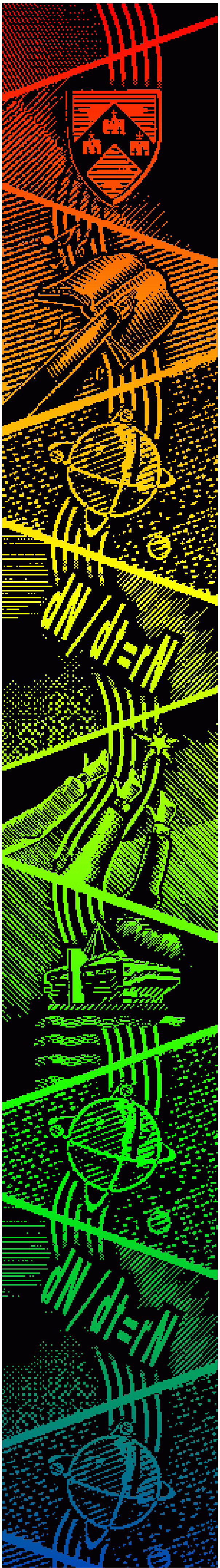

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Real Exchange Rate Misalignments: Theoretical Modelling and Empirical Evidence

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Real Exchange Rate Misalignments:

Theoretical Modeling and Empirical Evidence

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Abstract

The real exchange rate (RER) misalignment is a key variable in academic and policy circles. Among policy circles, sustained RER overvaluations are observed by authorities for future exchange rate adjustments. Some countries, on the other hand, have pursued very active exchange rate policies in order to undervalue their currencies to foster growth through export promotion (e.g. China). Our goal is to assess whether these policies can sustain RER undervaluation. In this context, this paper complements and improves upon the existing literature by formulating a theoretical based model to compute equilibrium real exchange rate and its misalignment and to estimate and calculate RER misalignments. One of the novelties is to derive and solve for what we call intertemporal BOP equilibrium and equilibrium in the tradable and non-tradable goods market based on the current account dynamics and Harrod-Balassa-Samuelson (HBS) productivities. With our novelty of modeling RER misalignments we estimate fundamental RER equation using cointegration techniques for time series –i.e. Johansen's (1988,1991) multivariate analysis and the error correction model (ECM) by Bewley (1979) and Wickens and Breusch (1987)– and for heterogeneous panel data –i.e. the pooled mean group estimator (PMGE) by Pesaran, Shin and Smith (1999).

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1. Motivation

A key factor in the determination of the real exchange rate (RER) is the relative price of traded to non-traded goods which signals the allocation of resources across these sectors. The RER provides a measure of the relative incentives to different types of activity in an economy and a way to assess a broader set of macroeconomic, structural and sectoral policies and their effectiveness in influencing export and import performance.

RER misalignment is important in academic and policy circles because it reflects distortions in relative prices that could be attributed to unsound domestic policies. Real overvaluation of the currency, and hence a loss of competitiveness may have an adverse impact on economic performance and is usually the result of weak macroeconomic fundamentals and inconsistent exchange rate policies[1]. Recent research suggests that a RER undervaluation may trigger growth, a potentially beneficial effect (Hausmann, Pritchett and Rodrik, 2005; Rodrik, 2007). For example, activist exchange rate policies to keep the RER undervalued may generate competitive gains that help exports grow and, in turn, promote growth (Aizenman and Lee, 2007). Understanding the determinants and consequences of misalignments is therefore important.

RER misalignments can result from two types of shocks: (a) inconsistent domestic policies (e.g. inconsistent monetary or fiscal policies and inward orientation), and (b) adverse external shocks (e.g. sharp increases in foreign interest rates and deterioration of terms of trade). RER misalignments are usually very persistent as Rogoff (1996) claims that deviations of the RER from its parity are very persistent and may sometimes be linked to the evolution of fundamentals —e.g. driven by real shocks that represent shifts in relative prices consistent with some internal and external equilibrium (Lucas, 1982; Stockman, 1987; Edwards, 1989a). It is preferable to measure RER misalignments in terms of deviations from its long-run equilibrium value and to use this to provide a link between (the persistence of) RER misalignments and economic policies. The relevant policy questions are what type of policy shocks may cause RER misalignments and what the consequences of these misalignments on economic performance are.

[1] For instance, the experience of Latin American countries in the 1980s in defending their nominal peg in the context of substantial fiscal and external imbalances lead to a significant RER overvaluation which distorted relative prices.

To compute our theory-based measure of a RER misalignment, we first obtain a long-run RER equation from a theoretical model that considers the equilibrium real exchange rate (ERER) as the relative price of tradable to non-tradable goods. Based on the intertemporal balance of payments (BOP) we obtain the equilibrium levels of tradable and non-tradable goods which give simultaneously both internal and external equilibrium (Obstfeld and Rogoff, 1985; Obstfeld and Stockman, 1985; Edwards, 1989a; Alberola and Lopez, 2001).[2] The building blocks of the model for equilibrium in the tradable and non-tradable goods will follow Balassa (1964) and Samuelson (1964) and for the BOP equilibrium or external equilibrium follow Mussa (1984) and Frenkel and Mussa (1985). Here we consider the dynamic behavior of the exchange rate. There are some important driving factors of the RER such as net foreign assets (NFA), the Harrod-Balassa-Samuelson (HBS) and productivity differentials and terms of trade (TOT).

The long-run RER equation —which allows us to compute the RER misalignment as deviations from the long-run RER equilibrium— will be estimated using time-series multi-equation cointegration techniques developed by Johansen (1988, 1991). We also proceed to estimate the error correction model (ECM) as suggested by Bewley (1979) and Wickens and Breusch (1987) and the pooled mean group estimator (PMGE) of Pesaran, Shin and Smith (1999) to test the hypothesis of the homogeneity of the long-run coefficients across countries.[3]

Although the issue of the ERER has received attention from, for example, Edwards, 1989a; Faruqee, 1995; Balvers and Bergstrand, 1997; MacDonald and Stein, 1999; Lane and Milesi-Ferretti, 2002, 2004, 2006, our work complements and improves the existing literature in several aspects. First, in contrast to Calderon (2004) and Dufrénot et al. (2005) we focus on time-series as well as heterogeneous panel techniques to estimate the coefficients of the long run RER. This is important given the heterogeneity of our sample which comprises 79 countries, of which 21 are

[2] The ERER guarantees *internal equilibrium* if this relative price helps achieve equilibrium in the non-traded goods markets not only in the current but also in future periods. On the other hand, the ERER yields *external equilibrium* if it guarantees a sustainable current account position. This is compatible with long-run sustainable capital flows.

[3] The PMGE is ideal for the estimation of dynamic heterogeneous panels –and, hence, suitable for the estimation of error-correction models. It combines the efficiency gains from restricting long-run parameters to be the same across countries (the units in the panel) with the flexibility and consistency gains of country-specific short-run adjustment. Furthermore, the approach allows formal testing of the pooling long-run restrictions imposed by the model. In addition, further research may explore the possibility of non-linear adjustment of the RER in the face of shocks to fundamentals and, hence, use non-linear co-integration techniques to compute RER misalignment (see Dufrénot et al. 2006).

industrial economies and 58 are developing countries over the period 1970-2005 (*i.e.* at most 36 observations per country).[4] Second, we formulate a simple model that would provide a benchmark for the measurement of ERER and enables the computation of RER misalignments as deviations from ERER.

This paper consists of the following sections: Section 2 briefly reviews the literature on RER behavior from an intertemporal open economy perspective. Section 3 derives our theoretical model of RER that determines the long run fundamental RER equation with the inter-temporal approach incorporated BOP and HBS effect.Section 4 explains the data for our empirical work while Section 5 models RER misalignments and explains the econometric methodology applied to estimate the long run RER equation –i.e. time series and panel unit roots and cointegration analysis, the PMGE, trend-cycle decomposition and the ECM. Section 6 analyzes the empirical assessment on RER misalignments while Section 7 concludes.

