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Unemployment and Real Exchange Rate Dynamics in Latin American Economies

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Abstract

Edwards and Savastano (2000) survey on the equilibrium real exchange rate (RER) literature identify two important limitations: the lack of explicit derivation of flow and stock equilibrium variables as determinants of the equilibrium RER and the failure to allow for unemployment. This paper develops a general equilibrium model that includes both elements, as well as other traditional determinants of the RER such as productivity, terms of trade and government policies. The model is tested against the experience of ten Latin American economies in the 1970-2004 period. From an econometric point of view the model is consistent with the evidence, providing an estimate of the RER misalignment. When evaluating the contribution of labor market distortions to changes in the equilibrium RER, they appear to be less significant than changes in productivity or government policies.

1. Introduction

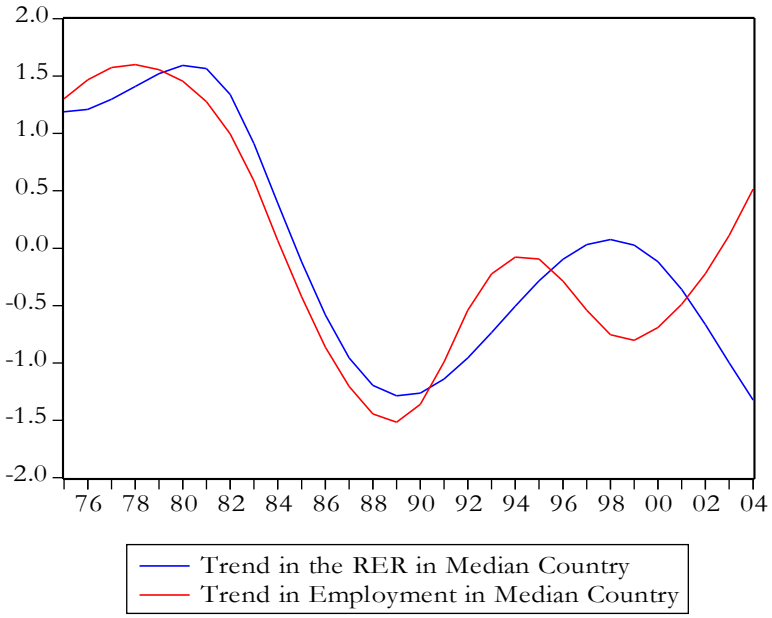
The real exchange rate is an economy-wide relative price (between traded and non-traded goods) and, as such, it signals for intersectoral resource transfers and factor movements in the economy. It has strong influence on economic activity, in particular on foreign trade, and it affects economic growth by determining the relative profitability of investment in traded and non-traded sectors. Not surprisingly, the RER occupies a central position in macroeconomic analysis (Lane, 2001) and policy design (Edwards and Savastano, 2000). RER misalignment, especially overvaluation, has been linked to lower long-run economic growth (Aguirre and Calderón, 2006), lower financial deepening (Dehesa et al., 2007), and higher tendency to currency crises (Burkart and Coudert, 2002). RER instability has also been found to affect negatively macroeconomic performance, in particular long-run economic growth (Hnatskova and Loayza, 2004), exports (Elbadawi et al, 2007), private investment (Servén, 2003) and productivity growth (Aghion et al., 2006).

The literature on the determinants of RER misalignment, nevertheless, is limited in three dimensions (Edwards and Savastano, 2000). First, the use of static, partial equilibrium models is ill-designed for the analysis of a slow-adjusting, economy-wide relative price. As discussed in Elbadawi and Soto (2007), the analysis of the RER misalignment ought to proceed within a dynamic, general equilibrium framework. Second, most standard models do not provide for a consistent measure of the equilibrium RER and usually cannot distinguish between movements toward equilibrium from changes in misalignment (e.g., when misalignment is measured as the actual changes in the RER, the residuals from regressions of the real exchange rate on selected variables, or the distance between the actual RER and trend filters or PPP benchmarks). Third, existing models neglect the role of key elements that characterize changes in the RER of less developed economies, in particular foreign aid flows, export taxes, workers remittances, concentration of exports on natural resources and, more importantly labor market characteristics such as persistent unemployment.

The lack of models linking the RER and employment is a major disadvantage to our understanding of economic policy in Latin America. Casual evidence –as depicted in Figure 1— suggests both variables tend to move in tandem, with a correlation of around 85% for the median

Latin American economy in the 1970-2004 period. Consequently, it would be useful to introduce labor market considerations when modeling the evolution of the RER and its misalignment. Recently, Frenkel and Ros (2006) have tried to address the link between the RER and unemployment in Latin American countries, but their econometric results are doubtful as they assume the RER to be an exogenous variable, against most of the existing literature. A simple Granger causality test suggests that causality runs from employment to the RER and not otherwise.

Figure 1
Trends in Employment and the Real Exchange Rate
in the median Latin American economy
(normalized scale, HP filtered data)



This paper extends the model by Elbadawi and Soto (2007) to explore the role of the labor market –in particular, persistent unemployment— in affecting the equilibrium of the RER. The framework consists of a general equilibrium model for a small open economy, from which the equilibrium RER obtains as the result of the intertemporal, optimal decisions of households on consumption and production of different goods, conditional upon government policies and external conditions (debt stock and its service, terms of trade, and unrequited transfers). The solution of the model provides for an explicit, parametric, encompassing empirical model linking the RER and its

determinants (fundamentals). The model derives a concept of the sustainable current account which provides a rigorous framework for the computation of the equilibrium RER and misalignment indexes. The sustainable current account is given by the discounted present value of exports proceeds plus foreign aid and remittances flows net of payments for external debt service. In addition to accounting for the flow fundamentals, the model allows for unemployment that may or may not be consistent with non-clearing labor market conditions (i.e. equilibrium unemployment might be higher than purely frictional).

Section 2 of the paper provides the stylized facts of the Latin American economies that the theoretical model should address. Section 3 describes the RER model of the paper. Section 4 describes the econometric procedures and analyzes the estimation results. Section 5 describes the methodology to compute the misalignment of the real exchange rate in countries of the sample. Section 6 provides a summary of the contributions and main findings of the paper.

