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Financial Dollarization

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Abstract

This paper presents a portfolio model of financial intermediation in which currency choice is determined by hedging decisions on both sides of a bank's balance sheet. Minimum variance portfolio (MVP) allocations are found to provide a natural benchmark to estimate the scope for dollarization of bank deposits and loans as a function of macroeconomic uncertainty. Dollarization hysteresis is shown to occur when the expected volatility of the inflation rate is high *in relation to* that of the real exchange rate. The evidence shows that MVP dollarization generally approximates actual dollarization closely for a broad sample of countries. Policy implications are explored.

I. INTRODUCTION

While substantial progress has been achieved during the last decade in controlling inflation throughout the world, dollarization, the holding by residents of a significant share of their assets or liabilities in foreign currency, remains a common feature of both developing economies and economies in transition.[2] In several developing countries that have experienced severe inflationary experiences, particularly in Latin American countries such as Argentina, Bolivia, and Peru, dollarization remains very high, notwithstanding several years of stable macroeconomic policies that have gradually improved confidence (Figure 1). While dollarization trends in the transition economies are somewhat more subdued, dollarization also appears to have become entrenched in many cases (Figure 2).

Although the literature on dollarization is very vast, it leaves some important gaps.[3] While the importance of macroeconomic expectations as a key determinant of the demand for dollar assets is well recognized, few attempts have been made at systematically estimating dollarization levels across countries, based on macroeconomic conditions. In addition, most of the literature is concerned with currency substitution (i.e., the use of foreign currency as a means of payment), rather than asset substitution (i.e., the use of foreign currency instruments for investment purposes). However, the latter generally accounts for the bulk of measured dollarization.[4] Moreover, the papers that

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[2]The term "dollarization" is applied generically to the use of foreign currency assets and liabilities, although in some cases the dollar is not the main foreign currency of choice of domestic residents.

[3]The dollarization literature is quite extensive and has grown rapidly in recent years. Recent surveys can be found in Calvo and Vegh (1992 and 1997), Giovannini and Turtleboom (1994), and Savastano (1996). Guidotti and Rodriguez (1992) present a model of hysteresis based on switching costs.

[4]Hence, as noted by many observers, much of the empirical literature is plagued by a definitional

specifically address the issue of asset substitution as a portfolio choice generally do not recognize the implications of dollarization for financial intermediation.[5] Yet, the fact that the dollarization of bank deposits generally has as mirror image that of loans is important to determine the nature and extent of dollarization. In particular, the extent of loan dollarization determines the financial system's exposure to systemic credit risk in the case of large devaluations. Finally, while there is a general presumption that dollarization restricts the scope for independent monetary and exchange rate policies, the scope for altering dollarization through monetary and exchange rate policies has not been well explored.

Following contributions by Thomas (1985) and others, this paper presents a model of asset substitution based on a Capital Assets Portfolio Model (CAPM) formulation. However, unlike in the earlier literature, currency choice is determined on both sides of a bank's balance sheet by hedging against inflation and foreign exchange risk. Thus, the dollarization of deposits and loans interact through the loanable funds market. The paper shows that this interaction leads to financial equilibria which gravitate around interest rate parity and minimum variance portfolio allocations (MVP). Hence, MVP, which is found to be a simple function of the volatility of inflation and real depreciation, provides a natural benchmark to measure underlying dollarization and relate it to macroeconomic stability.

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problem, as interest bearing deposits are used to estimate money demand equations.

[5]See, e.g., Sahay and Vegh (1996). An exception is Ize (1981), on which this paper draws.

In MVP equilibria, dollarization is explained by the second moments (i.e., volatility) of inflation and real exchange rate depreciation, rather than the first moments (i.e., expected inflation and depreciation), as in the case of currency substitution models.[6] For a given variance of inflation, an increase in the variance of the rate of depreciation reduces dollarization as it limits the hedging benefits of dollar assets. Hence, stabilization may fail to reduce dollarization if accompanied by policies that target the real exchange rate. This provides an alternative explanation for the permanence of dollarization to the ones based on switching costs or long lasting memories. In the model presented here, hysteresis can occur even when the memory of past macroeconomic unbalances has faded away, if the expected volatility of inflation remains high *in relation to* that of the real exchange rate.

The evidence seems to support this result as underlying dollarization, defined as the dollar share of the MVP allocation, generally approximates actual dollarization closely for a broad sample of countries. The empirical results are confirmed by a panel regression for five highly dollarized Latin American economies, Argentina, Bolivia, México, Perú and Uruguay.

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[6]These conclusions are reminiscent of those reached for Bolivia and Peru by McNelis and Rojas-Suarez (1996) who conclude, on the basis of a similar CAPM approach, that dollarization is related to devaluation uncertainty. However, the results in this study differ in that they focus on MVP allocations, rather than deviations from MVP, and on asset substitution, rather than currency substitution. Thus, while McNelis and Rojas-Suarez find that devaluation uncertainty promotes dollarization, in our model underlying dollarization is correlated positively with the variance of inflation but *negatively* with the variance of the rate of real depreciation.

While this conclusion suggests that a floating exchange rate policy could, in principle, be used as a means to limit dollarization (i.e., by increasing real exchange rate volatility relative to price volatility), financial dollarization is also shown to be related to real sector dollarization, as measured by the pass-through coefficient of exchange rate changes on prices. Hence, in highly dollarized economies, it may not be possible to increase the volatility of the exchange rate, without increasing that of inflation. This limits the feasibility of using exchange rate policy as a means to reverse dollarization. It also implies that dollarization should be regarded, at least in part, as a natural consequence of trade liberalization and international economic integration. Hence, attempts to limit it may be ill-advised in those cases.

