	(0.7220)	(0.1280)
4. Flight to quality		
Log. global risk aversion indicator (VIX)	-0.0108**	-0.0221
	(0.0110)	(0.4570)
5. Controls		
Crisis time dummy	0.0642*	0.0638
	(0.0570)	(0.5550)
Exchange rate regime	-0.0725	-0.0562
	(0.4760)	(0.6550)
Constant	0.2319***	
	(0.0000)	
Number of observations	944	989
R-squared	0.4749	
ρ----AR(1)	0.8354	
F-ratio	100.74	501.49
Prob > F	0.0000	0.0000
Sargan Test of Overidentification (χ^2)		352.9
Prob > (χ^2)		1.0000
Arellano-Bond AR(1) Test in first differences (z)		-0.6200
Prob >z		0.5320
Arellano-Bond AR(2) Test in first differences (z)		0.3300
Prob >z		0.7440

Source: IMF *World Economic Outlook* (WEO) database; and authors' estimations using panel methods in Stata.

Notes: All variables are expressed in logarithms. Figures in parenthesis are probability values, with ***, ** , and * indicating statistical significance at 1 percent, 5 percent, and 10 percent respectively.

- **Increases in sovereign risk and entrepreneurial activity increase real dollarization.** Economies with high sovereign risk classification or perception (as reflected in the ICRG score) tend to have higher real deposit dollarization. Similarly, economies with relatively high entrepreneurial activity (as reflected in the Kauffman entrepreneurial activity indicator), unsurprisingly, have higher real dollarization. In addition, increasing inflation (or volatility of inflation), which increases sovereign risk, also fuels real dollarization; this finding is corroborated by earlier work by Ize and Levy-Yeyati (2003) on financial dollarization.

- **Strengthening prudential measures during an upsurge does not moderate dollarization**; it may actually worsen the situation. Although statistically insignificant, the estimated elasticities point to a mixed impact of exchange-rate-related prudential measures on real deposit dollarization, once other macroeconomic variables are included in the regression.

To assess the dynamic responses of real deposit dollarization to the determinants of discussed above, we specify and estimate a panel VAR of the form

$$\ln y_{it} = \sum_{j=1}^{k} \alpha_j \ln y_{i,t-j} + \sum_{j=0}^{l} \beta_j \ln RR_{i,t-j} + \sum_{j=0}^{m} \gamma_j \ln S_{i,t-j} + \sum_{j=0}^{n} \delta_j \ln VIX_{i,t-j} + \eta_i + v_{it} \quad (10)$$

where the variables are as defined in equation (9) above, with the variables *RR, S* and *VIX* assumed to follow autoregressive processes with lag lengths *k, l, m,* and *n* as specified, and the optimal lag length is determined using statistical methods. The linear GMM estimator is used to estimate this equation in first differences; a simple Choleski decomposition scheme is used to identify the various shocks. One standard deviation shocks to global uncertainty (VIX), relative prices (RR), and exchange rates (S) have a strong and significant impact on real dollarization surge (Appendix Figures 7 and 8); whereas results presented in Appendix Figure 7 reflect an ordering of the variables with relative prices preceding exchange rates (in which case, relative prices determine exchange rate movements, in a purchasing power parity (PPP) fashion), those in Appendix Figure 8 are based on an ordering where the exchange rate precedes relative prices (in an exchange rate pass-through to prices fashion). The estimated results turned out to be robust to between these two specifications, although the transmission mechanisms differ. Generally, the estimated responses to a shock to one of these variables (VIX, RR, and S) tend to be large but short-lived, lasting up to about 2 months. These results are corroborated by estimated variance decompositions (Appendix Figures A4 and A5). The detailed results from the PVAR estimations are discussed below.