2. Theoretical Insights: the Brief Literature Review

In this section we briefly review the existing literature on the determination of RER in the long run and the calculation of RER misalignments based on fundamentals. RER misalignment is conceptually defined as the deviation of the actual RER relative to some benchmark (or equilibrium) level. Its calculation therefore depends upon the measurement of the equilibrium level of RER. A survey of the literature on the determination of the equilibrium RER (Edwards and Savastano, 2000) classifies most empirical efforts in this area into two groups: one, single equation models and another, general equilibrium simulation models. In both approaches the ERER is defined as the relative price of tradable and non-tradable goods that achieves internal and external equilibrium simultaneously. *Internal equilibrium* is usually defined as the sustainable equilibrium in the market of non-tradable goods which is compatible with unemployment rates at their natural level while *external equilibrium* takes place whenever the current account position can be financed with sustainable capital flows —that is, whenever the inter-temporal budget constraint is satisfied (Edwards, 1989a).

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[4] The use of panel cointegration techniques would allow me to overcome the low power of the time-series unit roots and cointegration testing procedure.

Three different approaches to measuring RER misalignment may be observed in the literature: PPP-based, model-based measure and the black market premium.[5] The *PPP-based measure* of misalignment is calculated from the deviations of RER with respect to some parity level from some determined equilibrium year. As pointed out by Balassa (1964, 1990), the main disadvantage of this approach is that it only accounts for monetary sources of exchange rate fluctuations and not for real sources (for example, productivity shifts, TOT shocks among others). The *model-based measure* of RER misalignment is calculated as the deviation of the actual RER from some theoretically-based equilibrium path of the RER. ERER models are usually specified by fundamentals (i.e. Edwards, 1989a and Frenkel and Razin, 1996). Particularly, Edwards (1989a), and Alberola and Lopez (2001) model RER as relative prices that guarantee internal and external equilibrium simultaneously. The *black market premium* (BMP)[6] is used as a proxy for RER misalignment. The drawback of the black market premium is that it is likely to be better capture the degree of foreign exchange controls than RER misalignments —especially in the era of increasing international financial integration.[7] In addition, the empirical evidence finds that BMP overstates the degree of misalignment for developing countries in the 70s and 80s (Ghura and Grennes, 1993).

Although deviations of the exchange rate from its PPP value are corrected by causing current account imbalances and a gradual change in the exchange rate in the long run, the absence of non-tradable goods in the PPP theory is the main problem. The price ratio between tradable and non-tradable goods may not move together over time due to differences in productivities across sectors. Further the PPP approach measures changes in relevant variables from some base period, and this does not address the issue of whether the exchange rate is at its equilibrium level. PPP-based approach cannot therefore capture major changes either in economic policies or in economic structure such as TOT movements.

In the model-based measure of RER misalignments it is necessary to define a sustainable or equilibrium exchange rate (EER). This overcomes the deficiencies of

[5] The single-equation approach follows the model-based measure of our theoretical and empirical model.
[6] The black market premium measures the deviation og the official exchange rate (usually is a country with some degree of exchange rate fixity) vis-à-vis the parallel exchange rate (usually attributed to be closer the equilibrium level).
[7] In addition, the black market premium on the foreign exchange market is a flawed measure of misalignment since it is more of an indicator of rationing in this market.

the PPP approach because the underlying payments of disequilibria method take care of the underlying balance-of-payments positions rather than the price level. Frenkel and Goldstein (1986) explain the underlying payments disequilibria as the underlying balance approach to the EER. This EER defines the real effective exchange rate (REER) which consists of medium-term internal and external macroeconomic balance –which Williamson (1983) labels as the fundamental EER and according to Wren-Lewis (2003), this is a macroeconomic balance approach while assuming the economies are in internal balance. The key exogenous inputs are medium term capital flows and the cyclically-adjusted level of output. This approach is similar to Keynesian cyclical effects and short-term transitory shocks in domestic and abroad. Bayoumi et al (1994) suggest the "*desired equilibrium exchange rate*" according to which the actual stocks are at their desired levels in the long run. Hence, there is a set of desired macroeconomic objectives. The ERER is consistent with underlying macroeconomic balance based on the desired macroeconomic objectives. The calculated EER is not desired EER but it simply achieves the desired equilibrium positions of internal and external balance.

Edwards and Ostry (1990) build a general equilibrium model to assess how anticipated protectionist policies may affect the RER and the current account where these are labor market distortions. Their model finds that imposing tariffs may have an effect on the RER and the current account although the effect may differ if the economy has rigid or fully flexible labor market.

However, one of the main problems of computing RER misalignments using our approach is that the measure of RER misalignment would be *model dependent*. However, Cassel (1928, pp.29) argues that:

> *…(t)he art of economic theory to a great extent consists in the ability to judge which of a number of different factors cooperating in a certain movement ought to be regarded as the most important and essential one. Obviously in such cases we must always be at work. Other factors which are only of a temporary character and may be expected to disappear, or at any rate can be theoretically assumed to be absent, must for that reason alone be put in a subordinate position(.)*

Hence, it is important to find the model the main economic fundamentals that drive the behavior of the real exchange rate misalignments.

As Viner (1937) points out, the notion of non-tradable goods –i.e. the non-transportable goods and services in a country– becomes a key factor explaining exchange rate determination. Kravis (1986) and Dornbusch (1989) empirically show that there is a significant service component in the RER. If productivity in tradables grows faster than those in nontradables, this causes higher wages in tradables which push the wages in nontradables upward. As a result, a real appreciation in nontradables will occur. This is known as the *HBS* effect where shifts in the RER are determined mainly by movements in the relative productivity of tradables and non-tradables.[8] In a recent paper, Obstfeld (2009) argues that the RER depends on the international productivity "difference in differences" between tradable and nontradable sectors. He argues that the model proposed by HBS provides a benchmark to measure the ERER: real appreciations predicted by this model do not involve a decline in export competitiveness but are purely productivity driven. This argument is empirically supported by De Gregorio, Giovannini and Wolf (1994), and Chinn and Johnston (1996).

More recent research by Burstein, Neves and Rebelo (2000), Obstfeld and Rogoff (2000) and MacDonald and Ricci (2001) suggests that the distribution sector plays an important role in our understanding of the link between the movements in the relative prices of tradable to non-tradable goods.[9] Those papers theoretically argue that PPP fails in the presence of distribution costs since the distribution services are intensive in the use of labor and land, and generate a wedge between the prices of any good across countries. MacDonald and Ricci (2001) find that the RER may appreciate if there is an increase in the productivity and the degree of competition of the distribution sector of the home country relative to the foreign country (in a similar fashion to the HBS effect). They argue that improvements in the distribution of traded goods may lie behind their result. Ricci et al. (2008) also find evidence in support of the HBS effect. This effect seems to be economically important as they estimate that a 10 % increase in relative productivity differentials appreciates REER by about 2%. They use a new dataset for the productivity differentials, which uses a six-sector classification on productivity and employment while their measure of TOT is based on the price of the main imported and exported commodities relative to the price of manufactured goods.

[8]Engel (1993, 2000) shows that the law of one price holds for traded goods.
[9]Burstein et al. (2003) show that distribution costs are very large for the average consumer good: they represent more than 40 percent of the retail price in the US and roughly 60 percent of the retail price in Argentina.

The *single-equation approach* usually derives reduced forms for the ERER from a wide variety of theoretical models and most of these efforts have been based on Edwards (1989a) and Obstfeld and Rogoff (1995, 1996).[10] The long run relationship derived from theoretical models usually links the RER with a set of *"fundamentals"* (e.g. productivity differentials, terms of trade, government spending, trade policy among other factors). The RER misalignments arise when RER deviations from the equilibrium path are quite persistent. This may be due to inadequate macroeconomic, trade and exchange rate policies among other factors.

The single-equation approach is followed in our research. In order to compute the RER misalignment we first estimate the long-run ERER. Here we collect historical data on the RER and its fundamentals and apply time series and/or panel cointegration techniques.[11]

The RER fundamentals are decomposed into their permanent and transitory components, and we use the long-run values (or permanent component) of the RER fundamentals. Although researchers have not agreed on the procedure to calculate the permanent component of the fundamentals, a variety of trend-cycle decomposition techniques —such as Beveridge and Nelson (1981), the Hodrick-Prescott (HP) filter, the band-pass filter (Baxter and King, 1999)— have been used in the literature to compute the long-run values of the fundamentals. In this paper, we use the band-pass filter due to the following advantages: one, it passes through components of the time series with periodic fluctuations between six and thirty two quarters while removing components at higher and lower frequencies, and another, it produces more flexible and easier to implement more accurate approximation to the optimal filter.