The paper briefly explores how actual dollarization can deviate from underlying dollarization. Based on portfolio interaction between country risk (i.e., confiscation and banking system risk) and macroeconomic risk (i.e., inflation and foreign exchange risk), dollarization and the structure of interest rates are shown to depend on the volume of net foreign assets, the magnitude and currency of denomination of public domestic debt (including the central bank's domestic liabilities), and the taxation of financial intermediation (e.g., through unremunerated reserve requirements). In particular, capital inflows due to declining country risk, a tightening of monetary policy or a shift in the currency composition of public domestic debt toward the domestic currency, increase the differential between home currency and local foreign currency interest rates, thereby reducing deposit dollarization while increasing loan dollarization. Instead, unremunerated reserve requirements on foreign currency deposits can contain dollarization on both sides of a bank's balance sheet, although at the cost of capital flight and financial disintermediation.

The paper is organized as follows. Section II presents the model and derives expressions for the deposit and loan dollarization ratios as a function of MVP allocations and deviations from interest rate parity. Section III presents empirical evidence of the link between actual and underlying dollarization ratios. Section IV discusses the policy implications. Section V summarizes and concludes.

II.   THE PORTFOLIO MODEL

A.   Depositors' Portfolio Choice

Domestic depositors' portfolios comprise three assets: domestically held home currency deposits (HCD), domestically held foreign currency deposits (FCD) and cross-border foreign currency deposits (CBD), with real returns in terms of the domestic price index expressed as r_D^H, r_D^F and r^C, respectively. We assume that depositors are not allowed to short-sell deposits in any currency

and, in accordance with the emphasis of this paper on asset substitution, rather than currency substitution, that agents hold no cash.[7]

Due to foreign exchange rate risk, dollar deposits or loans (at home or abroad) are imperfect substitutes for home currency deposits or loans. In addition, deposits held locally are imperfect substitutes for deposits held abroad, because of country risk. The latter is assumed to incorporate all sources of risk which are not strictly macroeconomic in nature. Thus, it includes confiscation risk, as well as banking system risk. Although it would be reasonable to expect some correlation between macroeconomic risk and country risk, these risks are assumed to be independent for purposes of analytical tractability.

Thus, it is assumed that:

$$r_D^H = E(\ r_D^H\ ) + \boldsymbol{m_p} + \boldsymbol{m_c}$$

$$r_D^F = E(\ r_D^F\ ) + \boldsymbol{m_s} + \boldsymbol{m_c}$$

$$r_D^C = E(\ r^C\ ) + \boldsymbol{m_s}$$

(1)

where μ_π, μ_s and μ_c are disturbances associated with inflation, the real exchange rate, and country risk, respectively, assumed to be distributed with zero mean and variance-covariance matrix $[S_{ij}]$, and E is the expectations operator. In addition, it is assumed that:

$$S_{sc} = S_{\pi c} = 0$$

(2)

Depositors' preferences are represented by:

$$U_D = E(r_D) - c_D\ Var(r_D)/2$$

(3)

where r_D is the average real return of the deposit portfolio, $c_D > 0$ reflects depositors' aversion to risk and V is the variance operator. If λ_D is the share of total dollar deposits (including CBD) and G the share of cross-border deposits in the deposit portfolio, familiar CAPM formulations are found to

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[7]However, the results are identical when cash holdings are introduced. See Thomas (1985).

hold for total dollar deposits and deposits held abroad as a function of excess returns (Appendix I. A):

$$\lambda_D = \lambda^* - \delta^I_D / (c_D\, V), \tag{4}$$

$$G = 1 - \delta^X / (c_D\, S_{cc}) \tag{5}$$

where:

$$V = Var(r^H_L - r^F_L) = S_{\pi\pi} + S_{ss} - 2S_{\pi s}, \tag{6}$$

δ^I_D and δ^X are the expected internal and external deposit rate differentials:

$$\delta^I_D = E(r^H_D - r^F_D), \tag{7}$$

$$\delta^X = E(r^F_D - r^C), \tag{8}$$

and λ^* is the dollar share of MVP, which can be written as:

$$\lambda^* = [Var(r_D^H) - Cov(r_D^H, r_D^F)] / Var(r_D^H - r_D^F). \tag{9}$$

We denote this share as the "underlying" dollarization ratio.

Thus, for a level of country risk such that $\lambda_D > \gamma$,[8] the choice of currency (as reflected in the dollar share of deposits) depends only on inflation and foreign exchange risk, while the choice of location (as reflected in the cross-border share of deposits) depends only on country risk.[9] Moreover, as country risk favors holding assets abroad, a positive country risk premium δ^X is needed to induce depositors to hold FCD.[10]

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[8]For sufficiently high levels of country risk, deposit dollarization may be determined solely by the location decision, as the optimal share of (foreign currency) deposits abroad exceeds the desired share of foreign currency deposits ($\gamma > \lambda_D$). In this case, the existence of small amounts of FCD may be explained by pure transaction motives, independent of the portfolio selection decision.

[9]This follows from the assumption that country risk is uncorrelated with variations in the real exchange rate and inflation rate.

[10]We implicitly assume that λ_D (alternatively, G) $\in [0,1]$. Otherwise, under the no-short-sales condition, the solution would be at one corner, and the ratio would not respond to small changes in the volatility parameters.

As nominal interest rates are assumed to be fixed during the life of the deposit or loan contract, uncertainty about real rates of return arises only from price or exchange rate volatility. Approximating s as $e - \pi$, where e denotes the rates of change of the nominal exchange rate, underlying dollarization can be expressed as a simple function of the volatility of inflation and the rate of real depreciation:

$$\lambda^* = \frac{S_{pp} + S_{ps}}{S_{pp} + S_{ss} + 2\,S_{ps}} \tag{10}$$

It can readily be checked from this equation that λ^* increases with inflation volatility, and decreases with the volatility of real exchange rate depreciation (see Appendix I. B).[11]

B. Borrowers' Portfolio Choice

Cross-border loans (CBL) are assumed to be intermediated by the local banking system, reflecting the fact that in most developing and transition economies there exists an asymmetry of access to foreign capital markets between deposits and loans. As borrowers only have access to local loans, in dollars (FCL) or home currency (HCL), there is incomplete arbitrage between local and foreign rates in the dollar loan market. Hence, local dollar loan rates can be above comparable foreign rates adjusted for country risk.