2. Stylized Facts

In this paper, the real exchange rate is defined as the relative price between traded and non-traded goods.[1] Thus, an increase in the RER index indicates an appreciation. The data were obtained from the IMF Statistical database and is computed by deflating a trade-weighted average of the nominal exchange rates that apply between trading partners. Figure 1 depicts the evolution of the RER for the group of ten Latin American countries in the 1970-2004 period.

Several elements strike as important stylized facts that any analytical model should account for. First, there are wide fluctuations in the real exchange rate in time and among countries. Contrary to the prediction of PPP-based theories, real exchange rates in developing economies fluctuate amply in time and departures from trend exhibit substantial persistence. Second, there has been a generalized path towards a more depreciated RER yet the pace and the timing of the convergence differ markedly among countries. For economies in the upper panel of Figure 1, the RER depreciated sharply and substantially in the first half of the 1980s and remained rather stable

1 Chinn (2005) discusses the issues of measurement of the RER based on price indeces, compares this measure against other alternatives such as labor costs and concludes that the analysis of competitiveness the latter is preferred but it is not as available as the former.

afterwards, despite a mild, transitory appreciation in the mid 1990s. On the contrary for those countries in the lower panel, the depreciation of the mid 1980s reversed and was followed by a substantial appreciation in the second half of the 1990s, leading in most countries to current account crises and a sharp depreciation of their currencies to restore equilibrium. Peru stands alone as a case of sustained yet slow appreciation since the mid 1980s.

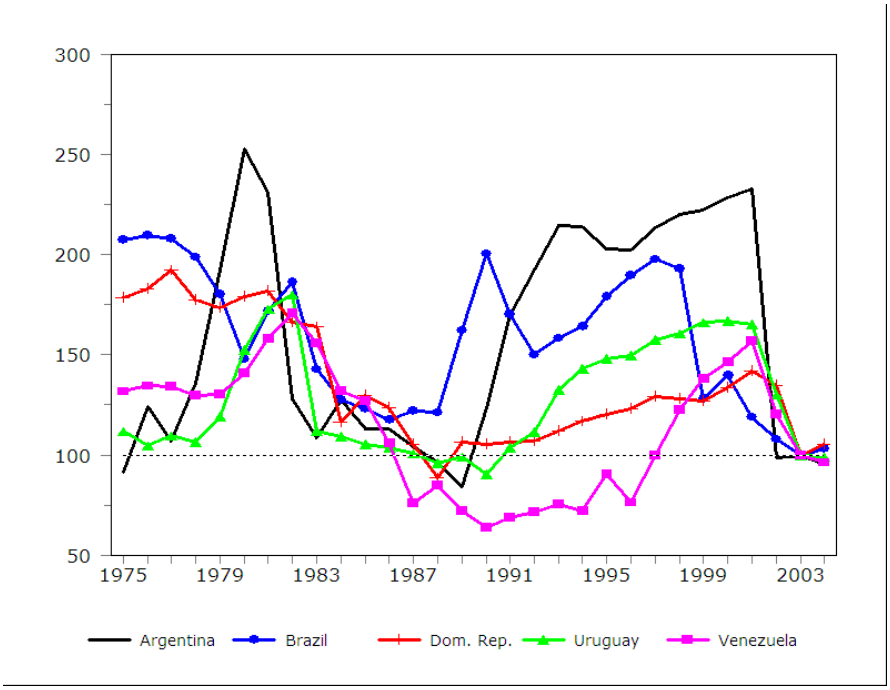
Naturally, the determinants of the RER –such as terms of trade and government policies— have evolved in different manner in the ten developing economies and, consequently, they have had a differential effect on the RER. To provide a general impression of the link between these fundamentals and the RER I computed sample correlations and collected the results in Table 1.

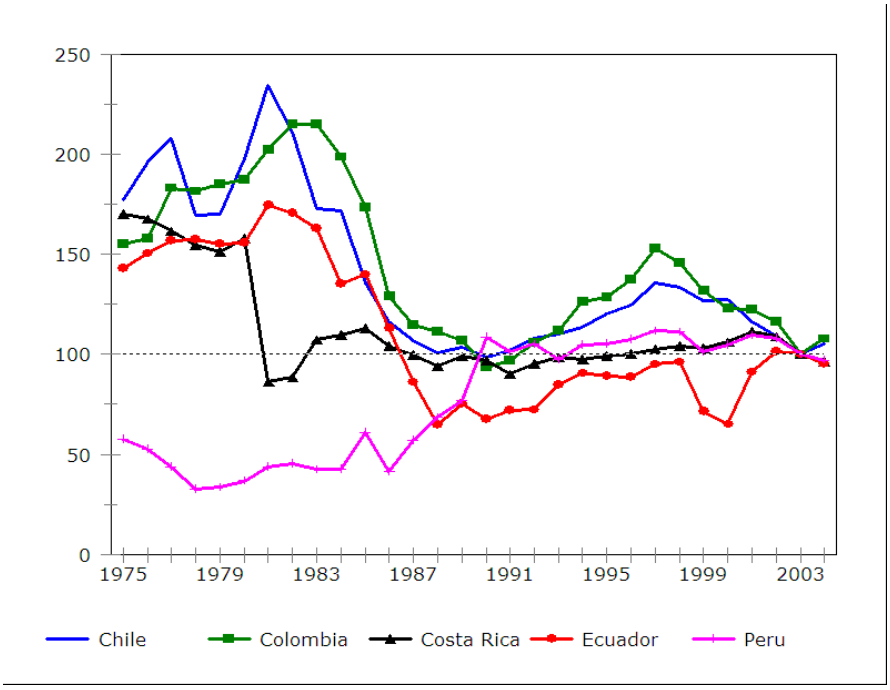
Table 1
Sample correlations of the RER and selected variables
1970-2004, average of 10 countries

Terms of Trade	0.41
Government Consumption	0.16
Productivity	0.81
Openness	-0.52
Taxes on Traded Goods	0.23
Taxes on Non Traded Goods	-0.10
Current Account Balance	-0.22

Source: own elaboration.

