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Álvaro Aguirre César Calderón

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

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Álvaro Aguirre
Banco Central de Chile

César Calderón
Banco Mundial

Resumen

En este trabajo evaluamos los efectos de desalineamientos en el tipo de cambio real (TCR) y la volatilidad de éstos sobre crecimiento económico. Calculamos desalineamientos en el TCR como desviaciones del TCR efectivo de su equilibrio para 60 países en el período 1965-2003 usando métodos de cointegración en series de tiempo y panel. Utilizando técnicas de paneles dinámicos encontramos que los desalineamientos del TCR reducen el crecimiento pero de forma no lineal: la caída en el crecimiento es mayor mientras mayor es el desalineamiento. Aunque grandes sobre depreciaciones reducen el crecimiento, sobre depreciaciones moderadas lo incrementan. Estos efectos son independientes de los causados por cambios en nivel de tipo de cambio real de equilibrio. No obstante encontramos algún rango de desalineamiento para el cual se producen efectos positivos en el crecimiento económico, encontramos que en la práctica es difícil seguir una política de desalineaminto que incremente éste. Finalmente, el crecimiento es afectado negativamente por la volatilidad de los desalineamientos, probablemente también de forma no lineal.

Abstract

We evaluate the growth effects of real exchange rate (RER) misalignments and their volatility. We calculate RER misalignments as deviations of actual RERs from their equilibrium for 60 countries over 1965-2003 using panel and time series cointegration methods. Using dynamic panel data techniques we find that RER misalignments hinder growth but the effect is non-linear: growth declines are larger, the larger the size of the misalignments. Although large undervaluations hurt growth, small to moderate undervaluations enhance growth. These results are robust when controlling for movements in the equilibrium real exchange rate. However, we find that it is difficult to follow a pro-growth RER policy. Finally, growth is hampered by highly volatile RER misalignments.

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E-mail: ccalderon@worldbank.org.

1. Introduction

The real exchange rate misalignment is a key variable in policy circles and its calculation is one of the most controversial issues in Open Economy Macroeconomics. Misalignments are used as a tool to predict future exchange rate shifts among floaters and to evaluate the need to adjust the exchange rate among countries with less flexible regimes. It has been argued that sustained real exchange rate (RER) overvaluations constitute an early warning indicator of possible currency crashes (Krugman, 1979; Frankel and Rose, 1996; Kaminsky and Reinhart, 1999) and they also have led to a drastic adjustment of relative prices and to a decline in the aggregate growth rate of the economy (See Table 1 for references on empirical assessments). On the other hand, and given that RER movements determine production and consumption choices between domestic and international goods, policymakers sometimes perceived the RER as an additional tool to influence the economy. Some countries have tried to maintain their currencies undervalued in order to boost the performance of the export sector and, hence, the aggregate economic activity. For instance, academics have suggested that capital controls and undervalued exchange rates have been key elements of an export-oriented development strategy for Japan and Germany after World War II and, more recently, China and other East Asian Economies (Dooley et al. 2003).

The literature argues that real exchange rate misalignments may affect growth and welfare (see Edwards, 1989): Keeping the RER at the *wrong levels* may create distortions in the relative price of traded to non-traded goods, generate incorrect signals to economic agents (thus, leading to sub-optimal allocation of resources across sectors) and result to greater economic instability. Note that the concept of RER misalignment requires the definition of equilibrium RER (ERER).[1] Others have argued that the growth effects of misalignments could differ if the RER appreciates in excess of the equilibrium appreciation (overvaluation) or if it depreciates in excess of the equilibrium depreciation (undervaluation). It is expected that undervaluation — which could be attributed to competitive devaluations— may drive the exchange rate to a level that encourages exports and promote growth. On the other hand, overvaluations —which may reflect macroeconomic policy inconsistencies— are likely to discourage growth (Razin and Collins, 1999).

It has also been stressed the importance of RER stability and the correction of misaligned RERs as determinants of economic performance in less developed countries (Krueger, 1983; Edwards, 1988). Sachs (1985) claims that the different development experiences in East Asia, Latin America and Africa may be attributed to their different trade regimes and exchange rate management practices. On the one hand, unstable and overvalued RERs provided weak incentives to exports and were supported by protectionist policies, while persistent misaligned RERs in Africa caused a severe drop in agricultural output (The World Bank, 1984). On the other hand, it has been argued that outward-orientation policies and exchange rate levels that encouraged export growth in East Asian countries generated a boost in their growth rates (Dollar, 1992).[2] More recently, the appropriate level of the RER and its effects on economic activity has been present in crucial debates like the performance showed by the Chinese economy and the exchange rate policy of future accession countries to the Euro Area. All these observations have led us to believe that RER misalignments (as well as its volatility) can influence a country's economic performance.

The main goal of our paper is two-fold: First, we calculate fundamental measures of RER misalignment based on a theoretical model in the spirit of Obstfeld and Rogoff (1996) New Open Economy Macroeconomics.[3] From the model, we obtain a long run relationship between the RER and its fundamentals —the ratio of net foreign assets to GDP, relative productivity, terms of trade, and government spending— and we estimate this equation for an ample set of countries using both time series and panel cointegrating techniques. After estimating the parameters of the RER equation, we calculate the equilibrium RER and we define the misalignment as the deviation of the actual RER from the estimated equilibrium path. Second, we assess the relationship between economic growth and RER misalignments and their variability for a panel data of countries using dynamic panel data techniques. Here we also explore the significance of some important non-linearities such as the growth effects of both RER overvaluation and RER undervaluation, as well as the role of the size of the over- and/or under-valuation.

Surprisingly, the literature on the growth effects of RER misalignments is not abundant and still poses some questions that we try to address here. In the spirit of Razin and Collins (1999), our work improves and complements the existing evidence in the following dimensions: First, we developed a model of the fundamental RER exchange rate in the spirit of the New Open Economy Macroeconomics approach developed by Obstfeld and Rogoff (1995, 1996). A simple version of this economy with government spending is the basic framework that will yield our

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[1] Edwards (1989) argues that ERER is the real rate that guarantees the sustainability of the current (external equilibrium) and the intertemporal equilibrium in domestic goods market (internal equilibrium).

[2] Recent work has focused on the role of financial frictions —i.e. balance-sheet effects, higher levels of indebtness and low depth of domestic financial markets— in explaining contractionary devaluations (Céspedes, Chang and Velasco, 2004).

[3] Given that the equilibrium RER cannot be observed, the calculation of RER misalignments is not trivial and could generate controversy since the result is usually model dependent (Edwards and Savastano, 2000).

long run real exchange rate equation. Second, we estimate our long-run RER equation using time-series cointegration techniques but also the more recent panel cointegration techniques. Specifically, we apply dynamic least squares on our RER equation for each country (Saikkonen, 1991; Phillips and Loretan, 1991; Stock and Watson, 1993) and compare summary measures of these estimates with panel dynamic least squares estimates (Kao and Chiang, 2000). Third, the existing literature does not treat reverse causality and endogeneity properly in a panel environment. Here, we use the GMM-IV system estimator for dynamic panels (Arellano and Bover, 1995; Blundell and Bond, 1998) to deal with the problems of unobserved country effects and endogenous regressors in a dynamic setting. Fourth, we thoroughly test for the existence of a non-linear relationship between RER misalignments and growth. Specifically, we test whether RER over- and under-valuations have different effects on economic growth, and whether these effects depend on the size of the over- or under-valuation. Fifth, we evaluate the growth effects of the variability of RER misalignments with emphasis on possible non-linearities. Finally, we perform an event analysis of the economies with undervalued currencies that were potentially able to increase their growth rate. In addition, we support this evidence with an econometric analysis of the persistence of RER deviations. Here, we link the persistence of deviations with some structural and policy variables.

We organize the paper in 6 sections. Section 2 reviews the literature on fundamental RER equations and the impact of RER misalignments on growth. Section 3 presents the econometric methodology used to estimate the RER equations and our growth equations. It also describes the data used in our analysis. Section 4 outlines our empirical assessment and Section 5 evaluates the determinants of the persistence of RER misalignments. Finally, section 6 concludes.

2. Review of the Literature

In the present section we briefly describe the empirical literature on two key issues for our analysis: (a) the measurement of real exchange rate misalignments, and (b) their impact on economic growth.

2.1 On the Measurement of Real Exchange Rate Misalignments

According to the literature, the real exchange rate misalignments are measured as the deviation of the actual real exchange rate with respect to some benchmark (or equilibrium) level. Based on the different methods to compute this benchmark, we can identify three different ways to measure RER misalignments. First, we have *PPP-based measures* of misalignment. Here, we use the deviations of the RER with respect to parity in some determined equilibrium year. One of the shortcomings of using this measure is that PPP only accounts for monetary sources of exchange rate fluctuations and does not capture exchange rate fluctuations attributed to real factors. Second, some researchers have calculated misalignments based on the difference between black market and official exchange rates. Here, the so-called *black market premium* is a proxy that captures better the degree of foreign exchange controls and may not be capturing misalignments in an era of increasing international financial integration. In addition, it has been empirically found that the black market premium overstate the degree of misaligment for developing countries in the 70s and 80s (Ghura and Grennes, 1993). Finally, we have *model-based measures* of RER misalignment. Here, the RER misalignment is calculated as the deviation of the actual RER from some theoretically-based equilibrium path of the RER.

In the present paper, we will focus on model-based —or fundamental— measures of RER misalignments. Usually, this type of measure is based on the calculation of equilibrium real exchange rates (ERER). Nurkse (1945) defined the ERER as the relative price that helps attain internal and external equilibrium simultaneously. Edwards and Savastano (2000) survey the literature on the measure of RER misalignments and they found that most empirical efforts can be classified in: (a) single equation models and (b) general equilibrium simulation models. In both approaches the RER is defined as the relative price of traded and non-traded goods that achieves internal and external equilibrium simultaneously.[4]

The *single-equation approach* have usually derived reduced forms for the equilibrium RER from a wide variety of theoretical models and most of these efforts have been based on Edwards (1989) and Obstfeld-Rogoff (1995, 1996).[5] The long-run relationship derived from theoretical models usually link the RER with a set of " fundamentals" such as net foreign assets, productivity differentials, terms of trade, government spending, trade policy, among other factors. Here, misalignments occur when RER deviations from the equilibrium path are persistent. Misalignments could arise —among other factors— due to inadequate macroeconomic, trade and exchange rate policies.

We follow the single-equation approach in this paper. In order to calculate the RER misalignment we first estimate our long-run RER equation using historical data and time series and panel cointegration techniques,[6] and then we compute the long-run values of the RER fundamentals. To compute the latter, most researchers use a variety of trend-cycle

[4] Edwards (1989) defines internal equilibrium as the sustainable equilibrium in the market of non-traded goods —which is compatible with the unemployment rate at its natural level. External equilibrium occurs when the current account position can be financed with sustainable capital flows —that is, when the intertemporal budget constraint is satisfied.

[5] Razin and Collins (1999), on the other hand, use a stochastic version of the Mundell-Fleming model as developed by Frenkel and Razin (1996).

[6] Alberola et al. (1999), Lane and Milesi-Ferreti (2004) and Calderón (2004b) are examples of RER equations estimated using panel cointegration techniques.

decomposition techniques. Here we use the band-pass filter. Then, we multiply the estimated coefficientes and the permanent values of the fundamentals to calculate the equilibrium RER. Finally, we estimate the RER misalignment as the difference between the actual and equilibrium RER. For a detailed revision of empirical papers on the estimation of equilibrium RERs, see Table 13.5 in Edwards and Savastano (2000).

Finally, other researchers have used *General Equilibrium Simulation Models* to assess the behavior or RERs (Williamson, 1991). Analogously to the other approach, the equilibrium RER should meet both internal and external equilibrium considerations. Most simulation models are based on flow considerations and ignore aspects such as the stock demand for net foreign assets.

2.2 Evidence on Real Exchange Rate Misalignments and Economic Performance

In the present section we present a brief overview of the evidence in the literature on the link between RER misalignments and economic performance. We observe that the literature not only evaluates the relationship between misalignment (as well as RER instability) and growth, but also the link with some sources of growth such as investment, productivity, export growth, and foreign direct investment, among others.

Regarding the economic links between RER misalignment and growth, some researchers suggest that misaligned RERs have a negative impact on the optimal allocation of resources and, hence, on growth. On the other hand, some may suggest that undervaluations —that could be the reflection of competitive devaluations— may drive the exchange rate to a level that encourages exports. In turn, this may affect positively growth due to economies of scale, adoption of technologies and other benefits already pointed out by the literature.

Earlier attempts in the literature used PPP-based measures and black market rates to measure RER misalignments. The problems with PPP-based measures have been stated above, whereas the black market premium on the foreign exchange market is also a flawed measure of misalignment since it is more of an indicator of rationing in this market. On the other hand, the use of fundamental measures of RER misalignment in the literature —defined as deviations from the equilibrium RER— were based on the equilibrium RER model specified by Edwards (1989) and Frenkel and Razin (1996). A description of the empirical literature on the growth effects of RER misalignment and its volatility is presented in Table 1. There, we find that for almost all studies, growth and misalignment (as well as its volatility) are negatively associated regardless of the measure of misalignment used. Only few papers such as Razin and Collins (1999) and Hausman et al. (2004) recognize potential non-linearities in the relationship between growth and RER misalignments. On the other hand, some of the earlier papers include either the standard deviation of the coefficient of variation of changes in the RER, instead of the volatility of RER misalignment. They robustly find that growth is inversely related to the volatility of either RER misalignment or RER fluctuations.

3. Methodology and Sources of Data

3.1 Defining the Equilibrium Real Exchange Rate and its Misalignment

Conceptually, we define the real exchange rate (RER) misalignment as the deviation of the actual RER from its equilibrium level. Therefore, we compute an equilibrium RER by estimating empirically a long-run RER equation derived from a theoretical model. To summarize it briefly, the model is the traded-non traded version of the Obsteld-Rogoff redux model augmented by the presence of government. There we find that the relative price of non-tradables is a function of the net foreign asset position, the relative productivity of traded vs. nontraded sectors, terms of trade and the government spending. The basic features and implications of the model are presented in Appendix I.[7]

The Long-Run Real Exchange Rate Equation. We define the RER as $Q = P / EP^*$, where P is the domestic price index, P^* is the foreign price index and E is the exchange rate (units of foreign currency per domestic currency). Note that our definition of Q implies that an increase (decrease) in Q denotes a real appreciation (depreciation) of the local currency. If we use lowercase letters to represent the natural log of uppercase letters, $x=ln\ X$, we obtain the following long-run RER equation from the model specified in Aguirre and Calderón (2005):

$$q_t = \beta_0 + \beta_1 \ln\left(\frac{F}{Y}\right)_t + \beta_2 \ln\left(\frac{y_T}{y_T^*} \Big/ \frac{A_N}{A_N^*}\right) + \beta_3 \ln\left(\frac{P_T^X}{P_T^M}\right)_t + \beta_4 \ln\left(\frac{G}{G^*}\right)_t + \xi_t \qquad (2)$$

where F/Y denotes the ratio of net foreign assets to GDP, Y_T/Y_T* is the labor productivity of the traded sector in the Home country relative to the Foreign country, P_X/P_M is the terms of trade index, A_N/A_N* is the labor productivity of the non-traded sector in the Home country relative to the Foreign country, and G_N/G_N* represents the government spending (as a percentage of GDP) for the Home country relative to the Foreign country.

Equation (2) represents our fundamental long-run RER equation —the baseline equation for our estimation of the equilibrium RER — and has several testable predictions. First, we expect that countries with significant external liabilities need to run trade surpluses in order to service them, and thus they require a real exchange rate depreciation (*"transfer effect"*). Also, Obstfeld and

[7] A similar version of this model, without government, is presented by Lane and Milesi-Ferreti (2004). However, their principal goal is to reassess the empirical evidence on the transfer effect for a sample of 64 countries (mostly, industrial and high and upper-middle income) over the 1970-96 period.

Rogoff (1995) claim that a transfer from Home to Foreign country reduces the domestic wealth and hence raises labor supply and the supply of exportables, thus affecting the relative price (we expect that $\beta_1>0$). Second, the relative price of non-traded goods must be growing faster at home than abroad if the ratio of traded to non-traded goods productivity is growing faster at home than abroad. Furthermore, if we assume that the price of tradables equalize, the price of home non-traded output must be rising relative to the price of foreign national output. Hence, if traded goods productivity relative to non-traded goods productivity is growing faster at home than abroad, home currency should appreciate in real terms (*i.e.* Balassa-Samuelson effect). Hence, we expect that $\beta_2>0$. Third, terms of trade improvements would increase the consumption of tradables and generate positive wealth effects that reduce the labor supply to the non-traded sector. This leads to an increase in the relative price of non-tradables and hence an appreciation of the real exchange rate (we expect that $\beta_3>0$). Fourth, assuming that the government mainly spends on non-traded goods, a surge in government consumption will adversely affect the demand of the non-traded sector, thus rising its price and generating a real exchange rate appreciation (that is, $\beta_4>0$). Finally, the *fundamental measure of RER misalignment* is obtained by substracting the equilibrium from the actual RER. As we stated before, the equilibrium RER is obtained from the multiplication of the estimated coefficients and the long-run values of the RER fundamentals in equation (2).