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[11]Appendix I.B also shows that a decline in the correlation between inflation and the real exchange rate implies an increase in the correlation of asset returns, which reduces the scope for hedging. Hence, it favors dollarization when inflation volatility is higher than real exchange rate volatility, as it reduces the attractiveness of domestic currency assets as hedging instruments against real exchange rate changes.

The representative borrower uses the loan to invest in a project with a known return in units of the domestic price index.[12] Hence, the real return on the project is riskless and the borrower's problem reduces to that of minimizing the risk-adjusted cost of borrowing. Denote λ_L the dollar share of the loan portfolio. The borrower's portfolio preferences are assumed similar to the depositor's, with the sign of the expected real interest payments inverted:

$$U_L = -E(r_L) \ - \ c_L \, Var(r_L)/2 \tag{11}$$

where r_L is the cost of the loan portfolio. The dollar share of the borrower's optimal portfolio has the same form as in the case of the depositor, with the real interest rate differential entering with the opposite sign:

$$\lambda_L = \lambda^* + \delta^I_L / (c_L \, V), \tag{12}$$

where $\boldsymbol{d}^I_L$ is the loan rate differential:

$$\delta^I_L = E(r^H_L - r^F_L). \tag{13}$$

C. Financial Equilibrium

In the absence of differential taxes on financial intermediation, the internal interest rate differentials on deposits and loans should be the same.[13] In this case, equations (4) and (12) readily imply that deposit and loan dollarization ratios should always be on opposite sides of MVP, if not at MVP. For example, starting from MVP, an increase in the domestic interest rate differential in favor of home currency should increase the attractiveness of home currency deposits and lower that of home currency loans, thereby reducing deposit dollarization below MVP and raising loan dollarization above MVP. But suppose, in addition, that the economy is closed to capital flows. In this case, all bank deposits should necessarily have bank loans as a counterpart. Hence, depositors' and borrowers' portfolios should be identical. If banks maintain balanced open foreign exchange positions, it is then obvious that MVP is the only possible financial equilibrium. Thus, deviations from MVP can only occur if the supply and demand of loanable funds do not coincide.[14]

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[12]We implicitly assume a balanced current account, so that the share of tradables (alternatively, dollar-priced goods) in the production basket is the same as in the consumption basket.

[13]The discussion in this section abstracts from the existence of public domestic debt or bank reserves at the central bank, which may induce deviations from MVP. Both are discussed in Section IV below.

[14]Note that an increase in devaluation expectations does not, by itself, induce more dollarization, as it should only be reflected in an increase of the internal interest rate differential.

This can be formalized as follows. Assume that banks can borrow abroad, with X being their net (dollar) foreign liabilities, and that their balance sheets reflect the equilibrium between the demand and supply for loanable funds:

$$(1 - \gamma)D + X = L, \tag{14}$$

where D and L denote total deposits (including CBD) and total loans, respectively. From which:

$$D - L = \gamma D - X, \tag{15}$$

In addition, if banks maintain balanced open foreign exchange positions, the home currency component of their balance sheet may be written:

$$(1 - \lambda_D)D = (1 - \lambda_L) L \tag{16}$$

Substituting equations (4), (12) and (15) into equation (16), setting $\delta^i_D = \delta^i_L = \delta$, and rearranging, we obtain:

$$\delta = - V (1 - \lambda^*) (\gamma D - X) (c_D\, c_L) / (c_D\, D + c_L\, L). \tag{17}$$

In turn, combining (4) and (12), it can be seen that deviations from λ^* are symmetric:

$$c_L (\lambda_L - \lambda^*)= \delta / V = c_D (\lambda^* - \lambda_D), \tag{18}$$

and, from (17), that they depend on the country's net foreign position, $\gamma D - X$.

Notice that λ_D and λ_L are affected by deviations from interest rate parity ($\delta \neq 0$) in proportion to c_D and c_L, respectively. In particular, if borrowers are less risk averse than depositors because they have better hedging opportunities at hand, loans are closer substitutes across currencies than deposits. In this case, a change in the interest rate differential as a result of a change in the net foreign position of the country should have a larger impact on the currency composition of loans, than deposits. Moreover, as the difference in risk aversion increases, c_D / c_L becomes arbitrarily large, and the deposit portfolio closely approximates MVP even in the presence of an unbalanced foreign position.[15]

D. Real Sector Dollarization

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[15] A limiting example is the case of risk-neutral borrowers ($c_L = 0$), in which interest rate parity always holds ($\delta = 0$).

While a full discussion of the factors underlying real sector dollarization (i.e., the prevalence of dollar pricing in price and wage contracts) falls largely outside the scope of this paper, linkages between real sector dollarization and financial sector dollarization (i.e., the extent of deposit and loan dollarization) can be usefully illustrated with a simple extension of the model. Suppose that inflation and the rate of change of the nominal exchange rate evolve according to:

$$\pi = \alpha e + (1 - \alpha)\varepsilon \,, \tag{19}$$

$$s = e - \pi = (1 - \alpha)\,(e - \varepsilon) \,, \tag{20}$$

where ε represents real or monetary-induced price shocks to the domestic currency component of the consumption basket and α represents the pass-through from the exchange rate to the price level (alternatively, the foreign currency component of the domestic consumption basket). A high pass-through could result from an open economy (i.e., a large tradable sector) or from dollar pricing of non tradable goods.[16] It can easily be shown, replacing (19) and (20) into (10), that λ^* can then be expressed as:[17]

$$\lambda^* - \beta = \rho_{e\pi}\, S_\pi / S_e \,, \tag{21}$$

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[16] For simplicity, foreign inflation price shocks are ignored.