A one standard deviation innovation in global volatility index (VIX) increases domestic prices (and relative prices) significantly during the following five months, the domestic currency depreciates (in a PPP fashion) and real dollarization surges (first column of Appendix Figure 7). Similar results are obtained for shocks to relative prices (column 2) and

shocks to exchange rates (column 3). In Appendix Figure 8, the transmission mechanism is slightly different, but the results are basically the same. Shocks to the global volatility index (VIX), or uncertainty, depreciate the domestic currency, increase domestic prices (and hence relative prices, in an exchange rate pass-through fashion), and drive up real dollarization (column 1). On the other hand, exchange rate appreciations reduce relative prices and real dollarization, while an increase in relative prices have similar results on real dollarization as when global uncertainty increases (column 3). These results are broadly consistent with our theoretical framework and empirical results presented in Table 1 above, with the exception of the VIX. The findings of a positive, albeit short-term, relationship between the VIX and dollarization suggests that in the face of global financial volatility, domestic residents may increased their "dollar" holdings due to uncertainty about the spillover effects of the financial crisis. In addition, the findings could reflect the fact that many LICs were not adversely affected by the global financial crisis.

VII. Conclusion and Policy Implications

This paper uses an approach to measuring deposit dollarization that adjusts foreign exchange deposits for fluctuations in exchange rates in order to capture actual changes in these deposits that are due exclusively to changes in behavior of economic agents. Since exchange rate movements affect the domestic currency value of foreign currency holdings or deposits, exchange rate movements could bias any measure of dollarization if not corrected for these movements. Indeed, as this paper shows, exchange rate changes (or more appropriately, expectations about these) could affect economic agent behavior *ex ante*. The import of our measure is to remove the *ex post* effects of exchange rate movements on foreign currency holdings or deposits due to measurement effects of exchange rates. Using this new definition of dollarization provides a different assessment of the trends in dollarization in LICs. Specifically, instead of a surge in dollarization, we find a continued decline in real dollarization ratio in LICs. In addition, the paper demonstrates that beyond the variance of inflation and depreciation, the level of inflation and size of depreciation also matter for dollarization.

This paper examines, using panel econometric methods, the responses of *real* dollarization in low-income countries to innovations in underlying factors, such as relative prices, exchange rates, global (as well as country-specific sovereign) risk or uncertainty. The results from the first two (fixed effects and system GMM) estimators suggest that (i) countries that had higher sovereign risk and entrepreneurial activity (as reflected in the Kauffman entrepreneurial activity indicator) exhibited higher surges in real dollarization; and (ii) exchange rate appreciation and declines in relative prices had dampening effects on real dollarization. However, exchange-rate-related macroprudential measures did not have statistically significant effects on dollarization, once other macroeconomic and institutional factors were controlled for.