Other Measures of RER Misalignments. In order to test the robustness of our results, we will use two additional measures of real exchange rate misalignment. First, we calculate the misalignment as the RER deviations from the trend computed using trend-cycle decomposition techniques such as the band-pass filter (Baxter and King, 1999). Second, we use *David Dollar's (1992) measure of RER overvaluation* that relies on the assumption that the relative price of non-tradables varies systematically with endowments. Therefore, he links the RER with GDP per capita (proxy of relative per capita factor availability), and the population density (proxy of land availability relative to the labor force). Then, he measures RER misalignments as deviations from the regression line, where positive (negative) deviations from the regression line imply over- (under-) valuation of the local currency. For more details on this calculation, see Dollar (1992).

3.2 Econometric Issues for the Estimation of the Equilibrium RER

The present section attempts to describe the econometric methods used to estimate the long-run real exchange rate equation and our growth regressions for our sample of 60 countries, with annual information over the 1965-2003 period (see Table A.1 for the list of countries).

3.2.1 Estimating the Long-Run RER Equation

Before we estimate our RER equation, we need to assess its validity as a long-run relationship in our panel dataset. Since our long-run equation involves more than two variables, it is likely that more than one cointegrating relationship may exist. Hence, the single equation approach outlined in section 3.1 requires the existence of at most one cointegrating vector in the panel. If more cointegrating relations were present, their separate identification and estimation would require different techniques. Here we implement the *panel data version* of Johansen's (1988, 1991) trace test, the $\overline{LR}$ test, as developed by Larsson, Lyhagen and Lothgren (2001) to assess the cointegrating rank in heterogeneous panels. This panel statistic —properly standardized— is the average of the N individual trace statistics and is asymptotically distributed as $N(0,1)$. Note that, before implementing the $\overline{LR}$ test, we correct the individual trace statistics for small-sample bias using Reimers' (1992) correction, and we remove the cross-sectional means from the data before implementing the trace test due to the assumption of cross-sectional independence in the formulation of the critical values.

Once we find evidence of cointegration, we estimate the RER regression equation using cointegration techniques for both time series and panel data. We estimate the RER equation using dynamic least squares (DOLS) on: (a) each country's time series, (b) a sample of industrial and developing countries, and (c) the full sample of countries. Note that (b) and (c) imply the use of panel cointegration techniques. From now on, we will briefly describe the panel DOLS methodology —with the time-series application of DOLS being derived straightforward. Our empirical model for the RER could be specified as follows:

$$\begin{aligned} q_{it} &= \mu_i + \mathbf{X}_{it}\boldsymbol{\beta} + u_{it} \\ \mathbf{X}_{it} &= \mathbf{X}_{it-1} + \mathbf{v}_{it} \end{aligned} \qquad (4)$$

where q_{it} represents the real exchange rate (in logs), $\mathbf{X}_{it}$ is the matrix of RER fundamentals, and the subscripts $i = 1,...,N$ and $t= 1,...,T$ index countries and years, respectively. We define μ_i as a country-specific constant, u_{it} is the error term of the RER equation, and $\mathbf{v}_{it}$ represents a stationary vector of errors to the $\mathbf{X}$ process.[8] The pooled OLS (or fixed-effect) estimator of (4) —although consistent under weaker conditions— potentially has a severe small-sample bias, which makes it a poor candidate for inference. One potential problem of applying OLS to (4) is the possible correlation between the stationary random error ν_{it} and u_{it}. Under appropriate assumptions (*e.g.* Saikkonen 1991) u_{it} has infinite representation, $u_{it} = \sum_{-\infty}^{\infty} \nu_{it-k}\boldsymbol{\delta}_{ik} + \varepsilon_{it}$, where $\boldsymbol{\delta}_{ik}$ is a coefficient vector and ε_{it} is uncorrelated with ν_{is} for all t and s (and independent

[8] For the time being, the error process u_{it} is assumed to be uncorrelated across countries.

across i). Under this representation, it is straightforward to show that the OLS estimates of our long-run RER equation are inconsistent due to a simultaneity bias that arises from the correlation between **X** and u.

The problem of reverse causality is addressed by implementing either a non-parametric correction (FM-OLS) or a parametric correction (DOLS) to remove the bias. Empirically, Kao and Chiang (2000) show that the DOLS estimator outperforms both the OLS and FM-OLS in small-sample panels. Here, we remove the OLS bias by projecting u_{it} on the leads and lags of v_{it} (as specified above). However, since it includes an infinite number of leads and lags, this equation can not be directly estimated. However, the stationarity of u_{it} and $\mathbf{v}_{it}$ makes it plausible to assume that the coefficients $\boldsymbol{\delta}_{ik} \approx 0$ for sufficiently large k. Under such assumption, we can suitably truncate the infinite sum to arrive at a version of (4) augmented with p_1 leads and p_2 lags of the differences of **X:**

$$q_{it} = \mu_i + \mathbf{X}_{it}\boldsymbol{\beta} + \sum_{k=-p_1}^{p_2} \Delta\mathbf{X}_{it-k}\boldsymbol{\delta}_{ik} + \varepsilon_{it} \tag{5}$$

If we pool across i and apply OLS on (5), we obtain the panel dynamic OLS estimator. For large T, the DOLS estimator of the cointegrating vector $\hat{\boldsymbol{\beta}}$ is asymptotically independent from that of the short-run dynamics $\hat{\boldsymbol{\delta}}$, while this estimator is also independent from that of $\hat{\mu}$ for large N (Mark and Sul 2003). Furthermore, $\hat{\boldsymbol{\beta}}$ is asymptotically normal and centered at $\boldsymbol{\beta}$ and its consistently estimated asymptotic covariance matrix is given by:

$$\hat{V}_{DOLS} = \left(\frac{1}{N}\sum_i\left(\frac{1}{T^2}\sum_t \tilde{\mathbf{X}}_{it}\tilde{\mathbf{X}}_{it}'\right)\right)^{-1}\left(\frac{1}{N}\sum_i \hat{\Omega}_i\left(\frac{1}{T^2}\sum_t \tilde{\mathbf{X}}_{it}\tilde{\mathbf{X}}_{it}'\right)\right)\left(\frac{1}{N}\sum_i\left(\frac{1}{T^2}\sum_t \tilde{\mathbf{X}}_{it}\tilde{\mathbf{X}}_{it}'\right)\right)^{-1}$$

where $\tilde{\mathbf{X}}_{it} \equiv \mathbf{X}_{it} - (1/T)\sum_t \mathbf{X}_{it}$ is the deviation of $\mathbf{X}_{it}$ from its country-specific mean and $\hat{\Omega}_i$ is a consistent estimator of the covariance of u_{it}. To compute $\hat{\Omega}_i$ we use the quadratic spectral window method of Andrews and Monahan (1992).[9]

3.2.2 Estimating Growth Regressions[10]

[9] It is worth noting that this framework allows for a good deal of cross-country heterogeneity. For instance, deterministic factors —e.g. the constants— and error variances can differ across i in (8) and (9), and there are no restrictions placed on the short-term coefficients $\boldsymbol{\delta}_{ik}$. Different lag truncations can be also used for different i to take account of the varying persistence of short-run dynamics across units —in other words, rather than imposing the same lead and lag lengths for all units, p_{1i} and p_{2i} can be allowed to vary over i.

[10] This section draws heavily from Loayza, Fajnzylber and Calderón (2005).

We use an estimation method suitable for our pooled data set of cross-country and time-series observations, which deals with static or dynamic regression specifications, controls for unobserved time- and country-specific effects, and accounts for some endogeneity in the explanatory variables. This is the generalized method of moments (GMM) for dynamic models of panel data developed by Arellano and Bond (1991) and Arellano and Bover (1995).

Following Loayza, Fajnzylber and Calderon (2005), we estimate the following variation of the standard growth regression:

$$y_{i,t} - y_{i,t-1} = \alpha \ y_{i,t-1} + \alpha_C (y_{i,t-1} - y^T_{i,t-1}) + \beta' X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \qquad (7)$$

where y^T represents the trend component of output per capita, ($y_{i,t-1}$ - $y^T_{i,t-1}$) is the output gap at the start of the period, μ_t is a period-specific effect, and η_i represents unobserved country-specific factors. The inclusion of the output gap as an explanatory variable allows us to control for cyclical output movements and, thus, differentiate between transitional convergence and cyclical reversion. Accounting for cyclical factors is important in our case because we work with relatively short time periods (i.e., 5-year and 10-year averages). The time-specific effect, μ_t, allows to control for international conditions that change over time and affect the growth performance of countries in the sample, while η_i accounts for unobserved country-specific factors that both drive growth and are potentially correlated with the explanatory variables.

The method deals with unobserved time effects through the inclusion of period-specific intercepts. Dealing with unobserved country effects is not as simple given the possibility that the model is dynamic and contains endogenous regressors —they are controlled for by differencing and instrumentation. Likewise, the method relies on instrumentation to control for joint endogeneity by relaxing the assumption of strong exogeneity of the explanatory variables and allowing them to be correlated with current and previous realizations of the error term ε.

Parameter identification is achieved by assuming that future realizations of the error term do not affect current values of the explanatory variables, that the error term ε is serially uncorrelated, and that *changes* in the explanatory variables are uncorrelated with the unobserved country-specific effect. As Arellano and Bond (1991) and Arellano and Bover (1995) show, this set of assumptions generates moment conditions that allow estimation of the parameters of interest. The instruments corresponding to these moment conditions are appropriately lagged values of both levels and differences of the explanatory and dependent variables (the latter if the model is dynamic). Since typically the moment conditions over-identify the regression model, they also allow for specification testing through a Sargan-type test. For a detailed description of the methodology, see Loayza, Fajnzylber and Calderón (2005).

3.3 The Data

Real Exchange Rate Analysis. We have collected annual data on the real exchange rate and its fundamentals (net foreign assets, productivity in the traded and non-traded sector, terms of trade, and public absorption) for a sample of 60 countries over the 1965-2003 period.. In this section we describe how we constructed these variables and their sources of information.

Our dependent variables is the *real Effective Exchange Rate*, which is defined as domestic price index of country i vis-a-vis the price index of its main trading partners multiplied by the nominal exchange rate of country i,

$$q_{it} = P_{it} \Bigg/ \left\{ \left(e_{it}/e_{i0}\right) \prod_{k=1}^{n} \left[\frac{P_{kt}^{*}}{e_{kt}} \Bigg/ \frac{P_{k0}^{*}}{e_{k0}} \right]^{\omega_k} \right\}$$

where e_{it} is the nominal exchange rate of country i (vis-a-vis the US dollar) in period t, P_{it} is the consumer price index of country i in period t, e_{kt} is the nominal exchange rate of the k-th trading partner of country i in period t (in units of local currency vis-a-vis the US dollar), and P_{kt}^{0} is the wholesale price index of the k-th trading partners in period t. The *nominal exchange rate*, e, is proxied by the average price of the dollar in local currency (line *rf* of the IMF's International Financial Statistics). On the other hand, domestic and foreign prices, P, are proxied by the consumer price index of the country (line *64* of the IMF's IFS).

For our regressions we use the ratio of *net foreign assets* to GDP, F/Y, which is drawn from Lane and Milesi-Ferreti (2001) and updated to the year 2003 using capital flows information from the IMF's Balance of Payments Statistics. The construction of the data is thoroughly documented in Lane and Milesi-Ferreti (2001), and we define the net foreign asset position of a country as the sum of net holdings of direct foreign investment, net holdings of portfolio equity assets, and the net position in non-equity related assets (*i.e.* "loan assets"). In turn, the net position in non-equity related assets consist of international reserves, and the net loan position. Our sample of countries will be limited by the lack of data availability for a larger set of countries.

In the case of *productivity differentials* we would have preferred to use data on labor productivity of traded and non-traded sectors based on ISIC code classifications of the economic activity. However, due to the lack of availability of long data for an ample set of countries, we use the ratio of output per capita in the domestic country relative to the output per capita in the foreign country.[11] Output per capita is proxied by the GDP per capita, and the output per capita of the foreign country is a trade-weighted average of GDP per capita of the domestic country's trading partners. The *terms of trade* is the ratio of export to import prices, while *government spending* is proxied by the ratio of general government consumption to GDP. Data on all these variables are taken from the World Bank's World Development Indicators (WDI).

Growth Analysis. Here we briefly describe the definition and sources of information for the variables used in our growth regression analysis —other than RER misalignment. Our dependent variable is the growth rate in real GDP per capita, which is obtained as the 5-year average of the log differences of the GDP per capita. In turn, our measure of output per capita is the ratio of total GDP to total population, measured in 1985 PPP-adjusted US dollars. We use Loayza et al. (2005) construction using Summers and Heston (1991) and World Bank's WDI. The initial value of the GDP per capita (in logs) for the 5-year period is the initial output per capita that proxies for conditional convergence. Our measure of cyclical reversion is the difference between (the log of) the actual GDP and (the log of) potential (trend) GDP around the start of the period. We use the band-pass filter to decompose GDP in trend and cycle.

Human capital is proxied by the ratio of total secondary enrollment (regardless of age) to the population of the age group that officially corresponds to that level of education. Our source is the World Bank's WDI. Financial depth is measured by the stock of claims on the private sector by deposit money banks and other financial institutions, expressed as a ratio to GDP. The data on financial depth was obtained from Beck, Demirgüç-Kunt, and Levine (2000). On the other hand, trade openness is the log of the ratio of exports and imports (in 1995 U.S. dollars) to GDP (in 1995 U.S. dollars). Government burden is proxied as the ratio of government consumption to GDP, and the data was obtained from the WDI. In addition to the indicators of structural reform and policies described above, we include the average annual CPI inflation rate (Source: IMF International Financial Statistics) as a proxy of lack of price stability. Also, we use as proxy for currency crises the number of years that a country underwent a currency crisis (as a fraction of the number of years in the corresponding period). The episodes of currency crises are constructed using the methodology of Eichengreen, Rose and Wyplosz (1995) and Frankel and Rose (1996). Finally, external conditions are captured by terms of trade shocks and period-specific shifts, with the latter variable being approximated by using time-dummy variables.

[11] We have to mention that the sign of the coefficient of relative labor productivity at Home (relative to the Foreign) country will be positive (negative) if the surge in aggregate labor productivity is explain by shocks to tradables (non-tradables).

4. Empirical Assessment

4.1 A Brief Analysis of the Equilibrium RER Estimation

In the present section we estimate the long-run exchange rate equation obtained from our theoretical model. As we stated before, our theoretical measure of the real exchange rate misalignment is defined as the difference between the actual real exchange rate and its equilibrium value. In order to make valid inferences from our RER equations, we need to test for cointegration in our panel data set. In Table 2 we present our cointegration analysis using both residual-based tests and reduced-rank tests. Our homogeneous and heterogeneous tests of panel cointegration consistently show that the residuals of our RER equation are stationary. However, for our purposes it is important to find that there exists only one cointegrating vector given that the existence of more than one would imply that we will be estimating not only a RER equation but also another different relationship. Here, the $\overline{LR}$ statistic shows that there is at most one cointegrating vector between the RER and its fundamentals for any of the samples evaluated.[12] In Table 3 we present both a summary of our time-series and our panel DOLS coefficient estimates of the RER equation for our sample of 60 countries over the 1960-2003 period.[13] First, we report the mean group (MG) estimator of our RER equation, computed as the simple average of the long-run coefficientes across countries. According to the MG estimator, all our coefficients are positive and significant (as expected in our model); however, there are some differences across countries. Specifically, we find that more than 60 percent of all the estimated coefficients have the expected sign and more than 50% are statistically significant. Also, the median estimator —which is the median of the DOLS estimates across countries— yields results that are slightly similar to those of the MG. Note that these techniques —relative to the panel cointegration methods— allow more degrees of heterogeneity. Finally, we also report a Hausman test where the null hypothesis is that the panel DOLS estimator is equal to the average of the country time-series DOLS estimator (that is, the MG estimator). We find that we fail to reject the null hypothesis for all RER fundamentals except for the coefficient of relative productivity.

We also present in Table 3 our homogeneous panel data estimations for the sample of all countries as well as for the sample of industrial and developing countries —accounting for fixed and time effects. Using Kao and Chiang's (2000) panel dynamic least squares (P-DOLS), we find that all our coefficient estimates have a positive sign —as expected from our model— and most of them are significant at the 10% for the sample of all countries. This result also holds for

[12] Our country -by-country cointegration analysis also yields at most one cointegrating vector for most of the countries in our sample.
[13] In Table A.1 we present the coefficient estimates of the RER equation for all countries in our sample. Note that we have computed DOLS estimates for each country with different lag structures.

the samples of industrial and developing countries, although we should note that there are some differences in the coefficient estimates across samples. Here we find that real exchange rates tend to appreciate in equilibrium in response to a permanent increase in net foreign assets, permanent surges in productivity surges relative to the rest of the world and in the terms of trade, as well as higher government consumption.