Figure 1
Real Exchange Rate
(2003=100)





It can be seen that distinctive stylized facts appear. Some conform to well known empirical regularities, others provide new, interesting insights on the working of Latin American economies. First, the RER is highly correlated to terms of trade. This is a standard result found by several authors in different developing countries and time periods (Edwards and Savastano, 2000). Devereux and Engel (2006) provide a rationale for this link based on exchange rate policies enacted by a government wishing to smooth fluctuations in real exchange rates so as to reduce distortions in consumption allocations, but facing the need to allow flexibility in the nominal exchange rate so as to facilitate terms of trade adjustment. Second, there is an equally significant association between the RER and government consumption, where expanding fiscal policies are associated with more appreciated exchange rates. This evidence is broadly consistent with models that highlight the role of government expenditures in affecting the evolution of, and inducing misalignment in, the RER (Elbadawi and Soto, 1997). Third, the evidence on the correlation of the real exchange rate and productivity is, as expected from the well known Balassa-Samuelson postulate, positive and relatively high. Fourth, the evidence for Latin American countries is also consistent with the tenet that more open economies tend to exhibit more depreciated exchange rates.

Other stylized facts characterize Latin American economies. First, taxes on traded and non-traded goods seem to have a significant yet opposite correlation to real exchange rates, indicating the importance of addressing them separately when modeling the effects of taxation or fiscal revenue on the RER. This characteristic has not been discussed in previous papers, yet it could provide for a significant source of understanding of the long run trends of the RER. In particular, when considering the recent market liberalization in the region that changed the composition of government revenue from foreign trade taxes towards domestic sources. Second, changes in the level of the current account –i.e., exports net of debt service and foreign transfers— seem to be positively correlated with real exchange rate movements.

3. The model

This paper dwells on the long tradition of defining the equilibrium RER as the path needed to achieve simultaneous internal and external balance by some date in the medium run future and maintain balance thereafter (Nurkse, 1945). Elbadawi and Soto (2007) develop a general equilibrium model of the RER that, in addition to standard fundamentals such as productivity levels and terms of trade, considers aid flows, distorting trade taxes, and concentration of exports on natural resources. I extend such framework to include unemployment and derive a congruent concept of the sustainable current account.[2]

The framework assumes the existence of a small-open economy producing non-traded (*N*) and traded (*T*) goods, the latter comprising exportable (*X*) and importable goods (*M*). The economy is inhabited by a representative household. Present discounted expected utility of the representative household is given by:

$$\textbf{(1)} \qquad max_{\{c,n,b\}} U_t = E_t \sum_{i=0}^{\infty} \beta^i [\log c_{t+i} + \xi g_{t+i} + \eta (1 - n_{t+i})]$$

where E_t is the expectations operator based on information at time t, β is the discount factor, c is consumption, ξ is the fraction of government expenditures g that is valued by consumers, and n is total hours of labor effort. Government expenditures affect welfare but are independent of consumption and labor decisions (e.g., they correspond to in-kind transfers such as publicly provided goods).

The representative household supplies labor to both non-traded and exportable sectors, so that $n_t = n_t^N + n_t^X$. The specification of the utility function follows the "lottery model" of Rogerson (1988) which assumes that each household can work an exogenous, fixed number of hours $\bar{n}$ with endogenous probability p or none at all (i.e., is unemployed). At the aggregate level, this specification

2 The alternative strategy of modeling the RER based on the PPP hypothesis has been largely rejected from an empirical viewpoint. As discussed by Rogoff (1996), PPP-based models fail to explain persistent deviations of the RER from the PPP benchmark in both developed and developing countries. Sarno and Valente (2006) claim that a weaker version of PPP –allowing for short-term deviations— could provide a useful benchmark for assessing RER misalignment in the very long run, i.e., 10 to 20 years. However, even if one is willing to use such long-horizon measures as equilibrium benchmarks, it should be acknowledged that PPP-based models are unlikely to provide an adequate description of the causes of misalignment and RER fluctuations at any short to medium horizon.

is consistent with an equilibrium in which a fraction p of the labor force is employed $\bar{n}$ hours per period while the rest is unemployed.[3]

The rest of the setup for the consumer is standard. Total consumption includes a basket of non-traded goods and a composite of internationally traded goods and non-traded goods. The household issues bonds, b, which are used to transfer wealth. In addition, she receives every period lump-sum transfers from the government (t) and from overseas (h). The latter may include official development assistance and unrequited workers remittances.[4] Other sources of funds are labor income (where the wage rate is the same in all sectors since labor is homogeneous) and profits from domestic firms producing non-traded goods and exports.

The production of non-traded and exportable goods is assumed to be competitive. Firms in these two sectors demand labor and a sector-specific input, z, and produce according to Cobb-Douglas technologies:

$$\textbf{(2)} \qquad \begin{aligned} y_t^N &= A_t^N (n_t^N)^{\gamma} (z_t^N)^{(1-\gamma)} \\ y_t^X &= A_t^X (n_t^X)^{\theta} (z_t^X)^{(1-\theta)} \end{aligned}$$

where A represents a total factor productivity (TFP) index for each sector. Following Prescott (1997) I assume that productivity changes are exogenous in the long run. Alexius (2005) provide evidence that productivity shocks tend to be weakly exogenous with respect to real exchange rates in developed economies, thus giving support to our assumption. The presence of sector specific inputs characterizes production in developing economies, especially in Latin American, where exports are usually concentrated in natural resources. An extensive literature has documented the links between fluctuations in commodity prices and RER instability (e.g., Cashin et al., 2004). On the other hand, production of non-traded goods in developing economies, such as services and commerce, are largely based on labor and, to a lesser extent, human capital.

The government collects taxes from the consumption of traded and non-traded goods. The government spends these resources on non-traded and imported goods (i.e., the government does not consume exportable goods). Whenever there is an imbalance, the government enacts a (positive

3 In equilibrium, parameter η in equation 1 is linked to the unemployment rate u by condition $u=(1-\bar{n})/(1-e^{\eta})*\zeta$ where ζ is a constant factor.

4 A justification for including these transfers when modelling the RER is their increasing importance and the fear that they might induce RER appreciation and Dutch disease problems (World Bank, 2006).

or negative) lump-sum transfer to consumers, so as to keep its budget balanced at all times. The government does not have access to domestic or external borrowing.