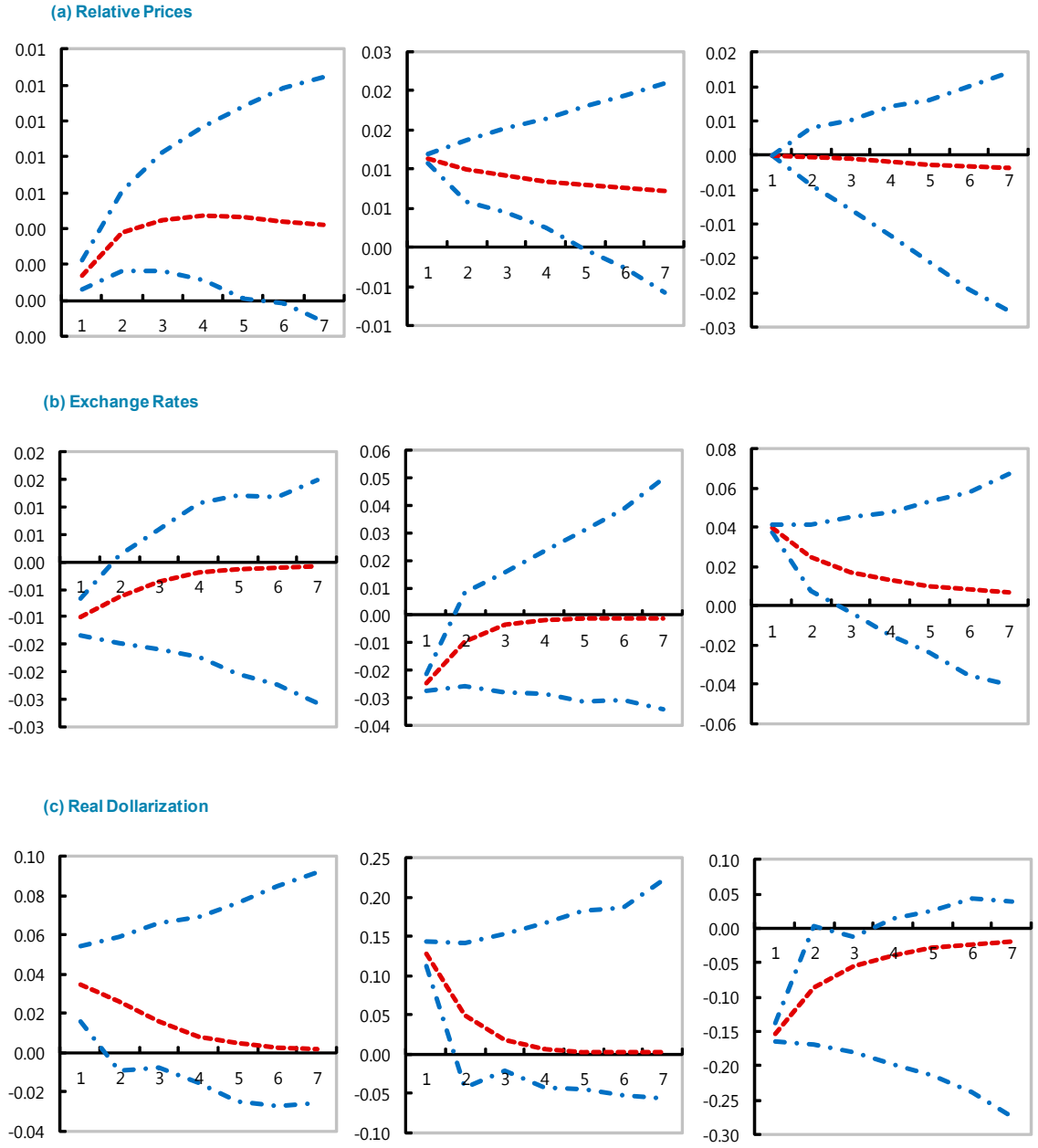
A rise in global financial stress had a positive, albeit economically-small impact on real dollarization, based on results from the fixed effects estimator, but yielded statistically insignificant results under the system GMM estimator. Subsequent panel impulse-response functions reveal that shocks to global uncertainty or risk (as measured by the VIX indicator), exchange rates and relative prices have strong, albeit short-lived, impact on real deposit dollarization. The findings of a positive, albeit short-term, relationship between the VIX and dollarization suggests that in the face of global financial volatility, domestic residents increased foreign currency holdings due to uncertainty about spillover effects from the crisis. These results are broadly in line with conventional economic wisdom, particularly regarding investor flight to quality (and in some instances, home asset preference), and household asset value preservation in the face of adverse shocks.

The findings of this paper suggest that, while there could be scope for macroprudential measures in dampening dollarization, policy efforts should focus primarily on macroeconomic stability to contain inflationary pressures and to anchor exchange rate expectations. Macroeconomic stability and prudent debt management to avoid debt distress and taper sovereign risk would help better integrate low-income economies into the international financial market and dampen the impact and amplitude of the identified drivers of dollarization.

Appendix Figures

Figure 1. Estimated Panel Impulse-Response Functions.