We then calculate the long-run equilibrium level of the RER by multiplying the estimated coefficients with the permanent values of the fundamentals. Finally, the RER misalignment is calculated by subtracting is the equilibrium level from the actual RER. For a detailed revision of empirical papers on the estimation of ERERs (see Table 13.5 in Edwards and Savastano, 2000).

Other researchers have used *General Equilibrium Simulation Models* to assess the behavior or RERs (Williamson, 1991). Analogously to the single-equation method, the ERER should meet both internal and external equilibrium considerations. Most

[10] Razin and Collins (1999), on the other hand, use a stochastic version of the Mundell-Fleming model as developed by Frenkel and Razin (1996).
[11] Alberola et al. (1999), Lane and Milesi-Ferretti (2004) and Calderón (2004) are examples of RER equations estimated using panel cointegration techniques.

simulation models are based on flow considerations and ignore aspects such as the demand shocks or the impact of net foreign assets.

Most of the models that fall into these two categories are surveyed by Edwards and Savastano (2000) who consider that there is a linear long-run relationship between RER and its fundamentals. This is therefore a linear adjustment of shocks to fundamentals on the RER. Unfortunately, the theoretical literature has been unable to replicate the empirical results on the persistent of misalignments in RER for industrial (as well as developing countries) after the collapse of the Bretton Woods system.[12]

3. Theoretical Model

In this chapter we derive the RER model that would yield the long-run relationship between RER and its fundamentals. We start from the intertemporal optimization problem and link between the RER equilibrium and dynamics of the current account and of *HBS* productivity differentials. The estimation of this model would allow us to calculate equilibrium RER and; hence, the RER misalignment as deviations of the actual from ERER.

Let us denote the real exchange rate as Q_t where $Q_t = \frac{P_t}{S_t P_t^*}$, the nominal exchange rate as S_t, and the domestic and foreign prices as P_t and P_t^*, respectively. Absolute PPP between two countries implies that Q_t is constant and is written as:

$$P_t = S_t P_t^*$$

Relative PPP implies:

$$\frac{P_{t+1}}{S_{t+1} P_{t+1}^*} = \frac{P_t}{S_t P_t^*}$$

Hence, the real exchange rate (in logs) can be expressed as (where $x_t = \ln X_t$):

$$q_t = p_t - (s_t + p_t^{\,*})$$

[12] The empirical literature finds that –among the studies in support of the validity of PPP in the long run– mean reversion of RER is slow, that is the size of the half-life of PPP deviations is between 3 and 5 years. In addition, the high degree of persistence in RER cannot be taken into account either by nominal shocks (highly volatile but not persistent) or by real shocks (persistent but with low volatility – e.g. preferences and technology). This is what Rogoff (1996) described as the *PPP puzzle*.

We assume the power utility function $U(C_t)$:

$$U(C_t)=\frac{C_t^{1-\sigma}-1}{1-\sigma} \qquad ,\sigma>0$$

where C_t is the total consumption and $\frac{1}{\sigma}$ is elasticity of inter-temporal substitution.

Total consumption is defined as a constant elasticity of substitution (CES) function of consumption in tradable and non-tradable goods (C^T and C^N, respectively),

$$C_t=\left[(1-\alpha)\left(C_t^T\right)^{1-\frac{1}{\gamma}}+\alpha(C_t^N)^{1-\frac{1}{\gamma}}\right]^{\frac{1}{1-\frac{1}{\gamma}}} \qquad ,\ 0<\alpha<1,\ \gamma>0$$

where α is the share of non-tradable goods in the consumption basket and $\gamma\geq 1$ is the elasticity of intra-temporal substitution between tradable and non-tradable goods. The latter can be mathematically defined as:

$$\gamma=-\frac{d\ln\left(C^T/C^N\right)}{d\ln\left[\frac{\left(\partial C/\partial C^T\right)}{\left(\partial C/\partial C^N\right)}\right]}$$

We can express consumption expenditure as:

$$P_tC_t=P_t^TC_t^T+P_t^NC_t^N$$

where P^T and P^N denote the prices of tradable and non-tradable goods, respectively. Analogously, the total expenditure on investment I and output Y are specified as follows:

$$P_tI_t=P_t^TI_t^T+P_t^NI_t^N$$

$$P_tY_t=P_t^TY_t^T+P_t^NY_t^N$$

Total output in the economy (*Y*) is:

$$Y=A\Phi(K,L)$$

where the factors of production being labor (*L*) and physical capital (*K*). *A* denotes the stochastic productivity disturbance and is a function of tradables A^T and nontradables A^N where $A\left(A^T,A^N\right)$. We assume that labor is internationally immobile and migrates between sectors where the total domestic labor is fixed at $L_t=L_t^T+L_t^N$ where L_t^T is labor in the tradables sector and L_t^N is labor in the nontradables sector. Total physical capital is $K_t=K_t^T+K_t^N$ where K_t^T is capital in the tradables sector, K_t^N is capital in the nontradables sector and capital accumulation takes place in each sector according to:

$$\Delta K_{t+s}^{T} = I_{t}^{T} - \delta_{t}^{T} K_{t}^{T}$$
$$\Delta K_{t+s}^{N} = I_{t}^{N} - \delta_{t}^{N} K_{t}^{N}$$

Therefore,

$$\begin{aligned} Y &= A\Phi(K, L) \\ &= A\Phi\left[\left(K^{T} + K^{N}\right), \left(L^{T} + L^{N}\right)\right] \\ &= A\Phi\left(K^{T}, K^{N}, L^{T}, L^{N}\right) \end{aligned}$$

We solve a social planner's problem for a small open economy by maximizing $\sum_{s=0}^{\infty} \beta^{s} U\left(C_{t+s}\right)$ with respect to $\left\{C_{t+s}^{T}, C_{t+s}^{N}, K_{t+s}^{T}, K_{t+s}^{N}, f_{t+s+1}; s \geq 0\right\}$ subject to the following BOP equation:

$$\begin{aligned} &\frac{P_{t}^{T}}{P_{t}} A\Phi(K_{t}^{T}, K_{t}^{N}, L_{t}^{T}, L_{t}^{N}) + \frac{P_{t}^{N}}{P_{t}} A\Phi(K_{t}^{T}, K_{t}^{N}, L_{t}^{T}, L_{t}^{N}) \\ &= \frac{P_{t}^{T}}{P_{t}}\left[C_{t}^{T} + K_{t+1}^{T} - (1-\delta^{T}) K_{t}^{T}\right] + \frac{P_{t}^{N}}{P_{t}}\left[C_{t}^{N} + K_{t+1}^{N} - (1-\delta^{N}) K_{t}^{N}\right] + f_{t+1} - (1+r_{t}^{*}) f_{t} \end{aligned}$$

where f represents the real net asset holdings.

The Lagrange function is:

$$\Psi = \sum_{s=0}^{\infty} \left\{ \begin{aligned} &\beta^{s} U\left(C_{t+s}\right) + \lambda_{t+s}\left[\frac{P_{t+s}^{T}}{P_{t+s}}\left(A\Phi\left(K_{t+s}^{T}, K_{t+s}^{N}, L_{t+s}^{T}, L_{t+s}^{N}\right) - C_{t+s}^{T} - K_{t+s+1}^{T} + \left(1-\delta^{T}\right) K_{t+s}^{T}\right)\right] \\ &+ \frac{P_{t+s}^{N}}{P_{t+s}}\left(A\Phi\left(K_{t+s}^{T}, K_{t+s}^{N}, L_{t+s}^{T}, L_{t+s}^{N}\right) - C_{t+s}^{N} - K_{t+s+1}^{N} + \left(1-\delta^{N}\right) K_{t+s}^{N}\right) - f_{t+s+1} + (1+r_{t+s}^{*}) f_{t+s} \end{aligned} \right\}$$

