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Alain Ize Eric Parrado

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Agustinas 1180
Teléfono: (56-2) 6702475; Fax: (56-2) 6702231

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REAL DOLLARIZATION, FINANCIAL DOLLARIZATION, AND MONETARY POLICY

Alain Ize
Fondo Monetario Internacional

Eric Parrado
Banco Central de Chile

Resumen
Este trabajo estudia la interacción entre la dolarización real (salarios denominados en dólares), la dolarización financiera (contratos financieros denominados en dólares) y la política monetaria, en un modelo de equilibrio general con *shocks* reales. La dolarización real se evita si las autoridades monetarias actúan óptimamente (esto es, maximizan el bienestar interno). En caso contrario, la dolarización se expande si los bancos centrales se desvían del óptimo; y aun más si la correlación entre *shocks* internos y externos es alta ya que la política monetaria externa (presumiblemente óptima) garantiza un mayor nivel de protección contra la incertidumbre macroeconómica. Si bien la dolarización real contribuye a la dolarización financiera, existen importantes asimetrías entre estas.

Abstract
This paper explores the interaction of real dollarization (dollar indexing of wages), financial dollarization (dollar denomination of financial contracts) and monetary policy in a general equilibrium model with real shocks. Real dollarization is avoided as long as the home monetary authorities perform optimally (i.e., they maximize local welfare). Instead, dollarization increases when central banks perform poorly, and even more so when the correlation between domestic and external shocks is high, since in this case the (presumably optimal) foreign monetary policy guarantees a better level of protection against macroeconomic uncertainty. While real dollarization contributes to financial dollarization, important asymmetries between the two arise.

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E-mails: aize@imf.org; eparrado@bcentral.cl.

I. INTRODUCTION

Notwithstanding substantial progress during the last decade in controlling inflation throughout the world, financial dollarization (the dollarization of financial contracts) has expanded, rather than receded, in many developing and transition economies.[1] This raises the possibility that dollarization is a one-way street that will sooner or later lead to the demise of all but a handful of world currencies. Yet, the spread of dollarization appears to have been mostly concentrated in the financial sector. Real dollarization (the dollar denomination of price and wage contracts) appears to remain very limited. In particular, the vast majority of wage earners continues to have their wage denominated and paid in local currency, even in countries with high financial dollarization.[2]

Explaining this apparent asymmetry between financial and real dollarization requires a better understanding of what causes dollarization. In turn, this requires distinguishing between payments dollarization, financial dollarization, and real dollarization. Explanations for payments dollarization can be found in the early currency-substitution literature, based on inflation differentials that penalize the holdings of domestic currency.[3] Since financial contracts are immune to systematic inflationary taxation, explanations for financial dollarization must be based instead on risk and volatilities. Much progress has been achieved along these lines over the last few years, with financial dollarization being explained as a result of risk aversion and price risk (Ize and Levy-Yeyati, 2003), credit risk (Aghion, Bacchetta and Banerjee, 2004, and Jeanne, 2005), or moral hazard (Burnside, Eichenbaum and Rebelo, 2001).[4]

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[1] De Nicolo, Honohan and Ize (2005) find that deposit dollarization increased during the late 1990s in most countries that allow domestic dollar deposits, with declines seen in only a handful of Eastern European countries and emerging economies.

[2] Although there is limited statistical evidence on the extent of wage dollarization in highly dollarized countries, such as Peru, Bolivia and Uruguay, all observers agree that it is limited to a small fringe of top executives, mostly in large transnational corporations.

[3] Early discussions of ratchet effects and the impact of financial innovations on money demand can be found in Goldfeld (1976). Calvo and Végh (1996) present comprehensive surveys of the currency-substitution literature.

[4] Ize and Levy Yeyati (2006) present a comprehensive review of the recent literature on financial dollarization.

The literature on real dollarization lags behind that on payments or financial dollarization. In part, this is because there are few, if any, direct measurements of the extent of real dollarization. There have been attempts to measure real dollarization on the basis of the passthrough of the exchange rate on prices.[5] However, this is problematic on at least two counts. First, price dollarization may not necessarily reflect wage dollarization. Hence, it can only provide a partial view of real dollarization. More importantly, a passthrough measure does not distinguish between formal ex-ante indexation and ex-post adjustments caused by large swings in monetary policy. High passthroughs are likely to be detected when the data set is dominated by large nominal shocks where all prices (including the exchange rate) move in parallel. Yet, during such episodes of high inflation there may not be any underlying dollarization of contracts. Hence, measured passthroughs may decline pari passu with inflation, as found in many studies.[6]

Whether real dollarization matches financial dollarization has important policy implications. Once most prices and wages are set in foreign currency, there is little the local monetary authorities can do that will have any impact on macroeconomic variables. On the other hand, when prices and wages are set in local currency but most (if not all) financial intermediation takes place in dollars, the scope for currency mismatches, balance sheet effects, and, as a result, fear of floating, is exacerbated.

This paper extends the analysis of Ize and Levy Yeyati (2003) to the real economy in the context of a fully endogenous monetary policy. The main question the paper addresses is whether real dollarization responds to the same factors as financial dollarization. It does so by examining optimal wage indexation in the setting of a two-country "new open-economy" model in the tradition of Obstfeld and Rogoff (1995 and 2000). The main conclusion is that agents' choice of the local or foreign currency for wage indexation depends, as financial dollarization, on price and exchange rate uncertainty. However, it also depends on the extent to which

[5] De Nicolo, Honohan and Ize (2005) and Reinhart, Rogoff and Savastano (2003) find a clear positive correlation between the passthrough of the exchange rate on the CPI and financial dollarization. But this is indeed exactly what one would expect if financial dollarization reflects the covariance of inflation and the exchange rate, as in the portfolio approach proposed by Ize and Levy Yeyati (2003). Thus, the passthrough may be a better proxy of financial dollarization than real dollarization. Even then, however, because it is purely backward looking (it does not reflect expectations), the passthrough is an imperfect measure of financial dollarization.