[17] See Appendix I.

which is the coefficient of a regression of the inflation rate on changes in the exchange rate, i.e. a crude measure of the pass-through coefficient, α. Thus, real and financial dollarization should generally be highly correlated. In part, this should reflect the fact that the factors underlying the choice of currency in the pricing of contracts are likely to be similar to those underlying asset substitution. But, in addition, real and financial dollarization should have a mutually reinforcing effect. As reflected in (20), an increase in α raises λ^* by reducing the volatility of the real exchange rate, hence increasing the attractiveness of dollar assets. In turn, an increase in λ^* promotes real dollarization by limiting the scope for anchoring the price level through monetary policy.[18] Such interdependencies may also contribute to hysteresis, by slowing the speed at which de-dollarization can take place in an economy that has stabilized.

III. EMPIRICAL EVIDENCE

The empirical evidence suggests that actual dollarization ratios can be largely explained in terms of underlying dollarization levels. Figure 3 compares actual dollarization with underlying dollarization for a broad sample of countries covering industrial, developing, and transition economies. Actual dollarization is defined as the ratio of total foreign currency deposits over total domestic and cross-border deposits for the year 1995, or the latest observation available.[19] Underlying dollarization is derived from the expression of $\lambda*$ in equation (10). In the absence of forward-looking data on inflation and real exchange rate expectations, the variance and covariance of these variables are obtained from quarterly observed data over the period 1990-1995, or the longest period for which meaningful data exists. The fit is highly satisfactory.

The relevance of MVP as a key explanatory factor of dollarization is confirmed by estimating a regression of actual dollarization on underlying dollarization (Table 3). The table also shows how the explanatory power of the rate of inflation, significant when taken alone, is substantially reduced when underlying dollarization is included as a regressor.[20] The importance of net external assets in

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[18] Such linkages between real and financial dollarization suggest that multiple equilibria could exist in which the choice of currency and the extent of dollarization become indeterminate. In the context of currency substitution, see the related discussion in Kareken and Wallace (1981) and the counter arguments presented by Giovannini and Turtelboom (1994).

[19] The list of countries and the period coverage are shown in Table 1. Table 2 provides a definition of the variables used in the empirical estimates.

[20] Average inflation is computed using quarterly data for the same period used to compute underlying dollarization.

explaining deviations from MVP is tested by including a proxy for net foreign assets, NFA.[21] The coefficient is significant and has the expected sign.
Although the relation between underlying dollarization and its different components is not linear, the signs of the coefficient on inflation and real depreciation volatility are, respectively, positive and negative, as predicted by the model, and highly significant. The positive sign of the covariance term is also consistent with the model when inflation volatility is higher than real exchange rate volatility.

The significant linkage between real and financial sector dollarization is illustrated in the second panel of Figure 3 where, following equation (21), we estimate the pass-through coefficient β based on data for the period 1990-1995, and plot it against actual dollarization values. The correlation between the two variables suggests that financial dollarization is substantially affected by real sector dollarization. This is confirmed by regressing the dollarization ratio on β or its individual components (the standard deviaton of inflation, the inverse of the standard deviaiton of the nominal depreciation rate, and the correlation between these two variables). In both cases, coefficients are significant and of the correct sign.

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[21] Net external assets are computed as net external assets of the banking system plus CBD minus CBL, over the sum of total deposits and loans, $(\gamma D - X)/(D+L)$, which is consistent with equation (17) for the case in which the coefficients of risk aversion of depositors and borrowers are the same. An alternativley proxy for the net external position of the country, $(\gamma D - X)/ L$, broadly consistent with the case in which $c_D << c_L$, was also tested with similar results.

Unfortunately, longer series for many of the dollarized economies in the sample are inexistent or unreliable, so that the results obtained from the cross country comparisons cannot be tested using panel data covering a longer period of time for all countries in the sample.[22] However, the model can be tested using panel data for a sub-sample of highly dollarized Latin American countries during the past two decades. Table 4 presents the results of panel regressions for a sample including Argentina, Bolivia, México, Perú and Uruguay.[23] The results closely resemble those in the previous table. The inflation rate, measured as the average quarterly inflation over the past year, loses its explanatory power once underlying dollarization is introduced.[24] Net foreign assets are positively correlated with dollarization ratios, and the individual components of $\lambda*$ display the correct sign. Both the pass-through coefficient β and its components present the correct sign and are highly significant.

It is also interesting to test the model's predictions for countries that have developed alternative instruments to limit foreign macroeconomic risk, particularly price-indexed or interest rate-indexed instruments. Abstracting from lags and other measurement problems, price-indexed assets are free of inflation or currency risk. As long as indices can be found that follow purchasing power closely, such instruments should dominate dollar-indexed instruments.[25] Table 5 compares underlying dollarization with actual dollarization and with the use of alternative indexing instruments for countries in which price or interest rate indexation have been broadly used, such as Chile, Israel and Brazil.[26] As expected, predicted dollarization, as measured by $\lambda*$, generally exceeds actual

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[22]A particular important obstacle is the fact that in most cases, official data aggregate time, saving and foreign currency deposits.

[23]These five countries are the Latin American examples most often cited in the literature. Dummies variables were used to control for country-specific effects.

[24] The coefficient of inflation is still significant when combined with $\lambda*$, but has negative sign.

[25]Notice that the development of alternative hedging instruments, such as foreign exchange derivatives, and, more generally, the deepening of financial markets, including stocks, corporate bonds and mutual fund shares, that allow for alternative ways to hedge against foreign exchange risk, should also contribute to lessen the demand for dollar indexation. Indeed, the same risk exposure can be achieved with local currency intermediation, coupled with a foreign exchange futures market, as with bi-currency financial intermediation.

[26]In Brazil, both price indexation and interest rate indexation have been broadly used. In particular, the indexation of deposits to the overnight interest rate protected the purchasing power of HCD throughout the turbulent period of the 1980's. In Chile, indexation has been facilitated by the introduction in 1967 of a unit of account, the UF, that is published by the central bank daily on the basis of the consumer price index. In Israel, a broad menu of indexed assets has been available to the public, including CPI-indexed assets, dollar-indexed assets (PATZAM), and dollar deposits (PATAM). However, the use of CPI-indexed assets has been mainly restricted to long-term time

dollarization by a large margin.