The first order conditions are:

$$\frac{\partial \Psi}{\partial C_{t+s}^{T}} = \beta^{s} C_{t+s}^{-\sigma} (1-\alpha)\left(\frac{C_{t+s}}{C_{t+s}^{T}}\right)^{\frac{1}{\gamma}} - \lambda_{t+s} \frac{P_{t+s}^{T}}{P_{t+s}} = 0, \qquad s \geq 0$$

$$\frac{\partial \Psi}{\partial C_{t+s}^{N}} = \beta^{s} C_{t+s}^{-\sigma} (\alpha)\left(\frac{C_{t+s}}{C_{t+s}^{N}}\right)^{\frac{1}{\gamma}} - \lambda_{t+s} \frac{P_{t+s}^{N}}{P_{t+s}} = 0, \qquad s \geq 0$$

$$\frac{\partial \Psi}{\partial K_{t+s}^{T}} = \lambda_{t+s}\left\{\frac{P_{t+s}^{T}}{P_{t+s}}\left[A\Phi_{k^{T}, t+s} + 1 - \delta^{T}\right] + \frac{P_{t+s}^{N}}{P_{t+s}}\left[A\Phi_{k^{T}, t+s}\right]\right\} - \lambda_{t+s-1} \frac{P_{t+s-1}^{T}}{P_{t+s-1}} = 0, \; s > 0$$

$$\frac{\partial \Psi}{\partial K_{t+s}^{N}} = \lambda_{t+s}\left\{\frac{P_{t+s}^{N}}{P_{t+s}}\left[A\Phi_{k^{N}, t+s} + 1 - \delta^{N}\right] + \frac{P_{t+s}^{T}}{P_{t+s}}\left[A\Phi_{k^{N}, t+s}\right]\right\} - \lambda_{t+s-1} \frac{P_{t+s-1}^{N}}{P_{t+s-1}} = 0, \; s > 0$$

$$\frac{\partial \Psi}{\partial f_{t+s}} = \lambda_{t+s}\left[1 + r^{*}_{t+s}\right] - \lambda_{t+s-1} = 0\,, \qquad s > 0$$

By setting $s = 0$ and from the conditions of $\frac{\partial \Psi}{\partial C^{T}_{t+s}} = 0$ and $\frac{\partial \Psi}{\partial C^{N}_{t+s}} = 0$, we obtain the relative consumption of tradable and non-tradable goods as a function of its relative price:

$$\frac{C^{T}_{t}}{C^{N}_{t}} = \left(\frac{1-\alpha}{\alpha}\frac{P^{N}_{t}}{P^{T}_{t}}\right)^{\gamma}$$

$$\frac{C^{N}_{t}}{C^{T}_{t}} = \left(\frac{\alpha}{1-\alpha}\frac{P^{T}_{t}}{P^{N}_{t}}\right)^{\gamma}$$

Thus, an increase in the relative price of tradable goods reduces their relative consumption. We could also express the above expression as:

$$\frac{P^{N}_{t}}{P^{T}_{t}} = \left(\frac{C^{T}_{t}}{C^{N}_{t}}\frac{\alpha}{1-\alpha}\right)^{1/\gamma} \qquad (1)$$

where the right-hand-side shows the demand for tradable and non-tradable goods.
As a result, the total consumption is:

$$C_{t} = \left[(1-\alpha)\left(C^{T}_{t}\right)^{1-\frac{1}{\gamma}} + (\alpha)(C^{N}_{t})^{1-\frac{1}{\gamma}}\right]^{\frac{1}{1-\frac{1}{\gamma}}}$$

$$= (1-\alpha)^{\frac{1}{1-\frac{1}{\gamma}}} C^{T}_{t}\left[1 + \left(\frac{\alpha}{1-\alpha}\right)^{\frac{1}{1-\frac{1}{\gamma}}}\left(\frac{C^{N}_{t}}{C^{T}_{t}}\right)\right]$$

$$= (1-\alpha)^{\frac{1}{1-\frac{1}{\gamma}}} C^{T}_{t}\left[1 + \left(\frac{\alpha}{1-\alpha}\right)^{\gamma}\left(\frac{P^{N}_{t}}{P^{T}_{t}}\right)^{1-\gamma}\right]^{\frac{1}{1-\frac{1}{\gamma}}}$$

and total consumption expenditure is:

$$P_{t}C_{t} = P^{T}_{t}C^{T}_{t} + P^{N}_{t}C^{N}_{t}$$

$$= P^{T}_{t}C^{T}_{t}\left[1 + \left(\frac{\alpha}{1-\alpha}\right)^{\gamma}\left(\frac{P^{N}_{t}}{P^{T}_{t}}\right)^{1-\gamma}\right]$$

Therefore, the home country's price level can be expressed as:

$$P_{t} = \frac{P^{T}_{t}C^{T}_{t}}{C_{t}}\left[1 + \left(\frac{\alpha}{1-\alpha}\right)^{\gamma}\left(\frac{P^{N}_{t}}{P^{T}_{t}}\right)^{1-\gamma}\right]$$

$$= (1-\alpha)^{\frac{\gamma}{1-\gamma}} P_t^T \left[1 + \left(\frac{\alpha}{1-\alpha} \right)^{\gamma} \left(\frac{P_t^N}{P_t^T} \right)^{1-\gamma} \right]^{\frac{1}{1-\frac{1}{\gamma}}}$$

$$= \left[(1-\alpha)^{\gamma} (P_t^T)^{1-\gamma} + \alpha^{\gamma} (P_t^N)^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$$

Analogously, the price level in the foreign country is:

$$P_t^* = \left[(1-\alpha^*)^{\gamma} (P_t^{T*})^{1-\gamma} + \alpha^{*\gamma} (P_t^{N*})^{1-\gamma} \right]^{\frac{1}{1-\gamma}}$$

Taking logarithms of P_t and linearizing gives

$$\ln P_t \approx p_t^T + \phi \left(p_t^N - p_t^T \right)$$

where $\phi = \alpha^{\gamma} \left(\frac{P^N}{P} \right)^{1-\gamma}$. Hence, the logarithm of the real exchange approximates:

$$\begin{aligned} q_t &= p_t^T - s_t - p_t^{T*} + \phi \left[p_t^N - p_t^T \right] - \phi^* \left[p_t^{N*} - p_t^{T*} \right] \\ &= q_t^{BOP} + q_t^{PRO} \end{aligned}$$

where $$q_t^{BOP} = p_t^T - s_t - p_t^{T*}$$

$$q_t^{PRO} = \phi \left[p_t^N - p_t^T \right] - \phi^* \left[p_t^{N*} - p_t^{T*} \right]$$

q_t^{BOP} denotes the relative price of tradable goods and, according to Engle (2000), is expected to be stationary. Deviations from the law of one price in tradables are large and persistent but stationary (Engle, 1993; Wei and Parsely, 1995), even in the presence of shipping costs[13] (Obstfeld and Taylor, 1997). q_t^{PRO} denotes the relative price of non-tradable to tradable goods. Engle (2000) suggests that the unit root behavior in real exchange rates might be induced by non-stationary behavior of real exchange rates driven by permanent shocks to tradable and non-tradable productivity differentials. q_t^{BOP} and q_t^{PRO} are the components of the equilibrium real exchange rate q_t. They satisfy external and internal balances, respectively (see Edwards 1989a). They are consistent with the balance of payments constraints, whether or not this is in the long-run equilibrium. If the balance of payments is in the long-run equilibrium then it must satisfy a further condition which we now derive.

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[13] For instance, the literature shows that increased fiscal deficits appreciate the equilibrium RER if the rising expenditures are biased towards non-tradables. Import tariffs and removal of capital controls also appreciate the ERER while a permanent deterioration of the terms of trade is likely to depreciate the ERER.