[6] See Goldfajn and Werlang (2000).

monetary policy is used to shield the economy from real disturbances and whether these disturbances are idiosyncratic (proper to each country) or systemic. Agents stick with the local currency (i.e., avoid wage dollarization) as long as the home monetary authorities conduct monetary policy close to optimally (in the sense of maximizing local welfare). Instead, large deviations from optimality promote dollarization, particularly when the correlation between domestic and external shocks is high, since in this case the (presumably optimal) foreign monetary policy guarantees a better level of protection. While financial dollarization is partially responsive to real dollarization (through its impact on prices and the exchange rate), high financial dollarization can coexist with low wage dollarization if: i) the economy is open; ii) shocks are mainly idiosyncratic; and iii) monetary policy emphasizes countercyclical management rather than strict inflation targeting.

The main conclusions of our paper are clearly reminiscent of the basic result of the optimal currency area (OCA) literature.[7] Countries that are exposed to systemic (rather than idiosyncratic) shocks are better candidates to forego of their currency and join a common currency area. Whether the outcome of a market process or the choice of a centralized planner, the basic driving force behind the adoption of a foreign currency is the same in both cases. Our paper also connects with the large literature on endogenous passthroughs that started with Taylor's (2000) seminal contribution.[8] However, this literature focuses on price formation looking out (i.e., on export prices) rather than looking in (i.e., on domestic prices). By assuming that domestic prices may not necessarily be set in local currency, our paper provides a complementary, dollarization-oriented, perspective to this mostly trade-oriented literature.[9]

The paper is organized as follows. Section II presents the model. Section III solves the model in a general equilibrium setting. Section IV extends the analysis to the case of financial intermediation, allowing for a comparison of wage and financial dollarization. Section V

[7] For a recent survey of the optimal currency area literature, see Alesina, Barro, and Tenreyro (2002).

[8] A number of recent papers, including Corsetti and Pesenti (2001, 2002, and 2005), Devereux, Engel, and Stoorgard (2004), and Bacchetta and van Wincoop (2005) explore the linkages between the passthrough and monetary policy based on similar new Keynesian open economy models.

[9] This paper is also related to a recent contribution by Velasco and Chang (2006) that discusses the interaction between monetary policy and financial dollarization in a somewhat similar setting. However, Velasco and Chang only deal with financial (not real) dollarization.

broadens the discussion to include the possibility of a regime change. Section VI concludes by briefly reviewing some policy implications.

II. The Model

A. Model Formulation

We use a model of a small open economy which is quite similar to the ones developed by Corsetti and Pesenti (2001, 2005), Devereux and Engel (2002, 2003), and Parrado and Velasco (2002), among others. Thus, for the sake of brevity we only describe here the model in general terms and explain how it differs from the rest of the literature.[10]

The world comprises a small open economy (SOE) and the rest of the world (ROW). Domestic and foreign agents face symmetric consumption and labor supply choices, except that only home agents have the possibility to denominate (at least) part of their wage in foreign currency. In both cases, agents consume local and imported goods and sell their differentiated labor, under monopsonic conditions, to a representative firm producing the local good. The representative firm is perfectly competitive and uses a continuum of labor inputs. Consumers hold only money as an asset. We assume away at this stage the existence of domestic financial intermediation.

In typical new-Keynesian fashion, agent *i* set his nominal wage in period *t*-1 and leaves it fixed for one period. Thus, he makes decisions in period *t*-1 based on his expected utility at time *t*, which depends on his consumption, C_t^i, real money balances, M_t^i / P_t^i, and labor L_t^i:[11]

$$U_t^i = E[c_t^i + \chi(m_t^i - p_t) - k_t L_t^i], \tag{1}$$

where the consumer price index is given by:

$$p_t = \gamma p_{H,t} + (1-\gamma)s_t, \tag{2}$$

where $p_{H,t}$ is the price of the home good, γ is the share of home goods, and s_t the nominal exchange rate. The production function exhibits decreasing returns with respect to aggregate labor:

[10] The model's starting equations are described in Appendix I and the main steps in resolving it in Appendices II and III.

[11] All variables are expressed in per-capita terms, with foreign variables denoted by an asterisk. We use capital letters for all natural magnitudes and lower case for logs.

$$y_t = \theta l_t, \theta < 1. \quad (3)$$

The real wage in period *t* may deviate from its optimal level due to unexpected real disturbances (domestic or foreign). To reduce their exposure, agents can index part of their wage to the exchange rate, i.e., partly dollarize it. Let μ_R^i be the share of agent *i*'s wage which is indexed. If the monetary authorities do not have a systematic inflationary bias, nominal variables should be expected to remain approximately constant. Thus, assuming $E[s_t]=s_{t-1}$, the wage indexation rule may be expressed as:

$$w_t^i = \tilde{w}_t^i + \mu_R^i (s_t - E[s_t]), \quad (4)$$

where $\tilde{w}$ is the base (unindexed) wage. Given that the only asset is money, which is fully neutral, period-by-period equilibria are independent, and all real state variables are stationary and time-invariant. Thus, the expectation of any real (stochastic) variable, for any monetary regime, is also constant.

The monetary authority of the home economy is assumed to follow a simple monetary rule that avoids surprises but reacts systematically to domestic and foreign productivity shocks:

$$m_t = E[m_t] + \lambda_k (k_t - E[k_t]) + \lambda_{k^*} (k_t^* - E[k_t^*]). \quad (5)$$

A similar rule applies for the rest of the world, except that SOE is too small to affect ROW; hence, the foreign monetary authorities only react to home shocks. The parameters λ and λ^* are set to maximize consumers' expected welfare.