IV. POLICY IMPLICATIONS

A. Exchange Rate Policy

The previous discussion indicates that $\lambda*$ increases with inflation volatility, and decreases with the volatility of real exchange rate depreciation. Thus, stable inflation and a fluctuating real exchange rate should be associated with low dollarization. In particular, the combination of inflation targeting (to the extent it reduces inflation volatility) with a floating exchange rate (to the extent it increases real exchange rate volatility) should foster the use of local currency and discourage that of foreign currency, since it reduces the risk associated with the former and increases that associated with the latter. Instead, a stabilization policy that reduces inflation volatility, through lowering inflation, may not succeed in reducing dollarization if it is accompanied by a stable real exchange rate. This would be the case, in particular, if the authorities target the real exchange rate (for example, through a crawling peg policy) rather than the inflation rate.

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deposits and saving deposits.

A good example is found in Latin American economies, in which the dollarization ratio remained high after stabilization, due to the fact that the decline of inflation volatility in the post-stabilization period was offset by that of real exchange rate changes, as Figure 4 shows.[27] Table 6 further illustrates this idea by comparing periods before and after exchange-rate based stabilizations.[28] While inflation fell significantly in most cases, actual dollarization continued to be high, reflecting the evolution of underlying dollarization. This explanation of the resilience of dollarization, which can in principle be generalized to economies that have implemented exchange rate-based stabilizations, contrasts with that generally offered by the currency substitution approach, that emphasizes the beneficial effect of low inflation on dollarization.[29]

At the same time, the linkage between real and financial dollarization raises an important caveat to the finding that dollarization may be reduced by increasing the flexibility of the exchange rate regime. Indeed, in a highly dollarized economy with a floating exchange rate, the high elasticity and instability of money demand should result in a high volatility of the nominal exchange rate.[30] However, in an economy with extensive asset substitution, the linkage between real and financial dollarization that underlies equation (21) suggests that a volatile nominal exchange rate would result in a more volatile rate of inflation. Thus, the scope for affecting λ^* through the adoption of a flexible exchange rate regime may be limited and the benefits of a decline in dollarization need to be weighed against the costs associated with a more volatile inflation.

The correlation between real and financial dollarization also suggests that trade liberalization and international economic integration should promote financial dollarization over time as they are likely to result in rising λ^*'s. In this context, financial dollarization should be viewed, at least in part, as a normal consequence of trade and financial integration. Hence, attempts to limit it may be ill-advised.

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[27]Bolivia is particularly interesting because it is the only country for which dollarization has actually increased after stabilization. In this case, underlying dollarization was bolstered by a de-facto crawling peg policy that corrected for most past inflation.

[28]Values before the stabilization took place are computed from data for the preceeding five-year period.

[29]That this explanation is not specific to Latin American economies is exemplified by the inclusion of Hungary, for which the previous argument holds.

[30]This factor has been used to argue in favor of a pegged system when currency substitution is extensive. See Girton and Roper (1981) and Giovannini and Turtelboom (1994).

The model can, in principle, also be applied to the case of a pegged exchange rate peg with imperfect credibility, e.g., in the case of a peso problem such that the exchange rate is expected to collapse with a positive probability.[31] While the expected volatility of the rate of depreciation can no longer be inferred from backward-looking exchange rate data during the period of the peg, lingering expectations of devaluation can still tilt portfolio preferences in favor of dollar assets. Hence, price stabilization through a fixed exchange rate arrangement such as a currency board may deepen dollarization than reducing it. On the other hand, with a fully credible peg, $\lambda*$ becomes indeterminate, as $S_{ss} = S_{\pi\pi} = -S_{\pi s}$. In this case, agents become indifferent in terms of portfolio choice between the home currency and the foreign currency, and dollarization needs to be explained through other factors.[32]

B. Monetary Policy

From the discussion in Section II, it follows that dollarization can be affected in two ways. It can be altered through measures that affect: (i) macroeconomic uncertainty, hence underlying dollarization; or (ii) the domestic interest rate differentials, hence that deviate dollarization from MVP allocations. The rest of this section focuses on the latter.

For this purpose, government assets need to be introduced. For simplicity, we assume that they are held in the form of domestic and foreign currency reserves of commercial banks at the central bank.[33] Denoting total bank reserves as R, and defining defining λ_R as the foreign currency share of bank reserves, equation (16) may be expressed, as:

$$(1 - \lambda_D)D = (1 - \lambda_L)L + (1 - \lambda_R)R \qquad (22)$$

which indicates that the dollarization of deposits is obtained as a weighted average of that of loans and reserves.

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[31]Lingering differentials between local currency and foreign currency interest rates in countries such as Argentina and Estonia suggest that even currency board arrangements lack full credibility.

[32]Currency substitution may provide, in such cases, an alternative explanation for asset substitution, as funds invested in term deposits or other financial instruments will eventually be spent. Hence, to limit the need for currency conversion, agents may allocate the currency of denomination of their investments in accordance with spending shares.

[33]The reserves may be required or free, remunerated or unremunerated. Moreover, nothing of substance would be altered in the model if the reserves were in the form of marketable central bank or treasury securities.

When the rate of remuneration of bank reserves is below market levels (as in the case of unremunerated reserve requirements), lending rates deviate from deposit rates and the domestic interest rate differential on the asset side of a bank's balance sheet may differ from that on the deposit side. Let ρ^H and ρ^F be the ratios of bank reserves to bank loans in home and foreign currency, i.e.:

$$\rho^H = \lambda_R R \ / \lambda_L L,$$

$$\rho^F = (1 - \lambda_R)R \ / (1 - \lambda_L)L,$$

and ε^H and ε^F the shares of reserves that are not remunerated. If banks are competitive with zero intermediation costs,   intermediation spreads may be expressed as:

$$E(\, r_L^i - r_D^i \,) = \mathbf{r}^i \, \mathbf{e}^i \, E(\, r_D^i \,) = t^i$$