The sustainable current account

The combined budget constraints of the consumer and the government allows us to derive the following expression for the current account balance:

(3) $$-b_t+(1+r_t+\mu_t)b_{t-1}=p_t^N\left(y_t^N-c_t^N-cg_t^N\right)+p_t^X y_t^X-p_t^X c_t^X-p_t^M\left(c_t^M+cg_t^M\right)+h_t$$

where $(r_t+\mu_t)$ represents the debt service, including the interest rate, *r*, and a sovereign risk premium, μ.

Solving forward this intertemporal condition and imposing the transversality condition that in the long run the economy would hold no debt and leave no bequest, I obtain the present value of the external trade restriction:

(4) $$(1+r_t+\mu_t)b_{t-1}+\sum_{t=s}^{\infty}R_{t,s}\,p_t^M c_t^M(1+\theta_M)=\sum_{t=s}^{\infty}R_{t,s}\,p_t^X X_t+\sum_{t=s}^{\infty}R_{t,s}\,h_t$$

where $R_{\tau,s}=\left(\prod_{\tau=t+1}^{s}(1+r_\tau+\mu_\tau)\right)^{-1}$ is the market discount factor between dates *t* and *s*. The left hand side of external trade restriction is the present value of net imports plus the value of the existing stock of external debts and its service from last period. The right hand side comprises the present value of exports and the present value of foreign transfers. Using the first order condition for the accumulation of foreign assets, I obtain the sustainable level of imports:

(5) $$p_t^M c_t^M=\frac{1-\beta}{\beta}\frac{1}{(1+\theta_M)}\left[-\zeta_t(1+r_t)b_{t-1}+\sum_{t=s}^{\infty}R_{t,s}p_t^X X_t+\sum_{t=s}^{\infty}R_{t,s}h_t\right]$$

Note that this *optimal* level of imports was derived imposing the restriction that in the long-run net foreign assets should be zero (the no Ponzi-game condition), i.e., in present value terms the current account should be zero.

Equilibrium Real Exchange Rate

As discussed, the equilibrium real exchange rate achieves both internal and external equilibrium. Consequently, I use the sustainable level of imports and determine the wage rate that achieves internal equilibrium condition to derive the equilibrium real exchange rate. The final structural expression (in logs) is:

$$\begin{aligned}\log ERER_t = \pi_0 + \pi_1 \log\left(\frac{1-\beta}{\beta}\left[-\zeta_t(1+r_t)b_{t-1} + \sum_{t=s}^{\infty} R_{t,s}\tilde{p}_t^X \tilde{X}_t + \sum_{t=s}^{\infty} R_{t,s}\tilde{h}_t\right]\right) \\ -\pi_2 \log \eta_t + \pi_3 \log TOT_t + \pi_4 \log A_t^X - \pi_5 \log A_t^N + \pi_6 \log\left[\frac{\tilde{z}_t^X}{\tilde{z}_t^N}\right] \\ -\pi_7 \log(1+\theta_t^M) - \pi_8 \log(1+\tau_t^M) - \pi_9 \log(1+\tau_t^X) + \pi_{10} \log(1+\tau_t^N)\end{aligned} \quad \textbf{(6)}$$

where parameters π correspond to positive, linear combinations of the structural parameters of the model. Parameter π_0 is a combination of the structural parameters pertaining to the utility function, the production function and the discount rate) indicates the need to account for country-specific effects when estimating the model using panel data.

It can be seen that the equilibrium real exchange rate depends on external variables (such as the terms of trade), endowment variables (natural resources and human capital), policy variables (such as taxes and the structure of government consumption), exogenous variables (such as productivity levels and foreign aid), and state variables (such as the stock of foreign debt).

Since the model is based on relative sector production, the intensity use of factors in production plays an important role in determining the marginal effect of some fundamentals on the equilibrium real exchange rate (e.g., government consumption, taxes or the sustainable level of the current account). To determine the sign of the parameters in equation (6) I assume that the non-traded sector is more labor-intensive than the exporting sector, which is consistent with the evidence presented, among others, by Morshed and Turnovsky (2004) and Elbadawi and Soto (2007).

According to equation (6), lower unemployment rates will be congruent with higher real wages and, given the labor intensity assumption, a higher ERER. However, if labor intensity is equal in both sectors, unemployment does not affect the ERER. This is natural since, in that case, changes in relative production will not affect relative factor prices, household income, or the demand for non-traded goods.

A higher level of sustainable imports is predicted to lead to more appreciated ERER. In terms of its components, a higher level of existing foreign debt would imply a lower disposable income for consumers and, hence, a lower demand for non-traded goods and a more depreciated ERER. Likewise, a higher cost of borrowing –itself the result of higher international interest rates or higher country risk— also depreciates the ERER as consumers foresee a decline in permanent income. Finally, a higher inflow of foreign transfers in the form of aid or unrequited private transfers, allows for a higher sustainable current-account deficit that, in turn, is congruent with higher consumption and, hence, with a higher demand for non traded goods and a more appreciated ERER.

Higher permanent terms of trade raise the consumer's disposable income and, hence, its demand for non-traded goods, thereby increasing their relative price. The absence of intermediate goods in our model inhibits the substitution effect in production, arising from the potentially higher cost of imported inputs. The effect of the terms of trade is, perhaps, one of the more discussed determinants of the equilibrium RER and, in general, empirical models tend to support the conclusion of our model (Mendoza, 1995; Kehoe and Ruhl, 2007).

The model reproduces several analytical results obtained in previous papers. According to our derivation, the ERER appreciates if production in the traded sector becomes relatively more efficient than in the non-traded sector. Increased efficiency translates into higher wages which, in turn, allow consumers to expand their demand for non-traded goods, thus leading to higher prices for non-traded goods. In this sense, the model reproduces the Balassa-Samuelson effect that has been the cornerstone of previous models of the RER (see Bergin et al., 2007).

The model also predicts the ERER to be higher for economies with higher natural resources relative to human capital endowment. The intuition is straightforward. A higher relative productivity or abundance of inputs in the exportable sector means higher wages and income for the consumers. This, in turn, is consistent with higher demand for non-traded goods and a higher RER. This allows the producers of non-traded goods to meet higher wages. The relationship between the endowment of natural resources and the RER has been largely neglected in the literature, yet it is an important characteristic of the economic structure of developing countries.