B. Model Resolution

Resolving the supply side of the model leads to a conventional Phillips-type output equation with an added nominal exchange rate term (see Appendix II):

$$y_{H,t} - \hat{y}_H = \frac{\theta}{1-\theta} [\mu_R (E[s_t] - s_t) + (p_{H,t} - E[p_{H,t}])], \quad (6)$$

where $\hat{y}_H$ is the flex-price equilibrium output. Hence, fix price output deviates from its flexible price level due to unexpected price movements, as well as, when wages are partly indexed (μ_R^i>0), unexpected exchange rate fluctuations.

On the demand side, the model can be reduced to a system of three equations such that output, the home price, and the exchange rate are a function of home and foreign monetary surprises (see Appendix III):

$$y_{H,t} - \hat{y}_H = \theta(1-\mu_R)(m_t - E[m_t]) + \theta\mu_R(m_t^* - E[m_t^*]), \tag{7}$$

$$p_{H,t} - E[p_{H,t}] = [1-\theta(1-\mu_R)(m_t - E[m_t]) - \theta\mu_R(m_t^* - E[m_t^*]), \tag{8}$$

$$s_t - E[s_t] = (m_t - E[m_t]) - (m_t^* - E[m_t^*]). \tag{9}$$

A positive domestic monetary impulse increases domestic demand, raising output and prices and leading to a nominal exchange rate depreciation. Inversely, a positive foreign monetary impulse leads to an exchange rate appreciation. In addition, in this model, the foreign shock reduces real wages when the latter are (at least partly) dollarized, thereby raising output and reducing prices.

Rearranging the equations above, using (2), gives similar expressions for the domestic consumer price level and the real exchange rate, $e = s - p$:

$$p_t - E[p_t] = [1-\theta\gamma(1-\mu_R)](m_t - E[m_t]) - (1-\gamma+\gamma\theta\mu_R)(m_t^* - E[m_t^*]), \tag{10}$$

$$e_t - E[e_t] = \theta\gamma(1-\mu_R)](m_t - E[m_t]) - \gamma(1-\theta\mu_R)(m_t^* - E[m_t^*]). \tag{11}$$

An increase in real dollarization μ_R magnifies the impact of home monetary shocks on prices while limiting their impact on the real exchange rate. Thus, it raises the volatility of inflation but reduces that of the real exchange rate. This will establish a positive link between real and financial dollarization, since, as we shall see, financial dollarization increases with the ratio of inflation volatility to real exchange rate volatility. Note also from the price equation that the pass-through of the exchange rate on the CPI, which is given by the coefficient of the foreign money term $1-\gamma+\gamma\theta\mu_R$, has two components: an imported goods components, and a local goods component, with the latter being proportional to the degree of wage dollarization. We will refer back to these features later in the paper.

In traditional neo-Keynesian fashion, uncertainty induces workers to mark up their real wage (and hence to work less) so as to limit their risk exposure. Thus, the fix-price expected real wage is a function of the flex-price real wage $\hat{\omega}$ augmented by a risk premium V:

$$\frac{W_t}{E[P_{H,t}]} = \hat{\varpi}(1+V)^{1-\theta}, \tag{12}$$

where:

$$V = \frac{1}{2(1-\theta)^2}\{\sigma_{p_H}^2 + 2(1-\theta)\sigma_{p_H,k} + (1-\theta)^2\sigma_k^2 + \mu_R^2\sigma_s^2 - 2\mu_R[\sigma_{p_H,s} + (1-\theta)\sigma_{k,s}]\}. \qquad (13)$$

As a result, average fix-price consumption is lower than average flex-price consumption:

$$C = \widehat{C}/(1+V)^{\theta}, \qquad (14)$$

and maximizing expected welfare is equivalent to minimizing the risk premium.

III. Real Dollarization

A. Optimal Monetary Policy

The risk premium in ROW can be similarly expressed as a function of the shock and monetary policy:

$$V^* = \frac{1}{2}[1+\lambda^{*2}]\sigma_{k^*}^2. \qquad (15)$$

It follows that the optimal monetary policy for ROW (that minimizes V^*) is a reactive policy such that $\lambda^* = -1$. By tightening (relaxing) monetary policy when agents' disutility of work is high (low), the foreign monetary authorities mimic an optimal flex-price wage policy, with labor adjusting through aggregate demand rather than the real wage. This reduces the macroeconomic uncertainty to which workers are exposed.

With such an optimal monetary policy in ROW and assuming that the shocks in SOE and ROW have similar magnitude ($\sigma_k^2 = \sigma_{k^*}^2$), a similar derivation for V can be obtained for SOE. Assuming for the time being that the home monetary authorities only react to the home shocks (this assumption is relaxed later), the optimal home monetary policy as a function of actual dollarization can be found by differentiating V with respect to λ_k, which gives:

$$\lambda_k = -1 - \frac{\mu_R}{1-\mu_R} \ . \qquad (16)$$

The resulting monetary policy schedule is shown in Figure 1. In the absence of wage dollarization ($\mu_R = 0$), the home monetary authorities adopt the same counter-cyclical policy as the foreign monetary authorities ($\lambda_k = -1$). Instead, with positive wage dollarization, monetary policy becomes less effective as real wages are less sensitive to money-induced price shocks. Thus, a higher “dosage” of monetary shocks (a more negative λ_k) is needed to obtain the same impact on real wages and output. At the same time, the adverse impact of monetary volatility on welfare is dampened by the fact that dollarization shields real wages from nominal shocks. Thus, monetary policy is both required and allowed to become more "aggressive" in counteracting domestic productivity shocks.

B. Optimal Wage Indexation

Setting μ_R^i to minimize V leads to the following expression:

$$\mu_R = \rho_{p_H,s}\frac{\sigma_{p_H}}{\sigma_s} + (1-\theta)\rho_{k,s}\frac{\sigma_k}{\sigma_s}, \tag{17}$$

where ρ_{ij} is the correlation coefficient between variables *i* and *j*.