Using our estimates, we compute the measure of misalignment as the deviations of the RER from its equilibrium level, where the latter is given by the adjusted value of the RER equation using the permanent component of the RER fundamentals. That is, $q^m = q - \bar{X}^P \hat{\beta}$, where $\bar{X}^P$ is the (band-pass) trend component of the RER fundamentals. We compute three sets of RER misalignment measures:

(a) Fundamental Misalignment 1 (FRERM1). It is computed using the time-series estimates of the equilibrium real exchange rates —that is, using the DOLS coefficient estimates for each country in Table A.1. This measure allows the highest degree of heterogeneity among steady states.

(b) Fundamental Misalignment 2 (FRERM2). Here we compute the equilibrium RER using the panel DOLS estimates for the sub-samples of industrial and developing countries —that is, panel DOLS coefficients in columns 5 and 6 of Table 3 that account for fixed and time effects. We apply the two sets of coefficients to the corresponding countries; that is, we assume differences between long-run coefficientes between industrial and developing countries.

(c) Fundamental Misalignment 3 (FRERM3). In this case, we use the panel DOLS estimates for the full sample of countries —column 4 of Table 3. Note that this measure assumes the existence of common long run coefficients for the RER equation across countries in the sample. This measure assumes full homogeneity in the cointegration estimation.

These three measures are positively and highly correlated. The correlation between the time-series estimate (FRERM1) and the panel estimates (either FRERM2 or FRERM3) is over 0.4, while the association between both panel estimates is greater than 0.9. Note that there is a trade-off between choosing time-series and panel cointegration techniques. Our panel data estimations may not account adequately for heterogeneity, whereas our time series estimations may suffer from small-sample bias.

4.2 Growth and RER Misalignments: Basic Statistics

In the present section we report some basic statistics (mean and standard deviation) on growth and real exchange rate misalignments for our sample of countries as well as for industrial and developing countries. Table 4 we present the mean and standard deviation for economic growth and RER misalignment, as well as the degree of RER overvaluation and undervaluation.

First, we find that average growth is higher among industrial countries (2.7 percent per year) than among developing countries (1.5 percent) and also less volatile —with a standard deviation of 1.7 among industrial countries relative to 3.1 among developing nations.

Second, we find that real exchange rates show a higher degree of misalignment in developing countries regardless of the measure of fundamental RER misalignment used. For instance, using the FRERM1 measure we find that industrial countries show a degree of misalignment of 4%, while developing nations have approximately 9%.

Third, developing countries also show a large degree of both RER over- and under-valuation. This result holds for all the measures of fundamental RER misalignment considered. Again, the FRERM1 measure of misalignment shows that the real exchange rates among developing countries relative to industrial countries are not only more overvalued (5 vs. 2 percent) but also more undervalued (4 vs. 2%).

Finally, we should also note that the RER misalignment is more volatile among developing countries than among industrial countries. On average, the standard deviation of the fundamental RER misalignment using FRERM1 is approximately 4.8 percent for developing countries and it is 8 percent for industrial economies.

4.3 Regression Analysis

4.3.1 Growth and Misalignments

In Table 5 we report our first regression estimates using the GMM-IV system estimation technique. Before we describe our results, we should mention that the specification tests —both the Sargan test of over-identifying restrictions and the test for higher order correlation— validate our regressions for inference. That is, our instruments are not correlated with the error term and the latter does not display higher order serial correlation.

Regarding the control variables used in our growth equation, we first find evidence of conditional convergence —*i.e.* countries with lower income per capita tend to grow faster. Second, we find the cyclical reversion has a negative and significant impact on growth. That is, an economy in recession at the start of the period should be expected to display subsequent higher growth. Controlling for the cyclical stance of the economy is important for our purposes because we expect a high correlation of the RER misalignment with the initial output gap. Third, growth is enhanced by more education, deeper financial markets and favorable terms of trade shocks. Finally, growth is hampered by higher inflation rates and currency crises.[14]

Regarding our variable of interest, we find that there is a negative and significant relationship between growth and RER misalignment regardless of the measure used —that is either for fundamental measures of RER misalignment or other proxies. This result implies that growth would decline in response to increases in the real exchange rate misalignment. Note that since we are controlling for the output gap and episodes of currency crises in the growth regression, the impact of RER misalignments on growth captures the effects of misalignments not driven by the cyclical position of the economy or the occurrence of a currency crises.

Economically speaking, our estimates suggest that if the average RER overvaluation of industrial economies rises to the average overvaluation of developing countries (0.02 vs. 0.05, respectively, using the FRERM1 measure), the growth rate would decline by 12 basis points. In addition, we can also find that an increase in the degree of misalignment (say, an increase in the extent of RER overvaluation) of 5 percent would lead to a fall in growth of 20 basis points per annum. Therefore we obtain that, regardless the initial level of misalignment, an increase of 5 percentage points in the extent of RER misalignment would lead us to lower growth by 20 bp when we use FRERM1. On the other hand, a similar increase in the RER overvaluation (say, 5 percent) would imply a growth decline of approximately 6 basis points when we use the either FRERM2 or FRERM3 measures. Finally, a decline in the degree of overvaluation of developing countries to average industrial countries' level would raise the growth rate by *5* basis points for the Dollar measure and by *7* basis points per year for the band-pass measure.

From our results in Table 5, it may be inferred that in order to boost growth, policymakers may undervalue their currencies. Although this framework is limited, we expect that depreciating the currency in excess of its equilibrium level may —to certain extent— encourage exports and, hence, growth. However, very large undervaluations may hurt growth. In the next section we test this proposition in detail. In what follows, we will try to evaluate the possibility of non-linearities in the relationship between growth and RER misalignments in two dimensions: First, the possible different effects on growth of RER over- and under-valuation. Second, the growth effects of different degrees of over- and under-valuation.

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[14] Controlling for the latter variable may probably overestimate the growth effects of RER misalignment since our RER misalignment coefficient may not capture the indirect effects on growth —through higher crises probability (see Berg y Patillo, 1999; Kaminsky and Reinhart, 1999).

4.3.2 Non-Linear Effects of Misalignments

In Table 6, we explore whether RER overvaluation and undervaluation have a different impact on growth and whether this impact depends on the size of the deviation from the equilibrium. Here we answer the following questions: do RER overvaluations hinder growth? Do undervaluations enhance it? Does the growth effect depend upon the size of the over- or under-valuation? The literature argues that overvaluations may hurt growth since they may either reflect inconsistent macroeconomic policies or proxy the size of a future currency crisis episode (Razin and Collins, 1999; Chinn, 2005). Others have argued that to the extent that undervaluations reflect competitive depreciations, they will have a positive impact on growth (Razin and Collins, 1999; Dooley et al. 2003).

In order to test these hypotheses, we define the dummy variable D_t that takes the value of *1* when the RER is overvalued and *0* otherwise. Then, we define our variables of overvaluation and undervaluation of the RER as $q_{+}^{m} = \left(q - \overline{X}^{P}\hat{\beta}\right)\cdot D_t$ and $q_{-}^{m} = \left(q - \overline{X}^{P}\hat{\beta}\right)\cdot\left(1 - D_t\right)$. Next, we modify our baseline regression by including the RER overvaluation and undervaluation variables instead of the RER misalignment. Note that q_{+}^{m} (q_{-}^{m}) takes positive (negative) values when the RER is over- (under-) valued, and 0 otherwise. Hence, the coefficient of q_{+}^{m} in our growth regression will be negative and significant if we expect growth to be hindered by RER overvaluations. On the other hand, the coefficient q_{-}^{m} will be positive (negative) if RER undervaluation boost (harm) economic growth. Our results for the fundamental measures of RER misalignment a re reported in columns [1]-[3] of Table 6.

We first discuss the effects of RER overvaluation on growth. Here we find that the coefficient of RER overvaluation is negative and significant regardless of the fundamental measure of RER misalignment used. Here we find that a decline in the extent of RER overvaluation will have positive effects on growth. For instance, if developing countries reduce their average degree of RER overvaluation to the one exhibited by industrial countries (from 0.05 to 0.02 using FRERM1), the growth rate will be higher by approximately 30 basis points per year. In addition, let us assume that the extent of overvaluation increases by 5 percentage points. Regardless of the initial level of overvaluation, growth rate would decline by 56 basis points when we use FRERM1, and by 21 and 17 basis points when using FRERM2 and FRERM3 measures, respectively.

On the other hand, we find that the estimated coefficient of RER undervaluation is positive and significant regardless of the FRERM used. This implies that the larger the degree of RER undervaluation, the lower the growth rate of the economy. Economically speaking, our estimates suggests that if the average RER undervaluation among developing countries declines to the average level among industrial countries (from 0.04 to 0.02 in absolute value), the growth rate will increase by 6 basis points. Again, if the degree of undervaluation is raised by 5 percent, our estimates suggest that growth falls 16 basis points per year when using FRERM1, while it declines 13 and 4 basis points to an analogous increase in the undervaluation when using FRERM2 and FRERM3, respectively.

Next, we evaluate whether the growth effects of RER over- and under-valuations are driven by the size of the deviation of the actual RER from its equilibrium level. In that respect, we include quadratic terms for both RER over- and under-valuation in our regression equation in addition to the linear terms. If both RER overvaluation coefficient estimates are negative, growth will be lower, the higher the degree of overvaluation is. In addition, if both RER undervaluation are negative, the growth effects may be positive for small to moderate degrees of undervaluation and negative for larger undervaluations. Our results are reported in columns [4]-[6] of Table 6.

Using our FRERM1 measure of misalignment (column [4] of Table 6), we find that the growth effects of RER overvaluations are harmful, the larger these overvaluations are. In figure 1.1 we present the growth effect of different degrees of RER overvaluations. We observe that for very small degrees of overvaluation (below 2 percent), there is a positive although not significant growth effect. Note that for larger degrees of overvaluation (above 5%) we already have a negative and significant growth effect. According to our regression estimates we find that the adverse growth effect of an additional 5 percent increase in the degree of RER overvaluation is more severe the larger is the initial level of overvaluation. For instance, an increase in the level of RER overvaluation from 5 to 10 percent would lead to a decline in the growth rate of 12 basis points per year, whereas an increase in the degree of overvaluation from 10 to 15 percent renders a growth reduction of approximately 30 basis points. The growth effects are even more devastating if the existing level of overvaluation is larger: the increase in overvaluation from 20 to 25 percent yields a fall in growth of 69 basis points per annum, while its increase from 30 to 35 brings about an annual average reduction in growth of 1.07 percent. In sum, we can claim that an additional appreciation of the local currency would generate more adverse growth effects on countries with higher current degrees of overvaluation.

We should note that the results are qualitatively similar for the other measures of fundamental RER misalignment. In the case of FRERM2 (see Figure 1.2), we also observe statistically negligible positive growth effects for small degrees of overvaluation (below 6%), with negative and significant growth effects for larger degrees of overvaluation (that is, over 15%). If we simulate the growth effect of an additional 5 percent overvaluation to countries with different levels of RER overvaluation, we have that adverse growth effects are small (3 basis points per year) when overvaluation increases from 10 to 15 percent. However, if overvaluation increases from 20 to 25 percent, growth will be cut by 11 basis points per year. In sum, the results are similar but the growth decline occurs at a much slower pace.

Now we turn to our analysis of the growth impact of a real undervaluation of the local currency. Regardless of the FRERM used, we find that the coefficients of both linear and squared undervaluation are negative and significant at the 5 percent level. In Figure 2.1 we depict the growth impact of different levels of RER undervaluation and we find a positive growth response for small degrees of undervaluation (up to 12 percent) and with negative and significant growth effects for larger degrees of overvaluation (over 25 percent). We again calculate the impact on growth of an additional 5 percent real undervaluation of the local currency to countries with different initial levels of undervaluation. For a country with an initial RER undervaluation of 10 percent, a 5 percent increase in undervaluation would lead to a negligible increase in growth rate (only 4 basis points per year). On the other hand, an increase in the degree of real undervaluation from 20 to 25 percent would reduce the growth rate by 43 basis points per year, while an increase in undervaluation from 30 to 35 percent leads to an even more severe decline in growth (approximately 0.9 percent per year).

Growth response to real undervaluation in qualitatively similar if we use FRERM2 (see Figure 2.2), with growth effects being positive and significant for real undervaluation levels up to 11 percent. Note that for undervaluation levels between 11 and 20 percent, growth effects are positive although statistically not different from zero. Finally, growth impact of undervaluation becomes negative for undervaluation higher than 20 percent —and significant for undervaluation higher than 30 percent.

4.4 Robustness Analysis

In the present section we will analysis the robustness of our results in the following dimensions: (i) the inclusion of equilibrium shifts in the RER in our regression equation, (ii) the sensitivity of the coefficient estimate of RER misalignment to the occurrence of currency crisis episodes, and (iii) the impact on growth of the volatility of the misalignment in the real exchange rate.

4.4.1 Equilibrium vs. Disequilibrium Movements in the RER

The real exchange rate measures the domestic production costs of traded goods, with a real appreciation of the local currency reflecting an increase in the domestic cost of producing domestically a basket of traded goods (Edwards, 1989). If relative prices in the rest of the world remain invariant, the real appreciation translates into a deterioration of the country's international competitiveness. Analogously, a real depreciation of the local currency reflects an improvement in the extent of international competitiveness. Changes in the country's international competitiveness can be attributed to productivity shifts in the traded sector, more favorable terms of trade, changes in taxation, among other factors. These *justified changes*, as Edwards (1989) calls them, constitute an *equilibrium phenomenon*. However, there are *unjustified* deviations of the actual RER from its equilibrium rate —or so called *real exchange rate misalignments*. To distinguish both types of shifts in RERs, it is important to control for the equilibrium real exchange rate.

In the present section we include a measure of the equilibrium real exchange rate (ERER) in our growth regression equation. The inclusion of the ERER in our growth equation allows us to differentiate the effects of these different movements in the exchange rates —that is, equilibrium vs. disequilibrium movements in the RER. In order to contrast whether our measure of misalignment captures only disequilibrium movements and their effect on growth, it becomes relevant to include ERER in our regression equation. Otherwise, the omission of the ERER in our growth equation may yield inconsistent coefficient estimates for the RER misalignment indicator. Our results are presented in Table 7.

In columns [1]-[3] of Table 7 we include the equilibrium real exchange rate and the RER misalignment in our baseline regression. Regardless of the method used to estimate the RER equations (time-series vs. panel), the equilibrium RER has a positive and significant coefficient (at least at 10 percent significant level) while the RER misalignment has a negative and significant impact on growth. The positive correlation between growth and the equilibrium real appreciation of the local currency may be driven by technological improvements in the traded sector of the Home country, positive transfer effects, and permanent improvements in terms of trade. This result shows that, on average, it is not possible to positively influence growth via an increase in the ERER —for example, through permanent capital restrictions as could be the case of China.

On the other hand, note that the coefficient of the RER misalignment is still negative and significant. In this case, our estimates suggest that growth is still hampered by misalignments in the real exchange rate. Specifically, a reduction in the departure from the ERER from the average of developing countries to the one for industrial economies (from 0.05 to 0.02 using FRERM1) would lead an increase the growth rate of 14 basis points per year. In addition, we can also infer that a reduction in the volatility of the RER misalignment of 5 percent (regardless of the initial volatility) would lead to higher growth by 22 basis points per year when using

FRERM1. The growth increase to a similar reduction in misalignment volatility is substantially smaller when using either FRERM2 or FRERM3 —that is, 5 and 6 percent respectively.

In columns [4] through [6] of Table 7 we perform our growth regressions for the ERER as well as real over- and under-valuation of the local currency. Again, we find a positive and significant coefficient for the movements in the equilibrium RER. On the other hand, as found in Table 6, the coefficient estimate for real overvaluation is negative and significant while the one for real undervaluation is positive and significant. This implies that an equilibrium depreciation may slow down growth and a small undervaluation may raise growth prospects. On the other hand, growth might be enhanced by an equilibrium real appreciation while RER overvaluation might reduce growth. Again, a five percent increase in the extent of overvaluation would lead to a decline in growth rate of 0.6 percent per year when using FRERM1, and approximately 0.2 percent per annum when using either FRERM2 or FRERM3. Analogously, a worsening of the extent of undervaluation by 5 percent would cut growth by 15 basis points when using FRERM1, and by 7 and 4 basis points when using FRERM2 and FRERM3 respectively.

4.4.2 Are the growth effects of RER Misalignments more severe during currency crises?

As stated above, we claim that our coefficient estimate for RER misalignment does not capture the growth effects of departures from the ERER driven by subsequent currency crisis episodes. In this section, we want to investigate whether the reduction in growth per capita due to misalignments in the RER is more severe during currency crises. Here we include in an interactive term between RER misalignment and our currency crisis variable to our baseline regression. Our results are reported in Table 8.