The Inter-Temporal BOP Equilibrium in the Real Exchange Rate

The balance of payments in nominal terms in domestic currency is:

$$CA_t = P_t^T x_t(Q_t^T) - S_t P_t^{T^*} x_t^m(Q_t^T) + R_t^* S_t B_t^* - R_t B_t^F = S_t \Delta B_{t+1}^* - \Delta B_{t+1}^F$$

where $x_t(Q_t^T)$ is exports, $x_t^m(Q_t^T)$ is imports expressed in foreign real prices, B_t^* is domestic nominal holding of foreign assets expressed in foreign currency, B_t^F is the foreign holding of domestic assets expressed in domestic currency, R_t is the domestic nominal interest rate, R_t^* is the world nominal interest rate and $F_t = S_t B_t^* - B_t^F$ is the net asset position[14]. Dividing by P_t gives the real BOP constraint:

$$\frac{CA_t}{P_t} = \frac{P_t^T x_t}{P_t} - \frac{S_t P_t^{T^*}}{P_t} x_t^m + \frac{R_t^* S_t B_t^*}{P_t} - \frac{R_t B_t^F}{P_t} = \frac{S_t}{P_t}(B_{t+1}^* - B_t^*) - \frac{(B_{t+1}^F - B_t^F)}{P_t}$$

$$= \frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right] + \frac{S_t B_t^*}{P_t} + \frac{R_t^* S_t B_t^*}{P_t} - \frac{B_t^F}{P_t} - \frac{R_t B_t^F}{P_t} = \frac{S_t B_{t+1}^*}{P_t} - \frac{B_{t+1}^F}{P_t}$$

where $x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)$ =TB is the trade balance, $Q_t^T = \dfrac{P_t^T}{S_t P_t^{T*}}$ represents the terms of trade, P_t^T is the domestic currency price of domestic tradables, $P_t^{T^*}$ is the foreign currency price of foreign tradables,

$$\frac{CA_t}{P_t} = \frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right] + (1+R_t^*)\frac{S_t B_t^*}{P_t^T} - (1+R_t)\frac{B_t^F}{P_t^T} = \frac{P_{t+1}^T}{P_t^T}\frac{S_t}{S_{t+1}}\frac{P_{t+1}^{T^*} S_{t+1}}{P_{t+1}}\frac{B_{t+1}^*}{P_{t+1}^{T^*}} - \frac{P_{t+1}^T}{P_t^T}\frac{B_{t+1}^F}{P_{t+1}^T}$$

$$= \frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right] + f_t + R_t^* Q_t b_t^* - R_t b_t^F = \frac{(1+\pi_{t+1})}{(1+\Delta s_{t+1})}\left[Q_{t+1} b_{t+1}^* - (1+\Delta s_{t+1}) b_{t+1}^F\right]$$

Since $f_t = Q_t b_t^* - b_t^F$,

$$\frac{CA_t}{P_t} = \frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right] + (1+R_t^*) f_t - (R_t - R_t^*) b_t^F = \frac{(1+\pi_{t+1})}{(1+\Delta s_{t+1})}\left[f_{t+1} - \Delta s_{t+1} b_{t+1}^F\right]$$

If we assume that the expected nominal effective exchange rate is constant and uncovered interest parity condition holds, then $\Delta s_{t+1} = 0$ and $r_t = r_t^*$.[15]

Since $r_{t+1} = \dfrac{1+R_t}{1+\pi_{t+1}} - 1$:

$$\frac{CA_t}{P_t} = \frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right] + (1+r_{t+1}^*)(1+\pi_{t+1}) f_t = (1+\pi_{t+1}) f_{t+1}$$

Dividing the above equation by $1+\pi_{t+1}$,

[14] Wickens (2008)
[15] This is also the average yield on the stock of foreign assets.

$$\frac{\left\{\frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right]\right\}}{(1+\pi_{t+1})} + (1+r_{t+1}^*) f_t = f_{t+1}$$

Assuming that the world interest rate $\pi_{t+1} = \frac{\Delta P_{t+1}}{P_t}$ is exogenous and constant so that $r_{t+1}^* \equiv r^*$ and noting that we can show the change in the net foreign asset is:

$$\Delta f_{t+1} = \frac{\left\{\frac{P_t^T}{P_t}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right]\right\}}{\left(P_{t+1}/P_t\right)} + r^* f_t$$

$$= \frac{P_t^T}{P_{t+1}}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right] + r^* f_t$$

Hence,

$$f_t = \frac{\left\{f_{t+1} - \frac{P_t^T}{P_{t+1}}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right]\right\}}{(1+r^*)}$$

$$f_t = \frac{f_{t+1+n}}{(1+r^*)^{n+1}} - \frac{1}{1+r^*}\sum_{s=0}^{n} \frac{\left\{\frac{P_{t+n}^T}{P_{t+n}}\left[x_{t+n}(Q_{t+n}^T) - Q_{t+n}^T x_{t+n}^m(Q_{t+n}^T)\right]\right\}}{(1+r^*)^n}$$

where *s=0,…,n*

If we assume that the transversality condition holds as n →∞, then

$$\lim_{n\to\infty} \frac{f_{t+1+n}}{(1+r^*)^{n+1}} = 0$$

$$f_t = -\left(\frac{1}{1+r^*}\right)\sum_{s=0}^{\infty} \frac{\left\{\frac{P_{t+s}^T}{P_{t+s}}\left[x_{t+s}(Q_{t+s}^T) - Q_{t+s}^T x_{t+s}^m(Q_{t+s}^T)\right]\right\}}{(1+r^*)^s}$$

If we also assume that the trade balance is a Martingale process, so that expected future trade balances equal the current balance then,

$$\mathrm{E}_t\left\{\frac{P_{t+s}^T}{P_{t+s}}\left[x_{t+s}(Q_{t+s}^T) - Q_{t+s}^T x_{t+s}^m(Q_{t+s}^T)\right]\right\} = \left\{\frac{P_t^T}{P_{t+1}}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right]\right\},$$

$$f_t = -\left(\frac{1}{r^*}\right)\left\{\frac{P_t^T}{P_{t+1}}\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right]\right\}$$

Hence, in long-run balance of payments must equilibrium the net foreign asset position can be either negative, positive or zero depending on whether the trade balance is positive, negative or zero. If we divided this equation by real GDP $\hat{y}_t$ in order to express the ratio of net foreign asset to GDP as ψ_t,

$$\psi_t = \frac{f_t}{\hat{y}_t}$$
$$= -\left(\frac{1}{r^*}\right)\left(\frac{P_t^T}{P_{t+1}}\right)\left\{\frac{\left[x_t(Q_t^T) - Q_t^T x_t^m(Q_t^T)\right]}{\hat{y}_t}\right\}$$

Solving the above expression gives the long-run equilibrium value of TOT,

$$Q_t^T = \frac{x_t(Q_t^T) + \psi_t r^* \left(P_{t+1} / P_t^T\right)\hat{y}_t}{x_t^m(Q_t^T)} > 0 \quad \text{since TOT} > 0$$

We now consider a log-linear approximation to the terms of trade, noting that:

1) If the net foreign asset is positive $\psi_t > 0$, then $Q_t^T > 0$.
2) If the net foreign asset is zero such as $\psi_t = 0$, then $Q_t^T = \frac{x_t(Q_t^T)}{x_t^m(Q_t^T)} > 0$.
3) If the net foreign asset is negative such as $\psi_t < 0$, and at the same time TOT always has to be positive; therefore, $x_t(Q_t^T) > \psi_t r^* \left(P_{t+1} / P_t^T\right)\hat{y}_t$.

The logarithm of the TOT is:

$$\ln Q_t^T = \ln\left[x_t(Q_t^T) + \psi_t r^* \left(P_{t+1} / P_t^T\right)\hat{y}_t\right] - \ln\left[x_t^m(Q_t^T)\right]$$
$$= \ln\left[x_t(Q_t^T)\right] - \ln\left[x_t^m(Q_t^T)\right] + \ln\left[1 + e^{\vartheta_t}\right]$$

If we let $\vartheta_t = \ln\left(\frac{\psi_t r^* \left(P_{t+1} / P_t^T\right)\hat{y}_t}{x_t(Q_t^T)}\right)$, then the first-order approximation around ϑ_0:

$$\ln\left(1 + e^{\vartheta}\right) \cong \xi\vartheta + \varsigma,$$

where $\xi = \frac{e^{\vartheta_0}}{1 + e^{\vartheta_0}}$ and $\varsigma = \xi\vartheta_0 + \ln\left(1 + e^{\vartheta_0}\right)$

Hence, approximately

$$\ln Q_t^T \approx \xi \ln \psi_t + \xi \ln r^* + \xi \ln P_{t+1} - \left[(\xi - 1)\ln x_t(Q_t^T) + \ln x_t^m(Q_t^T) + \xi \ln P_t^T - \xi \ln \hat{y}_t\right] + \varsigma$$

