DOCUMENTO DE TRABAJO

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(*)The views conveyed in the paper represent those of the author, and do not necessary reflect those of the Bank of Spain. The paper was partly written during a short stay at the World Bank in June 2002, where it benefited from the discussions with Humberto Lopez and Luis Servén on a companion paper about the crises in Argentina. The comments by José Manuel Montero, Fernando Restoy, an anonymous referee and participants in seminars at the Bank of Spain, LACEA Madrid, University of Salamanca and GREQAM, Marseille are gratefully acknowledged. E-mail address: alberola@bde.es

BANCO DE ESPAÑA
SERVICIO DE ESTUDIOS

ISSN: 0213-2710 (print)
ISSN: 1579-8666 (online)
Depósito legal: M. 33508-2003
Imprenta del Banco de España

Abstract

Exchange rates in Latin America display a large volatility, constitute a central element of the policy strategies and their evolution have an important impact on financial stability due to the dollarization of liabilities which most countries exhibit. However, assessments on equilibrium exchange rates are scarce in the region. This paper aims at both filling this gap and analysing the impact of the adjustment of the exchange rates to equilibrium on financial stability. Building on the methodology of Alberola et al (1999,2002), we show that the stock of net foreign assets and the evolution of productivity are the fundamentals underlying the behavior of the real exchange rate. Using an unobserved components methodology in a cointegration framework, a time-varying equilibrium real exchange rate is derived, and deviations from this equilibrium provide an estimate of the degree of multilateral misalignment. The results uncover among other things the large overvaluation of the Argentinean peso in 2001, which was only partially explained by the estimated dollar overvaluation. The adjustment of exchange rates in 2002 corrected this and, to a lesser extent, other misalignments. The final part of the paper addresses the impact of liability dollarization on the adjustment of exchange rates. It is argued that the real exchange rate will tend to overshoot its equilibrium level, due to the need to foster higher current account surplus in the aftermath of depreciation to make up for to the increase in liabilities. An adjustment to account for this effect is performed on the previous results. This overshooting, when coupled with sudden stops of capitals, may help explaining the higher volatility of real exchange rates in the region.

JEL Classification Numbers: F31, F41, C23
Keywords: Equilibrium Exchange Rates, Liabilities dollarization, Overshooting

I. INTRODUCTION

Exchange rates strategies and developments are always important elements for the economic evolution of countries. Arguably, they have even more relevance in Latin America, for a number of reasons: first, real exchange rates are extremely volatile, as figure 1 illustrates, relative to developed countries, as the United States, and they have been used repeatedly as instruments for stabilization. It is telling in this respect that the shift to fixed exchange rates at the beginning of the nineties to back the processes of reform implemented in the region was dramatically reversed in the second half of the nineties as a series of financial and exchange rate crises plagued the region. Second, there is a close link between financial stability and the behaviour of exchange rates, due to the accumulation of external liabilities that most of these countries bear and, crucially, to the fact that most of them are denominated in foreign currency. The phenomenon of *liability dollarization* is due to the so-called original sin –lack of reputation extensively studied in the recent literature on emerging markets (see Eichengreen and Hausmann (1999). Figure 2[1] which displays the ratio of net foreign assets to GDP does not only show the debtor position of Latin American economies, but the volatility of the position, closely related to sharp currency depreciations in the region, like at the time of Mexico's Tequila crisis or the real crisis in Brazil.The relevance of the exchange rate for financial stability is underscored by the quasi-simultaneity between the abandonment of the peso peg in Argentina and the external debt default, or by the recent financial difficulties triggered by the sharp depreciation of the real in Brazil. Finally, the literature on financial crises has identified the overvaluation of exchange rates as its main cause (see Goldfajn & Valdés (1999) among others).

It is thus rather striking the scarcity of analysis aiming at the assessment of exchange rates for Latin America and, more precisely, of their position relative to their long-term equilibrium levels. In most cases, the approach relies on too rough models as PPP deviation or deviations from averages[2]. This narrow focus is particularly misguided for this region, where the processes of opening of the capital account and advances (and setbacks) in real convergence –which have been typically considered as fundamental determinants of the real exchange rates– have been particularly remarkable.

In this context, the aim of this paper is two-fold: contributing to filling the gap of estimating fundamental equilibrium exchange rates for Latin America and, by doing so, analysing the impact of exchange rate adjustment to equilibrium on financial stability, when liabilities are dollarized.

[1] A more detailed explanation of these variables is found in section 3.

[2] A notable exception is the study of Broner et al. (1998).

In order to address the first issue, we follow Alberola, G.Cervero, López & Ubide (1999,2002) [ACLU, hereafter], which present a methodology for the calculation of equilibrium multilateral and bilateral exchange rates –in a way that guarantees consistency at the global level–, in order to assess the degree of misalignment of the seven major Latin American countries.

The equilibrium real exchange rate is determined in our model by the evolution of relative productivity and the external net asset position. Both types of fundamentals have a large tradition in open macroeconomics. Balassa and Samuelson in 1964, emphasised that the divergent evolution of productivity explained permanent variations of the real exchange rate. Since the relative price of tradables is conditioned by international competition, productivity growth, which tends to be biased towards the tradable sector, will generate higher inflation in the non-tradable sector and therefore relative prices will tend to grow more in countries with higher productivity growth.