In columns [1]-[3] of Table 8 we find that the coefficient of RER misalignment is negative and significant and that the coefficient of the interaction between misalignment and currency crisis is negative, significant and larger in absolute value. This implies that the impact of misalignments on growth is negative and even more severe during currency crisis episodes. For instance, using the regression results in column [1] of Table 8, we find that an increase in RER misalignment of 10 percent would lead to a decline in growth of 36 basis points per year if there is no currency crisis episode. On the other hand, if the frequency of currency crisis is 0.4 (2 episodes in the 5-year period —*i.e.* the maximum value in our sample), growth will fall by 0.64 basis points per year.

In columns [4]-[6] of Table 8 we include the real overvaluation, real undervaluation and an interaction term between real overvaluation and currency crisis. We still find that the coefficient estimate of RER overvaluation is negative and coefficient while the one for RER undervaluation is positive and significant. That is, growth prospects are hurt by either under- or over-valuations. In addition, the interaction term between overvaluation and currency crisis is negative and significant, and larger (in absolute value) than the coefficient of overvaluation. Again, our results suggest that the impact of overvaluation on growth is more devastating during currency crisis episodes. Using the regression in column [4] of Table 8, we find that an increase in RER misalignment of 10 percent would lead to a decline in growth of 57 basis points per year if there is no currency crisis episode. On the other hand, if the frequency of currency crisis is 0.4 (2 episodes in the 5-year period —*i.e.* the maximum value in our sample), growth will fall by 2.3 percent per year.

4.4.3 The Growth Effects of RER Misalignment Volatility

Another strand of the empirical growth literature shows that volatile economic environments may hinder economic performance (Ramey and Ramey, 1995; Hnatkovska and Loayza, 2004), and the volatility of RER misalignments could be one of the sources of aggregate volatility —as argued by Razin and Collins (1999). In that respect, we include both RER misalignment and its volatility in our baseline growth regression. Our results are presented in Table 9 for our different measures of fundamental RER misalignment.

In columns [1]-[3] of Table 9, we analyze the impact of the volatility of RER misalignments on growth. Regardless of the measure of misalignment used, we find that both misalignment and its volatility have negative and significant coefficients. These results imply that growth is hampered by RER deviations from the equilibrium and the volatility of these deviations. According to our estimates using FRERM1 —column [1] of Table 9— we find that if the volatility of RER misalignments in developing countries (0.08) reduce to the level of industrial economies (0.05), the growth rate of developing countries would increase by 30 basis points. In addition, we can infer that a reduction in the volatility of misalignment of 5 percentage points (say from 10 to 5 percent) would lead to an increase in the growth rate by 0.47 percent per year. Gains in growth to such a reduction in volatility are similar when using FRERM2 and FRERM3 (approximately 0.5 percent per year).

On the other hand, in the last three columns of Table 7, we test the possible existence of a non-linear relationship between growth and the volatility of RER misalignments. Regardless of the measures of fundamental RER misalignment, we find that the coefficients of the misalignment volatility —both linear and squared— are negative and statistically significant. Hence we find that the impact of misalignment volatility on growth is negative, significant and increasing relative to the level of misalignment volatility (see Figure 3.1 and 3.2). An economic interpretation of our results can be obtained by evaluating the impact of a 5 percent increase in the volatility of RER misalignment for countries with different levels of misalignment volatility. For instance, using the FRERM1 estimates, an additional increase in misalignment volatility from 10 to 15 percent would reduce growth by 44 basis points. In addition, an increase in volatility from 20 to 25 percent would lead to a decline in growth of 53 basis points.

5. Misaligned Currencies and Intervention Policies: An exploration

Our results in the previous section indicate that countries may reap some growth benefits by maintaining its RER undervalued within some specified range. However, since the RER is not a policy variable, we find necessary to tackle some issues in order to make policy recommendations. For instance, we need to investigate how long could RER disequilibria be maintained and what country characteristics or policy tools are crucial to achieve this.

5.1 Heuristic Evidence on Pro-Growth Undervaluation Episodes

In this section we investigate these issues analyzing pro-growth undervaluation episodes and presenting some related statistical evidence. From our sample of 60 countries we have only 23 episodes in 19 countries where pro-growth misalignment have been maintained (using our FRERM1 measure). In Table 10, we classify these episodes in 4 groups where we present the 5-year average RER misalignment and some of its potential determinants: the nominal exchange rate regime in place, average inflation rate in the decade before the episode (proxy of monetary stability), output gap (proxy of resource availability),[15] capital controls, and trade union membership as percentage of labor force (proxy of labor market rigidities). We also present a variable showing if there were discrete adjustments of the nominal parity near the period of undervaluation in managed nominal exchange rate systems.

Group 1 includes all countries with rigid exchange rate systems that did not adjust temporarily the parity near the first year of undervaluation. It contains 9 episodes, with most of them taking place at the beginning of the sample period when international financial markets were less integrated. We observe that for most countries, fluctuations in their anchor currencies affected their undervalued currencies.[16] But why did RER undervaluations persist for so long? As we

[15] Due to data restrictions we do not present the unemployment rate, which is a better proxy of factor availability.

[16] Jordan and Singapore suffered the devaluation of the Sterling Pound in 1967, while Panama and Guatemala suffered the sharp depreciation of the US dollar early on the 1970s. Depreciation of the DM

observe in Table 10, setting aside Germany and Norway due to the lack of relevant data, only 3 countries had capital controls and some economies displayed high levels of labor market rigidities. Although we cannot identify a clear pattern related to the cyclical position of the economies in this group,[17] we observe that all had a good standing in terms of monetary and price stability. In *Group 2* we include countries that adjusted their relatively rigid exchange rate systems near the years of the episode. Here we see a common pattern of previous real overvaluation, negative —and in some cases large— output gaps and, in some cases, monetary and price stability.[18] Countries that display the highest levels of past inflation rates suffer the largest RER appreciation in the subsequent period. Only two episodes occurred after 1990 and there is not a clear relationship between capital controls and the pattern of the misalignment after the episodes. Canada seems to be different from the other countries; however, their unemployment rate was at a historical high (9.3% in 1997).

Group 3 is characterized by large and negative output gaps at the start of the undervaluation period —which may explain the persistence of undervaluations. In addition, Portugal and Syria had capital controls in place and very rigid labor markets and Singapore displays a high degree of overvaluation before 1987. Korea is one of only two floaters listed in table 8 and is the only one with a crisis episode. Finally, *Group 4* has only 2 countries that could not be classified in the previous groups. First, Iceland's undervaluation period was followed by an overvaluation, a pattern that can be expected from the country with the worst past record of price stability. On the other hand, the United States —the other floater— shows a flexible labor market and no capital controls. However, the beginning of its episode coincided with the Plaza Accord of 1985, after a long period of real overvaluation. Although the persistence of the devaluation after five years is difficult to justify, it could be partly attributed to the recession of the early 90s.

In sum, we observe some basic features behind pro-growth undervaluation episodes: (i) an important number of these episodes could be attributed to movements in anchor currencies. (ii) The cyclical position appears to be crucial to maintain the RER undervalued.[19] (iii) As countries have integrated financially, we cannot observe a clear relationship between capital restrictions

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affected Netherlands after 1980 and Belgium in 1997. Panama is an exception as it maintained the parity to the US dollar when most of the emerging market currencies were depreciating against it after the beginning of the Asian Crisis.

[17] However, in the most recent episodes –Belgium and Panama- there were high levels of unemployment rates: 9% and 13,6% respectively.

[18] The only episode of no previous overvaluation was Finland in 1977, which in turn had shown a large undervaluation because of earlier adjustments in its nominal exchange rate.

[19] The larger availability of factors of production probably decreases the effects of resource reallocation processes over price levels, thus, postponing the adjustment. A negative output gap -or high unemployment levels- also provokes discrete changes in managed systems, thus producing RER undervaluations.

and the persistence of RER undervaluation. (iv) Countries with bad inflation records were unable to sustain pro-growth undervaluation episodes.

Next we evaluate the properties of RER misalignments —especially, the extent of RER undervaluation— across exchange rate regimes. In Table 11 we present the average RER misalignment and its volatility for countries with floating, managed and fixed exchange rate systems. A first glance at Table 11 shows that RER misalignment exhibits different patterns of behavior among industrial economies and developing countries. For industrial countries, the extent of real under- and over-valuation of their currencies is smaller in countries with fixed rates —which could be attributed to the higher stability of economic fundamentals in these countries. On the other hand, developing countries show the opposite behavior. Average misalignments are smaller in countries with floating rates —especially, for RER overvaluations— although the volatility of the misalignment is larger.

Next we investigate further whether pro-growth devaluation episodes take place more frequently in countries with managed exchange rate systems. Table 12 evaluates the persistence of the under- and over-valuation episode across different samples of countries and across different exchange rate regimes. To accomplish this task we construct transition matrices for episodes of high vs. low under- and over-valuation. We define low undervaluation (LU) episodes as the ones that correspond to pro-growth misalignment (that is, smaller than 10 percent, as found in our regression analysis) and high undervaluations (HO) are considered for undervaluations of more than 10 percent. Analogously, we symmetrically define low (high) overvaluation when the degree of RER overvaluation is smaller (higher) than 10 percent (LO and HO, respectively). Some interesting results are found in our transition matrices:

(a) Industrial Countries. Mean reversion from a situation of high undervaluation is faster under floating than for other regimes —*i.e.* 29 percent probability having HU in periods t and t+1 for floaters. In addition, from HU in period t, there is a 50 percent probability of reaching LU in period t+1 and a 21 percent change of LO in t+1. This implies that in 71% of the cases, the country shifts from high undervaluation to low misalignment. On the other hand, if the industrial economy with fixed regime has HU in period t, it will remain HU in t+1 in 83% of the cases and in 17% of the cases reaches LU. Finally, we are more interested in the probability of countries keeping the undervaluation of the currency in levels that allow them to grow —that is, we are interested in the persistence of the LU scenario. Here, LU is more persistent under fixed rates than under floating rates. If the country has LU in period t, it will remain with LU in period t+1 in 73 percent of the cases when having fixed regimes and in 61 percent of the cases

when floating. We should also note that in 25 percent of the cases the LU in period t shifts to LO in period t+1 for countries with either fixed or floating exchange rate regime.

(b) Developing Countries. Mean reversion of high undervaluation episodes are similar for developing countries with either fixed or floating exchange rate regimes (with probability of remaining in HU after one period of 0.61 and 0.63, respectively). On the other hand, it is interesting to note that the mean reversion from high overvaluation episodes is substantially faster for floaters. For developing countries with HO in period t, there is a 41 percent probability of reaching lower levels of misalignment in period t+1 among floaters, where this probability is smaller (26 percent) for fixers. Finally, we find that episodes of LU are more persistent among fixed and intermediate regimes than among floaters. For developing countries with LU in period t, the probability of remaining with LU in period t+1 is 64 percent for countries with fixed regimes, 62 percent for countries with intermediate regimes, and only 46 percent for countries with floating regimes.

5.2 How persistent are undervaluation episodes? Exploratory Econometric Evidence

We want to contrast the heuristic findings presented in Tables 10-12 with some econometric evidence on the factors behind the persistence of RER misalignment. Our results are presented in Table 13. In order to control for the persistence in the deviations of the equilibrium RER fundamentals from their trends, we use the actual values of these variables when computing the ERER and the misalignment used as our dependent variable.[20] In addition, we control for the persistence in monetary and external determinants of RER misalignments.[21]

Our baseline specification of RER misalignment persistence is presented in column [1] of Table 13. We find that the speed of convergence to equilibrium is faster if the degree of misalignment is larger and in the case of RER undervaluations. In column [2] of Table 13 we include the exchange rate regime and capital controls to our regression analysis. We find that adjustment to equilibrium in overvaluation episodes is faster in countries with more flexible exchange rate arrangements. On the other hand, capital controls do not seem to be a significant factor explaining the persistence of RER misalignments under managed exchange rate systems. [22]

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[20] See Aguirre and Calderón (2005) for more details on the construction of this variable.
[21] These coefficients are not reported in Table 9 but the results could be requested to the authors. We use common dynamic factors of misalignments as our measure of external determinants. We allow different effects of them on developed, emerging, and other countries. Our proxy for monetary conditions is the deviation of M2 from its trend. We allow different effects in managed and non-managed nominal exchange rate systems.
[22] All variables interacted with the dummy of managed nominal exchange rate systems were first included alone and they were found not significant.

In column [3] of Table 13, we include *outcome* variables (and not direct policy variables) like monetary stability, currency crises and the output gap as determinants of persistence in RER misalignments. We find that negative output gaps (i.e. deepening of recession periods) postpone the adjustment of undervaluation while accelerating the adjustment of RER overvaluation episodes. Finally, in column [4] of Table 13 we include indicators of labor market rigidity to our analysis. We obtain that undervaluations are more persistent if labor markets are more rigid and we find an unexpected opposite result in the case of overvaluations.

6. Conclusions

The main goal of the present paper was to evaluate the growth effects of RER misalignments and their volatility. For that reason, we computed fundamental RER misalignments as deviations of actual from long-run equilibrium RER. Our long-run RER equation —derived from a simple general equilibrium model in the spirit of the New Open Economy Macroeconomics— was estimated using panel and time series cointegration techniques. After computing the fundamental RER misalignments, we evaluated their impact on growth using dynamic panel data techniques that address not only the problem of unobserved country-specific components but also the possibility of endogenous regressors.

Using a sample of 60 countries over the period 1965-2003 we obtained the following results: First, the main implications of the fundamental RER model are met by the data. That is, we find that an equilibrium RER appreciation is explained by permanent surges in relative productivity, favorable terms of trade shocks, a better net foreign asset position and higher government spending to GDP. These results hold for our panel cointegration estimates as well as for estimates that summarized our time-series cointegration estimates —such as mean group or median estimators.

Second, we find that RERs in developing countries show a higher degree of misalignment than the ones in industrial countries. This finding could be partially attributed to inappropriate macroeconomic, commercial and exchange rate policies among developing countries (Ghura and Grennes, 1993).

Third, we find a negative and significant relationship between growth and RER misalignment that is consistent with the existing empirical evidence. This result holds whether we use fundamental measures of RER misalignment or other measures such as Dollar's (1992) index of RER overvaluation and deviations of the RER from a computed band-pass trend. This result is consistent with evidence that persistent RER misalignments —due to inadequate policies— have proven to be a major source of growth slowdown in Africa and Latin America (The World Bank, 1984; Gulhati, Bose and Atukorala, 1985).

Fourth, we explore the possible existence of asymmetries in the relationship between growth and RER misalignments. Specifically, we assess the relationship between growth and RER overvaluation as well as between growth and RER undervaluation. Growth is adversely affected by both real overvaluation and undervaluation of the local currency, although in the first case the effect is bigger than in the second. Reducing overvaluation from average levels among developing countries to industrial economies standards would lead to growth benefits between 17 and 35 basis points per year. On the other hand, reducing the degree of undervaluation from average developing to industrial countries' levels would increase growth between 3 and 11 basis points per year.

Fifth, we look for non-linearities in the relations described above and find that the growth effect of RER misalignments depend on the size of the RER deviation from the equilibrium. We find that the growth effect is more adverse, the larger is the size of the RER overvaluation. On the other hand, we also find that growth is positive for small undervaluations (up to 12 percent) and negative for larger undervaluations.

Sixth, the impact of RER misalignment is still negative and significant when we control for equilibrium movements in the real exchange rate. Also, we find that the negative impact of misalignments on growth is even more severe during periods of currency crises.

Seventh, we find evidence of a negative relationship between economic growth and the volatility of RER misalignments. This result is consistent with the existing evidence of the adverse effects of RER instability on growth (e.g. Ghura and Grennes, 1993; Bleany and Greenaway, 2001). In addition, we also find that the relationship between growth and misalignment variability is possibly non-linear.

Finally, we investigate the pro-growth undervaluation episodes in our sample and explore econometrically the determinants of RER misalignment persistence in order to assess a country's possibility to follow an undervaluation strategy. Our analysis showed that policy variables, specifically capital controls in managed nominal exchange rate systems, are not significant in maintaining a RER undervaluation for the needed period of time. On the other hand, the cyclical position of the economy and the monetary stability are relevant.

Appendix I: Theoretical Model of the Exchange Rate[23]

In the present appendix we briefly describe the main features of our theoretical model based on the Obstfeld and Rogoff (1996) redux model, augmented by the presence of a government and assuming the absence of money. The incorporation of the government extends upon Lane and Milesi-Ferreti (2004) and Calderón (2004b).