(23)

where t^i, $i = H, F$, are the implicit tax rates on home and foreign currency intermediation that derive from unremunerated reserve requirements. In turn, from (23), we can define the differential tax wedge $\tilde{t}$ as:

$$\tilde{t} = \ t^F - t^H = \delta_L{}^I - \delta_D{}^I. \tag{24}$$

Substituting equations (4) and (12) into (22), using (24), and rearranging, deviations from underlying dollarization can now be written as:

$$\lambda_D - \lambda^* = (c_L/M) \ [(1-\lambda^*)(\gamma D - X) + (\lambda_R - \lambda^*)R - \tilde{t}\,L] \tag{25}$$

$$\lambda_L - \lambda^* = \ (c_D/M) \ [- (1-\lambda^*) \ (\gamma D - X) - (\lambda_R - \lambda^*)R - \tilde{t}\,D] \tag{26}$$

with:

$$M = c_D L + c_L D. \tag{27}$$

These expressions indicate that, in the context of the model, monetary policy can induce deviations from MVP through three types of wedges: (i) an external wedge, when changes in the overall stance of monetary policy induce capital flows that lead to an unbalanced net external creditor position for the country ($\gamma D - X \ ^{1} 0$); (ii) a public debt wedge, when the currency composition of bank reserves deviates from MVP ($\lambda_R - \lambda^* \ ^{1} 0$); and (iii) a tax wedge, when financial intermediation in domestic currency and foreign currency are not taxed at the same rates ($\tilde{t} \ ^{1} 0$).

Assuming an MVP currency composition of bank reserves and no tax wedge, to eliminate cross-term effects, a tightening of the monetary stance raises domestic interest rates, thereby increasing the external spread and inducing a shift from CBD to FCD, i.e. a fall of γD and a worsening of the country's net creditor position. As reflected in (25)-(26), the inflow gives rise to an excess supply of local dollars which depresses dollar rates relative to local currency rates, thereby reducing deposit dollarization but raising loan dollarization. Hence, if aimed at reducing dollarization, a tight monetary policy is unlikely to be successful. Besides being difficult to sustain on macroeconomic grounds, it has a mixed impact on dollarization.

Similarly, a tight monetary policy that aims at limiting the macroeconomic impact of capital inflows encourages loan dollarization. In this case, dollarization may be particularly acute as inflows, which originally result from the decline in the country's risk premium, are subsequently compounded by the tightening of monetary policy. As illustrated by recent events in several Asian countries, the prudential implications of such large loan dollarizations can be severe once the exchange rate collapses.[34]

Attempts to reduce dollarization by introducing a public debt wedge, for example by shifting the currency composition of public debt in favor of the local currency, are similarly bound to fail due to their symmetric impact on either side of a bank's balance sheet. As interest rates on the local currency rise relative to the foreign currency, deposit dollarization declines while loan dollarization rises.

Instead, when a tax wedge is introduced, the deposit and loan internal interest rate differentials deviate from each other and move in opposite directions. Thus, a positive tax wedge (i.e., in favor of home currency intermediation) reduces dollarization on both sides of a bank's balance sheet. However, by depressing the domestic foreign currency interest rate and, in turn, the external interest rate differential, it stimulates capital flight and causes desintermediation.

A similar outcome would be expected when FCD or FCL are prohibited. By forcing depositors to hedge exchange risk through CBD rather than FCD, forced conversions of FCD into HCD, as occurred in Mexico (1982), Bolivia (1982), and Peru (1985), can reduce dollarization but at the cost of provoking capital flight and financial disintermediation.[35] In contrast, the removal of a ceiling

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[34]It is also worth noting from equations (25) and (26) that phases of strong capital inflows induced by a fall in country risk would be expected, in our model, to be associated with a decline in the external spread and an *increase* in the internal spread, as the excess supply of local dollars drives home dollar rates down in relation to local currency rates. This appears to be corroborated by the recent experience of some heavily dollarized countries such as Peru and Bolivia (Ize and Levy Yeyati, 1998).

[35] The financial disintermediations were amplified in all three cases by expansionary fiscal and monetary policies which resulted in sharply negative real local currency interest rates. For a more

on local currency deposit rates, whose impact should be broadly equivalent to that of the removal of a tax wedge, can reduce deposit and loan dollarization while stimulating financial intermediation.[36]

V. CONCLUSIONS

This paper presented a portfolio model of dollarization in which agents hedge against macroeconomic risk on both sides of a bank's balance sheet. Due to the symmetry of portfolio decisions, this interaction leads to MVP portfolio allocations in the absence of external, public debt or tax wedges. Hence, MVP provides an important benchmark to relate financial dollarization to macroeconomic policies and estimate the scope for dollarization quantitatively. A novel explanation for dollarization hysteresis was offered, based on the relative variabilities of inflation and the real exchange rate.

Several important policy implications were derived for countries that seek to limit asset substitution. To reduce dollarization, countries should target inflation rather than the real exchange rate. In practice, however, the scope for using exchange rate policy as an instrument to reduce dollarization may be limited in heavily dollarized economies, due to a possible inconsistency between increasing real exchange rate volatility and limiting inflation volatility. On the other hand, a tight monetary policy that attempts to reduce dollarization by tilting the domestic interest rate differential in favor of home deposits is bound to increase the dollarization of bank loans. This effect could be particularly large when the tightening of monetary policy takes place in response to capital inflows, thereby raising severe prudential concerns. Tax-based or regulatory policies, while more effective to reduce dollarization, are likely to have substantial costs in terms of capital flight and financial disintermediation.

The paper also suggested that, in view of the close linkages between real and financial dollarization, attempts at slowing down financial dollarization can be particularly ill-advised when the latter reflects

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complete description of these events and their impact, see Savastano (1992).

[36] The main difference between a regulatory ceiling on deposit rates and unremunerated reserve requirements is that, in the former case, banks, rather than the central bank, appropriate the benefits of the higher intermediation margin.

real sector developments, including globalization and trade liberalization. In those cases, the potential benefits of reducing dollarization should be compared with the welfare loss from limiting the scope for currency risk hedging.