The first term on the right hand side of (17) is the minimum variance solution for employment (see Appendix V) and has the same form and rationale as a beta coefficient in the asset portfolio literature. Workers choose the level of real dollarization that stabilizes their employment the most, which amounts to minimizing the variance of the real wage in terms of home goods. Thus, workers prefer the dollar (they index their wage) if the volatility of the exchange rate is low relative to that of domestic prices, and the correlation between the exchange rate and home prices is high. As shown in Section IV, similar factors are at play when determining financial dollarization.

Looking now at the second term on the right hand side of (17), workers also take into account the impact of unexpected changes in the demand and supply for labor, as reflected in the cross-correlations between the exchange rate and the real shocks. A positive correlation between the exchange rate and the real shock promotes indexation. If the exchange rate depreciates when *k* is high (i.e., when agents would prefer to work less), this raises the real wage when the latter is indexed. Thus, it reduces the demand for labor, thereby allowing workers to work less and enhancing their welfare. Instead, a reactive monetary policy, that tightens monetary conditions and appreciates the exchange rate when workers' appetite for work declines, results in a higher unindexed real wage, enhancing the attractiveness of the local currency.

C. General equilibrium

With (8) and (9), the optimal dollarization can be expressed as a function of monetary policy:

$$\mu_R = \frac{(1+\lambda_k)(\lambda_k+\rho)}{\lambda_k^2+2\rho\lambda_k+1}, \qquad (18)$$

where ρ is the correlation between home and foreign shocks. The dollarization schedule has the shape shown in Figure 1. Notice in particular that wage dollarization vanishes for $\lambda_k = -1$ and becomes negative in the interval $\lambda_k \in \left]-1,-\rho\right[$. It follows that a monetary policy that is sufficiently (but not excessively) pro-active (i.e., $\lambda_k \in [-1,-\rho]$) is consistent with no real dollarization. The level of protection a well managed local currency provides against shocks is sufficient to make it more attractive than the foreign currency, for any correlation of domestic and foreign shocks.

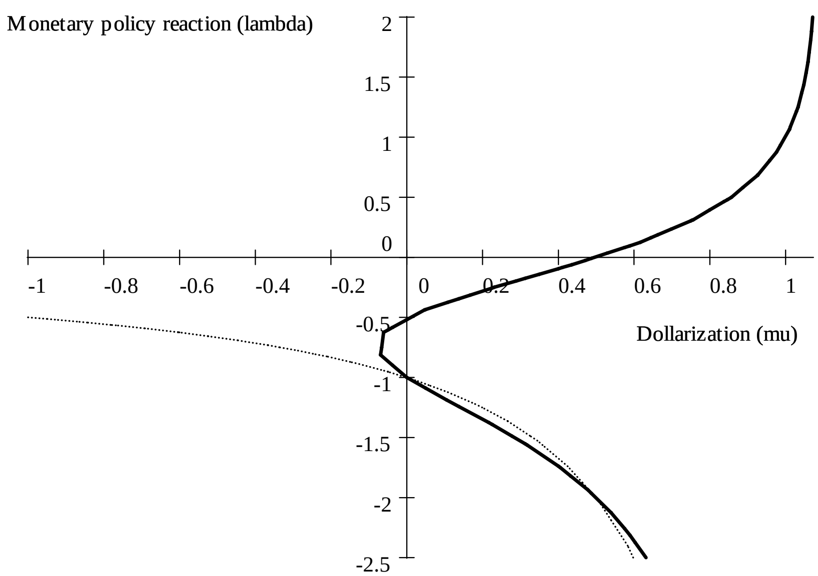

Figure 1. Monetary Policy and Dollarization (ρ = 0.5)

However, as ρ increases, the margin of error for maintaining a sub-optimal monetary policy without inducing dollarization shrinks. As $\rho \to 1$, $\mu_R \to 1$ unless $\lambda_k = -1$. Thus, small countries that are affected by the same shocks than their larger trading partners (for example the US) are more likely to dollarize.

Conversely, a passive monetary policy, $\lambda_k = 0$, promotes dollarization by the extent to which domestic and foreign real shocks are correlated, $\mu_R = \rho$. Thus, the combination of a passive monetary policy and an increasing correlation of shocks across countries, perhaps reflecting globalization, can result in growing dollarization.

The dollarization and monetary policy curves cross in two places, however. There is also an inferior partially dollarized equilibrium with an over-active monetary policy ($\mu_R = 1-\rho; \lambda_k = -1/\rho$). In the absence of dollarization inertia, the monetary authorities could presumably switch immediately from this inferior equilibrium to the non-dollarized equilibrium by adjusting monetary policy (setting $\lambda_k = -1$). However, with inertia, countries that are dollarized may get stuck in this inferior equilibrium.

Finally, a very poorly managed monetary policy (a very high or a very low λ_k) promotes dollarization even when local and foreign shocks exhibit little or no correlation. Thus, countries that clearly "lost it" (for example, that are unable to stabilize their currency) are likely to see dollarization increasing, even when they are large and do not trade much with the US.

IV. Financial Dollarization

We now expand the model to cover the case in which both consumers and the representative firm enter into financial contracts which can be (partly or totally) indexed to the dollar. To keep matters simple, we assume that consumers are paid their salary in advance and, to finance such payments, make loans to the firm. These loans can be denominated in local currency or in dollars and must be repaid, with interest, the following period.

A. Safe haven equilibria

We first examine the case in which firms are risk neutral. Let μ_F^i be the degree of financial dollarization chosen by consumer *i*, and i_t^* and i_t the nominal interest rates on foreign currency and home currency loans, respectively. The first order condition in μ_F^i applied to consumers' budget constraint leads to the following uncovered interest rate parity condition (see Appendix IV):

$$i_t^* + (E[s_t] - s_{t-1}) + \frac{1}{2}\sigma_s^2 - \sigma_{p,s} - \sigma_{c,s} = i_t. \tag{19}$$

When $\sigma_{c,s} > 0$, exchange rate depreciations (which raise the return on dollar instruments) occur when consumption is high, making dollar instruments relatively unattractive, as reflected in a negative risk premium. Inversely, when $\sigma_{c,s} < 0$, the dollar benefits from a "safe-haven" effect (returns are high at the time high returns are most needed, i.e., when consumption is low).