I.1 Main features of the model

Consider a two-sector, small open economy where the non-tradables are produced under a monopolistic competition structure and have sticky price problems. On the other hand, tradables are characterized by a single homogeneous good with their price being determined in competitive world markets. The representative agent of the Home country is endowed with a constant quantity, $\bar{y}_T$, of the traded good each period, and has monopoly power over one of the non-traded goods $z \in [0,1]$. Assume that all agents have similar preferences over a real consumption index and work effort. Given symmetry in preferences and budget constraints across agents, we can solve the optimization problem for the representative national consumer-producer. The intertemporal utility function of the typical Home agent *j* is given by:

$$U_t^j = \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{\sigma}{\sigma - 1} C_s^{1-\frac{1}{\sigma}} - \frac{\kappa}{2} y_{N,s}^2 \right] \tag{I.1}$$

where $\beta \in (0,1)$, and $\sigma, \kappa > 0$.[24] The consumption index, *C*, is an aggregate index of tradable and non-tradable consumption (C_N and C_T, respectively):

$$C_t = \left[\gamma^{1/\theta} C_{Tt}^{(\theta-1)/\theta} + (1-\gamma)^{1/\theta} C_{Nt}^{(\theta-1)/\theta} \right]^{\theta/(\theta-1)} \tag{I.2}$$

with θ representing the elasticity of intra-temporal substitution (i.e. elasticity of substitution between traded and non-traded consumption). Agent *j* can invest in an internationally traded asset (denominated in units of the import good), and her flow budget constraint is given by:

$$F_{t+1}^j = (1 + r_t) F_t^j + p_{Nt}(j) y_{Nt}(j) - p_{Tt}^X \bar{y}_{Tt} - p_t C_t^j - p_t \tau \tag{I.3}$$

where F_t denotes real bonds (in units of the tradable good), that pay off a real return *r*, $p_{Nt}(j)$ is the price of the non-traded good produced by agent *j*, p_{Tt}^X is the world price of the non-traded good, and τ represent lump-sum transfers. The consumer price index P_t for the Home country is given by:

$$P_t = \left[\gamma P_{Tt}^{1-\theta} + (1-\gamma) C_{Nt}^{1-\theta} \right]^{1/(1-\theta)} \tag{I.4}$$

with P_{Tt} and P_{Nt} being the prices of traded and non-traded goods at time *t*, respectively. In addition, the real exchange rate Q_t is defined as the ratio of domestic to foreign price consumer index,[25] $Q_t = P_t / (E_t P_t^*)$.

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[23] This appendix heavily draws from Calderón (2004b). Some of these results were already presented in Calderón (2004a),

[24] Disutility in producing more output is captured by the term $-(\kappa/2)y_{N,s}^2$. Assuming that disutility from effort ℓ_N is given by $-\psi\, \ell_N$ and that $y_N = A\ell_N^{\alpha}$ ($\alpha<1$), then $\kappa = 2\psi / A^{1/\alpha}$. The output term in equation (1) is obtained when $\alpha = 0.5$. A rise in productivity A is here captured by a fall in κ (Obstfeld and Rogoff, 1996).

On the other hand, we will assume that government spending G is purely dissipative and does not affect productivity or private utility.[26] We assume that non-traded good producers will face downward sloping demand curves from the private and public sector:

$$y_{Nt}^{d}(j)=\left[\frac{p_N(j)}{P_N}\right]^{-\theta} C_N^A \text{ and } g(j)=\left[\frac{p_N(j)}{P_N}\right]^{-\theta} G_N^A \tag{I.6}$$

where C_N^A and G_N^A represents private and public aggregate consumption of non-traded goods.

To solve the agent's optimization problem, we maximize equation (I.1) subject to equations (I.3) and (I.6). The solution for the consumption and work effort paths might meet the following first-order conditions:

$$\frac{C_{Tt+1}}{C_{Tt}}=[\beta(1+r_{t+1})]^{\sigma}\left(\frac{P_{Tt+1}}{P_{Tt}}\right)^{-\theta}\left(\frac{P_t}{P_{t+1}}\right)^{\sigma-\theta} \tag{I.7}$$

$$\frac{C_{Nt}}{C_{Tt}}=\left(\frac{\gamma}{1-\gamma}\right)\left(\frac{P_{Nt}}{P_{Tt}}\right)^{-\theta} \tag{I.8}$$

$$y_{Nt}^{(\theta+1)/\theta}=\left(\frac{\theta-1}{\theta\kappa}\right)C_t^{-1/\sigma}\left(C_{Nt}^A+G_{Nt}^A\right)^{1/\theta}\left(\frac{P_{N,t}}{P_t}\right) \tag{I.9}$$

Equation (I.7) reflects the consumption-based real interest-rate effect. That is, there is a shift towards present consumption as consumption-based real interest rate is lower if the aggregate price level relative to the price of tradables is currently low relative to its future value. However, it also encourages substitution from traded to non-traded goods. The inter-temporal effect will prevail over the intra-temporal if $\sigma > \theta$. Equation (I.8) depicts the relationship between consumption of tradables and non-tradables, with θ representing the elasticity of substitution among these goods. Finally, the equilibrium supply of non-tradables is presented in equation (I.9). Here, the higher is the aggregate consumption of non-tradables the lower is the level of production, as agents increase leisure along with the consumption of other goods.[27]

2.2. Approximate Solution

Consider the benchmark steady state in which all variables are constant.[28] We normalize the endowment of the traded good so that the relative price of non-traded goods in terms of traded goods P_N is equal to one. In addition, we assume that the price of the traded goods $P_{T,t}^X$ is equal to one. In this symmetric equilibrium, the steady state production and consumption of non-traded and traded goods are given by:[29]

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[25]Note that the CPI-based real exchange rate is independent of the terms of trade in this model. Here, real exchange rates might be influenced by the terms of trade indirectly through wealth effects on the relative price of non-tradables.

[26] Obsteld and Rogoff (1996) claim that some of the results that will follow would be qualititively similar if government spending entered separately into preferences.

[27]In addition to the first-order conditions (I.7)-(I.9), and the period budget constraint, eq.(I.3), we require the transversality condition: $\lim_{T\to\infty}\prod_{v=s}^{t+T}\left(\frac{1}{1+r_v}\right)F_{t+T+1}$ to characterize our equilibrium.

[28]We assume that the stock of net foreign assets is zero, *i.e.* $nF_{t+1} + (1\text{-}n)F_{t+1}^{*} = 0$.

[29]In steady state we find that: (a) if work effort is less taxing (smaller κ), production of non-tradables will be larger —equation (I.10), (b) if consumption of tradables has more weight in the utility function (larger γ), the ratio of traded to non-traded output is higher.

$$Y_N = C_N = \left(\frac{\theta - 1}{\theta\kappa}\right)^{\frac{\sigma}{1+\sigma}} (1-\gamma)^{\frac{1}{1+\sigma}} \tag{I.10}$$

$$Y_T = C_T = \left(\frac{\gamma}{1-\gamma}\right) C_N \tag{I.11}$$

Next, we take a log-linear approximation around the benchmark steady state. Let $\widetilde{X} \equiv dX/X_0$ denote the percentage change relative to the benchmark steady-state. In this case:

$$\widetilde{C}_T = r\widetilde{F} + \widetilde{Y}_N - \widetilde{P}_T^X \tag{I.12}$$

where $\widetilde{F} \equiv dF/C_{T,0} = (1/\gamma)(dF/Y_0)$. According to (I.12), consumption of tradables is driven by net foreign assets, output of tradables, and export prices. Log-linearizing around the steady state for the demand and supply of non-traded goods yields, respectively:

$$\widetilde{Y}_N = \widetilde{C}_T - \theta(\widetilde{P}_N - \widetilde{P}_T) + \widetilde{G} \tag{I.13}$$

$$\widetilde{Y}_N = \left(\frac{\sigma - \theta}{\sigma + 1}\right)\gamma(\widetilde{P}_N - \widetilde{P}_T) + \left(\frac{\sigma}{\sigma + 1}\right)\widetilde{A}_N \tag{I.14}$$

Note that (I.14) includes the impact of productivity surges in non-tradables, $\widetilde{A}_N$. Combining and rearranging eqs.(I.12)-(I.14), we find the expression for the relative price of non-traded goods:

$$\widetilde{P}_N - \widetilde{P}_T = \frac{1+\sigma}{\theta(1+\sigma) + \gamma(\sigma - \theta)}\left[r\widetilde{F} + \widetilde{Y}_T + \widetilde{P}_T^X - \frac{\sigma}{1+\sigma}\widetilde{A}_N + \widetilde{G}\right] \tag{I.15}$$

and its foreign counterpart is defined analogously,[30]

$$\widetilde{P}_N^* - \widetilde{P}_T^* = \frac{1+\sigma}{\theta(1+\sigma) + \gamma(\sigma - \theta)}\left[-\left(\frac{n}{1-n}\right)r\widetilde{F} + \widetilde{Y}_T^* + \widetilde{P}_T^M - \frac{\sigma}{1+\sigma}\widetilde{A}_N^* + \widetilde{G}^*\right] \tag{I.16}$$

We then plug these two latter equations into the equation (1) in the paper.

[30]We assume that the output of tradables exported from the Foreign country is entirely consumed by the Home country in a two-country world. Hence, $P_T^{*X} = P_T^M$.

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Table 1
Real Exchange Rate Misalignment and Economic Performance: Literature Review

Authors	Sample	Performance Indicator	RER Indicator 1/	Estimation Technique	Economic Effect
Cottani, Cavallo & Khan (1990)	24 Developing Countries 1960-83	Economic Growth, Investment, ICOR, Export growth, Agriculture growth	RER Misalignment: PPP and MODEL RER Instability: Coeff. of variation of RER deviations	Cross-Section OLS	[-] for MODEL [-] for Instability
Dollar (1992)	95 Developing Countries 1976-85	Economic Growth	RER Misalignment: MODEL RER Instability: CV- RER deviations	Cross-Section OLS	[-] for MODEL [-] for Instability
Ghura & Grennes (1993)	33 SSA countries 1972-87	Economic Growth, Export/GDP, Imports/GDP, Investment ratio, Savings/GDP	RER Misalignment: PPP, BLACK & MODEL. RER Instability: CV(RER deviations)	Panel data, annual Pooled OLS and IV (only I/Y endogenous)	[-] for MODEL [-] for Instability Not jointly
Easterly (1993)	51 countries, 1970-85	Economic Growth	RER Misalignment: BLACK	Cross-Section OLS, IV	[-] for MODEL
Easterly, Loayza & Montiel (1997)	81 countries, 1960-93	Economic Growth	RER Misalignment: BLACK	Panel data, 5-year avg. GMM-IV Difference	[-] for MODEL
Razin & Collins (1999)	93 countries, 1975-92	Economic Growth	RER Misalignment: MODEL RER Instability: CV(RER deviations)	Panel data, Fixed Effects	[-] for MODEL , NL [-] for Instability
Easterly (2001)	70 countries, 1960-99	Economic Growth	RER Misalignment: BLACK, MODEL	SUR with decade avg.	[-] for BLACK, MODEL
Bleany & Greenaway (2001)	14 SSA countries, 1980-95	Economic Growth, Domestic Investment	RER Misalignment: MODEL RER Instability: SD(RER deviations)	Panel data, Fixed Effects IV	[-] for MODEL
Loayza, Fajnzylber & Calderón (2004)	78 countries, 1960-2000	Economic Growth	RER Misalignment: MODEL	Panel data, 5-year avg. GMM-IV System	[-] for MODEL
Hausman, Pritchett & Rodrik (2004)	110 countries, 1950-99 (83 Episodes)	Growth acceleration (over a 7-year period span)	RER Misalignment: PPP	Probit models	[-] for RER misalignment
Easterly (2004)	82 countries, 1960-2000	Economic Growth	RER Misalignment: BLACK, MODEL	Panel data, 10-year avg. SUR	[-] for BLACK, MODEL

1/ We consider here three different measures of RER misalignment: purchasing power parity based measures (PPP), the black market premium on foreign exchange markets (BLACK) and different fundamental measures of RER misalignment (MODEL).

Table 2
Long-Run Real Exchange Rate Equation: Cointegration Techniques

Panel Cointegration Test	All Countries	Industrial Countries	Developing Countries
I. Reduced Rank based Cointegration Tests (Trace tests)			
Null Hypothesis: # coint. Vectors (r)			
None	6.1 **	6.3 **	6.0 **
At most 1	0.8	1.4	0.5
At most 2	-1.3	-0.4	-1.8
At most 3	-0.4	0.2	-0.6
At most 4	-0.8	0.2	-1.2
II. Residual-based Cointegration Tests			
II.1. Homogeneous Residual-based Cointegration Tests (p-values)			
Kao (1999)			
DF(rho)	(0.000)	(0.014)	(0.001)
DF(t_rho)	(0.002)	(0.008)	(0.013)
DF(rho)*	(0.000)	(0.000)	(0.000)
DF(t_rho)*	(0.000)	(0.000)	(0.000)
ADF	(0.000)	(0.000)	(0.000)
McCoskey and Kao (1998)			
Panel LM	(0.000)	(0.000)	(0.000)
Pedroni (1995)			
TN1(rho)	(0.000)	(0.000)	(0.000)
TN2(rho)	(0.000)	(0.000)	(0.000)
II.2. Heterogeneous Residual-based Cointegration Tests (p-values)			
Pedroni (1999)			
Panel-v	(0.000)	(0.000)	(0.000)
Panel-rho	(0.000)	(0.000)	(0.000)
Panel-t (non-parametric)	(0.000)	(0.000)	(0.000)
Panel-t (parametric)	(0.000)	(0.000)	(0.000)
Group rho	(0.000)	(0.000)	(0.000)
Group-t (non-parametric)	(0.000)	(0.000)	(0.000)
Group-t (parametric)	(0.000)	(0.000)	(0.000)

*Note: ** (*) implies statistical significance at the 5 (10) percent.*

Table 3

Long-Run Real Exchange Rate Equation: Time-Series and Panel Cointegration Techniques

Sample of 60 countries, 1965-2003 (Annual data)

	Time Series			Panel Cointegration 5/		
Variable	Mean Group 1/	% Coeff. [+] / Sgf.	Median Estimator 2/	All Countries	Industrial Countries	Developing Countries
NFA / GDP	0.0027	63.6 4/	0.0015	0.0010	0.0014	0.0009
	(0.01)	60.0	(0.01)	(0.01)	(0.00)	(0.05)
	(0.99) 3/					
Productivity	0.4903	60.0 4/	0.3921	0.1491	0.2978	0.1028
	(0.00)	52.7	(0.00)	(0.02)	(0.00)	(0.14)
	(0.00) 3/					
Terms of Trade	0.2203	70.9 4/	0.2267	0.2341	0.3560	0.2036
	(0.02)	58.2	(0.02)	(0.00)	(0.00)	(0.00)
	(0.79) 3/					
Government	0.2823	67.3 4/	0.2735	0.2796	0.5690	0.2180
Consumption / GDP	(0.00)	63.6	(0.00)	(0.00)	(0.00)	(0.00)
	(0.82) 3/					

1/ Mean group and median estimators are based on time series DOLS estimates for the long run real exchange rate equation presented in Table A.1. 2/ The numbers in parenthesis below the coefficient estimates of the median estimator represent the p-value of the Wilcoxon sign rank. 3/ We present the p-value of the homogeneity test of the coefficient of the RER determinants. Here we test whether the panel DOLS coefficient estimates for all countries are equal to the mean group estimates. 4/ In this column we report the % of the DOLS coefficient estimates that are positive and the % of estimates that are significant. For more details on the country estimates, see Table A.1. 5/ We present the panel DOLS estimates for each group of countries (22 industrial countries and 38 developing countries), accounting for country- and time-effects.

Table 4
RER Misalignment and Growth: Basic Statistics

Variable	All Countries	Industrial Countries	Developing Countries
Economic Growth	1.84	2.70	1.52
	(2.82)	(1.70)	(3.07)
Fundamental Measures of RER Misalignment			
FRERM1 -- Time Series Techniques			
Misalignment 2/	0.071	0.041	0.089
	(0.07)	(0.05)	(0.08)
Overvaluation	0.039	0.020	0.050
	(0.07)	(0.03)	(0.08)
Undervaluation	-0.032	-0.021	-0.039
	(0.06)	(0.05)	(0.06)
FRERM2 -- Panel Cointegration by Groups			
Misalignment 2/	0.146	0.088	0.179
	(0.15)	(0.08)	(0.16)
Overvaluation	0.075	0.044	0.093
	(0.13)	(0.07)	(0.15)
Undervaluation	-0.071	-0.044	-0.086
	(0.12)	(0.08)	(0.14)
FRERM3 -- Panel Cointegration Full Sample			
Misalignment 2/	0.149	0.093	0.182
	(0.15)	(0.09)	(0.17)
Overvaluation	0.076	0.046	0.094
	(0.13)	(0.07)	(0.16)
Undervaluation	-0.073	-0.047	-0.087
	(0.12)	(0.08)	(0.14)

1/ Numbers in parenthesis below the mean estimates represent the standard error of the series.
2/ We use here the absolute value of the RER misalignment.