The model provides for a rich analysis of the channels through which fiscal policy can affect the ERER. Higher taxes on the consumption of non-traded goods (τ^N) are predicted to lead to a more depreciated equilibrium RER. This is because such taxes lower demand –and hence the relative price— of non-traded goods. Higher export taxes (τ^X) have the opposite, appreciating effect: as a result of the tax, domestic consumption switches towards the now relatively cheaper non-trade goods thus leading to an appreciation of the ERER. On the other hand, a increase in import taxes (τ^M) –by far the most used tax in developing economies— has an ambiguous effect as it operates through two channels. On one hand, it leads to an unambiguous depreciation in the ERER reflecting the pure income effect leading to reduced aggregate demand and hence lower prices of non-traded goods. On the other hand, higher import taxes lead to an unambiguous ERER appreciation as it switches demand towards the now relatively cheaper non-traded goods. The government's expenditure patterns also affect the equilibrium RER. Finally, the model predicts government consumption of non-traded goods (θ_N) to unambiguously lead to RER appreciation, while the share of its expenditure on imports (θ_M) is predicted to be associated with RER depreciation, provided that the labor intensity assumption holds.

4. Taking the Model to the Data

The equilibrium RER model describes the long-run relationship between the real exchange rate and its fundamentals. Let $\tilde{F}_{it}$ is a vector of the right hand side variables of equation (6). Thus, the model can be compactly stated as:

(7) $$\log RER_{it} = \pi_0^i + \pi \tilde{F}_{it} + \epsilon_{it}$$

Pesaran and Smith (1997) suggest that the existence of the above long-run relationship is not contingent upon co-integration and can be embedded in a dynamic error-correction model of the form:

(8) $$\Delta \log RER_{it} = \phi^i \left(\log RER_{it-1} - \pi_0^i - \pi \tilde{F}_{it-1} \right) + \delta^i \Delta \tilde{F}_{it} + \eta^i M_{it} + \epsilon_{it}$$

where M_{it} is a vector of variables that may affect the RER in the short-run but have no permanent effects. Note that the adjustment parameter (ϕ) as well as the long-run intercept π_0^i and short-run coefficients (δ, η) are allowed to vary across countries, while the long-run coefficients, π, are restricted to be the same for all economies.

I estimate equation (8) using the Pooled Mean Group (PMG) estimator developed by Pesaran, Shin, and Smith (1999).[5] This estimator has several attractive features in terms of generality and flexibility, which makes it useful when estimating the model using panel data. These include (1) allowing the long–run RER to be influenced by fundamentals of varying degree of integration, including stationary country-specific fundamentals, (2) allowing the long-run intercept to vary across countries, accounting for differences in country-specific deep parameters, (3) allowing the short-run effects of the fundamentals and other variables to vary across countries, and (4) allowing the equilibrium correction parameter to vary across countries, which permits identifying differences in the speed at which countries adjust to new equilibria.

Prior to discussing the econometric results, some description of the estimation procedures is necessary. The PMG estimator can be seen as a restricted-model estimator, in the sense that it imposes the restriction that all countries share the long-run coefficients, against the more general model that assumes that economies differ in their short and long-run parameters. This restriction can be tested using a Hausmann test: in our case, the test was 11.1 which is not significant at the 95% level, signaling that the restriction on long-run coefficient homogeneity is not rejected by the data. On the other hand, the PMG estimator can be seen as a more general model estimator than the individual-effects panel-data model that assumes all parameters to be the same across countries. This restriction can also be tested: the null hypothesis of equality of coefficients can be rejected at the 0.01% level. Rejecting one model in favor of an alternative specification has important implications, as can be seen in Table 2 where we confront the estimators of the long-run coefficients obtained using the PMG estimator with those obtained using the dynamic, fixed-effects panel data estimator and the mean-group model estimator. We discuss in turn the long-run coefficients, the speed of adjustment coefficient, and the short-run estimated parameters.[6]

5 The data were obtained from Elbadawi and Soto (2007) database: sources and definitions are in the appendix.
6 Detailed results available upon request.

Focusing on the results obtained using the PMG estimator, observe that the point elasticity of the RER to unemployment is statistically significant yet very small in magnitude. On average unemployment in Latin America increased by 6 percentage points in the 1990-2002 period. Had this increase been of a permanent nature, it would have been consistent with an 8% RER appreciation. Hence the effect is of a rather small economic magnitude. Milas and Legrenzi (2006) found a very similar result for the UK over the 1973-2004 period, although in their model they were able to identify an asymmetric response of the RER to rising versus falling unemployment regimes. Lindblad and Sellin (2003) test the reverse causality for the case of Sweden and conclude that the depreciation of the equilibrium exchange rate could explain only 0.6 percentage points of the rise in unemployment of 1.5% observed between the 1970s and 1990s. Frenkel and Ros (2006) also test the reverse causality for 17 Latin American economies. And find that "a 10% appreciation (depreciation) of the RER is associated with a 5.6% increase (fall) in the unemployment rate two years later".

With regards to the terms of trade, the estimated parameter has the expected sign but is imprecisely estimated. However, the result is in line with that of Dufrenot and Yehoue (2005), obtained for a sample of 64 countries in the 1979-2000 period, and Elbadawi and Soto (2007), for a sample of 77 developing economies in the 1970-2004 period. My estimate suggests that, while terms of trade shocks can affect the real exchange rate in the short run, their long-run impact is modest. A one-standard deviation permanent increase in the terms of trade (around 30% in the sample), would only have an impact on the equilibrium RER of about 1%. This estimate is smaller than those found by Aguirre and Calderón (2006) and Razin and Collins (1997) which are in the 0.2-0.4 interval. An explanation for the difference is that I measure only the substitution effect of terms of trade shocks, since the income effect –which reflects in an increase in the sustainable current account— is captured by the optimal imports variable, that was excluded form their estimations.