Similarly, firms similarly choose μ_F to maximize the expected value of their (real) profits, leading to the condition:

$$i_t^* + (E[s_t] - s_{t-1}) + \frac{1}{2}\sigma_s^2 - \sigma_{p,s} = i_t. \tag{20}$$

Comparing (19) and (20), for both to be satisfied (i.e., to have an interior equilibrium), the equilibrium level of financial dollarization should be such as to eliminate the safe haven term, i.e., $\sigma_{c,s} = 0$. Should consumers' interest income be the only component of their income that is affected by the exchange rate, this condition would be satisfied when, in the event of a depreciation, valuation gains on dollar loans were exactly offset by the inflationary losses on peso loans. As shown in Appendix IV, this implies a minimum variance level of financial dollarization, such that:

$$\mu_F = \frac{\sigma_{p,s}}{\sigma_s^2} = \rho_{p,s}\frac{\sigma_p}{\sigma_s}. \tag{21}$$

Substituting the consumer price index for the home price, this expression is identical to the first term in (17).[12] Thus, as for the minimum variance component of real dollarization, financial dollarization rises with the ratio of price volatility (in this case, consumer prices rather than producer prices) to exchange rate volatility and with the correlation between prices and the exchange rate.

However, as consumers are both firm owners and lenders, valuation gains and losses on interest income are offset by opposite gains and losses originating from dividends. Indeed, consumers' total income equals national income, which is affected by real dollarization (and monetary policy) but not by financial dollarization. This leads to single-currency, corner

[12] This is the expression derived in Ize and Levy-Yeyati (2003), expressed in terms of the real exchange rate, rather than the nominal exchange rate.

solutions that are entirely dominated by safe haven effects (rather than relative volatilities). When income (and consumption) increases as a result of a depreciation ($\sigma_{c,s} > 0$), the safe haven effects plays in favor of the local currency. When income (and consumption) falls ($\sigma_{c,s} < 0$), the safe-haven effect plays in the other direction, inducing agents to intermediate in foreign currency exclusively. It is easy to check (see Appendix IV) that $\sigma_{c,s} < 0$ when:

$$\lambda_k > -\frac{\rho\theta\gamma + 1 - \gamma}{\theta\gamma + \rho(1-\gamma)}. \tag{22}$$

Hence, when safe haven effects dominate, a passive monetary policy ($\lambda_k = 0$) induces real dollarization.

B. Minimum variance equilibria

Consider now the (perhaps more realistic) case where firm managers are averse to risk and seek to smooth out profits over time. Thus, suppose firms maximize the log (rather than the level) of (real) profits, π. The first order condition for the firm's optimal degree of financial indexation becomes:

$$i_t^* + (E[s_t] - s_{t-1}) + \frac{1}{2}\sigma_s^2 - \sigma_{p,s} - \sigma_{\pi,s} = i_t. \tag{23}$$

This expression includes now a covariance term between profits and the exchange rate, which is similar to the one between consumption and the exchange rate in equation (19). However, given that firms minimize interest payments (instead of maximizing interest returns, as in the case of consumers), its impact on currency choice is opposite to that of consumers. A negative covariance (the exchange rate is high when profits are low) induces firms to avoid dollar borrowing, limiting the scope for corner solutions.

Instead, an interior solution is now obtained when:

$$\sigma_{\pi,s} = \sigma_{c,s}. \tag{24}$$

It is easy to show (see Appendix IV) that profits are a multiplicative function of output (hence consumption) and interest payments:

$$\Pi = C\left[1 - \theta\frac{P}{P_{-1}}[(1+i)(1-\mu_F) + (1+i^*)\mu_F\frac{S}{S_{-1}}\right]. \tag{25}$$

Hence, (24) requires that the covariance of interest payments and the exchange rate be equal to zero, yielding the minimum variance solution defined by (21). Safe haven effects vanish in this case because the negative correlation between consumption (or output) with the exchange rate, which makes the dollar attractive to a lender, makes it equally unattractive to a borrower. Hence, only relative volatilities matter.[13]

C. Relative dollarization levels

In either case, financial dollarization tends to exceed real dollarization. Take first the case of safe haven effects and risk neutral firms. As already noted, a passive monetary policy leads to full financial dollarization but to only partial real dollarization ($\mu_R = \rho$). On the other hand, an optimal monetary policy ($\lambda_k = -1$) eliminates real dollarization ($\mu_R = 0$). Yet, (22) continues to be satisfied if the economy is relatively open ($\gamma < \frac{1}{1+\theta}$). Thus, except if the economy is relatively closed (in which case $\mu_F = \mu_R = 0$), financial dollarization exceeds real dollarization.

Take now the case of risk averse firms. The linkage between real and financial dollarization can be derived by replacing in (21) the variance and covariance of the exchange rate, as obtained from (9) and (10):

$$\mu_F = 1 - \gamma + \gamma\theta\overline{\mu}_R + \gamma(1-\theta)\lambda_k \frac{\sigma_{s,k}}{\sigma_s^2}, \tag{26}$$

where $\overline{\mu}_R$ stands for actual real dollarization (as distinct from its optimal level). This expression shows that financial assets can be divided up into those associated with imported goods, which should be fully dollarized, and those associated with local goods; in turn, the latter can be broken down according to the labor and non labor shares of output.