Table 5

RER Misalignment and Economic Growth: Baseline Regression

Dependent Variable: Growth Rate of GDP per capita

Estimation Technique: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond, 1998)

	Fundamental Measures of Misalignment			Other Measures	
Variables	FRERM1	FRERM2	FRERM3	Dollar (1992)	Band-Pass
Transitional Convergence:					
- Initial GDP per capita	-2.693 **	-2.861 **	-3.155 **	-2.321 **	-3.287 **
(in logs)	(0.41)	(0.24)	(0.23)	(0.17)	(0.20)
Cyclical Reversion					
- Initial Output Gap	-22.191 **	-17.902 **	-18.341 **	-15.171 **	-14.963 **
(log[actual / potential GDP])	(2.26)	(2.24)	(1.55)	(2.47)	(2.61)
Structural Policies					
- Human Capital	2.610 **	2.715 **	3.032 **	3.676 **	3.304 **
(Secondary Enrollment, logs)	(0.31)	(0.26)	(0.26)	(0.26)	(0.27)
- Financial Depth	0.977 **	1.242 **	1.346 **	0.860 **	1.187 **
(Private Credit / GDP, logs)	(0.14)	(0.13)	(0.13)	(0.22)	(0.12)
- Trade Openness	0.389 **	0.524 **	0.360 **	0.693 **	0.332 *
(Exports + Imports / GDP, logs)	(0.17)	(0.18)	(0.16)	(0.13)	(0.19)
Stabilization Policies					
- Lack of Price Stability	-1.836 **	-0.540 *	-0.365	-0.116	-0.873 **
(inflation rate, log[(1+inf)*100]])	(0.27)	(0.33)	(0.31)	(0.64)	(0.42)
- Currency Crises	-3.230 **	-3.831 **	-3.816 **	-4.642 **	-4.303 **
(frequency under crisis, 0-1)	(0.36)	(0.33)	(0.33)	(0.47)	(0.42)
- RER Misalignment	**-4.023 ****	**-1.253 ****	**-1.214 ****	**-1.264 ****	**-6.151 ****
(log[actual / equilibrium RER])	**(0.36)**	**(0.11)**	**(0.07)**	**(0.18)**	**(1.21)**
External Shocks					
- Terms of Trade	0.065 **	0.081 **	0.086 **	0.076 **	0.075 **
(growth rate of ToT)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
- Period Shifts					
76-80:	-0.544 **	-0.541 **	-0.566 **	-0.830 **	-0.690 **
81-85:	-2.325 **	-2.582 **	-2.663 **	-2.862 **	-2.429 **
86-90:	-1.541 **	-1.725 **	-1.726 **	-2.026 **	-1.890 **
91-95:	-2.136 **	-2.280 **	-2.133 **	-2.390 **	-2.128 **
96-00:	-2.145 **	-2.333 **	-2.256 **	-2.674 **	-2.317 **
No. Countries	60	60	60	60	60
No. Observations	354	354	354	354	354
Specification Tests (p-values)					
- Sargan Test	(0.26)	(0.38)	(0.39)	(0.37)	(0.47)
- 2nd Order Correlation	(0.47)	(0.50)	(0.49)	(0.51)	(0.60)

*Numbers in parenthesis below the coefficient estimates are the robust standard errors. ** (*) implies significance at the 5% level.*
The regression model includes a constant.

Table 6
RER Overvaluation, RER Undervaluation and Economic Growth
Dependent Variable: Growth Rate of GDP per capita
Estimation Technique: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond, 1998)

	Linear Specification			Non-Linear Specification		
	FRERM1	FRERM2	FRERM3	FRERM1	FRERM2	FRERM3
Variables	[1]	[2]	[3]	[4]	[5]	[6]
Transitional Convergence:						
- Initial GDP per capita	-3.033 **	-3.299 **	-2.324 **	-3.079 **	-3.178 **	-0.929 **
(in logs)	(0.29)	(0.20)	(0.31)	(0.23)	(0.15)	(0.37)
Cyclical Reversion						
- Initial Output Gap	-15.166 **	-23.606 **	-19.413 **	-15.619 **	-37.084 **	-5.933 **
(log[actual / potential GDP])	(2.41)	(2.91)	(2.29)	(1.34)	(4.13)	(2.01)
Structural Policies						
- Human Capital	2.602 **	2.838 **	2.292 **	2.767 **	3.533 **	0.994 **
(Secondary Enrollment, logs)	(0.31)	(0.26)	(0.34)	(0.23)	(0.30)	(0.34)
- Financial Depth	0.515 **	0.969 **	0.750 **	0.728 **	1.171 **	0.730 **
(Private Credit / GDP, logs)	(0.13)	(0.15)	(0.16)	(0.16)	(0.13)	(0.13)
- Trade Openness	0.067	0.627 **	0.279 **	-0.089	0.502 **	0.691 **
(Exports + Imports / GDP, logs)	(0.12)	(0.13)	(0.11)	(0.20)	(0.11)	(0.17)
Stabilization Policies						
- Lack of Price Stability	-2.674 **	-0.982 **	-1.174 **	-2.437 **	-0.096	-1.595 **
(inflation rate, log[(1+inf)*100]])	(0.47)	(0.44)	(0.53)	(0.57)	(0.68)	(0.39)
- Currency Crises	-3.591 **	-2.737 **	-4.049 **	-4.034 **	-4.084 **	-4.623 **
(frequency under crisis, 0-1)	(0.27)	(0.50)	(0.37)	(0.41)	(0.35)	(0.23)
- RER Overvaluation	**-11.146 ****	**-4.163 ****	**-3.493 ****	**1.274**	**0.930**	**3.668 ****
	(0.60)	**(0.31)**	**(0.28)**	**(2.40)**	**(1.14)**	**(1.28)**
- RER Overvaluation Squared	**...**	**...**	**...**	**-37.713 ****	**-8.042 ****	**-6.651 ****
				(9.67)	**(1.94)**	**(1.99)**
- RER Undervaluation	**3.208 ****	**2.697 ****	**0.781 ***	**-10.084 ****	**-6.705 ****	**-11.148 ****
	(0.62)	**(0.48)**	**(0.49)**	**(4.23)**	**(1.54)**	**(2.10)**
- RER Undervaluation Squared	**...**	**...**	**...**	**-46.788 ****	**-16.565 ****	**-11.189 ****
				(17.13)	**(3.11)**	**(3.98)**
External Shocks						
- Terms of Trade	0.047 **	0.072 **	0.072 **	0.057 **	0.063 **	0.052 **
(growth rate of ToT)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
- Period Shifts						
76-80:	-0.308 **	-0.771 **	-0.450 **	-0.433 **	-0.720 **	-0.369 **
81-85:	-1.643 **	-3.002 **	-2.604 **	-1.794 **	-3.156 **	-2.317 **
86-90:	-1.071 **	-1.757 **	-1.447 **	-1.330 **	-1.910 **	-1.667 **
91-95:	-1.506 **	-1.971 **	-1.712 **	-1.692 **	-2.488 **	-2.127 **
96-00:	-1.544 **	-1.878 **	-1.724 **	-1.638 **	-2.587 **	-2.299 **
No. Countries	60	60	60	60	60	60
No. Observations	354	354	354	354	354	354
Specification Tests (p-values)						
- Sargan Test	(0.39)	(0.28)	(0.37)	(0.59)	(0.41)	(0.36)
- 2nd Order Correlation	(0.78)	(0.49)	(0.48)	(0.73)	(0.81)	(0.78)

*Numbers in parenthesis below the coefficient estimates are the robust standard errors. ** (*) implies significance at the 5% level.*

Table 7

RER Misalignment and Economic Growth: Controlling for the equilibrium level of the RER

Dependent Variable: Growth Rate of GDP per capita

Estimation Technique: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond, 1998)

	Fundamental Measures of Misalignment			Fundamental Measures of Misalignment		
Variables	**FRERM1**	**FRERM2**	**FRERM3**	**FRERM1**	**FRERM2**	**FRERM3**
Transitional Convergence:						
- Initial GDP per capita	-2.711 **	-3.579 **	-3.203 **	-2.797 **	-2.570 **	-2.450 **
(in logs)	(0.30)	(0.21)	(0.21)	(0.33)	(0.37)	(0.32)
Cyclical Reversion						
- Initial Output Gap	-14.217 **	-15.043 **	-17.608 **	-17.200 **	-20.757 **	-17.126 **
(log[actual / potential GDP])	(1.91)	(2.19)	(1.63)	(2.63)	(2.13)	(2.44)
Structural Policies						
- Human Capital	2.361 **	3.513 **	3.212 **	2.127 **	2.809 **	2.403 **
(Secondary Enrollment, logs)	(0.23)	(0.26)	(0.22)	(0.30)	(0.36)	(0.34)
- Financial Depth	0.982 **	1.382 **	1.296 **	0.727 **	0.771 **	0.653 **
(Private Credit / GDP, logs)	(0.15)	(0.11)	(0.12)	(0.18)	(0.15)	(0.16)
- Trade Openness	0.297 *	0.132	0.315 **	0.141	0.281 **	0.317 **
(Exports + Imports / GDP, logs)	(0.17)	(0.17)	(0.15)	(0.14)	(0.14)	(0.12)
Stabilization Policies						
- Lack of Price Stability	-2.135 **	-0.276 *	-0.699 **	-1.880 **	-0.379	-2.191 **
(inflation rate, log[(1+inf)*100]])	(0.32)	(0.17)	(0.22)	(0.82)	(0.54)	(0.62)
- Currency Crises	-3.941 **	-3.966 **	-3.985 **	-3.718 **	-4.117 **	-4.055 **
(frequency under crisis, 0-1)	(0.23)	(0.29)	(0.32)	(0.30)	(0.41)	(0.37)
Real Exchange Rate						
- RER Misalignment	**-4.497 ****	**-0.943 ****	**-1.266 ****	**...**	**...**	**...**
(log[actual / equilibrium RER])	**(0.44)**	**(0.12)**	**(0.10)**			
- RER Overvaluation	**...**	**...**	**...**	**-12.243 ****	**-3.835 ****	**-3.633 ****
				(0.80)	**(0.42)**	**(0.28)**
- RER Undervaluation	**...**	**...**	**...**	**3.026 ****	**1.340 ****	**0.807 ***
				(1.09)	**(0.66)**	**(0.47)**
- Equilibrium RER	**0.128 ****	**2.994 ****	**0.525 ***	**0.123 ****	**2.671 ****	**0.351 ***
(in logs)	**(0.05)**	**(0.25)**	**(0.27)**	**(0.06)**	**(0.23)**	**(0.22)**
External Shocks						
- Terms of Trade	0.057 **	0.091 **	0.077 **	0.048 **	0.090 **	0.067 **
(growth rate of ToT)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
- Period Shifts						
76-80:	-0.643 **	-0.611 **	-0.613 **	-0.329 **	-0.505 **	-0.494 **
81-85:	-2.099 **	-2.530 **	-2.707 **	-1.612 **	-2.741 **	-2.456 **
86-90:	-1.465 **	-1.671 **	-1.790 **	-0.975 **	-1.449 **	-1.404 **
91-95:	-1.823 **	-1.924 **	-2.190 **	-1.464 **	-1.703 **	-1.683 **
96-00:	-1.922 **	-2.120 **	-2.412 **	-1.412 **	-1.689 **	-1.812 **
No. Countries	60	60	60	60	60	60
No. Observations	354	354	354	354	354	354
Specification Tests (p-values)						
- Sargan Test	(0.26)	(0.47)	(0.40)	(0.44)	(0.54)	(0.38)
- 2nd Order Correlation	(0.53)	(0.72)	(0.52)	(0.32)	(0.44)	(0.52)

*Numbers in parenthesis below the coefficient estimates are the robust standard errors. ** (*) implies significance at the 5% level.*

The regression model includes a constant.

Table 8

RER Misalignment and Economic Growth: Are the Effects more harmful during Currency Crises?

Dependent Variable: Growth Rate of GDP per capita

Estimation Technique: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond, 1998)

	Misalignment and Crises			Overvaluation and Crises		
Variables	FRERM1	FRERM2	FRERM3	FRERM1	FRERM2	FRERM3
Transitional Convergence:						
- Initial GDP per capita	-3.022 **	-3.077 **	-2.854 **	-2.857 **	-2.357 **	-2.567 **
(in logs)	(0.26)	(0.23)	(0.31)	(0.25)	(0.28)	(0.22)
Cyclical Reversion						
- Initial Output Gap	-18.976 **	-15.396 **	-18.584 **	-17.369 **	-11.544 **	-21.794 **
(log[actual / potential GDP])	(2.41)	(1.59)	(2.01)	(2.87)	(2.48)	(2.08)
Structural Policies						
- Human Capital	2.740 **	2.885 **	2.701 **	2.530 **	2.412 **	2.814 **
(Secondary Enrollment, logs)	(0.17)	(0.26)	(0.31)	(0.29)	(0.32)	(0.25)
- Financial Depth	0.972 **	1.252 **	1.293 **	0.894 **	0.602 **	0.731 **
(Private Credit / GDP, logs)	(0.14)	(0.18)	(0.09)	(0.13)	(0.16)	(0.19)
- Trade Openness	0.237 *	0.310 **	0.570 **	0.280 *	0.580 **	0.617 **
(Exports + Imports / GDP, logs)	(0.15)	(0.12)	(0.16)	(0.15)	(0.09)	(0.10)
Stabilization Policies						
- Lack of Price Stability	-2.653 **	-0.689 **	-0.406 **	-1.389 **	-1.777 **	-0.643 **
(inflation rate, log[(1+inf)*100]])	(0.29)	(0.18)	(0.17)	(0.38)	(0.53)	(0.29)
- Currency Crises	-3.439 **	-4.503 **	-3.491 **	-1.629 **	-2.229 **	-0.683 *
(frequency under crisis, 0-1)	(0.20)	(0.14)	(0.39)	(0.24)	(0.56)	(0.39)
- RER Misalignment	**-3.592 ****	**-1.080 ****	**-0.930 ****	...	...	...
(log[actual / equilibrium RER])	**(0.48)**	**(0.16)**	**(0.10)**			
- RER Overvaluation	...	...	...	**-5.726 ****	**-0.837 ****	**-1.344 ****
				(0.70)	**(0.22)**	**(0.15)**
- RER Undervaluation	...	...	...	**2.086 ****	**0.906 ****	**1.337 ****
				(0.52)	**(0.45)**	**(0.31)**
- RER Misalignment * Currency Crises	**-6.977 ****	**-4.218 ****	**-2.556 ****	...	...	...
	(2.46)	**(0.99)**	**(1.11)**			
- RER Overvaluation * Currency Crises	...	...	...	**-44.219 ****	**-34.191 ****	**-35.121 ****
				(7.10)	**(4.05)**	**(3.39)**
External Shocks						
- Terms of Trade	0.065 **	0.078 **	0.087 **	0.060 **	0.046 **	0.071 **
(growth rate of ToT)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
- Period Shifts						
76-80:	-0.525 **	-0.591 **	-0.480 **	-0.414 **	-0.403 **	-0.638 **
81-85:	-2.149 **	-2.551 **	-2.560 **	-1.842 **	-2.334 **	-2.682 **
86-90:	-1.433 **	-1.681 **	-1.621 **	-1.288 **	-1.538 **	-1.483 **
91-95:	-1.910 **	-2.007 **	-2.126 **	-1.788 **	-1.728 **	-1.906 **
96-00:	-1.995 **	-2.145 **	-2.130 **	-1.803 **	-1.915 **	-2.199 **
No. Countries	60	60	60	60	60	60
No. Observations	354	354	354	354	354	354
Specification Tests (p-values)						
- Sargan Test	(0.24)	(0.36)	(0.51)	(0.28)	(0.34)	(0.33)
- 2nd Order Correlation	(0.38)	(0.69)	(0.60)	(0.59)	(0.85)	(0.63)

*Numbers in parenthesis below the coefficient estimates are the robust standard errors. ** (*) implies significance at the 5% level.*

Table 9

RER Misalignment, Volatility of Misalignment and Economic Growth

Estimation Technique: GMM-IV System Estimator (Arellano and Bover, 1995; Blundell and Bond, 1998)