The measures of the response of the equilibrium RER to changes in productivity provide also interesting insights. Sample averages indicate that average labor productivity in the non-traded sector grew at only 0.2% per year in Latin American countries in the 1970-2004 period. Using the estimated elasticity (-0.61) it is straightforward to deduce that it had only a marginal effect on the RER depreciation. Elbadawi and Soto (2007) report that productivity in East Asian economies grew at around 1.5% per year and that the equilibrium RER could have accumulated the equivalent to a 40% depreciation in the same period. Changes in productivity levels in the traded sector, on the

contrary, have been similar among all developing countries and do not provide for different trajectories in the equilibrium RER.

Table 2
Econometric Results: Estimated Long-run Parameters
Dependent Variable: log(RER)

Fundamentals	Pooled Mean Group	Dynamic Fixed Effects	Mean group Estimator
Terms of trade	0.01 (0.061)	0.19 (0.222)	0.20 (0.298)
Productivity in non-traded sector	-0.61 (0.113)	-0.98 (0.261)	-0.12 (0.252)
Productivity in traded sector	0.58 (0.065)	0.32 (0.155)	0.55 (0.194)
Resource endowment	0.02 (0.037)	0.19 (0.291)	0.55 (0.194)
Share of government consumption in imports	0.049 (0.049)	-0.14 (0.147)	-0.43 (0.204)
Taxes on imports	0.35 (0.210)	-1.47 (0.961)	-0.04 (0.532)
Openness	-0.50 (0.116)	-1.51 (0.291)	-0.78 (0.277)
Taxes on non-traded goods	1.85 (0.588)	5.55 (2.673)	4.96 (2.154)
Optimal imports	0.31 (0.059)	0.91 (0.249)	0.09 (0.144)
Unemployment rates	-1.27 (0.470)	0.21 (1.64)	-0.03 (1.260)

Note: standard deviations in parenthesis. Individual and time effects included.

The model provides for a rich decomposition of the impact of the different components of fiscal policy on the trajectory of the equilibrium real exchange rate. I obtain the standard result that a rising government expenditures lead to RER appreciation. However, contrary to most of the existing literature, the point estimate is small, indicating that the appreciating impact of government

consumption in Latin American countries is negligible. Aguirre and Calderón (2006) and Elbadawi and Soto (2007) found an estimate of around 0.3 but Dufrenot and Yahoue (2005) find a smaller estimate of around 0.10. With regards to taxes, I obtain as expected that higher taxes on non-traded goods lead to a more depreciated exchange rate. Since the average tax rate on non-traded goods is only 5.7%, one could be tempted to conclude that the economic impact of this levy is not very significant. However, lowering tax rates on traded goods to the level of developed economies (1%) would account for a change of 25% in the equilibrium RER. On the other hand, taxes on imports tend to appreciate the equilibrium RER. Again the comparison of developing and developed countries is useful. If a median developing country would reduce its current 11% tax rate to the level of developed economies (9%), the RER would appreciate by only 1%.

I test the role of resource endowment on the equilibrium RER. The estimated parameter is statistically insignificant. This contrasts with the evidence presented by Elbadawi and Soto (2007), which found that the greater abundance of natural resources relative to human capital in African economies appreciates the RER by around 12% on average. My result could be due to the crudeness of the endowment measure or to its low variance in the sample.

The impact of trade liberalization, as reflected in the -0.5 coefficient of openness is similar to what is usually found in the cross-country RER literature. Drine and Rault (2004) found an average value of -0.36 for a group of 45 economies in the 1975-1992 period. The above mentioned study by Dufrenot and Yehoue (2005) report a value in the neighborhood of -0.4. These estimates, however, are not directly comparable to mine, since they use unfiltered openness measures (usually, total trade over GDP) whilst I use a filtered measure that is closer to the variable in our analytical model because it controls for country-specific endowment elements such as size, population, and geographical conditions.

With regards to the equilibrium-consistent current account we obtained a point elasticity of 0.31 suggesting that the stock-flow restriction appears to be quite binding. A negative permanent shock of size one-standard deviation –which occurs 75% of the cases— would induce a 15% equilibrium depreciation of the RER on average. In general, the literature does not consider stock-flow restrictions when modeling RER determinants. Exceptions are Lane and Milesi-Ferreti (2000) who proxy this restriction for the OECD countries with a measure of the changes in the net foreign asset position. For the 1975-1998 period, they estimated elasticity very similar to my result, 0.32.

Elbadawi and Soto (2007) find an elasticity of 0.34 for their panel of 77 developing countries. In addition, finding a positive, significant estimate for this parameter confirms our assumption that the non-traded sector is more labor-intensive than the exporting sector $(\gamma > \theta)$.

The speed of adjustment of the real exchange rate to its equilibrium is captured in the coefficient of the error-correction term. For all countries I obtained estimates in the [-1,0] interval that are statistically significant at conventional levels. The exceptions are Venezuela, where there is evidence of overshooting as the parameter is around -1.5, and Peru, where the estimate is close to zero and statistically insignificant indicating no adjustment whatsoever to the equilibrium. Some countries exhibit rather fast adjustment to equilibrium: in Argentina and Brazil it would take around five years to dissipate 90% of an RER deviation from equilibrium. In other economies adjustment takes much longer: in Costa Rica and Chile, for example, it would take around eight years. The sample average for the adjustment coefficient is -0.4, larger than that obtained by Elbadawi and Soto (2007) for 77 developing countries, indicating faster adjustment in Latin America than in Africa and East Asia.