(Based on estimated panel VAR(1) of [log. VIX, log. Rel P., log. Exrate, log. Rdol])

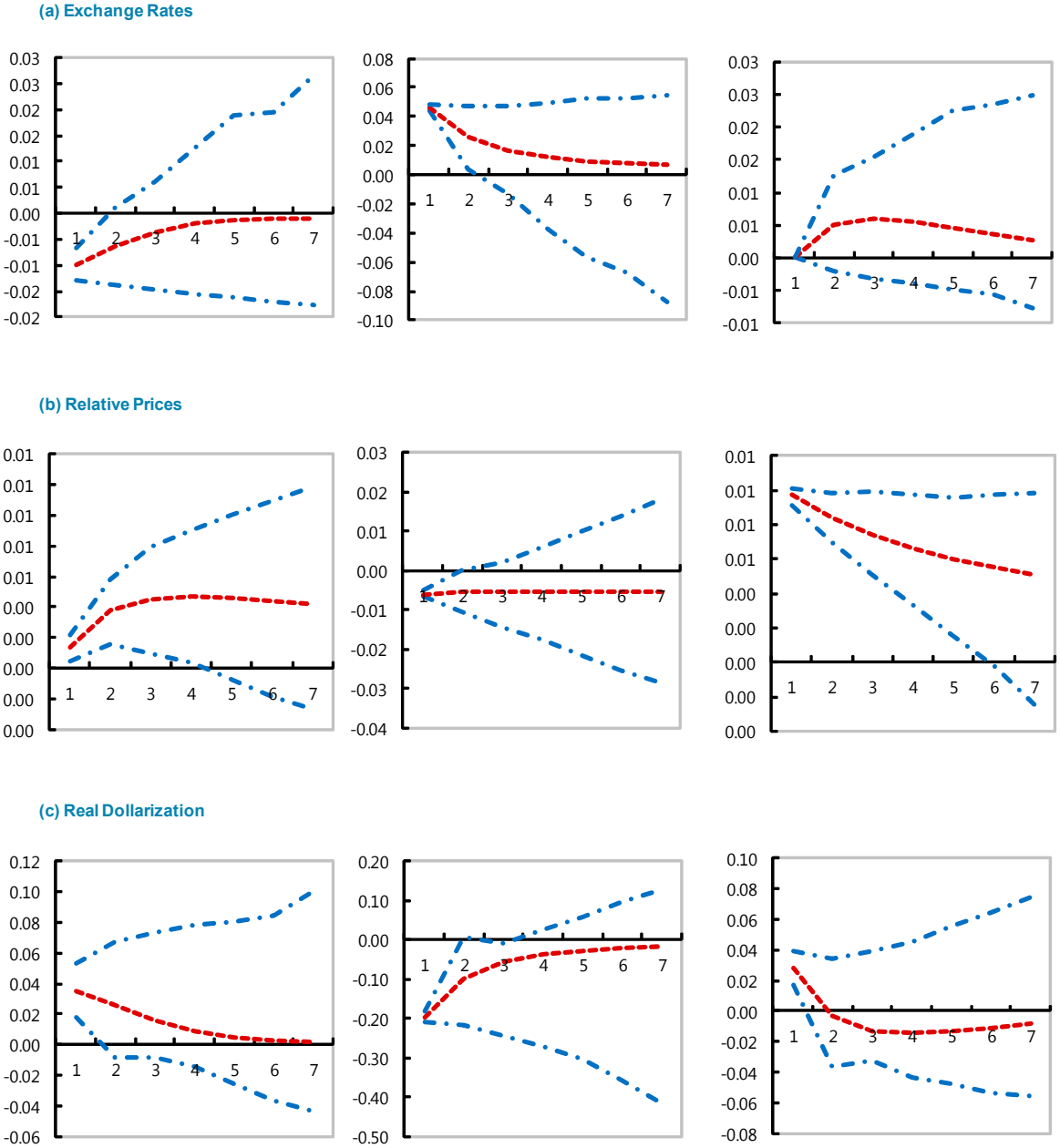


Source: IMF World Economic Outlook (WEO) database; and authors' panel VAR estimates.