	Linear Specification			Quadratic Specification		
Variables	FRERM1	FRERM2	FRERM3	FRERM1	FRERM2	FRERM3
Transitional Convergence:						
- Initial GDP per capita	-2.988 **	-3.225 **	-3.008 **	-2.622 **	-2.357 **	-3.746 **
(in logs)	(0.30)	(0.22)	(0.27)	(0.27)	(0.29)	(0.16)
Cyclical Reversion						
- Initial Output Gap	-13.246 **	-16.160 **	-11.568 **	-15.251 **	-17.879 **	-8.754 **
(log[actual / potential GDP])	(2.07)	(2.00)	(1.95)	(2.88)	(2.64)	(2.50)
Structural Policies						
- Human Capital	2.486 **	2.561 **	2.378 **	2.253 **	2.337 **	2.671 **
(Secondary Enrollment, logs)	(0.22)	(0.23)	(0.28)	(0.24)	(0.27)	(0.14)
- Financial Depth	0.448 **	0.820 **	0.836 **	0.501 **	0.916 **	1.372 **
(Private Credit / GDP, logs)	(0.13)	(0.11)	(0.12)	(0.15)	(0.13)	(0.10)
- Trade Openness	0.188 *	0.238 **	0.236 **	0.213	0.037	0.084
(Exports + Imports / GDP, logs)	(0.11)	(0.08)	(0.12)	(0.15)	(0.07)	(0.15)
Stabilization Policies						
- Lack of Price Stability	-1.462 **	-0.141	-0.029	-0.977 **	0.042	-0.797 **
(inflation rate, log[(1+inf)*100]])	(0.31)	(0.46)	(0.41)	(0.36)	(0.32)	(0.21)
- Currency Crises	-3.120 **	-2.855 **	-3.251 **	-2.366 **	-3.033 **	-2.416 **
(frequency under crisis, 0-1)	(0.34)	(0.28)	(0.29)	(0.36)	(0.28)	(0.23)
- RER Misalignment	**-4.269 ****	**-0.587 ****	**-0.622 ****	**-3.799 ****	**-1.502 ****	**-1.004 ****
(log[actual / equilibrium RER])	**(0.27)**	**(0.16)**	**(0.12)**	**(0.34)**	**(0.08)**	**(0.11)**
- Volatility of RER Misalignment	**-9.441 ****	**-10.254 ****	**-10.482 ****	**-6.765 ****	**-3.709 ****	**-27.929 ****
	(0.70)	**(0.53)**	**(0.64)**	**(2.40)**	**(1.58)**	**(1.50)**
- Volatility of RER Misalignment	**...**	**...**	**...**	**-19.441 ****	**-13.206 ****	**59.393 ****
Squared				**(8.13)**	**(5.76)**	**(4.79)**
External Shocks						
- Terms of Trade	0.055 **	0.063 **	0.064 **	0.062 **	0.001	0.056 **
(growth rate of ToT)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
- Period Shifts						
76-80:	-0.214 **	-0.396 **	-0.419 **	-0.366 **	-0.286 **	-0.026
81-85:	-1.715 **	-2.299 **	-2.280 **	-1.927 **	-2.495 **	-1.952 **
86-90:	-1.007 **	-1.214 **	-1.284 **	-1.135 **	-1.626 **	-0.965 **
91-95:	-1.332 **	-1.566 **	-1.689 **	-1.621 **	-1.948 **	-0.929 **
96-00:	-1.321 **	-1.625 **	-1.751 **	-1.533 **	-2.132 **	-1.228 **
No. Countries	60	60	60	60	60	60
No. Observations	354	354	354	354	354	354
Specification Tests (p-values)						
- Sargan Test	(0.34)	(0.65)	(0.58)	(0.48)	(0.31)	(0.42)
- 2nd Order Correlation	(0.50)	(0.85)	(0.91)	(0.67)	(0.90)	(0.88)

*Numbers in parenthesis below the coefficient estimates are the robust standard errors. ** (*) implies significance at the 5% level.*

Table 10
Episodes of at least five years of permanent expansive RER undervaluations

Country	Year	Exchange rate regime classification	Historical Inflation Rate	Output Gap***	Discrete change in NER?	Capital Controls?	Union Membership (% of labor)	Average RER Misalignment		
								5 years before**	5 years period	5 years after
GROUP 1										
Germany	1965	Peg to USD	4.8%	0.6%	no		0.25		-6.7%	3.8%
Norway	1965	Peg to USD	3.1%	-0.3%	no		0.39		-7.3%	0.8%
Singapore	1967	Peg to Pound Sterling	1.2%	-2.6%	no	yes	0.26		-7.8%	4.4%
Jordan	1967	Peg to Pound Sterling	-3.2%	2.2%	no	yes	0.60		-7.7%	1.4%
Guatemala	1972	Peg to USD	0.8%	-0.3%	no	yes	0.12	4.6%	-8.5%	9.8%
Panama	1972	USD	1.7%	1.6%	no	no	0.13	6.1%	-7.7%	-4.6%
Netherlands	1980	Crawling peg around DM (1983 peg to DM)	7.1%	0.9%	no	no	0.33	3.3%	-5.8%	1.4%
Belgium	1997	Peg to DM (1999 Euro)	2.3%	-0.5%	no	no	0.58	-1.5%	-5.1%	1.3%
Panama	1998	USD	1.0%	0.5%	no	no	0.12	3.7%	-9.0%	
GROUP 2										
Spain	1969	Peg to US Dollar	6.9%	-0.1%	yes	yes	0.94	4.4%	-5.2%	2.9%
Trinidad & Tobago	1970	Managed	3.0%	).8% (-5.6%	yes	yes	0.27	6.9%	-6.5%	-12.0%
Philippines	1975	Crawling band around USD	11.0%	-0.8%	yes	yes	0.13	0.3% (3.3%)	-5.0%	15.9%
Finland	1977	Band around DM	8.8%	-1.9%	yes	yes	0.65	-10.0%	-7.3%	0.7%
Indonesia	1987	Crawling band around USD (1989 peg to USD)	11.6%	-1.6%	yes	no	0.36	18.4%	-8.2%	16.5%
Jordan	1989	Crawling band against USD	6.0%	-3.0%	yes	yes	0.45	13.4%	-8.9%	-6.1%
Finland	1995	Peg to DM	4.3%	-1.3%	yes	no	0.77	17.6%	-7.7%	-14.7%
Canada	1998	Moving band around USD	5.3%	-0.3%	yes	no	0.28	-0.3% (2.7%)	-3.4%	
GROUP 3										
Syria	1972	Band around USD	2.1%	-3.4%		yes	0.50	-11.2%	-9.1%	-7.0%
Portugal	1986	Crawling band around DM	22.3%	-2.1%		yes	0.57	1.2%	-7.4%	-0.7%
Singapore	1987	Moving band around USD	3.1%	-3.2%		no	0.17	5.1%	-10.0%	-0.7%
South Korea	1999	Freely floating	6.3%	-2.6%		yes	0.75	-5.2% (1.2%)	-8.0%	
GROUP 4										
Iceland	1982	Managed floating / crawling band around DM	35.6%	0.4%		yes		-0.3%	-4.4%	5.2%
USA	1987	Freely floating	7.2%	0.1%		no	0.15	10.7%	-10.2%	-7.9%

** 1971 output gap in parenthesis. ** In parenthesis the average without the year before the overvaluation episode. *** Three year average centered in the starting year (Band Pass Filter calculation). Sources: Reinhart and Rogoff (2002) except Trinidad & Tobago for nominal exchange rate regimes, IMF, Exchange Arrangements and Exchange Restrictions for capital controls, Rama and Artecona (2002) for Trade Union Membership (% total labor force).*

Table 11
RER Misalignment and Exchange Rate Regimes 1/

	All Countries			Industrial Countries			Developing Countries		
	Fixed ER	Mixed ER	Floating ER	Fixed ER	Mixed ER	Floating ER	Fixed ER	Mixed ER	Floating ER
Misalignment 2/	0.054	0.057	0.057	0.028	0.037	0.051	0.076	0.077	0.065
	(0.08)	(0.09)	(0.11)	(0.04)	(0.05)	(0.05)	(0.09)	(0.09)	(0.19)
Overvaluation	0.065	0.060	0.061	0.022	0.040	0.060	0.085	0.082	0.065
	(0.10)	(0.10)	(0.15)	(0.04)	(0.05)	(0.05)	(0.11)	(0.11)	(0.26)
Undervaluation	0.047	0.054	0.052	0.036	0.034	0.047	0.064	0.071	0.065
	(0.05)	(0.07)	(0.05)	(0.04)	(0.06)	(0.04)	(0.06)	(0.07)	(0.07)

Note: We include only periods in which the exchange rate regime remained invariant for at least 4 years. Numbers in parenthesis below the median estimates represent the standard error of the series. 1/ We use the FRERM1 measure of fundamental real exchange rate misalignment computed using dynamic least squares on a country-by-country basis. 2/ We use the absolute value of the RER misalignment in the calculation of the median.

Table 12

Transition matrices among high / low under / overvaluation episodes

RER Misalignment: FRERM1 (Time Series estimation)

		All Countries				Industrial Countries				Developing countries			
		mt+1=hu	*mt+1=lu*	*mt+1=lo*	*mt+1=ho*	*mt+1=hu*	*mt+1=lu*	*mt+1=lo*	*mt+1=ho*	*mt+1=hu*	*mt+1=lu*	*mt+1=lo*	*mt+1=ho*
All ER regimes	*mt=hu*	0.65	0.29	0.05	0.01	0.64	0.29	0.07	0.00	0.65	0.29	0.04	0.01
	mt=lu	0.10	0.62	0.25	0.03	0.05	0.67	0.27	0.01	0.15	0.58	0.23	0.04
	mt=lo	0.03	0.23	0.61	0.13	0.00	0.27	0.67	0.06	0.04	0.20	0.56	0.20
	mt=ho	0.06	0.06	0.22	0.67	0.00	0.08	0.40	0.52	0.06	0.05	0.19	0.69
Floating ER	*mt=hu*	0.56	0.26	0.14	0.04	0.29	0.50	0.21	0.00	0.63	0.20	0.13	0.05
	mt=lu	0.14	0.54	0.25	0.07	0.10	0.61	0.25	0.03	0.18	0.46	0.25	0.11
	mt=lo	0.08	0.34	0.46	0.13	0.02	0.37	0.51	0.10	0.13	0.31	0.40	0.15
	mt=ho	0.08	0.08	0.34	0.50	0.00	0.08	0.38	0.54	0.10	0.08	0.33	0.49
Mixed ER	*mt=hu*	0.67	0.31	0.02	0.00	0.69	0.25	0.06	0.00	0.67	0.32	0.01	0.00
	mt=lu	0.11	0.61	0.27	0.02	0.05	0.60	0.33	0.02	0.13	0.62	0.24	0.01
	mt=lo	0.02	0.20	0.65	0.13	0.00	0.25	0.70	0.05	0.04	0.16	0.61	0.19
	mt=ho	0.02	0.06	0.24	0.69	0.00	0.04	0.31	0.65	0.02	0.06	0.20	0.72
Fixed ER	*mt=hu*	0.64	0.36	0.00	0.00	0.83	0.17	0.00	0.00	0.61	0.39	0.00	0.00
	mt=lu	0.07	0.69	0.22	0.01	0.03	0.73	0.24	0.00	0.12	0.64	0.20	0.03
	mt=lo	0.01	0.20	0.66	0.14	0.00	0.26	0.68	0.06	0.01	0.15	0.65	0.20
	mt=ho	0.01	0.02	0.23	0.73	0.00	0.00	0.33	0.67	0.01	0.03	0.23	0.73

Note: The classification across exchange rate regimes considers only periods in which the exchange rate regime has not changed at least for 4 years. In addition mt=hu when there is high undervaluation (more than 10%) in period t, mt=lu if there is low undervaluation (less than 10%) in period t, mt=lo when there is low overvaluation (less than 10%) in period t, and mt=ho when there is high overvaluation (more than 10%) in period t.

Table 13

Characterizing the Persistence of RER Misalignments

Dependent variable: Fundamental RER Misalignment (FRERM1)

Sample: 1965-2003 (Annual Data)

Variables	Baseline Equation [1]	[1] + Policy Variables [2]	[2] + Outcome Variables [3]	[3] + Rigidity Variables [4]
Constant	-0.004	-0.002	0.001	0.001
	(0.004)	(0.004)	(0.005)	(0.005)
Misalignment lag squared	-0.513 **	-0.440 **	-0.249 **	-0.306 **
	(0.07)	(0.08)	(0.08)	(0.08)
Currency Crises * Misalignment lag			-0.486 **	-0.483 **
			(0.05)	(0.06)
<u>*Undervaluation*</u>				
Misalignment lag (ML)	0.378 **	0.452 **	0.266 *	0.069
	(0.05)	(0.12)	(0.17)	(0.20)
ML * Exchange rate system (flexibility degree)		-0.010	0.010	0.012
		(0.01)	(0.01)	(0.01)
ML * Capital controls (managed ERS)		0.088	-0.016	-0.005
		(0.08)	(0.10)	(0.10)
ML * Output Gap (managed ERS)			-2.066	-2.202
			(1.54)	(1.73)
ML * Inflation record (managed ERS)			-0.261 *	-0.277 *
			(0.14)	(0.15)
ML * Union Membership				0.757 **
				(0.29)
<u>*Overvaluation*</u>				
Misalignment lag (ML)	0.835 **	1.090 **	1.013 **	1.109 **
	(0.06)	(0.08)	(0.12)	(0.13)
ML * Exchange rate system (flexibility degree)		-0.029 **	-0.016 *	-0.014 *
		(0.01)	(0.01)	(0.01)
ML * Capital controls (managed ERS)		-0.110 **	-0.092 *	-0.089
		(0.05)	(0.06)	(0.06)
ML * Output Gap (managed ERS)			3.840 **	3.325 **
			(0.88)	(0.91)
ML * Inflation record (managed ERS)			0.089	0.057
			(0.09)	(0.09)
ML * Union Membership				-0.642 **
				(0.20)
No. Countries	60	59	59	58
No. Observations	2250	2155	2155	2084

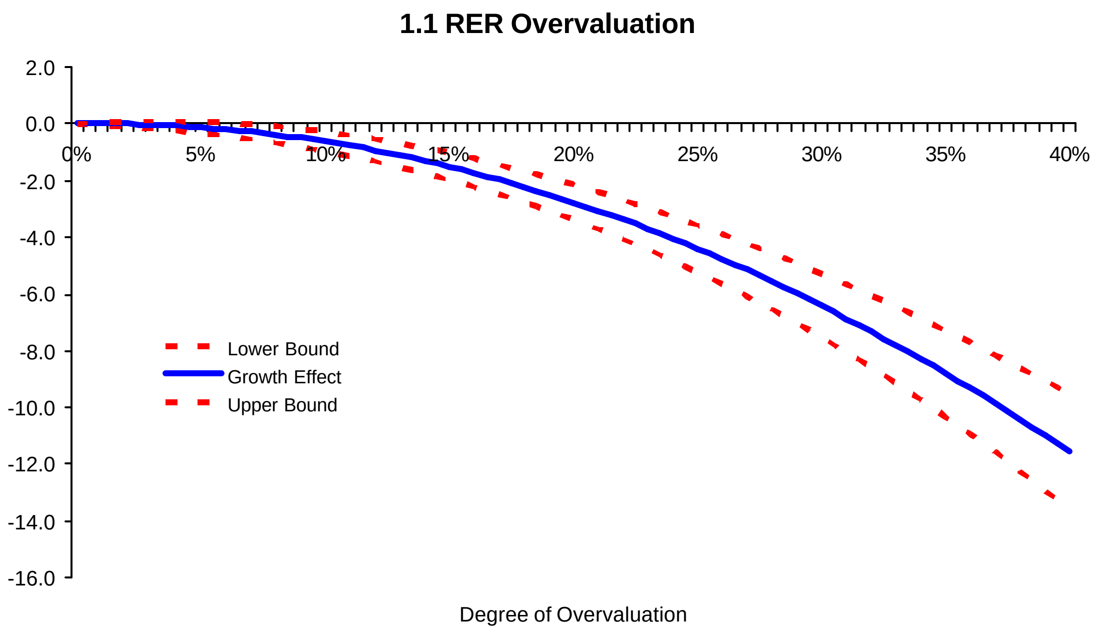
*Estimation method: Least Squares with fixed effects. All variables are lagged one period. Undervaluation (overvaluation) periods are defined in base of the lagged misalignment. Other controls not reported are common misalignment dynamic factors with differentiated effects among developed, emerging and other countries, money, with differentited effects among managed and not managed ERS, and deviations of real exchange rate fundamentals from their trends (see the text for details). Inflation record is calculated as -infh/(1+infh), where infh is the past 10 years average inflation rate. Numbers in parenthesis below the coefficient estimates are standard errors. ** (*) implies significance at the 5% (10%) level.*

Table A.1
The Long-Run Real Exchange Rate Equation: Time Series Estimation
Dependent Variable: Real Effective Exchange Rate (in logs)
Estimation Technique: Dynamic Least Squares (Saikkonen, 1991; Stock and Watson, 1993)