5. Computing Misalignment

I use the estimated model of the equilibrium RER to compute misalignment in each of the ten countries in the sample. Let the empirical counterpart of equation (7) be:

(9) $$\log RER_{it} = \hat{\pi}_0^i + \hat{\pi} F_{it} + \hat{\epsilon}_{it}$$

where $\hat{\pi}$ are the estimated parameters. Under the assumption that the model is correctly specified, the misalignment of the real exchange rate is simply given by subtracting the equilibrium from the observed values:

(10) $$RERMIS_{it} = \hat{\pi}_0^i - \pi_0^i + \hat{\pi} F_{it} - \pi \tilde{F}_{it} + \hat{\epsilon}_{it}$$

Equation (10) does not identify the misalignment at the country level. Even if $E[\hat{\pi}]=\pi$, there is no reason to expect $E[\hat{\pi}_0^i]=\pi_0^i$ since for a single country residuals need not be zero on average. The following identification condition of RER misalignment must be satisfied:

(11) $$E_t[RERMIS_{it}]=E_t[\hat{\pi}_0^i-\pi_0^i]+E_t[\hat{\pi}F_{it}-\pi\tilde{F}_{it}]+E_t[\hat{\epsilon}_{it}]=0 \qquad \forall i=1,\ldots,n$$

This condition requires that, for any given country, the expected value of the misalignment across time must be equal to zero. This is because eventually the RER must revert to it equilibrium level; otherwise it will not be misalignment but a permanent phenomenon.[7]

The equilibrium intercept is:

(12) $$\hat{\pi}_0^i=R\bar{E}R_i+\hat{\pi}\left(\bar{F}_i-\bar{\tilde{F}}_i\right)-\hat{\pi}\bar{F}_i=R\bar{E}R_i-\hat{\pi}\bar{F}_i$$

where $\bar{\tilde{F}}_i$ denote the mean values (over time) of the permanent components of fundamentals. Using equation (12) one can obtain an alternative expression for the equilibrium RER index that is useful to understand the sources of misalignment:

(13) $$R\tilde{E}R_{it}=R\bar{E}R_{it}+\hat{\pi}\left(\tilde{F}_i-\bar{\tilde{F}}_i\right)$$

This expression states that, for any given country *i*, the equilibrium RER index must be equal to the average of the observed RER over the estimation period plus (minus) a component reflecting equilibrium appreciation (depreciation), where an equilibrium appreciation (depreciation) is required when the weighted permanent component of the fundamentals in time *t* is larger (smaller) than the corresponding average over the estimation period (second right hand side term).

Subtracting the above index from the observed RER gives the corresponding expression for RER misalignment:

(14) $$RERMIS_{it}=\left(RER_{it}-R\bar{E}R_{it}\right)-\hat{\pi}\left(\tilde{F}_{it}-\bar{\tilde{F}}_{it}\right)$$

7 It can be shown that the equilibrium RER is the same whether or not we assume the expected values of the transitory fundamentals to be zero (see Elbadawi and Soto, 2007).

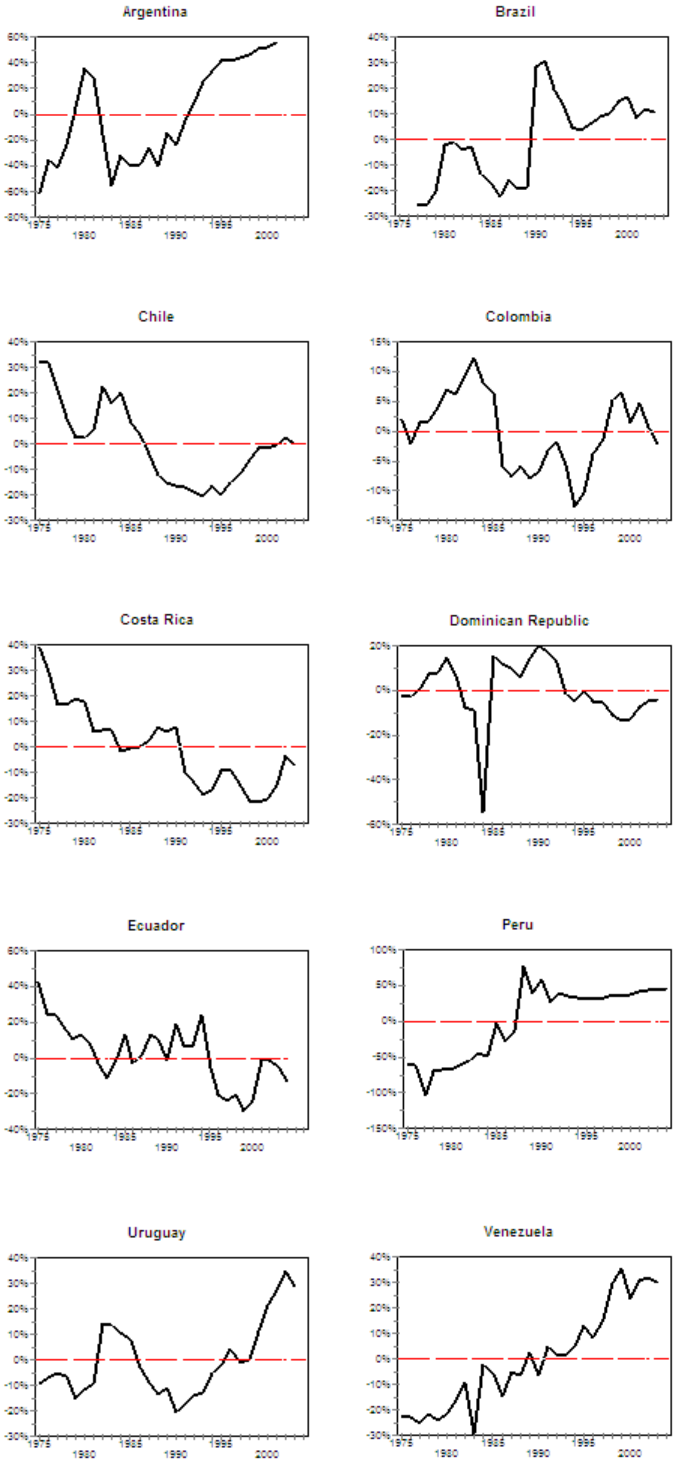
Like the equilibrium RER index, the expression for misalignment is also very intuitive. It suggests that, at any point in time, if the difference between the actual RER and the average RER is in excess of the equilibrium appreciation component, the exchange rate is overvalued and the extent of the overvaluation is given by the net difference. This expression also suggests that, depending on the size of the equilibrium appreciation component, a higher than average real exchange rate is compatible with overvaluation ($RERMIS>0$), undervaluation ($RERMIS<0$) or equilibrium ($RERMIS=0$). If the permanent components of the fundamentals are time-invariant, the second term in the RHS of equation (14) will be zero. The equilibrium RER will, therefore, be equal to the mean of the observed RER and the misalignment will be given by the deviation from the mean RER.