DERIVATION OF THE MODEL

A. Depositors' Portfolio

Defining x_F, x_C, and x_H as the portfolio shares of FCD, CBD and HCD, respectively, the reader can readily check that, from (1)-(2), the first and second moments of the probability distribution of portfolio real returns can be expressed, after substituting $x_H = 1 - x_F - x_C$, as:[37]

$$E(r) = \mathbf{x'w} + r^H \qquad\qquad (A.1)$$

and:

$$Var(r) = \mathbf{x'B\,x} + 2\mathbf{C\,x} + Var(r^H), \qquad\qquad (A.2)$$

where:

$$\mathbf{x} = \begin{pmatrix} x^F \\ x^C \end{pmatrix},$$

$$\mathbf{w} = E\begin{pmatrix} r^F - r^H \\ r^C - r^H \end{pmatrix},$$

$$\mathbf{B} = \begin{pmatrix} Var(r^F - r^H) & Cov(r^F - r^H, r^C - r^H) \\ Cov(r^F - r^H, r^C - r^H) & Var(r^C - r^H) \end{pmatrix}$$

$$\mathbf{C} = \begin{pmatrix} Cov(r^F - r^H, r^H) \\ Cov(r^C - r^H, r^H) \end{pmatrix},$$

and E is the expectations operator. Assuming that depositors' preferences are represented by:

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[37] We drop the superscript for notational simplicity.

$$U = E(r) - c_D \, Var(r) / 2 \qquad (A.4)$$

with $c_D > 0$, the first order condition for a solution to the portfolio selection problem can be expressed as:

$$-\mathbf{w}/c_D + \mathbf{Bx} + \mathbf{C} = 0 \qquad (A.5)$$

from which one obtains the optimal portfolio shares:

$$\mathbf{x} = \mathbf{B}^{-1} [-\mathbf{C} + (1/c_D) \, \mathbf{w}] = \mathbf{l}^* + (1/c_D) \, \mathbf{B}^{-1}\mathbf{w} \qquad (A.6)$$

where $\mathbf{l}^* = -\mathbf{B}^{-1}\mathbf{C}$, $\qquad \mathbf{B}^{-1} = \dfrac{1}{|\mathbf{B}|}\begin{pmatrix} V + S_{cc} & V \\ V & V \end{pmatrix}$ characterizes the currency composition of the minimum variance portfolio (MVP). It can be shown, using (2), that:

$$\qquad (A.7)$$

where:

$$V = (S_{ss} - 2S_{s\pi} + S_{\pi\pi}) = Var(r^F - r^H), \qquad (A.8)$$

and:

$$|\mathbf{B}| = S_{cc} \, V. \, (A.9)$$

It is easy to check that $(C_1 - C_2) = S_{cc}$, from which:

$$\lambda^*_2 = (C_1 - C_2) \, V / |\mathbf{B}| = 1 \qquad (A.10)$$

and:

$$\lambda^*_1 = -1 + C_1 / V \qquad (A.11)$$

Moreover:

$$C_1 = Cov(r^H, r^F) - Var(r^H), \qquad (A.12)$$

which, combined with (A.6) and (A.7), yields:

$$\lambda_D = x_F + x_C = \lambda_1^* + \lambda_2^* - (1/ \, c_D \, |\mathbf{B}|) \, S_{cc} \, (r_H - r_F) =$$

$$= \lambda^* - (1/ c_D V) \delta^I{}_D , \tag{A.13}$$

where:

$$\boldsymbol{I}^* = \lambda_1^* + \lambda_2^* = [Var(r^H) - Cov(r^H, r^F)] / V. \tag{A.14}$$

Finally, from (A.7):

$$x_C = 1 + (1/ c_D S_{cc}) [(r^H - r^F) + (r^C - r^H)], \tag{A.15}$$

or:

$$x_C = 1 + (1/ c_D S_{cc}) \delta^X{}_D. \tag{A.16}$$

B. Determinants of underlying dollarization

From (10), we know that:

$$\boldsymbol{I}^* = \frac{S_{pp} + S_{ps}}{[S_{pp} + S_{ss} + 2 S_{ps}]} \tag{A.17}$$

It is easy to check that, for $\lambda^* \varepsilon [0,1]$:

$$S_{ss} + S_{ps} > 0 \tag{A.18}$$

and:

$$S_{\pi\pi} + S_{\pi s} > 0. \tag{A.19}$$

Then, taking derivatives:

$$\partial\lambda^*/\partial S_{ss} = -1/ (S_{\pi\pi} + S_{ss} + 2S_{\pi s})^2 < 0, \tag{A.20}$$

$$\partial\lambda^*/\partial S_{\pi\pi} = (S_{ss} + S_{ps}) / (S_{\pi\pi} + S_{ss} + 2S_{\pi s})^2 > 0, \tag{A.21}$$

and:

$$\partial\lambda^*/\partial S_{\pi s} = (S_{ss} - S_{\pi\pi}) / (S_{\pi\pi} + S_{ss} + 2S_{\pi s})^2 . \tag{A.22}$$

From which:

$$\text{sign} \left(\partial\lambda^* / \partial S_{\pi s} \right) = \text{sign} \left(S_{ss} - S_{\pi\pi} \right). \tag{A.23}$$

C. Impact of dollar pricing on underlying dollarization

It follows from (19) and (20) that:

$$S_{\pi\pi} = \alpha^2 S_{ee} + (1 - \alpha)^2 S_{\varepsilon\varepsilon} + 2\alpha(1 - \alpha)S_{e\varepsilon}, \tag{A.25}$$

$$S_{ss} = (1 - \alpha)^2 (S_{ee} + S_{\varepsilon\varepsilon} - 2S_{e\varepsilon}), \tag{A.26}$$

and:

$$S_{\pi s} = \alpha(1 - \alpha)S_{ee} - (1 - \alpha)^2 S_{\varepsilon\varepsilon} + (1 - \alpha)(1 - 2\alpha)S_{e\varepsilon.} \tag{A.27}$$