More crucial in Latin America is the second determinant, related to the sustainability of the external position of the economy. This has been the basis of the balance of payments approach to real exchange rate (Nurske (1944)), which underlies the so-called macroeconomic balance approach of the IMF: continued current account deficits imply an accumulation of net foreign liabilities which should be redeemed in the future by current account surpluses; a depreciation of the real exchange rate will contribute to generate such surpluses, implying that a deterioration of the net foreign asset position leads to a depreciation of the real exchange rate in the long run.

From an empirical point of view, we use cointegration techniques to map the equilibrium conditions derived from the theoretical model into the available data. In this regard, using a vector of real exchange rates for the period 1960–2001 allows for the possibility of testing for cointegration with the identified fundamentals (relative productivity –proxied by relative prices– and an estimated stock of net foreign assets). An orthogonal decomposition of the cointegration matrix allows to separate the permanent and a transitory component. The time varying permanent component is identified as the equilibrium multilateral real exchange rate for each currency and the transitory component reflects the misalignment. A simple algebraic transformation allows to determine the set of bilateral misalignments.

Figure 1. Real effective exchange rates
(1987=100)

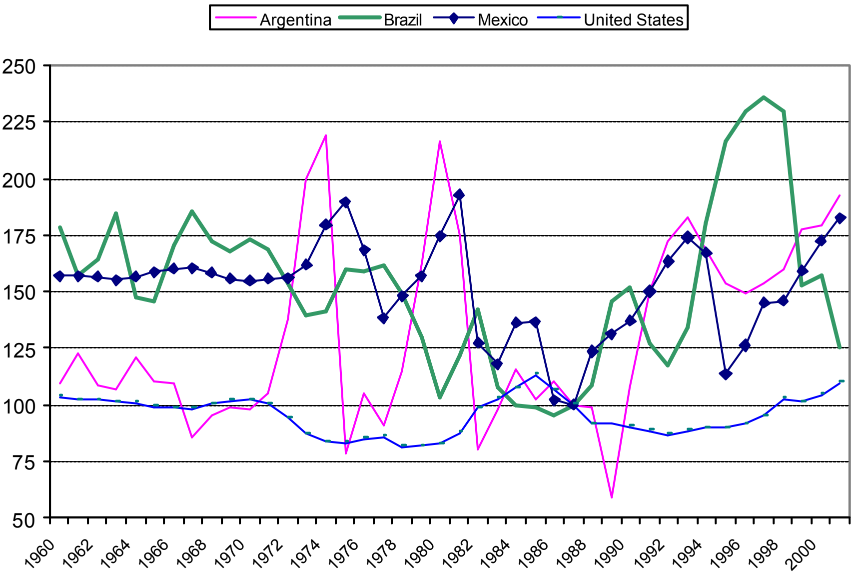
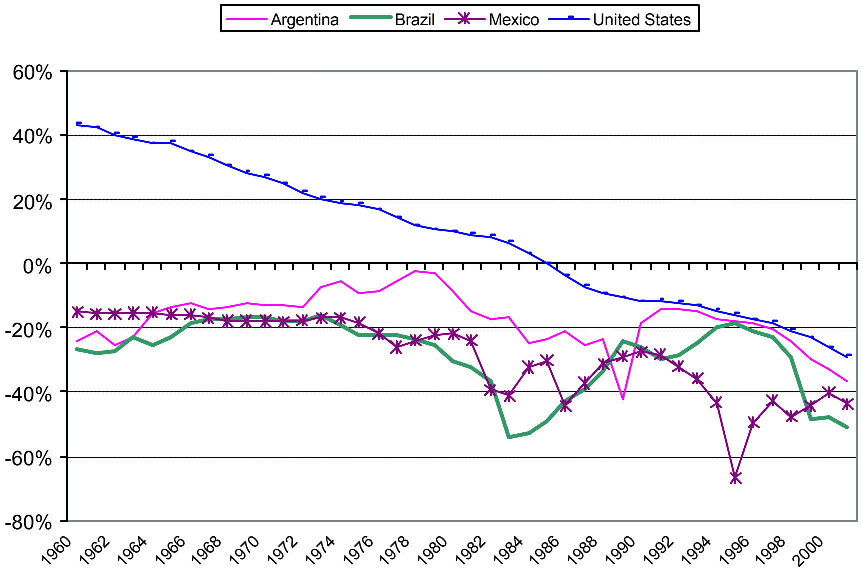


Figure 2 Net foreign asset positions
(%GDP)



However, liability dollarization in Latin America introduces a critical caveat to the interpretation of the results, because the positive effect of exchange rates on the *flow* of net foreign assets is counterbalanced by a negative valuation effect on the *stock* of liabilities[3]. We argue that this effect does not impinge, in principle, on the equilibrium exchange rate, but it has important implications for the dynamics of the exchange rates bringing about the possibility of overshooting of the equilibrium exchange rates. An adjustment is hence in order on the empirical results to account for this effect.

The rest of the paper is organised as follows. Section II presents a sketch of the theoretical framework that lays out the basis for the computation of the equlibrium exchange rates. Empirical issues are developed in section III and the results are presented in section IV. In section V the effects of dollar liabilities on the adjustment is considered, both formally and empirically. Section VI sums up the main conclusions.

II. THE DETERMINANTS OF THE EQUILIBRIUM EXCHANGE RATE

The concept of long-run or equilibrium exchange rate has been addressed in the literature from different approaches, starting from the simple and popular concept of purchasing power parity (PPP), implying a constant equilibrium real exchange rate (see Breuer (1994) for a recent survey). Its lack of empirical support opened the door to two main lines of research on the determination of the real exchange rates based on economic fundamentals: one emphasising the underlying net foreign asset position, and another the sectoral (tradable-nontradable) evolution of productivity. The following model encompasses both perspectives on exchange rate determination.