The dollarization of the labor share should equal that of wages. Hence, real dollarization (a higher $\overline{\mu}_R$) induces financial dollarization. In turn, the dollarization of the non labor share

[13] More generally, should borrowers be risk averse but less so than lenders, the optimum lending mix would respond both to safe haven and volatility effects. If borrowers are risk averse, they care about volatility. Yet, if they are less risk averse than lenders, they can accommodate to some extent lenders' preference for a safe haven investment (the effectively provide lenders some insurance against the risk associated with the safe haven effect). Hence, safe haven effects should also matter in determining the optimum lending mix.

depends on monetary policy (i.e., on how monetary policy affects relative price volatilities). Under an optimal monetary policy, this term is positive, as both λ_k and $\sigma_{s,k}$ are negative. Hence, financial dollarization clearly exceeds wage dollarization, even when the latter is in excess of its optimal level (which is zero in this case). Under a passive monetary policy, this term disappears. Yet, financial dollarization still exceeds real dollarization, unless real dollarization is large ($\bar{\mu}_R > \frac{1-\gamma}{1-\gamma\theta}$). But if real dollarization is optimal, this could only occur in the rather unprobable case where shocks are highly correlated and yet the economy is relatively closed ($\rho > \frac{1-\gamma}{1-\gamma\theta}$).

V. REGIME CHANGES

Expectations of possible monetary regime changes may affect current dollarization. To see this, suppose that the monetary authorities currently peg the exchange rate but would be ready to let it float if the size of the real shocks affecting the economy rises sufficiently. From (9) it can be readily inferred that a peg requires that the home monetary policy mimic that of ROW: $\lambda_k = 0; \lambda_{k^*} = -1.$ In the absence of the possibility of a regime change, both real and financial dollarization become indeterminate (this follows from (17) and (21) since $\sigma_{p_H,s} = \sigma_{p,s} = \sigma_s = \sigma_{k,s} = 0$). Indeed, it does not make any difference which currency to use when they are perfectly correlated.

Suppose however that the real shocks are such that with a probability α they are expected to maintain their current variance σ_k^2 while with a probability $1-\alpha$ they are expected to increase in amplitude, to $\sigma_{k'}^2 \gg \sigma_k^2$. Since all stochastic variables in the model are expressed as deviations from their expected means (i.e., they have zero means), the variances and covariances of the joint distribution are simply obtained as the weighted averages of the variances and covariances of each distribution, with weights $\alpha, 1-\alpha$. But since the variance of the nominal exchange rate and all the covariances with the nominal exchange rate are zero under the first regime, it follows that the variance and covariances of the joint distribution are equal to the variances and covariances under the new distribution of shocks and the new monetary regime, times 1-α. It can then be immediately inferred from (17) and (21) that the 1-α terms cancel out and current dollarization is only a function of expected monetary policy under the new regime, irrespective of the likelihood of a regime change.

Suppose in particular that, should a switch from small to large shocks occur, the public expects the monetary authority to switch from a peg to an active float ($\lambda_k = -1; \lambda_{k^*} = 0$). In this case, the monetary authorities would follow an essentially passive monetary policy under the peg. Yet, real dollarization would be zero because workers would not wish to be taken “flat footed” in the event of a large shock that motivates a regime change. The local currency effectively provides an “insurance” option against the possibility of large changes, no matter how remote.

A similar argument could be made to justify the existence of very large financial dollarization under a peg. If the public expects that there is a positive probability that the monetary authorities may need to exit the peg at some point in order, say, to monetize an excessive public debt, the public would expect inflation and the nominal exchange rate to become highly (even if briefly) correlated in the event of a regime change. This would induce a current preference for the dollar as a way to protect the value of financial contracts under a bad state of the world.

Indeed, the argument can be further generalized. When shocks and volatilities are limited under normal times, the use of a currency (local or foreign) may respond more to precautionary motives (i.e., to the expected monetary policy in the event of a large shock and a bad day) than to the current stochastic structure of shocks and the current monetary regime.

VI. Conclusions

This paper has shown, based on a simple open-economy, general equilibrium model, that real and financial dollarization can be similarly explained by the stochastic properties of the economic environment and the policy response of the monetary authorities. Both types of dollarization should rise in response to an increase in the volatility of domestic inflation and fall in response to an increase in the volatility of the real exchange rate. The paper also showed that real dollarization contributes to financial dollarization.

At the same time, the paper found at least three ways of explaining the apparent asymmetry between the substantial and rapidly expanding financial dollarization in many regions of the world and the so far contained real dollarization. First, while wage dollarization should remain limited if monetary policy is used actively to offset output and productivity shocks (i.e., if it used for "countercyclical" purposes), financial dollarization may remain substantial if such a policy triggers some inflation volatility.

Second, financial dollarization, unlike wage dollarization, should reflect the trade structure of the economy. Thus, trade globalization could lead to rising levels of financial dollarization but not wage dollarization. This effect could be magnified, reflecting safe haven effects, if there is a strong asymmetry between borrowers and lenders as regards their tolerance to risk.

Third, dollarization, both real and financial, can be determined by what could happen under a bad day rather than by what happens under normal days. Thus, while the local currency may be retained in real transactions as a protection against a large *real shock* requiring substantial relative price adjustments, the use of the dollar may become widespread in financial transactions as a protection against a large *nominal shock* (an inflationary bubble).

The paper also found, however, that more highly correlated local and world real shocks (i.e., more syncronic business cycles, which one would expect to also accompany globalization) should also raise real dollarization unless the quality of local monetary management improves pari passu. Wage earners should be increasingly induced to switch to the currency of the country which does a better job at running its monetary policy. This last result is consistent with the thrust of the optimal currency area literature.