The term ψ_t is net foreign asset to GDP, the term of $\xi \ln r^* + \xi \ln P_{t+1}$ expresses the world real interest rate or marginal product of capital in tradable sector, the term of $\left[(\xi - 1)\ln x_t(Q_t^T) + \ln x_t^m(Q_t^T) + \xi \ln P_t^T - \xi \ln \hat{y}_t\right]$ depends on terms of trade because the balance of trade is a function of terms of trade. Hence, we can see the effect of terms of trade changes on the balance of trade. As a result, we can see the classical transfer effect pointed out by Keynes.[16]

The Inter-Temporal Equilibrium in the Tradable and Non-Tradable Goods Markets

The behavior of sectoral relative prices between countries (*i.e.* the forcing variables that influence these relative prices) determines the evolution of the real exchange rate. We assume Cobb-Douglas technology for the production of tradable and non-tradable goods, and we denote θ and δ the elasticity of output with respect to labor in the tradable and non-tradable sector, respectively, where $0 < \theta < \delta$,

$$Y_t^T = A_t^T \left(L_t^T\right)^{\theta} \left(K_t^T\right)^{1-\theta}$$
$$Y_t^N = A_t^N \left(L_t^N\right)^{\theta} \left(K_t^N\right)^{1-\theta}$$

Differentiating the production function of the tradable and non-tradable sectors with respect to labor (L), while holding capital (K) constant, we find that the marginal product of labor is:

$$MP_H^T = \frac{\partial Y_t^T}{\partial L_t^T} = A_t^T \theta \left(\frac{K_t^T}{L_t^T}\right)^{1-\theta} = \theta \frac{A_t^T \left(L_t^T\right)^{\theta} K_t^T}{L_t^T} = \theta \frac{A_t^T Y_t^T}{L_t^T}$$

$$MP_H^N = \frac{\partial Y_t^N}{\partial L_t^N} = A_t^N \delta \left(\frac{K_t^N}{L_t^N}\right)^{1-\delta} = \delta \frac{A_t^N \left(L_t^N\right)^{\delta} K_t^N}{L_t^N} = \delta \frac{A_t^N Y_t^N}{L_t^N}$$

Assuming labor is mobile across sectors but not across countries implies that wages in the tradable and nontradable sectors within a country are equal (in nominal terms), that is:

$$W = W^T = W^N$$

Since the nominal wage is a product of the marginal product and price,

$$W = \frac{\partial Y}{\partial L} \times P$$

the real wage can be expressed as:

[16] Lane and Milesi-Ferretti (2004) show that the size of the transfer effect is related to country characteristics such as trade openness, output per capita, country size, the composition of external liabilities, and restrictions on the external payments system.

$$\frac{W}{P} = \frac{\partial Y}{\partial L}$$

Calculating the ratio of real wages in the tradable sector relative to the non-tradable sector yields:

$$\frac{W^T / P^T}{W^N / P^N} = \frac{\partial Y^T / \partial L^T}{\partial Y^N / \partial L^N} = \frac{\theta \frac{A_t^T Y_t^T}{L_t^T}}{\delta \frac{A_t^N Y_t^N}{L_t^N}} = \left(\theta / \delta\right)\left(\frac{A_t^T}{A_t^N}\right)\left(\frac{y^T}{y^N}\right)$$

Assuming that technological progress between sectors is equal, then

$$\frac{P_t^N}{P_t^T} = \left(\theta / \delta\right)\left(\frac{y^T}{y^N}\right)$$

where $$y^i = \frac{Y_t^i}{L_t^i}, \; i = T, N$$

The following is also true from formula *(1)*:

$$\frac{P_t^N}{P_t^T} = \left(\theta / \delta\right)\left(\frac{y^T}{y^N}\right) = \left(\frac{C_t^T}{C_t^N} \frac{\alpha}{1-\alpha}\right)^{1/\gamma}$$

Expressing the equation above in logs,

$$p^N - p^T = \log\left(\theta / \delta\right) + y^T - y^N$$

As a result, the tradable to non-tradable price differential is equal to the productivity of the tradable sector relative to the non-tradable sector. Hence, the sectoral price differential in the inter-temporal equilibrium in the goods market is determined by:

$$\left[p_t^N - p_t^T\right] = \log\left(\theta / \delta\right) + \left(y_t^T - y_t^N\right)$$

We substitute this into the exchange rate associated with inter-temporal equilibrium in tradable and non-tradable goods. We obtain:

$$\begin{aligned} q^{PRO} &= \phi\left[p^N - p^T\right] - \phi^*\left[p^{N*} - p^{T*}\right] \\ &= \phi\left[\left(y^T - y^N\right) - \left(y^{T^*} - y^{N^*}\right)\right] + \varsigma \\ &= \phi HBS + \varsigma \end{aligned}$$

where $\varsigma = \phi\left[\log\left(\theta / \delta\right) - \log\left(\theta / \delta\right)^*\right]$ and $\phi = \phi^*$

Note that we obtain the last step by assuming identical preferences between domestic and foreign consumers —that is:

(a) The shares of tradable and non-tradable consumption in total consumption are similar for the representative domestic and foreign agents, and
(b) The elasticity of substitution is similar for the representative domestic and foreign agents.

HBS_t denotes the Harrod-Balassa-Samuelson productivity term. If tradable goods productivity relative to non-tradable goods productivity is growing faster at home than abroad, home currency should appreciate in real terms (i.e. HBS effect). The empirical long run RER model can be expressed as the sum of inter-temporal BOP equilibrium and inter-temporal equilibrium in the goods market to give:

$$\begin{aligned} q &= q^{BOP} + q^{PRO} \\ &= f\left(nfa, TOT\right) + g\left(\text{HBS}\right) \end{aligned}$$

For empirical purposes we express these as:

$$q_{ti} = \beta_0 nfa_{ti} + \beta_1 TOT_{ti} + \beta_2 HBS_{ti} + \varepsilon_{ti}$$

The Model Prediction

According to the theoretical model we expect a positive relationship between RER and productivity (*HBS* effect) as well as between RER and terms of trade. This is consistent with De Gregorio, Giovannini and Wolf (1994) where permanent surges in productivity and favorable TOT shocks may appreciate RER (*i.e.* positive relationship). This theoretical model also predicts a positive relationship between the ratio of NFA to GDP and RER in the long run. This is consistent with the *transfer effect* predicted by Lane and Milesi-Ferretti (2004), where a transfer of external wealth from the foreign to the domestic country will appreciate RER in the long run.

4. The Data

This section provides the description and sources of the data on RER and its fundamentals used in our empirical analysis. Our data is annual for a sample of 79 countries from 1970 to 2005. The determinants of RER are the ratio of net foreign asset to GDP (*NFAy*), terms of trade (*TOT*) and the productivity differentials (*Prod*).

Our dependent variable is *REER* defined as domestic price index of country *i* vis-à-vis the price index of its main trading partners multiplied by the nominal exchange rate (NER) of country *i*,

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

where e_{it} is the NER of country i (*vis-à-vis* the US dollar) in period t, P_{it} is the consumer price index of country i in period t, d_{kt} is the NER of the k-th trading partner of country k in period t (in units of local currency *vis-à-vis* the US dollar), and P_{kt}^{0} is the wholesale price index of the k-th trading partners in period t. The *NER*, e, is proxied by the average price of the dollar in local currency (line *rf* of the International Monetary Fund's International Financial Statistics (IFS). Domestic and foreign prices, P, are proxied by the consumer price index of the country (line *64* of IFS). According to this definition, an increase in q implies a real appreciation of the domestic currency.

NFA data is drawn from Lane and Milesi-Ferretti (2001, 2007). This database comprises a set of foreign asset and liability stocks for a large group of industrial and developing countries from 1970 to 2005. The data construction is documented in Lane *et al.* (2001, 2007), and the NFA position of country i in year t is defined as:

$$NFA_{it} = \left[FDIA_{it} - FDIL_{it}\right] + \left[EQYA_{it} - EQYL_{it}\right] + \left[RA_{it} + LA_{it} - LL_{it}\right]$$

where the letters A and L denote assets and liabilities, respectively. Thus, the net foreign asset position is the sum of net holdings of direct foreign investment, *FDIA-FDIL*, plus net holdings of portfolio equity assets, *EQYA-EQYL*, and the net position in non-equity related assets (*i.e.* "loan assets"). In turn, the net position in non-equity related assets consists of international reserves, *RA*, and the net loan position, *LA-LL*.