Let us assume that there are two countries in the world, each producing two goods: one tradable (subscript T, in what follows) and one non-tradable (N). The real exchange rate (q) is defined as the relative price of domestic to foreign goods in the consumption basket, p and p^*, respectively,[4] expressed in domestic currency.

$$q = p - (s + p^*) \qquad (2.1)$$

where s is the (log) nominal exchange rate, defined as the price of foreign currency in terms of domestic currency. Thus, an increase in q represents an appreciation of the real exchange rate.

The consumer price index (CPI) for each country is a weighted-average of the tradable, non-tradable, and imported (tradable) prices, all expressed in their own currency:

[3] This effect has been recently explored by Calvo et al. (2002) on public finances.

[4] An asterisk denotes foreign variables.

$$p = (1 - a_N - a_{T^*})p_T + a_N p_N + a_T(s + p^*_T)$$
$$p^* = (1 - a^*_N - a^*_T)p^*_T + a^*_N p^*_N + a^*_T(p_T - s) \qquad (2.2)$$

where the as are the weights of the respective goods in the consumer basket. Substituting these expressions in *(2.1)*, assuming that $a_N = a^*_N$, and rearranging terms we obtain

$$q = (1 - a_{T^*} - a^*_T)q_X + a_N q_I \qquad (2.3)$$

where:

- $q_I = \left[(p_N - p_T) - (p_N^* - p_T^*)\right]$ is the price of non-tradables relative to tradables across countries.

- $q_X = \left[p^T - (s + p_T^*)\right]$ is the relative price of domestic to foreign tradables

The first component captures the competitiveness of the economy and determines the evolution of the foreign asset position, while the second plays a central role in adjusting excess demand across sectors in the economy. Each relative price adjusts to achieve equilibrium in one of the markets, and hence we will denote q_X and q_I as the internal and the external relative prices, respectively. The equilibrium exchange rate ($\bar{q}$, where the bar denotes equilibrium values) will require simultaneous equilibrium in both markets, and thus it will be a combination of the equilibrium internal and external relative pr ices.

The internal equilibrium exchange rate

The different behaviour of sectoral relative prices between countries determines the evolution of the internal real exchange rate. In turn, sectoral prices are related to the evolution of sectoral productivity. These notions were first explored by Balassa and Samuelson and can be illustrated with a simple model with two production factors, labor (L) and capital (K). Output in each sector is determined by a Cobb-Douglas production technology:

$$Y_N=A_N L_N^{d} K_N^{1-d} \qquad (2.4)$$
$$Y_T=A_T L_T^{q} K_T^{1-q},$$

where $0<q,d<1$ represent the intensity of labor in each sector. Labor is assumed to be perfectly mobile between sectors (but not between countries), implying nominal wage equalization : $W_T = W_N = W$. Labor is paid the value of its marginal product $?Y_i/?L_i=W/P_i$. Under Cobb-Douglas technology the ratio of marginal productivities is proportional to the ratio of average productivities:

$$\frac{\partial Y_T / \partial L_T}{\partial Y_N / \partial L_N} = \frac{qY_T / L_T}{dY_N / L_N}. \qquad (2.5)$$

From here, it follows that the sectoral price differential is equal to the level of labor productivity differentials plus a drift capturing the relative intensity of labor. Expressing with lower case the natural logarithms of sectoral labor productivities, (2.5) reduces to

$$\overline{p}_N - \overline{p}_T = log(q/d) + (y_T - y_N). \qquad (2.6)$$

Neglecting constant terms and denoting $n=(y_T-y_N)-(y^*_T-y^*_N)$, we may write the following expression of the internal equilibrium exchange rate:

$$\overline{q}_I = a_N \overline{n}, \qquad (2.7)$$

with bars denoting equilibrium values.

The external equilibrium exchange rate

The external balance is characterised by the achievement of the optimal or desired stock of net foreign assets. The dynamics to equilibrium are determined by the current account balance, which in turn leads to an accumulation of net foreign assets (*F*). By definition, the current account balance (*CA*) is the sum of the trade balance (*XN*) and the net income that residents receive (or pay) on their foreign asset holdings:

$$\Delta F = CA = XN + i^*F \qquad (2.8)$$

where i^* is the real international interest rate. A positive stock of net foreign assets ($F>0$) reflects a creditor position for the country, whereas a negative stock indicates that the country is a net debtor.

The previous equation is usually expressed in terms of GDP, both to state it in real terms and to facilitate comparison among countries and periods:

$$\Delta f = ca = xn + (i^* - g)f \qquad (2.9)$$

where lower case letters represents ratio to GDP (*f=F/GDP*, etc.) and g is the real rate of growth. This seemingly innocuous change is bound to be relevant for the dynamics of the exchange rate when the foreign assets are denominated in foreign currency, as we will demonstrate in section V.