A number of important policy implications looking forward can be derived. First, in the context of rising globalization, the competitive pressure on currencies should rise. Poorly performing central banks might lose their market share not only of financial transactions but real transactions as well. When the latter happens, central banks might as well “fold their tent”. Monetary policy is a case of “use it well or lose it”.[14]

Second, there is a potential trade-off between policy objectives. Central banks that conduct strict inflation targeting limit financial dollarization, but may promote real dollarization (which could limit the effectiveness of monetary transmission). Inversely, central banks that are willing to accept some inflation volatility in order to attain a better countercyclical performance may limit real dollarization at the expense of broader financial dollarization (which, by accentuating currency mismatches, could induce some financial instability).

Third, to avoid large currency mismatches driven by expectations of what could happen under a bad day, the monetary authorities would be well advised to adopt monetary regimes that are perceived to be fully sustainable.

[14] Indeed, countries that have “given up” on their monetary policy are likely face an uphill struggle should they wish to resume an active monetary management after years of monetary passivity. At that stage, their real economy may have become so dollarized that their efforts to resume monetary operations may be totally ineffective or could trigger severe financial instability. See Ize and Levy Yeyati (2006).

APPENDIX

I. MODEL FORMULATION

The full model comprises the following equations:

$$U_t^i = E_{t-1}\left[\log C_t^i + \chi \log \frac{M_t^i}{P_t} - k_t L_t^i\right] \quad \text{(A1)}$$

$$C_t^i = \frac{(C_{H,t}^i)^{\gamma}(C_{F,t}^i)^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}} \quad \text{(A2)}$$

$$n^*(1-\gamma^*) = n(1-\gamma) \quad \text{(A3)}$$

$$P_t C_t^i + (M_t^i - M_{t-1}^i) = W_t^i + \Pi_t^i + \tau_t^i \quad \text{(A4)}$$

$$\tau_t = M_t - M_{t-1} \quad \text{(A5)}$$

$$P_t C_t = P_{H,t} Y_t \quad \text{(A6)}$$

$$\Pi_t = P_{H,t} Y_t - W_t L_t \quad \text{(A7)}$$

$$L_t = \left[\int_0^1 (L_t^i)^{\frac{\varepsilon}{\varepsilon-1}}\right]^{\frac{\varepsilon}{\varepsilon-1}} \quad \text{(A8)}$$

$$W_t = \left[\int_0^1 (W_t^i)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \quad \text{(A9)}$$

$$Y_t = L_t^{\theta} \quad \text{(A10)}$$

$$W_t^i = \left[\frac{s_t}{E[s_t]}\right]^{\mu_R^i} \tilde{W}_t^i \quad \text{(A11)}$$

The parameter k, which represents the disutility of work, is assumed to be lognormally distributed around its mean. (A2) is the aggregate real consumption index C_t^i for agent *i.* In accordance with the small country assumption, $\gamma^* >> \gamma$ and $n^* >> n$, where n and n^* are the measures of home and foreign workers. However, we assume that the demand for home goods by foreign agents is of similar size as the demand of foreign goods by domestic agents, from which (A3) follows. (A4) is agent *i*'s budget constraint is, where Π^i is the dividend received from the firm and τ^i is a tax transfer from the monetary authorities that, in the aggregate, distributes all seigniorage back to households (Equation A5). Since agents, in the aggregate, do not accumulate assets, they consume all their income and the current account is always balanced (Equation A6). The representative firm maximizes profits, as given by (A-7), after it knows the shocks that will affect it during the period; hence, it does not face uncertainty. (A8) and (A9) define the aggregate wage and employment, where $\varepsilon > 1$ is the elasticity of substitution between labor inputs. (A10) is the production function and (A11) the wage indexing rule, as described in the text.

II. AGGREGATE SUPPLY

Maximizing (A7) subject to (A8), (A9), and (A10), yields the labor demand function as a function of relative wages (the time subscript is dropped to simplify the notation):

$$L^i = \left[\frac{W}{W^i}\right]^{\varepsilon} Y^{\frac{1}{\theta}}, \qquad \text{(A12)}$$

and output as a function of the real product wage:

$$Y = \left[\theta \frac{P_H}{W}\right]^{\frac{\theta}{1-\theta}} \qquad \text{(A13)}$$

Plugging the wage indexation rule (A11) into (A13) gives output as a function of unexpected exchange rate and price shocks:

$$Y = \left[\theta \frac{E[P_H]}{\tilde{W}}\right]^{\frac{\theta}{1-\theta}} \left[\frac{E[s]}{s}\right]^{\mu_R \frac{\theta}{1-\theta}} \left[\frac{P_H}{E[P_H]}\right]^{\frac{\theta}{1-\theta}} \qquad \text{(A14)}$$

Using (A4) and (A12), agent *i*'s consumption and employment may be expressed, respectively, as:

$$C^i = \theta C \left[\frac{s}{E[s]}\right]^{(\varepsilon-1)(\mu_R-\mu_R^i)} \left[\frac{\tilde{W}}{\tilde{W}^i}\right]^{\varepsilon-1} + \frac{\Pi^i}{P} \qquad \text{(A15)}$$

$$L^i = \left[\frac{s}{E[s]}\right]^{(\varepsilon-1)(\mu_R-\mu_R^i)} \left[\frac{\tilde{W}}{\tilde{W}^i}\right]^{\varepsilon} Y^{\frac{1}{\theta}}. \qquad \text{(A16)}$$

Maximizing (A1) with respect to $\tilde{W}^i$ subject to (A15) and (A16) leads to:

$$E\left[\theta \frac{C}{C^i}(1-\varepsilon)\left[\frac{\tilde{W}^i}{\tilde{W}}\right]^{-\varepsilon} \frac{1}{\tilde{W}}\left[\frac{s}{E[s]}\right]^{(\varepsilon-1)(\mu_R-\mu_R^i)}\right] = E\left[\varepsilon k Y^{\frac{1}{\theta}} \frac{1}{\tilde{W}}\left[\frac{\tilde{W}^i}{\tilde{W}}\right]^{\varepsilon-1}\left[\frac{s}{E[s]}\right]^{\varepsilon(\mu_R-\mu_R^i)}\right]$$