For *productivity differentials* we use labor productivity differentials weighted by the trade patterns. Then, we develop the data on labor productivity of traded and non-traded sectors based on ISIC code classifications of the economic activity.[17] 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. This is our "*productivity index"*. *TOT* is the ratio of export to import prices. Data are taken from IMF, the World Bank, OECD, national central banks.

[17] 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).

5. Econometric Methodology

This section describes the econometric techniques used in our analysis of the dynamics of RER misalignments. After modeling RER misalignments, we assess the estimates of the long-run RER equation that allows us to calculate the RER misalignment (or deviation from the long-run equilibrium). Our long-run equilibrium RER values would be *model dependent*; hence, it relies on the specification and set of fundamentals included in the analysis —*i.e.* these fundamental are *NFAy*, *Prod* and *TOT*.

Stationarity and cointegration tests. To estimate the long-run RER equation we first check whether the RER and its fundamentals exhibit a unit root or are stationary processes. We conduct time series and panel data unit root tests. For time series, we conduct Augmented Dickey-Fuller (ADF) unit root tests. We then proceed to conduct panel unit root testing. More specifically, we use homogeneous panel unit root tests such as Maddala and Wu (1999), Levin, Lin and Chu (2002), and heterogeneous tests like that of Im, Pesaran and Shin (2003) and Pesaran (2007).

Analogously, we conduct tests of cointegration developed for time series and for panel data. In the case of time series, we use the multivariate cointegration analysis developed by Johansen (1988, 1991) to estimate cointegrating vectors and, hence, characterize the long-run relationship between the RER and its fundamentals. In addition to the Johansen methodology, we use the Wickens and Breusch methodology (1987) to estimate the ECM on a country-by-country basis. This implies simply estimating a linear transformation of the ARDL model. One of the advantages of this method is that the ECM regression can instantaneously provide parameters to explain the extent of short-run adjustment to disequilibrium (Banerjee et al, 1993). The Wickens-Breusch estimator belongs to the IV estimator family and is an alternative to the Engle-Granger (1987) estimator. For panel data, we use homogeneous panel cointegration tests by McCoskey and Kao (1998), Kao (1999), and heterogeneous tests implemented by by Pedroni (1999). The estimation of regressions with non-stationary panel data is addressed by using non-stationary time series techniques for heterogeneous panels such as the *Mean Group Estimator* (MGE) by Pesaran, Smith and Im (1996) and the PMGE by Pesaran, Shin and Smith (1999).

The empirical implementation of the model on a large cross-country time-series sample poses two main challenges. First, although the model defines a long-run relationship among the RER and its fundamentals, the RER may not always be in equilibrium at every point in time due to imperfections, rigidities or regulations. The equilibrium may be achieved gradually in the long run. Hence, in the empirical analysis, the process of a short-run adjustment must complement the long run equilibrium model.

Second, it is reasonable to assume that countries can differ regarding, for instance, market imperfections (*e.g.* labor or product market rigidities), monetary arrangements or different access to the international goods and capital markets —and perhaps even in the parameters characterizing the long-run equilibrium. Thus, it is important to take into account the very likely possibility of parameter heterogeneity across countries. We deal with each of these two issues in turn.

As a result, we implement both the ECM and the PMGE techniques to provide us with even broader avenues to approach to estimate our RER equation.

Pooled Mean Ggroup Estimator

Single-Country Estimation

The challenge that we face is to estimate long- and short-run relationships without being able to observe long- and short-run components of the variables involved. Over the last decade or so, a booming cointegration literature has focused on the estimation of long-run relationships among I(1) variables (Johanssen 1995, Phillips and Hansen 1990). From this literature two common misconceptions have been derived: (a) long run relationships exist *only* in the context of cointegration of integrated variables. (b) Standard methods of estimation and inference are incorrect. Pesaran and Smith (1995), Pesaran (1997) and Pesaran and Shin (1999) argue against both misconceptions, showing how small modifications to standard methods can render consistent and efficient estimates of the parameters in a long-run relationship between integrated and stationary variables.[18] Furthermore, the methods proposed by Pesaran

[18] Pesaran and Smith (1995), Pesaran (1997), and Pesaran and Shin (1999) propose the assumptions and properties of the ARDL method to estimate a long-run relationship. The standard estimation and inference can be used whether the regressors are stationary or integrated. The main assumption is a single long-run relationship between the endogenous and forcing variables. It is worth noting that this assumption underlies implicitly the various single-equation based estimators of long-run relationships commonly found in the cointegration literature. Without such assumption, these estimators would at best identify some linear combination of all the long-run relationships present in the data. For consistency and efficiency the shocks in the dynamic specification has to be serially uncorrelated and the forcing variables has to be strictly exogenous. The pre-requisites can be met by augmenting sufficiently the lag order of the dynamic regression equation. For practical purposes Pesaran and Shin

et al avoid the need for pre-testing and order-of-integration conformability given that they are valid whether or not the variables of interest are I(0) or I(1). The main requirements for the validity of this methodology are such that: one, there exists a long-run relationship among the variables of interest and, another, the dynamic specification of the model be augmented such that the regressors are strictly exogenous and the resulting residual is not serially correlated. For reasons that will become apparent shortly, Pesaran *et al* call their method "an autoregressive distributed lag (ARDL) [19] approach" to long-run modeling.

Multi-Country Estimation

Typically, the appropriate sample for the implementation of these techniques is characterized by time-series (T) and cross-section (N) dimensions of roughly similar magnitude. In such conditions, there are a number of alternative methods for multi-country estimation, which allow for different degrees of parameter heterogeneity across countries. At one extreme, the fully heterogeneous-coefficient model imposes no cross-country parameter restrictions and can be estimated on a country-by-country basis— provided the time-series dimension of the data is sufficiently large. When the cross-country dimension is large, the mean of long- and short-run coefficients across countries can be estimated consistently by the un-weighted average of the individual country coefficients. This is the MGE introduced by Pesaran, Smith, and Im (1996). At the other extreme, the fully homogeneous-coefficient model requires that all slope and intercept coefficients be equal across countries. This is the simple "pooled" estimator.

(1999) recommend a two-step procedure while choosing the lag order with a consistent information criterion, and then the corresponding error-correction model is estimated and tested by standard methods.

[19] The comparison of the asymptotic properties of PMGE and MGE can be put in the general trade-off between consistency and efficiency. If the long-run coefficients are equal across countries, then the PMGE will be consistent and efficient while the MGE will only be consistent. If the long-run coefficients are not equal across countries, then the PMG estimates will be inconsistent while the MGE will be still a consistent estimate of the mean of long-run coefficients across countries. The long-run homogeneity restrictions can be tested by Hausman or likelihood ratio tests to compare the PMGE and MGE of the long run coefficients. Comparison of the small sample properties of these estimators relies on their sensitivity to outliers. In small samples (low T and N) the MGE, being an unweighted average, is excessively sensitive to the inclusion of outlying country estimates (for instance those obtained with small T). The PMGE performs better in this regard because it produces estimates that are similar to *weighted* averages of the respective country-specific estimates where the weights are given according to their precision which is the inverse of their corresponding variance-covariance matrix.

In 'between two extremes', there are a variety of estimators. The "dynamic fixed effects" estimator restricts all slope coefficients to be equal across countries but allows for different country intercepts. The PMGE introduced by Pesaran, Shin, and Smith (1999), restricts the long-run coefficients to be the same across countries but allows the short-run coefficients (including the speed of adjustment) to be country specific. The PMGE also generates consistent estimates of the mean of short-run coefficients across countries by taking the unweighted average of the individual country coefficients (provided that the cross-sectional dimension is large).

In choosing between these estimators there is a general trade-off between consistency and efficiency. Estimators that impose cross-country constraints dominate the heterogeneous estimators in terms of efficiency if the restrictions are valid. If they are false, however, the restricted estimators are inconsistent. In particular, imposing invalid parameter homogeneity in dynamic models typically leads to downward-biased estimates of the speed of adjustment (Robertson and Symons, 1992; Pesaran and Smith, 1995).