Notes: The dashed lines are the estimated responses of (a) relative prices, (b) exchange rates, and (c) real dollarization index to one standard deviation shocks to global volatility index (col. 1), relative prices (col. 2), and exchange rates(col. 3).

Figure 2. Estimated Panel Impulse-Response Functions

(Based on estimared Panel VAR(1) of [log. VIX, log. Exrate, log. Rel. P., log. Rdol])



Source: IMF World Economic Outlook (WEO) database; and authors' panel VAR estimates.

Notes: The dashed lines are the estimated responses of (a) exchange rates, (b) relative prices, and (c) real dollarization index to one standard deviation shocks to global volatility index (col. 1), exchange rates (col. 2), and relative prices (col. 3).

Appendix Tables

Table A1. Country List and Average Deposit Dollarization, January 2006–December, 2009

Economy	Country	nominal DOL1	real RDOL1
EM	Albania	40.54	35.84
LIC	Armenia	51.77	48.60
EM	Azerbaijan, Rep. of	59.63	56.21
LIC	Bangladesh	2.09	2.20
EM	Belarus	41.91	51.27
LIC	Bhutan	3.93	3.59
LIC	Bolivia	65.55	59.34
LIC	Burundi	15.82	16.81
LIC	Cambodia	97.80	94.47
LIC	Cape Verde	6.29	5.40
LIC	Comoros	0.28	0.25
LIC	Dominica	1.44	1.44
LIC	Eritrea	17.70	17.70
LIC	Georgia	65.64	59.75
LIC	Ghana	27.58	40.93
LIC	Grenada	6.09	6.09
LIC	Guyana	2.93	3.00
LIC	Haiti	52.93	53.83
LIC	Honduras	28.96	28.96
EM	Kazakhstan	38.62	41.22
LIC	Kenya	16.44	16.14
LIC	Maldives	55.08	55.08
LIC	Moldova	45.99	36.40
LIC	Mongolia	39.08	44.81
LIC	Mozambique	42.07	41.18
LIC	Myanmar	0.28	0.26
LIC	Nepal	7.64	7.43
LIC	Nicaragua	90.85	102.64
LIC	Nigeria	12.05	13.00
EM	Pakistan	7.34	9.63
LIC	Papua New Guinea	9.95	8.96
LIC	Samoa	3.17	3.05
LIC	Sao Tome & Principe	63.57	79.41
LIC	Sierra Leone	32.32	34.79
LIC	Solomon Islands	7.13	7.43
LIC	St. Lucia	6.27	6.27
LIC	St. Vincent & Grens.	4.06	4.06
LIC	Sudan	20.06	21.67
LIC	Tanzania	36.03	35.23
LIC	Tonga	4.90	4.92
LIC	Uganda	28.56	28.13
EM	Ukraine	39.20	56.66
EM	Uzbekistan	26.00	29.63
LIC	Vanuatu	53.15	48.72
LIC	Zambia	39.61	47.03

Source: IMF IFS and staff estimates

Table A2: Variable Description and Definition

Variable	Description	Definition	Source
y	Real dollarization index	Foreign currency deposits/domestic deposits in deposit -taking deposit-taking institutions that are included in the broad money Adjusted for exchange rate movements	IFS
RR	Relative prices	Domestic price index/US consumer price index	IFS
S	Exchange rates	Nominal exchange rates (US dollars per domestic currency	IFS
VIX	Global risk aversion	Chicago Board Options Exchange (CBOE) Volatility Index	CBOE
Crisis_dum	Crisis dummy	August 2008-December 2009=1, zero otherwise	Authors
Kauff	Instutional quality indicator	Kauffman Entrepreneurial Activity Index	Kauffman Indicator
ICRG	Instutional quality indicator	International Country Risk Guide (ICRG)	ICRG
Er_Reg	Exchange Rate Regime	Exchange rate regime dummy (higher more flexible)	IMF ARAER
Prud_ER	Exchange rate related prudential indicator	Prudential measures undertaken	IMF ARAER