If the Marshall-Lerner condition holds an increase in the relative price of domestic tradables q_X shifts consumption toward foreign tradables and worsens the trade balance. Consistent with this interpretation it is plausible to assume that the trade balance as a percentage of GNP (xn) is determined by:

$$xn=-\gamma qx, \qquad \gamma>0. \tag{2.10}$$

The rest of the world (which is large relative to the home country) absorbs changes in assets F at the fixed foreign interest rate i^*. The dynamics of the capital account is determined by the accumulation of net foreign assets by the home country, whose pace is expected to depend on the divergence between the current level of assets as a percentage of GNP (f) and the country's desired equilibrium level ($\bar{f}$).

$$\Delta f=a(\bar{f}-f), \qquad a>0. \tag{2.11}$$

The equilibrium level is exogenous to the model and it is determined by such factors as saving, demographics and state of development. Also, the degree of dollarization of liabilities should be a relevant factor in the determination of $\bar{f}$: as emphasised in this paper dollarized liabilities expose countries to perverse debt dynamics under stress on the exchange rate, increasing the investors risk, reducing their appetite and the sustainable level of debt.

Equation (2.11) indicates that if the actual net asset position is below equilibrium countries will be accumulating assets (saving) to reach such target level. Conversely if f is greater than $\bar{f}$, countries will be reducing assets until they reach $\bar{f}$. Equating (2.9) and (2.11) and solving for (2.10) it follows:

$$q_x=[a/\gamma](f-\bar{f})+[(i^*-g)/\gamma]f. \tag{2.12}$$

This equation indicates that the external real exchange rate depends on (i) the divergence between current asset holdings and targeted holdings; and (ii) the current stock of net foreign assets f. It is then to be expected that when the accumulation of liabilities (assets) the real exchange rate will adjust by depreciating (appreciating) Defining the equilibrium for the external real exchange rate $\bar{q}_X$ as the exchange rate consistent with $f=\bar{f}$ (i.e. the exchange rate consistent with asset holdings at their targeted level) it follows that

$$\bar{q}_X=(i^*-g)/\gamma \ \bar{f} \tag{2.13}$$

Note that if liabilities were dollarised changes in q_x would have an impact on f and therefore on the adjustment path, as we will develop in section IV, but these variations do not directly impinge on the equilibrium exchange rate, which just depend on the equilibrium level of net foreign assets.

The real exchange rate

Substituting (2.7) and (2.13) into (2.3) the following expression for the equilibrium exchange rate is obtained:

$$\bar{q} = (1-\alpha_T-\alpha^*_T)(i^*-g)/\gamma\ \bar{f} + \alpha_N\ \bar{n}\ . \qquad (2.14)$$

Observe that in principle both $(1-\alpha_T-\alpha^*_T)(i^*-g)/\gamma$ and α_N can be expected to be positive[5]. Therefore, long-term increases in the desired asset position and in relative productivity will determine a long-term real exchange rate appreciation.

III. EMPIRICS

The theoretical model has identified two fundamentals for the evolution of the real exchange rate: the level of net foreign assets (*f*) and relative sectoral productivity shocks (*n*). In principle, a suitable empirical model to estimate under these assumptions would be

$$q_t = b_0 + b_F f_t + b_N n_t + u_t \qquad (3.1)$$

where q is the real effective exchange rate of the country, f is the stock of net foreign assets and n is a measure of relative productivity shocks, to be defined below.

At this stage, one could think that finding a long-run cointegration relationship between the real exchange rate and its fundamentals would yield an estimate of its equilibrium rate. However, for this to be true, we should first observe the *equilibrium* levels of the fundamentals, and then apply a cointegration analysis to them. Unfortunately, we can observe only the actual values of the variables, and therefore some further econometric manipulation is needed to estimate the equilibrium real exchange rate.

Intuitively, the observed exchange rate could be decomposed into two components: the first one, when the fundamentals are at their steady state levels, would be the equilibrium exchange rate

[5] We assume the usual condition $i^*>g$. Also note, that positive risk premia, expected in the region would increase this wedge.

$$\bar{q}_t = b_0 + b_F \bar{f}_t + b_N \bar{n}_t \qquad (3.2)$$

where, from *(2.14)*, the parameters are expected to take positive values. The second component, when the fundamentals are away from their respective steady states, would correspond to the deviations of the exchange rate from its equilibrium level.

$$\hat{q}_t = b_0 + b_F \hat{f}_t + b_N \hat{n}_t + u_t \qquad (3.3)$$

where $\hat{f}_t$ and $\hat{n}_t$, refer to deviations of fundamentals from their equilibrium values.

Thus, a strategy towards the estimation of the equilibrium real exchange rate can be based on the econometric decomposition of the observed real exchange rate into a transitory and a permanent component. The estimated equilibrium exchange rate is taken to be the permanent component, while the transitory component reflects deviations with respect to equilibrium[6].

The decomposition of the observed series into the permanent and transitory components is done through the identification procedure devised by Gonzalo and Granger (1995). The choice of this decomposition relative to others is determined by two factors: first, it conveys the information contained in the cointegration relationships among the variables, which is discarded when equilibrium paths for fundamentals are obtained by just fitting them a trend or a smoothing filter, as for example in Faruquee (1995); second, within the class of unobserved components class decomposition (for instance Quah (1992) or Kasa (1992), this particular approach has the desirable features that the transitory component does not Granger-cause the permanent component in the long run, and the permanent component is a linear combination of contemporaneous observed variables. The first feature implies that a change in the transitory component today will not have an effect on the long-run values of the variables; otherwise, the economic interpretation of the components may be misleading, for whether a shock is temporary or permanent would depend on whether the researcher is observing the component or the aggregated series. The second feature makes the permanent component observable and assumes that the contemporaneous observations contain all the necessary information to extract the permanent component.