Country	DOLS (lead,lag)	Net Foreign Assets	Relative Productivity	Terms of Trade	Government Spending
Argentina	(1,0)	-0.015	0.507	-0.251	0.368 *
Australia	(1,1)	0.007 **	-0.285	0.372	-0.100
Austria	(0,1)	0.000	0.559 *	0.118	1.016 **
Belgium	(0,1)	-0.001	-0.707 *	2.440 **	1.185 **
Bolivia	(0,1)	-0.014 **	1.330 **	0.327 *	-0.031
Brazil	(1,1)	0.036 **	1.286 **	-0.301	-0.095
Botswana	(0,1)	0.001	-0.302 **	-0.829 **	-0.337 **
Canada	(1,0)	-0.002	1.374 **	0.524 *	0.473 **
Switzerland	(1,0)	-0.002 **	-1.594 **	-0.206	-1.006 **
Chile	(1,1)	-0.001	0.136	1.404 **	0.919 **
Côte d'Ivoire	(0,1)	-0.002 **	0.357 **	0.012	0.094
Colombia	(1,0)	0.017 **	1.787 **	-0.734 **	0.123
Costa Rica	(1,0)	0.001	2.424 **	0.199	-0.618 **
Germany	(0,1)	-0.003	2.632 **	0.504 **	1.430 **
Denmark	(0,1)	0.003 *	-0.670 **	-0.235	-0.058
Dominican Republic	(0,1)	0.010 **	1.509 **	0.334	0.124
Algeria	(0,1)	0.006 **	1.376 **	0.491 **	1.843 **
Ecuador	(0,1)	0.005 **	-0.320	0.892 **	0.071
Egypt	(0,1)	-0.001	2.821 **	-1.392 **	2.209 **
Spain	(0,1)	0.009 **	0.555 *	0.123	0.567 **
Finland	(1,0)	0.008 **	-0.106	0.302	-0.271
France	(0,1)	-0.008 **	-2.078 **	-0.081	-0.492 **
United Kingdom	(0,1)	0.001	0.029	1.093 **	-0.076
Greece	(0,1)	0.002 **	0.084	0.898 **	0.274
Guatemala	(1,1)	0.002	1.619 **	0.750 **	-0.583
Indonesia	(1,0)	0.023 **	-2.378 **	0.144	-0.315
India	(1,0)	0.073 **	0.895	1.157 **	-1.639 **
Ireland	(0,1)	-0.002 **	-0.160	-0.319	-0.581 **
Iceland	(1,0)	0.002	0.625 **	0.181	-0.239 *
Israel	(0,1)	0.006 **	-0.232	-0.084	0.479 **
Italy	(1,0)	0.009 **	0.623	0.227	1.314 **
Jamaica	(1,0)	0.004 **	0.402 **	-0.651 **	0.721 **
Jordan	(1,0)	0.000	0.713 **	-0.813 *	0.825 **
Japan	(1,0)	0.003	2.073 **	0.724 **	0.892 *
Korea	(0,1)	-0.002 **	-0.059	0.120	0.074
Sri Lanka	(1,0)	0.014 **	4.411 **	-0.943 **	0.368
Morocco	(1,0)	0.005 **	0.583	-1.002 *	0.495 **
Mexico	(1,0)	-0.010 **	0.105	0.349 **	-0.256
Malaysia	(0,1)	-0.001	0.110	0.473	1.501 **
Netherlands	(1,0)	0.004	0.968 **	-5.004 **	0.730
Norway	(1,0)	-0.001	0.261	0.070	0.252
New Zealand	(0,1)	0.005 **	-0.720 **	0.468 **	-0.117
Pakistan	(1,0)	0.011 **	1.162	1.400 **	-0.496
Panama	(1,1)	-0.009 **	-0.194	0.458 *	0.106
Peru	(1,0)	-0.004	-1.468 **	0.444	0.806 *
Philippines	(1,1)	-0.005	1.226 **	0.007	0.867 **
Portugal	(1,0)	0.001 **	0.173	0.337	0.241
Paraguay	(1,0)	0.007 **	2.534 **	0.378	0.595 **
Singapore	(1,1)	0.001 **	-0.587 **	-0.008	-0.851 **
El Salvador	(1,1)	0.011	-1.534 **	-0.450 **	-0.367
Sweden	(0,1)	-0.001	0.570	1.221 **	0.826 **
Syrian, Arab Rep.	(1,1)	0.012 **	0.621 **	-0.977 **	-0.230
Thailand	(0,1)	0.000	-0.135	0.581 **	0.853 **
Trinidad and Tobago	(0,1)	-0.001	0.221	0.145	0.313 **
Tunisia	(0,1)	0.004 **	2.478 **	0.345 **	0.859 **
Turkey	(0,1)	0.013 **	-0.968	-0.016	-1.408 **
Uruguay	(1,0)	0.004	0.235	0.296	-0.829 **
United States	(1,1)	0.001	-1.813 **	1.599 **	0.616 *
Venezuela	(0,1)	0.013 **	0.392 **	0.707 **	0.511
South Africa	(0,1)	0.004	1.185 **	-0.516 **	0.305

*We run our RER equations using 39 annual observations (1965-2003). Note that in the second column we report the leads and lags used in our country-by-country DOLS estimations. ** (*) denotes statistical significance at the 5 (10) percent level.*

Figure 1
Growth Effects of Real Exchange Rate Misalignments
Using Fundamental RER Misalignment FRERM1
(in percentages)



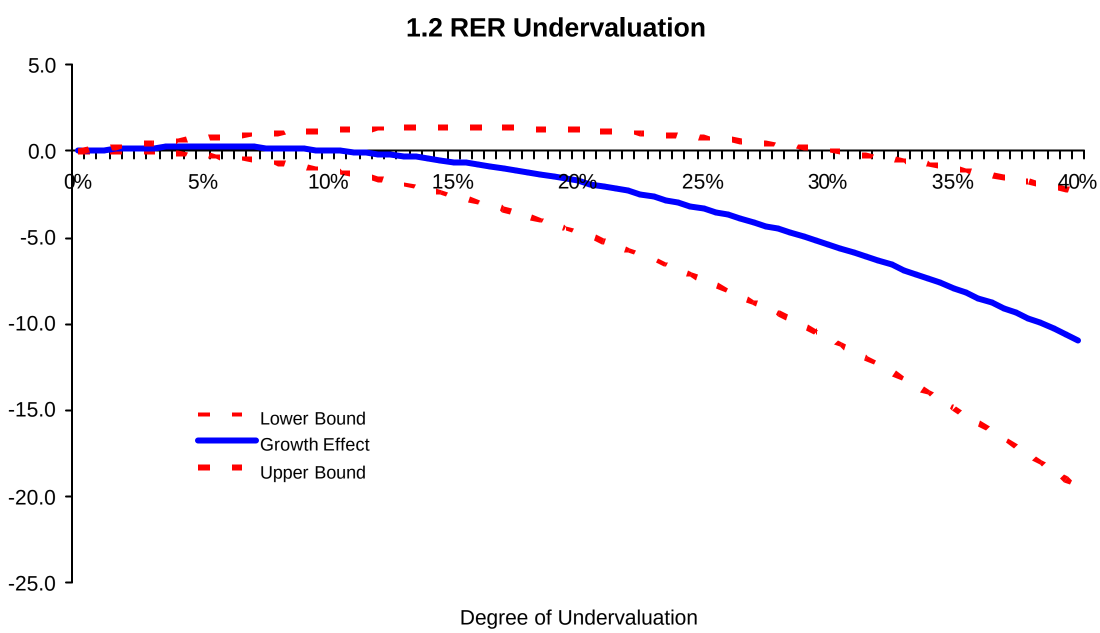
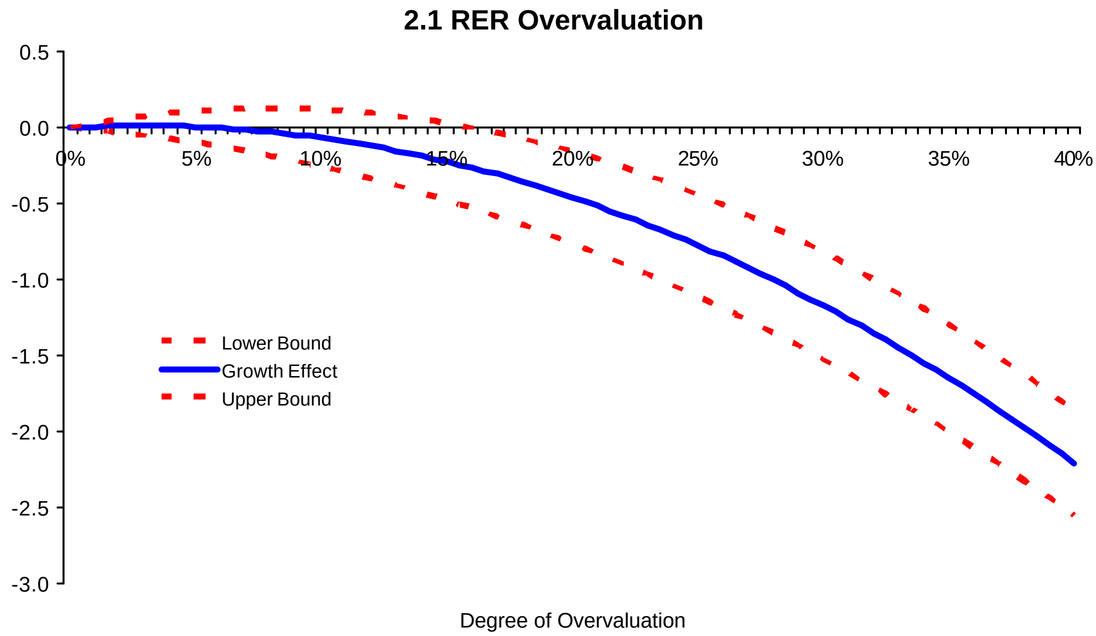


Figure 2
Growth Effects of Real Exchange Rate Misalignments
Using Fundamental RER Misalignment FRERM2
(in percentages)



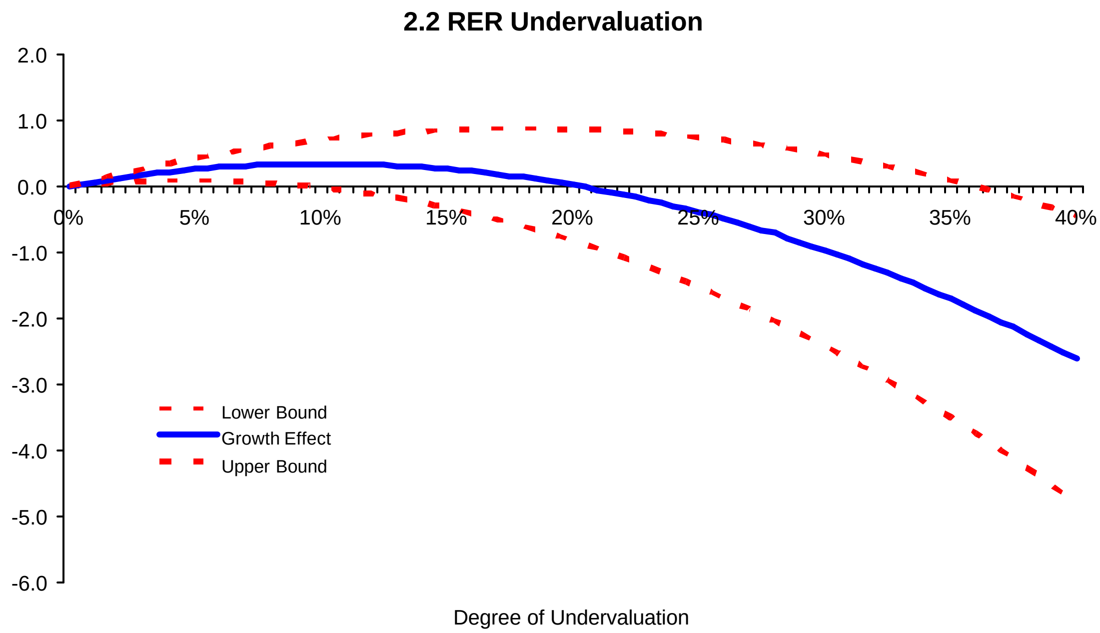
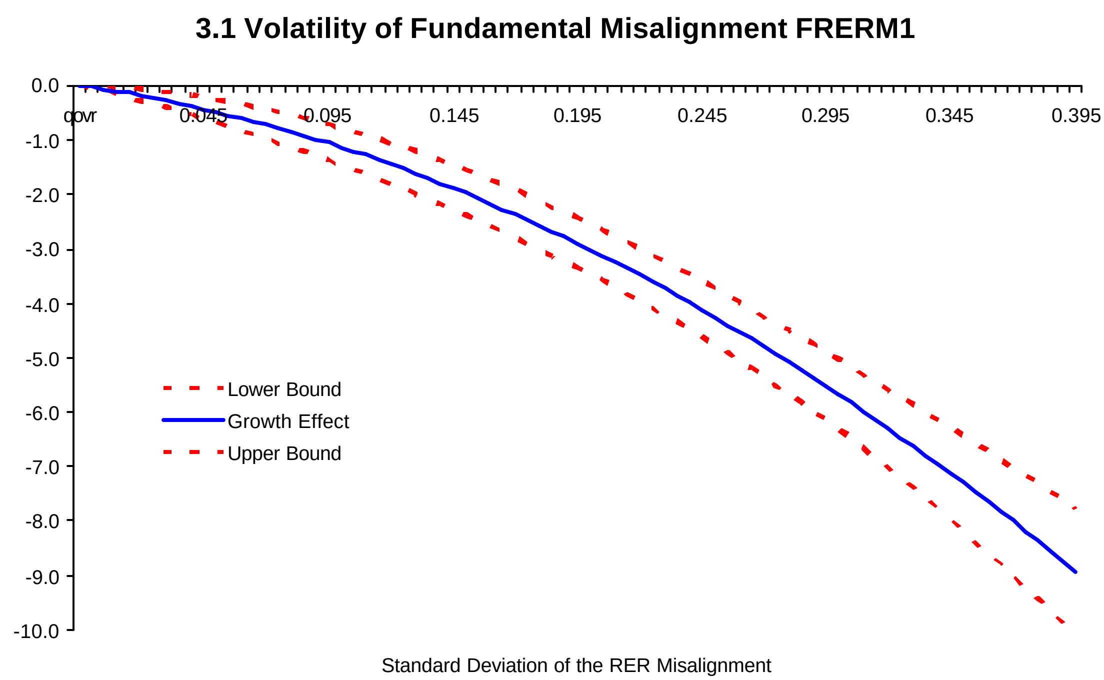
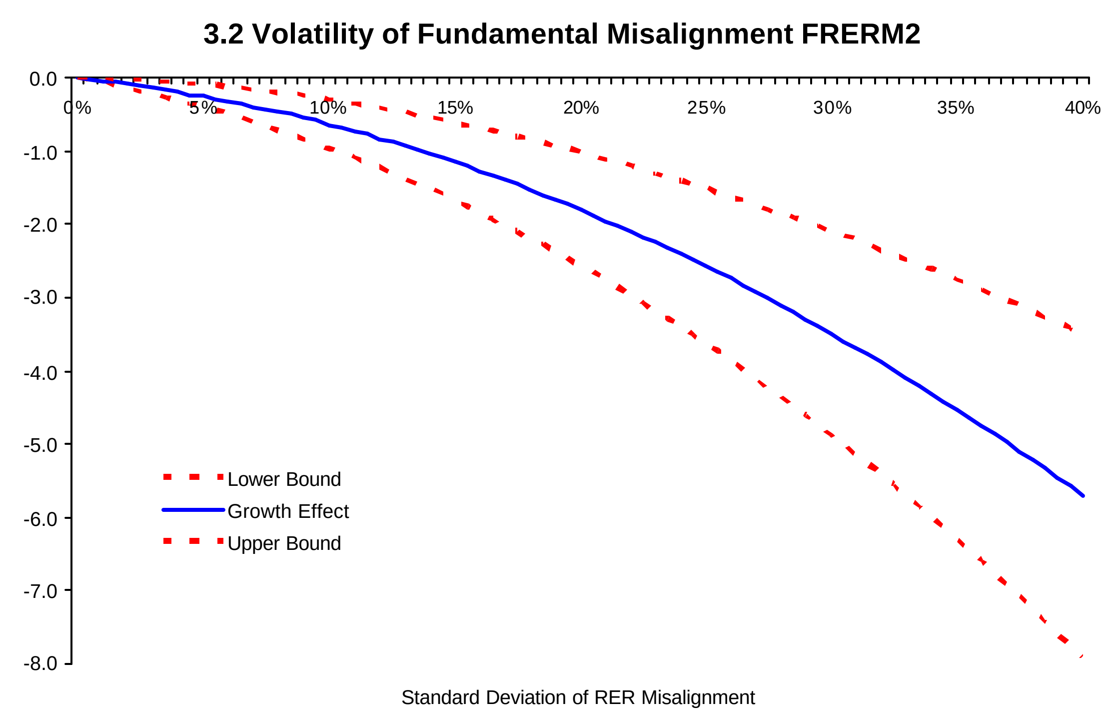


Figure 3
Growth Effects of the Volatility of Real Exchange Rate Misalignments
(in percentages)





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