Replacing (A.25)-(A.27) into (A.17):

$$\boldsymbol{I}^* = \frac{\boldsymbol{a} S_{ee} + (1 - \boldsymbol{a}) S_{e\boldsymbol{e}}}{S_{ee}}. \tag{A.28}$$

Finally, using (A.22), $S_{e\boldsymbol{p}} = \alpha S_{ee} - (1 - \alpha)S_{e\varepsilon,}$ and (A.28) becomes:

$$\lambda^* = S_{e\boldsymbol{p}} / S_{ee} = \rho_{e\pi} S_{\pi} / S_{e.} \tag{A.29}$$

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TABLE 1
LIST OF COUNTRIES [1]

Albania	1992:2-1995
Argentina	
Armenia	1993:2-1995
Bolivia	
Bulgaria	1991:3-1995
Canada	
Costa Rica	
Croatia	1993:2-1995
Czech Republic	1993:2-1995
Ecuador	
Egypt	1991:1-1995
El Salvador	
Germany	
Guinea-Bissau	
Honduras	
Hungary	
Jamaica	
Japan	
Jordan	
Laos	1993:1-1995
Malawi	
Mexico	
Mongolia	1992:1-1995
Nicaragua	
Pakistan	
Peru	
Philippines	
Poland	1990:3-1995
Romania	1991:1-1995
Slovak Republic	1993:2-1995
Turkey	
Uganda	
United Kingdom	
Uruguay	
Zambia	

[1] Data available for the sample period used in the tests, except otherwise indicated.

TABLE 2

DEFINITION OF VARIABLES AND SOURCES

CBD = Cross border deposits (IFS).

CBL = Cross-border loans (IFS).

FCD = Foreign currency domestic deposits (IMF, 1998; Central Bank Bulletins, and IFS).

HCD = Local currency domestic deposits (Central Bank Bulletins, and IFS).

Dollarization ratio (λ_D) = (FCD + CBD)/(FCD + CBD + HCD).

FA (FL) = Foreing assets (liabilities) of commercial banks (IFS).

CR = Total claims of deposit money banks (IFS).

D = FCD + HCD + CBD.

L = CR + CBL.

NFA = (FA - FL + CBD - CBL)/(D + L).

S_{xy} = Covariance of variables x and y computed based on quarterly data covering the previous 6 years (latest 24 observations).

TABLE 3

CROSS-COUNTRY REGRESSIONS

	π	λ^*	NFA	$S_{\pi\pi}$	S_{ee}	$S_{\pi e}$	β	S_{π}	$1/S_{\varepsilon}$	$r_{\pi e}$	R^2
(1)	0.309 (0.090)										0.190
(2)		0.619 (0.055)									0.802
(3)	-0.120 (0.050)	0.690 (0.070)									0.820
(4)		0.614 (0.050)	0.169 (0.082)								0.815
(5)			0.284 (0.261)	0.010 (0.002)	-0.010 (0.004)	0.016 (0.004)					0.178
(6)							0.611 (0.087)				0.695
(7)			0.363 (0.145)					0.086 (0.043)	39.552 (16.140)	0.563 (0.085)	0.678

Number of observations: 35. White heteroskedastic-consistent standard errors in parentheses.

Actual dollarization and net foreign assets (NFA) averages computed from annual data for the period 1990–1995. All other variables computed from quarterly CPI and exchange rate data, and averaged over the period 1990 to 1995, or the longest period for which there is available data.

TABLE 4
LATIN AMERICA - PANEL REGRESSIONS (1982-1995)

	π	λ^*	NFA	$S_{\pi\pi}$	$1/S_{ee}$	$S_{\pi e}$	β	S_π	$1/S_\varepsilon$	$r_{\pi e}$	R^2
(1)	0.036 (0.015)										0.690
(2)		0.155 (0.023)									0.728
(3)	0.028 (0.015)	0.151 (0.023)									0.733
(4)		0.071 (0.021)	0.346 (0.044)								0.778
(5)			0.261 (0.039)	0.006 (0.001)	19.244 (6.239)	0.005 (0.002)					0.818
(6)	0.044 (0.012)		0.299 (0.039)	0.005 (0.001)	20.970 (6.202)	0.005 (0.002)					0.829
(7)							0.114 (0.025)				0.703
(8)								0.172 (0.019)	26.461 (4.296)	0.033 (0.024)	0.804

Number of observations: 280. White heteroskedastic-consistent standard errors in parentheses.

Actual dollarization and net foreign assets (NFA) computed from annual data. All other variables computed from quarterly CPI and exchange rate data.

TABLE 5

DEVIATIONS FROM MVP IN THE PRESENCE OF INDEXATION

	Period	MVP	Actual[1]
Chile	1975:1 – 1985:3	57.6	36.2
	1985:4 – 1996:3	32.0	14.2
Brazil [2]	1980:1 – 1996:3	99.0	11.6
Israel	1980:1 – 1985:4	86.4	26.1
	1986:1 – 1996:4	10.4	18.2

1/ End of last year of corresponding period.
2/ CBD only. FCD are not allowed in Brazil.

TABLE 6

EXCHANGE RATE-BASED STABILIZATION AND DOLLARIZATION

	Period	Inflation rate	λ*	Dollarization ratio
Argentina	1986 - 1990	88.75	89.15	78.37
	1991 - 1995	5.20	78.48	71.65
Bolivia	1985 - 1989	58.45	94.88	88.02
	1990 - 1995	2.94	89.90	90.81
Mexico	1983 - 1987	17.45	49.46	44.62
	1988 - 1995	5.95	28.72	33.30
Peru	1986 - 1990	110.29	91.99	84.79
	1991 - 1995	11.24	78.94	80.48
Uruguay	1986 - 1990	16.16	91.86	90.99
	1991 - 1995	11.58	89.46	86.33
Hungary	1988 - 1992	5.67	37.67	23.96
	1993 - 1995	5.44	43.21	39.95

Inflation rate computed as the average of quarterly inflation during the period. Dollarization ratios are measured at the end of the period.