Let us consider the 3x1 vector x_t=[q_t, f_t n_t]' which under the null of one cointegration vector admits the following representation:

$$\Delta x_t = D_1 \Delta x_{t-1} + ... + D_{p-1} \Delta x_{t-p+1} + \Pi x_{t-p} + e_t \qquad (3.4)$$

[6] See ACLU for a detailed explanation of the link between cointegration and equilibrium. Cointegration relationships uncover the existence of long-run relationship among the variables which can be interpreted as a time-varying equilibrium. The decomposition through unobserved components allows to specify the equilibrium path as the permanent component.

where e_t is a vector white noise process with zero mean and variance S and P is 3 x 3 matrix with rank 1. Given that P is not full rank, it can be written as the product of two rectangular matrices a and b of order 3 x 1 such that $P=ab'$. The vector b is the cointegration vector and the vector a is the factor-loading vector. Next, we can define the orthogonal complements $a_{\wedge}$ and $b_{\wedge}$ as the eigenvectors associated with the unit eigenvalues of the matrices $(I- a\ (a'\ a)^{-1}\ a')$ and $(I- b\ (b'\ b)^{-1}\ b')$, respectively. Notice that $a'_{\wedge}a$ = 0 and $b'_{\wedge}b$ = 0. With this notation it is possible to write

$$x_t = b_{\perp}(a'_{\perp} b_{\perp})^{-1} a_{\perp} x_t + a(b'a)^{-1} b' x_t \qquad (3.5)$$

where $b_{\wedge}\ (a'_{\wedge}\ b_{\wedge})^{-1}\ a_{\wedge}\ x_t$ would capture the permanent component and $a\ (b'\ a\ )^{-1}\ b'\ x_t$ the transitory component.

The identification of the permanent component with equilibrium implies that

$$\overline{x}_t = b_{\perp}(a'_{\perp} b_{\perp})^{-1} a_{\perp} x_t \text{ and } \hat{x}_t = a\,(b'a)^{-1} b' x_t \qquad (3.6)$$

from where the estimation of the equilibrium exchange rate and its deviations directly follows, since:

$$q = \hat{q} + \overline{q}\text{, and } f = \hat{f} + \bar{f}\text{, } n = \hat{n} + \overline{n} \qquad (3.7)$$

IV. THE COMPUTATION OF MULTILATERAL AND BILATERAL EQUILIBRIUM RATES

In this section we present the results of applying this methodology to the main Latin American countries: Argentina, Brazil, Mexico, Chile, Colombia, Venezuela and Perú. For the empirical computation of the multilateral rats it is also necessary to use the rest of major currencies which also represent in general the main trading partners of the region[7]. The sample covers the period 1960-2001 and the data are annual. The variables used are the real effective exchange rate (q_t), the stock of net foreign assets (f_t), and an index of relative prices which is the chosen proxy for relative sectoral productivity shocks (n_t)[8].

We start by checking the order of integration of the series and the cointegration tests results that serve as the basis for the computation of the equilibrium real exchange

[7] US Dollar, Euro, Sterling Pound, Canadian Dollar and Japanese Yen. Only the US dollar analysis is explicitly considered in this paper. For the rest of currencies, results from 2000, appearing in ACLU (2002) have been extrapolated.

[8] Relative prices are not completely satisfactory but there exist no long reliable series for productivity in LA. The stock of net foreign assets is computed by accumulation of current account balances. The results do not differ substantially from those displayed by Lane & Milesi-Ferreti (2001). In neither case, the reduction in liabilities when debt is restructured is considered.

rates[9]. The results confirm that the null of the series being I(1) cannot be rejected for standard significance levels. The panel cointegration test, clearly rejects the null of no cointegration at the 5 percent significance level. Table 1 displays the cointegration vectors for the country under study. Note that all of them display the expected negative signs.

Table 1. Cointegration Vectors			
	q	*F*	*N*
Argentina	1	-1.82	-0.69
Brazil	1	-0.92	-0.52
Chile	1	-1.47	-0.04
Colombia	1	-2.32	-0.98
México	1	-0.25	-1.14
Peru	1	-1.62	-1.56
Venezuela	1	-0.08	-2.45
USA	1	-0.18	-2.48

Using these cointegrating vectors and the loading factors of the cointegration relationships (a 's), the real exchange rate series are decomposed into a permanent and a transitory component. The permanent and transitory components represent in our empirical model the real equilibrium exchange rate and the deviations from equilibrium, respectively.

Figure 3.A-D presents the results for the three main LA countries plus the US dollar, with computed 95 percent standard error bands[10]; values above zero imply an overvaluation of the multilateral rate. Table 2 shows the misalignment of the multilateral exchange rate, $\hat{q}$, for 2001 (with the computed standard errors in brackets) and the implicit nominal exchange rates relative to the dollar.