Imposing symmetry, $\mu_R^i = \mu_R$ and $\tilde{W}^i = \tilde{W}$, this simplifies to:

$$E[kY^{\frac{1}{\theta}}] = \theta(\frac{\varepsilon-1}{\varepsilon}) \qquad \text{(A17)}$$

In turn, inserting (A14) into (A17) and linearizing leads to equations (12) and (13) in the text, where the expected real wage under the flex-price solution equals:

$$\hat{\varpi} = \theta^{\theta}\left[\frac{\varepsilon}{\varepsilon - 1}k\right]^{1-\theta}$$

Using (A10) and (A17), and assuming that the money-services component of utility is small and can therefore be neglected, (A1) can be written:

$$E[U] = E[\log C - \theta\frac{\varepsilon - 1}{\varepsilon}] \qquad \text{(A18)}$$

Thus, maximizing expected welfare is equivalent to maximizing consumption, which, with (12), is equivalent to minimizing the risk premium V.

III. AGGREGATE DEMAND

Maximizing (A1) with respect to money balances leads to quantity-type home (and foreign) money demands:

$$\frac{M}{P} = \chi C \qquad \text{(A19)}$$

The domestic goods market equilibrium condition may be written:

$$nP_H Y = n\gamma PC + n^*(1-\gamma^*)SP^*C^* \qquad \text{(A20)}$$

or, with (A3) and (A6):

$$C = QC^* \qquad \text{(A21)}$$

where $Q = SP^*/P$ is the real exchange rate. In turn, expressing (A19), and (A21) in logs, and assuming $\chi = \chi^*$:

$$m - p = \chi + c = \chi + q + c^* = q + m^* - p^* \qquad \text{(A22)}$$

It follows from this expression that:

$$s = m - m^* \qquad \text{(A23)}$$

Using (A6), (A19), (A21) and (A22), we can express the producer price as a function of output and the money stock:

$$p_H = -(y + \chi - m) \qquad \text{(A24)}$$

Finally, using (A14), (A23), and (A24), and solving for $s - E[s]$ and $p_H - E[p_H]$ gives output, the domestic producer price level and the exchange rate as a function of home and foreign monetary surprises, as shown in the text.

IV. Financial Dollarization

Consumer *i*'s budget constraint can be written:

$$PC^i + (M^i - M^i_{-1}) = W^i L^i + P\Pi^i + \tau^i - B^i + (1+i)(1-\mu^i_F)B^i_{-1} + (1+i^*)\mu^i_F \frac{S}{S_{-1}} B^i_{-1}, \quad \text{(A25)}$$

where B^i is the loan he provides to the firm. The first order condition in μ^i_F leads to:

$$\frac{1}{S_{-1}}(1+i^*)E\left[\frac{S}{PC^i}\right] = (1+i)E\left[\frac{1}{PC^i}\right], \quad \text{(A26)}$$

which, taking logs and approximating for small values of the interest rates leads to (19) in the text.

The firm maximizes the expected value of its (real) profits:

$$E[\Pi] = \frac{P_H}{P}Y - \frac{W}{P}L + \frac{1}{P}B - \frac{1}{P}(1+i)(1-\mu_F)B_{-1} - \frac{1}{P}(1+i^*)\mu_F \frac{s}{s_{-1}} B_{-1} \quad \text{(A27)}$$

In this case, the first order condition in μ_F is:

$$E\left[(1+i)\frac{1}{P}\right] = E\left[(1+i^*)\frac{S}{PS_{-1}}\right], \quad \text{(A28)}$$

which, taking logs and approximating, leads to (20) in the text.

Using (A25) and since $WL/P = \theta C$:

$$(1-\theta)C = \Pi - \frac{B}{P} + \frac{B_{-1}}{P_{-1}}\left[(1+i)(1-\mu_F) + (1+i^*)\mu_F \frac{S}{S_{-1}}\right]\frac{P_{-1}}{P} \quad \text{(A29)}$$

Assuming that all wages are pre-paid, $B/P = B_{-1}/P_{-1} = WL/P = \theta C$, leading to (25) in the text.

Taking logs and using a linear approximation, the interest bill can be written: $i(1-\mu_F) + i^*\mu_F + \Delta s \mu_F - \Delta p$ and its variance: $\mu_F^2\sigma_s^2 + \sigma_p^2 - 2\mu_F\sigma_{s,p}$. Minimizing this last expression with respect to μ_F immediately leads to (21).

Using (A19) and (6), it follows that:

$$c - E[c] = \theta\gamma(1-\mu_R)(m - E[m]) + (1-\gamma+\theta\gamma\mu_R)(m^* - E[m^*]) \quad \text{(A30)}$$

Taking the covariance with respect to s and using the monetary reaction functions leads to:

$$\sigma_{c,s} = -[\theta\gamma(\lambda + \rho) + (1-\gamma)(1+\lambda\rho)], \tag{A31}$$

from which (23) in the text follows.

V. Minimum Variance Real Dollarization

Employment is a function of the real wage, expressed in terms of the price of the home good:

$$L^i = Y^{\frac{1}{\theta}} = \theta^{\frac{1}{1-\theta}} \left[\frac{P_H}{W} \right]^{\frac{1}{1-\theta}} \tag{A32}$$

Thus, minimizing the variance of employment is equivalent to minimizing the variance of the real wage in terms of home goods. Using the indexing rule (A11), the variance of the probability distribution of the real wage can be expressed as:

$$Var\left[w - p_H\right] = \mu_R^2 \sigma_s^2 + \sigma_{p_H}^2 - 2\mu_R \sigma_{s,p_H} \tag{A33}$$

It immediately follows that the minimum variance real dollarization is:

$$\mu_R^{MVP} = \frac{\sigma_{s,p_H}}{\sigma_s^2} \tag{A34}$$

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