Table A3: Summary Statistics of Monthly Panel Data, 2006-09

Variables	Observations		Mean	Std. Dev.	Min.	Max.
Log. Real dollarization index	overall	4,559	2.67	1.46	-3.37	6.32
	between	97		1.42	-2.32	4.62
	within	47		0.31	0.82	4.79
Log. Relative prices	overall	3504	4.71	0.13	4.48	5.37
	between	73		0.11	4.53	5.07
	within	48		0.08	4.34	5.04
Log. Exchange rates	overall	3534	-4.56	2.50	-24.96	0.09
	between	74		2.47	-9.70	-0.06
	within	48		0.53	-21.30	0.10
Log. Global volatility index	overall	4070	2.13	1.38	-0.36	4.63
	between	185		0.00	2.13	2.13
	within	22		1.38	-0.36	4.63
Crisis dummy (august 2008=1, zero otherwise)	overall	8880	0.35	0.48	0	1
	between	185		0.0	0.35	0.35
	within	48		0.48	0	1
Kauffman Entrepreneurial Activity Index	overall	3696	4.48	1.63	1.24	8.13
	between	77		1.64	1.33	8.04
	within	48		0.13	4.07	5.09
International Country Risk Guide (ICRG)	overall	3696	41.96	30.51	0	80.00
	between	77		30.64	0	74.87
	within	48		2.03	30.32	47.89
Exchange rate regime dummy (higher more flexible)	overall	3696	2.14	0.50	1	3
	between	77		0.39	1	3
	within	48		0.32	1.16	3.10
Exchange rate related prudential indicator	overall	3696	0.03	0.17	0	1
	between	77		0.07	0	0.35
	within	48		0.15	-0.33	1.01

Source: IMF *World Economic Outlook* (WEO) database; and authors' estimations using panel methods in Stata.

Table A4: Estimated Variance Decompositions

(Based on estimated panel VAR(1) of [log. VIX, log. Rel P., log. Exrate, log. Rdol])

	Explained by a shock to:					
	Global volatility index		Relative prices		Exchange rates	
Variations in:	*k=10*	*k=20*	*k=10*	*k=20*		
(a) Relaive prices	8.55	6.76	35.93	24.98	1.31	2.11
(b) Exchange rates	1.48	1.46	6.49	6.21	26.93	24.96
c) Real Dollarization	1.88	1.83	15.92	15.20	31.15	29.77

Source: IMF *World Economic Outlook* (WEO) database; and authors' estimations using panel methods in Stata.

Note: Numbers presented in the table indicate percent of variation in (a) relative prices, (b) exchange rates, and (c) rea dollarization, *k- periods* after a one standard deviation shock to global volatility index, relative prices and exchange rates, using ordering of the variables indicated in the sub-title.

Table A5. Estimated Variance Decompositions: Alternative of Variable for Choleski Decomposition

(Based on estimated panel VAR(1) of [log. VIX, log. Exrate, log. Rel P., log. Rdol])

	Explained by a shock to:					
	Global volatility index		Exchange rates		Relative prices	
Variations in:	*k=10*	*k=20*	*k=10*	*k=20*		
(a) Exchange rates	14.83	14.59	32.15	29.98	1.27	1.18
(b) Relaive prices	8.55	6.76	15.45	13.56	21.78	13.52
c) Real Dollarization	1.88	1.83	45.75	43.71	1.31	1.26

Source: IMF *World Economic Outlook* (WEO) database; and authors' estimations using panel methods in Stata.

Note: Numbers presented in the table indicate percent of variation in (a) exchange rates, (b) relative prices, and (c) real dollarization, *k- periods* after a one standard deviation shock to global volatility index, relative prices and exchange rates, using ordering of the variables indicated in the sub-title.

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