	Table 2. Multilateral misalignments (with s.d), 2001							
	Argentina	**Brazil**	**Chile**	**Colombia**	**México**	**Peru**	**Venez**	**USA**
Misalignment	41,0%	3,3%*	-9,1%*	18,6%*	24,5%	6,1%	2,3%*	18,2%
S.E	(7,9)	(2,3)	(13,1)	(11,2)	(4,7)	(0,4)	(1,3)	(6,6)
Implied e/$	1.69	2.43	582	2825	12.4	3.74	741	-

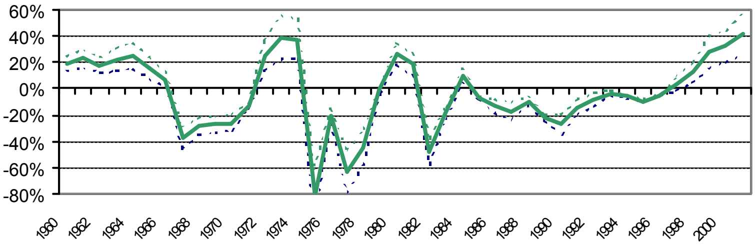
A positive signs indicates overvaluation. Asterisks indicate non-significant misalignment

[9] Panel integration and cointegration techniques to infer the long-run properties of our series are used, given the notorious low power of standard unit root and cointegration techniques when applied to the individual time series. In this regard, recent research by Im, Pesaran, and Shin (1997) and Pedroni (1998), among others, has developed panel unit root and cointegration statistics that, under fairly general conditions, have more power than the standard time series tests. Moreover, the mentioned tests allow for heterogeneity in the dynamics of each of the cross section units in the panel. This flexibility makes it appropriate to use these tests in this framework, where the parameters controlling the long-run equilibrium and the short-run dynamics are likely to differ across countries. This approach has been used for the exchange rates, among others, by Canzoneri, Cumby, and Diba (1996) or Bayoumi and MacDonald (1999).

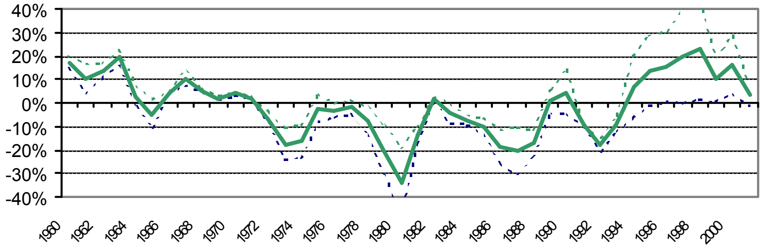
[10] See ACLU (1999) for a explanation on the computation of these bands.

Figure 3. Estimated exchange rate misalignment
(% deviation from equilibrium)

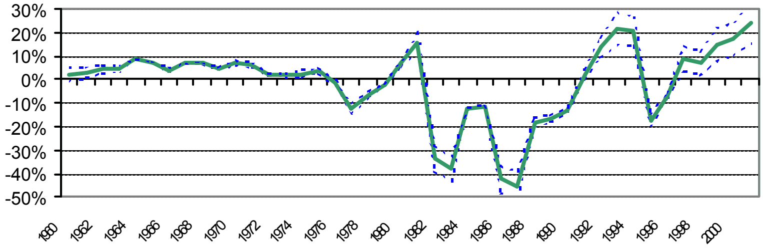
A. Argentina



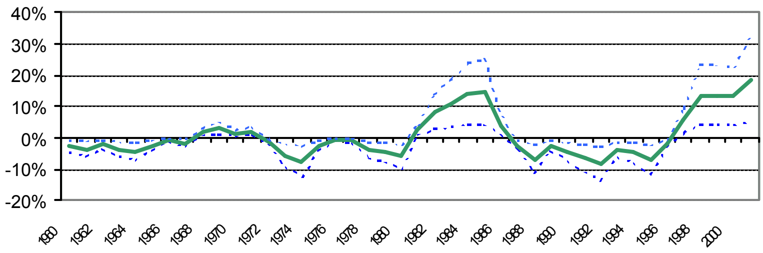
B. Brazil



C. Mexico



D. United States



Brazil (figure 2), the real crisis in 1999 was not enough to return the currency to its equilibrium rate, but the ensuing evolution has place the currency very close to balance. The estimation for Chile is not precise and this translates into too wide bands to allow for an assessment; Colombia and Mexico display similarly strong overvaluations built up from 1996 on. Finally, Perú and Venezuela (non significant) are also close to balance. Also note that the overvaluation trend starts from 1996, which is when Argentina, Colombia and Mexico start their positive multilateral misalignment. The results also include US because, it is probably the main driver of the region overvaluations, given its relevance as trading partner for most of them[11].

This remark induces our following exercise which consists on the computation of bilateral rates through a simple algebraic operation, which makes use of the trade matrix of each country, described in detail in ACLU (1999). The computed vector of multilateral rates results in a matrix of bilateral rates, so that they are globally consistent with the multilateral equilibrium estimation[12]. It is assumed that the all the multilateral exchange rates return to equilibrium, so that the resulting bilateral rates relative to the dollar, displayed in table 3 convey the implicit misalignment of the LA, provided the dollar, the respective LA currency and the rest of currencies are back to equilibrium. The magnitude of the differences relative to the multilateral rates is determined by the bilateral misalignment relative to the non-dollar currencies and on the relative trade weights. They underscore the degree of overvaluation of Argentina and Mexico, since they reveal their respective overvaluation even relative to the strong dollar. Note, on the contrary that Brazil is not overvalued with respect to the US dollar because a large share of its trade is with the euro area whose currency is overvalued according to our extrapolation (22%)[13].

Table 3	
Bilateral deviations of ¯:	**Relative to** US$
Argentina	+27,0%
Brazil	-7,3%
Chile	-18,9%
Colombia	+5,2%
México	+21,9%
Peru	-8,0%
Venezuela	-10,3%
A positive sign indicates overvaluation of the respective currency in the column	

[11] US represents more than 25% of the trade for most countries, and more than 80% for Mexico.