I computed the misalignment of the ten countries in the sample according to equation (14). The permanent component of the fundamentals for each country was obtained using the band-pass filter proposed by Christiano and Fitzgerald (2003) which performs better than other filters (Hodrick-Prescott or Baxter-King) at the ends of the sample. Figure 2 presents the RER misalignment for all countries in the sample.

It can be seen that in all countries there are periods of sustained misalignment –either over or undervaluation— and the return to equilibrium is not immediate. This is consistent with the econometric evidence on the speed of adjustment implicit in the error-correction coefficient. This also attests to the importance of keeping track of the RER deviation for policy purposes, as the slow adjustment indicates that relative price changes are costly in any economy.

Turning to the individual country experience, it can be seen that overvaluation was characteristic in several economies in the 1970s and early 1980s: Chile, Costa Rica, Ecuador, and Colombia. In these countries a combination of multiple exchange rates, capital controls, and distorted incentives led initially to highly appreciated currencies and, later, to drastic adjustments following the debt crisis of the mid-1980s. For these countries, the 1990s were a decade of mild but sustained RER undervaluation. Nevertheless, by 2004 they were back in equilibrium.

Figure 2
Estimated Real Exchange Rate Misalignment
(positive values indicate RER overvaluation)



Other economies, such as Argentina, the Dominican Republic, Uruguay and Brazil to some extent, also went through drastic adjustment in the mid 1980s as a result of episodes of sharp appreciation of their currencies, the outcome of fixed exchange rate policies under unsustainable fiscal deficits. The southern cone countries went to similar episodes of sharp appreciation in the late 1990s and early 2000s. The effects of the convertibility plan of Argentina can be seen in the sustained appreciation since its implementation in the early 1990s until its collapse in 2003. Neighbor country Uruguay followed a similar pattern, largely the result of its integration to the Argentinian economy. Brazil, on the other hand, suffered similar turmoil in the early 1990 but managed to steer its economy and keep its RER closer to equilibrium afterwards.

Venezuela and Peru, on the other hand, display a very different pattern: after being undervalued in the 1970s, they have experienced a sustained appreciation of their RER, leading in the early 2000s to be quite out of the equilibrium. Again, the evidence on misalignment for Peru is consistent with our previous econometric result that suggested the absence of an error-correction mechanism.

6. Conclusions

The real exchange rate is an important economy-wide relative price closely watched and analyzed by policy makers and academic researchers alike. This paper studies the relationship between unemployment and the real exchange rate. The issue has been largely ignored in the literature. I develop a general equilibrium analytical framework that extends previous models (Elbadawi and Soto, 2007) to include labor market distortions, which I characterize using the lottery model developed by Rogerson (1988). Other determinants of the RER include classical variables such as productivity, terms of trade, and government consumption as well as fundamentals that are important to portray the working of developing economies, including the endowment of natural resources, the distorting effects of trade taxes, and foreign debt service. The analytical model provides also a theoretically consistent measure of the external equilibrium, as the situation where net exports plus foreign transfers balance, in present value terms, imports and the value of the existing stock of external debt.

The theoretical model generates a single-equation framework which allows for a straightforward estimation of the elasticities of determinants of the equilibrium RER. The econometric analysis –based on the generalized error-correction model for panel data by Pesaran et al. (1999)– strongly suggest that the model is consistent with the data for ten Latin American economies in the 1970-2004 period.

The econometric results indicate that effect of changes in unemployment on the equilibrium RER are small. The increase in unemployment in Latin America by 6 percentage points observed in the 1990-2002 period would be consistent with an appreciation of the RER of around 10%. Hence I conclude that the effect is of a rather small economic magnitude. My estimates indicate, on the other hand, that the trajectory of the equilibrium RER in Latin America is more closely related to economic policies, in the form of government consumption and taxes, and the growth in productivity levels in the non-traded sector.

I compute the misalignment of these countries according to the methodology and find that in all countries there are periods of sustained misalignment –either over or undervaluation— and the return to equilibrium is not immediate. This is consistent with the econometric evidence on the slow speed of adjustment derived from the error-correction coefficient. This attests to the importance of keeping track of the RER for policy purposes, as the slow adjustment indicates that relative price changes are costly and that deviations of the RER from equilibrium may require lengthy adjustment processes. The traumatic experience of Latin American economies with regards to RER mismanagement appears quite clearly. Countries exhibit a tendency to let the RER to overvalue – largely the result of unsustainable policies— that is drastically corrected usually in the form of a currency or balance of payments crisis.

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Appendix
Data Sources and Definitions

Macroeconomic data were obtained from Elbadawi and Soto (2007). Their database was assembled using IMF and World Bank data, as well as statistics from the central bank of each country. Unemployment figures were obtained from ECLAC.

Standard regressors

1. **Real effective exchange rate:** trade-weighted averages of the exchange rates that apply between trading partners with base 100 in 2003. An increase in the REER represents an appreciation of the local currency.
2. **Taxes on imports** correspond to taxes on international trade (as percent of GDP) net of export taxes.
3. **Terms of trade:** relative price of exports to imports with base 100 in 1995.
4. **External debt, debt service and official development aid:** nominal data were obtained from the World Bank and converted to real US$ using the US wholesale price index.
5. **Labor productivity** in non-traded goods was computed as (GDP-Exports)/Labor force.
6. **Natural resources** endowment was estimated as secondary education divided by area (km2) per capita.
7. **Openness:** residual of a regression of the log of exports (as % of GDP) on the log of land size, the log of population, a dummy for oil exporters, and a dummy for landlocked countries.
8. **Share of government expenditures in imported goods:** proxied by government consumption as ratio of total imports

Sustainable current account

Since the sustainable current-account level is not observed, Elbadawi and Soto (1997) build a proxy variable as follows. The model indicates that the optimal, time-consistent level of imports is a linear function of the long run, permanent value of exports, foreign aid, and external debt service. In econometric terms, they ought to cointegrate. Panel-data unit-root tests on imports, exports, official development assistance, and debt service (all variables in real US$ per-working age person) conclude that all variables could be characterized as I(1) series, i.e., they do have permanent shocks. A GMM panel-data regression was estimated for 69 countries and the residuals tested for stationarity. I use the predicted value of this auxiliary model as an instrument for the sustainable level of imports when estimating the RER equation.