[12] The results are obtained using the point relative point estimates of misalignment. S.D bands are not feasible for the bilaterals.

[13] Other bilateral deviations of interest are the 36% overvaluation of the Argentine peso relative to the Brazilian real and the 58% overvaluation relative to the euro.

V. LIABILITY DOLLARIZATION AND THE DYNAMICS OF ADJUSTMENT

Most Latin American countries under analysis –the exception being Venezuela which enjoys a positive net foreign asset position– are subject to liability dollarization. The denomination of debt arises a relevant issue for the adjustment of exchange rate to equilibrium related to the impact of exchange rate variations on the stock of net assets.

To see this, consider a situation –like Argentina's displayed in graph 4-, in which the exchange rate is estimated to be overvalued, granting a future depreciation (amounting to $\Delta q = -\hat{q} < 0$), to adjust to equilibrium. This depreciation will have a negative valuation impact on the ratio of debt to GDP, $f=F/GDP$: the numerator of this expression increases when the currency depreciates by a larger proportion than the denominator. The difference will in principle depend on the share of tradable GDP in the economy, which can reasonably be expected to adjust to the new relative prices and thus increase with the depreciation. Only in the limiting, and unrealistic case that the economy were fully tradable (α_N=0), then there would be no valuation effect. Assuming that the whole stock of liabilities are in foreign currency and expressing the the ratio F in foreign currency as:

$$f \approx \frac{F}{a_N GDPq + (1 - a_N)GDP} \qquad (5.1)$$

it is straightforward to derive the precise impact on the ratio of net assets as[14]:

$$\partial f/\partial q \approx -a_N f \qquad (5.2)$$

implying that the exchange rate depreciation sets in motion dynamics on the stock of net foreign assets which run counter the adjustment path of such variable. Furthermore, since f is one of the identified fundamentals of the exchange rate, this changes will impinge on the dynamics of the exchange rate adjustment to equilibrium, too.

From (3.2),(3.3) it follows that the observed net foreign asset position is the sum of its transitory and permanent components: $f = \hat{f} + \bar{f}$. As stressed in section II, the equilibrium net asset position ($\bar{f}$) is exogenous implying that: i) the shift in f from the exchange rate change will fall on the transitory component $\hat{f}$; ii) the equilibrium exchange rate, which according to (3.2) exclusively depends on the equilibrium levels of the fundamentals is unaltered by changes in the transitory component. Thus, from (3.1),(3.7) and (5.2) it follows that

[14] From the exact derivative it results that the expression is $-\alpha_N/(1-\alpha_N(1-q))$. This would imply that when the real exchange rate diverges from its average or notional level of 1, the derivative would be larger for overvalued exchange rates and lower for undervalued rates. For simplicity, we dismiss this effect in what follows.

$$\left.\frac{\partial \hat{q}}{\partial q}\right|_{\Delta q=-\hat{q}} = -a_N b_f f \qquad (5.3)$$

which will be positive in the case of net liabilities (*f<0*). Observe that the required additional exchange rate correction will be larger the larger is the cointegration coefficient, the closer is the economy and the larger is the stock of NFA. This differential equation will only be stable if the derivative is lower than one, otherwise the system would be explosive and no solution would be found. When the equation is stable a solution can be found by iterating on (5.2) and (5.3). It is convenient to express the additional adjustment derived from this iteration as $\int q$.

Before stating the implications of this valuation effect on the trajectory of the exchange rate towards equilibrium, some remarks are in order. We have not qualified the way adjustment to equilibrium takes place in the model. From an econometric perspective the implied cointegration relationships suggest that error-correction mechanisms will be at work to engineer the return to the equilibrium level. In practice, the dynamics of exchange misalignments are more complex and subject to multiple shocks and diverging inertia. We noted in figure 1 the higher volatility of LA currencies relative to the US. Figure 3 confirms this intuition when considering the adjustments to (and beyond) equilibrium, as shown by the sharp movements in the misalignment of the exchange rates, relative to the US. Another remarkable feature of LA currencies is that depreciation movements tend to be more dramatic than appreciations. One reason for this is that currency depreciation tends to be associated with financial turbulence and sudden stops, but in these countries these phenomena turbulence are heightened by the fears that exchange rate and interest rate increases compromise the financial position of domestic agents. Beyond this expectational channel, the contribution of our model is that it predicts these sharp exchange rate downward adjustments.

Indeed, it is simple to show that the dollarization of liabilities is bound to engineer an overshooting of the exchange rate when the exchange rate is overvalued. Let us assume that the exchange rate adjusts instantly, and that this adjusts conveys the valuation effect on the liabilities, so that, $\Delta q = -(\hat{q} + \int q)$. From (3.7) it follows:

$$q' = q + \Delta q = \hat{q} + \overline{q} - (\hat{q} + \int q) = \overline{q} - \int q \quad \Rightarrow \quad q' < \overline{q}$$

that is, the actual exchange rate, denoted by *q'*, will overshoot its equilibrium level since $\int q$ *>0.* The intuition for this outcome is the following: the increase in the stock of liabilities from the depreciation will require a larger current account surplus to compensate the worse external position. This larger current account adjustment will be engineered by a larger exchange rate depreciation than originally envisaged, hence the overshooting. On the contrary, in an equivalent situation of exchange rate overvaluation, the case of net positive assets, f>0 ($\int q$ <0), would lead to an exchange rate underlined undershooting[15].

Figure 4. Argentina: adjustment to equilibrium and overshooting

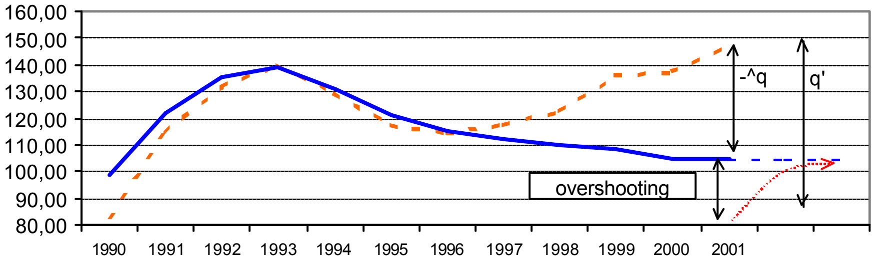


Table 4. Adjustment for change in NFA derived from exchange rate correction							
	Argentina	**Brasil**	**Chile**	**Colombia**	**México**	**Peru**	**Venezuela**
Misalignment	41,0%	3,3%	-9,1%	18,6%	24,5%	6,1%	2,3%
Liabilities/GNP (-f)	*36%*	*51%*	*61%*	*51%*	*44%*	*66%*	*-25%*
Share non-tradables(a_N)	*70%*	*70%*	*30%*	*60%*	*30%*	*70%*	*60%*
Coint.coeff ß	*1,82*	*0,92*	*1,47*	*2,33*	*0,25*	*1,62*	*0,08*
Additional adjustment	30,0%	5,6%	-2,6%	15,4%	1,2%	32,6%	0
Total exchange rate adjustment	**71,3%**	**8,9%**	**-11,7%**	**34,0%**	**25,7%**	**38,7%**	**2,3%**
Adjusted NFA	**57%**	**54%**	**60%**	**63%**	**45%**	**83%**	**-25%**

A positive sign indicates overvaluation.

Table 4 performs the adjustment for the Latin American countries in the sample. The first row repeats the estimated multilateral misalignment derived in the previous section. The next of rows display for each country the factors which determine the additional adjustment from liability dollarization: cointegration coefficient, a proxy to the non-tradable sector derived from the openness of the economy and the net stock of assets. The additional adjustment to the exchange rate, that is, the magnitude of overshooting is shown in the next row. Note that for countries like Argentina (relatively closed and with a large *ß*), Colombia (open but heavily indebted and with a large *ß*) Peru or Brazil (a closed economy with a large liabilities ratio) the estimated overshooting is large, relative to the misalignment. On the contrary the small value of ß in Mexico (which besides is highly open) or Venezuela (which in any case enjoys a positive asset position)

[15] By the same token, starting with an exchange rate undervaluation, a net liability position would lead to undershooting and a net asset position would bring about an overshooting relative to the equilibrium level.

limit this effect. The sum of the misalignment and the overshooting adds to the total expected adjustmen. Finally, the last row displays the final stock of net foreign assets to GDP, after the exchange adjustment.

VI. CONCLUSIONS

This paper has, in the first place proposed a methodology for the analysis of equilibrium exchange rates that offers an anchor to this debate. From a theoretical point of view, we have outlined a model that encompasses two well-known theories of real exchange rate determination. From an empirical point of view, we have exploited the advantages of panel cointegration and unobserved component decomposition to estimate time-varying multilateral equilibrium exchange rate paths and, through a algebraic transformation, bilateral rates, which are directly comparable to market rates, which sheds light on the dragging effect of the dollar overvaluation on the misalignment of the Latin American currencies. Finally, an adjustment to account for the impact of the exchange rate correction on the stock of net foreign assets is devised.

The main conclusions regarding the misalignment of Latin American currencies for year 2001 are the following:

- A central element steering the misalignment in the region is the strength of the dollar whose overvaluation was around 18%. This strength drags many of the currencies in the region –in particular the Argentine peso.

- However, the bilateral computation shows that the three most overvalued currency were also overvalued relative to the dollar:

    - Argentina presented a substantial overvaluation of the peso (41% in multilateral terms, although only 27% relative to the dollar).
    - Mexico's overvaluation reached 24% and a similar magnitude relative to the dollar.
    - Colombian peso, also displayed a large overvaluation, although non-significant.
- Brazil and Venezuela were close to equilibrium, with non-significant divergences.

- Finally, Chile (undervaluation) and Peru (overvaluation) displayed moderate divergences from their estimated equilibria.

The evolution of the exchange markets in Latin America during 2002 has favoured the adjustment of the exchange rate to equilibrium. The crisis in Argentina brought about a 46% real exchange rate depreciation. The Mexican peso has depreciated around 10% during the last year, correcting around half of the previous misalignment, so that by now it is not significant. Finally, the real depreciation of the Brazilian currency has been, relatively muted (around 5%) a similar magnitude to its prior disequilibrium.

In the final part of the paper, it is shown that liability dollarization is bound to bring about an overshooting of the equilibrium rate, due to the need to foster higher current account surplus in the aftermath of depreciation to make up for to the increase in liabilities. This effect will tend to be higher in highly indebted, close economies with high estimated elasticity of the exchange rate to the stock of assets, such as Argentina, Colombia, Peru or Brazil. It can be also added, as a final remark, that this overshooting effect, when coupled with sudden stops of capitals, may help explaining the higher volatility of real exchange rates in the region.

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