For our purposes, the PMGE offers the best available compromise in the search for consistency and efficiency. This estimator is particularly useful when the long run is given by country-independent equilibrium conditions while the short-run adjustment depends on country characteristics such as financial development and relative price flexibility. The PMGE is sufficiently flexible to allow for the long-run coefficient homogeneity over only a subset of variables and/or countries.

We use the PMG method[20] to estimate the long run relationship which is common across countries while allowing for unrestricted country heterogeneity in the adjustment dynamics. In the PMGE process the estimation of the long-run coefficients is jointly estimated across countries through a (concentrated) maximum likelihood procedure. The estimation of short-run coefficients (including the speed of adjustment), country-specific intercepts, and country-specific error variances is estimated on a country-by-country basis through maximum likelihood with using the estimates of the long-run coefficients previously obtained. An important assumption for the consistency of our PMG estimates is the independence of the regression residuals across countries. In practice, non-zero error covariances usually arise from *omitted* common factors that influence the countries' ARDL processes.

[20] Please also refer to Pesaran, Shin, and Smith (1999) where the PMGE is developed and compared with the MG estimator.

5.1. Modeling the RER Misalignment and its Short-and Long-Run Behavior

We have derived the long-run equilibrium solution for the RER which consists of two components in Section 3. In the short run the RER and the two components may deviate from the long-run equilibrium. We refer to the deviation of the RER as its misalignment. Our measure of misalignment in logarithms is:

$$mis_t = q_t - \overline{q}_t$$
$$= (q_t^{BOP} + q_t^{PRO}) - (\overline{q}_t^{BOP} + \overline{q}_t^{PRO})$$

We assume that the dynamic adjustment of the RER back to equilibrium is modeled by the ECM:

$$\Delta mis_t = \sum_{i=1}^{m} \beta_i \Delta mis_{t-i} + \sum_{j=0}^{n} \gamma_j \Delta \overline{q}_{t-j} - (1-\alpha) mis_{t-1} + u_t$$

where $i=1,\ldots,m$ and $j=0,\ldots,n$

This can also be written as an ECM in terms of q_t and $\overline{q}_t$. Our econometric model is given by,

$$q_t = \sum_{i=1}^{m} \alpha_i q_{t-i} + \sum_{j=0}^{n} \beta_j x_{t-j} + u_t \qquad (2)$$

$$\overline{q}_t = \frac{\sum \beta_j}{1 - \sum \alpha_i} \cdot x_t \qquad (3)$$

Wickens and Breusch (1987) show the equivalence of estimates from different transformations in the ECM such as IV estimation with ARDL regressors by Bewley (1979). The transformation by Bardsen (1989) is treated as a variant of the ECM and another transformation is an estimation of the general ECM with OLS by Banerjee, Galbraith and Dolado (1990). In order to estimate the ECM modeled in Section 3 we use the following empirical model:

$$\Delta q_t = \mu - (1-\alpha)(q_{t-1} - \theta x_{t-1}) + (\beta - \theta)\Delta x_t + e_t \qquad (4)$$

where q is the real exchange rate and $x = \begin{pmatrix} TOT \\ NFAy \\ \mathrm{Pr}\,od \end{pmatrix}$ is the matrix of the RER fundamentals. Note that both *TOT* and *Prod* are expressed in logs. After running the regression *(4)*, we plot $\{\alpha_i\}_{i=1}^{n}$ coefficients where *n* is the number of countries in our sample (i.e. n = **79**). Then we run the second regression with 3 lags:

$$\Delta q_t = \nu + L\Delta q_{t-1} + L\overline{q}_t + \varepsilon_t \qquad (5)$$

6. Empirical Assessment

In this section we discuss the empirical results on the long-run RER equation and the calculation of RER misalignments. We not only show evidence on the stochastic properties of the RER and its fundamentals—*NFAy*, *Prod* and *TOT*— (see Section 4) but also examine the validity of the fundamental RER equation as a long-run cointegration relationship. The following subsections report evidence on the existence of unit roots in the RER and its determinants and the presence of cointegration on both time-series and panel. Finally, we assess the calculation of RER misalignments.

6.1. Unit Roots

Time Series Unit Roots

Before testing for the existence of a cointegrating relationship between RER and its fundamentals, it is required to examine the stochastic properties of each series involved in our analysis. We need to test whether RER, the ratio of net foreign assets to GDP, relative productivity and the terms of trade are stationary or not.

Table 1 shows ADF tests on country-by-country information of the real effective exchange rate (REER) and its fundamentals. The REER is, for most countries, non-stationary in log levels and stationary in log differences. Hence, the real exchange rate is a I(1) process for all countries. Moreover, in most cases its fundamentals are stationary in differences —that is I(1).

Table 2 summarizes the country-by-country ADF test for unit root presented in Table 1. Our results fail to reject the null of non stationary at the 5% significance level for the long level of the REER in more than 90% of the 118 countries. We reject the null of unit root in levels for 8% of the sample; hence, RER is not stationary in log levels in 92% of the cases at the 5% level of significance.

At the 5% significance level the ADF tests reject the null hypothesis for *TOT* (in log levels) in 12% of the countries. Hence, *TOT* is non-stationary in log levels in 88% of our sample. *Prod* is stationary in log levels in 6% of our sample. For 94% of the countries the *Prod* series is not stationary in levels. *NFAy* is stationary in log levels in 4% of our sample; therefore, for 96% of the countries *NFAy* is not stationary in levels and has a unit root. For the series in differences, we find that, at the 5% significance level, we reject the null hypothesis for the REER and its fundamental in almost all countries (at least 99% of the countries); hence, they are stationary with expressed in first differences. Combining the evidence presented in levels and first differences, for most of our countries, RER and its fundamentals are I(1) processes in differences.

Panel Unit Root testing

We conduct both homogeneous and heterogeneous panel unit root tests: homogeneous tests developed by Levin, Lin and Chu (2002) and Maddala and Wu (1999) as well as heterogeneous tests by Im, Pesaran and Shin (2003) and Pesaran (2007).

Homogeneous tests assume that the AR(1) coefficient in the unit roots testing is equal across countries while heterogeneous tests address the issue of differences in the degree of persistence of the series across countries. The evidence presented in Table 3 shows the existence of panel unit root in the levels of REER and its fundamentals.

Table 3 shows that regardless of the panel unit root test used —homogeneous or heterogeneous— we are unable to reject the null of non-stationary for all the panel data series in levels and we also reject the null of unit root for all the panel data series in differences. Hence, the panel unit root testing confirms that our series are I(1).

6.2. Cointegration Analysis

Time-Series Cointegration Test: the Trace Test (Johansen, 1988, 1991)

We perform the multivariate time-series cointegration analysis of REER, *NFAy*, *TOT*, and productivity differentials. For the latter specification we use different proxies such as the *productivity index* and the productivity in each sector is included separately.

To test for cointegration we follow the methodology developed by Johansen (1988, 1991) and compute the trace test that examines the number of cointegrating vectors within the vector of variables. In the presence of more than 2 variables, there is the possibility of the existence of more than one cointegrating relationship. The trace and maximum eigenvalue (λ-max) tests indicate whether there is cointegration and, if so, whether there is more than one cointegrating relationship.

Table 4 reports the trace tests of cointegration for the 79 countries of our sample from 1970 to 2005. To select the optimum lag of the VECM model used to calculate the trace tests we use the Schwartz Bayesian information criterion (SBIC); therefore, the optimal lag would be the one that minimizes the information criterion. We test for the existence of multivariate cointegration using the Johansen methodology in the vector [REER *NFA*y *TOT Prod*]. Then we test for the null of: (a) no cointegration (r=0), (b) at most 1 cointegrating vectors (r ≤1), (c) at most 2 cointegrating vectors (r≤2), and (d) at most 3 cointegrating vector (r ≤3). Hence, for most countries there is evidence of cointegration, and in some cases, there is more than one cointegrating relationship.

Table 5 summarizes the country-by-country trace tests computed in Table 4. We report the percentage of countries in our sample where we reject the null hypothesis and *r* is the number of vectors of cointegration. At the 10% significance level, 86% of the countries are able to reject the null of no cointegration (r≤0); therefore, there is 1 vector of cointegration for 86% of the countries. For 28% of our sample we reject the null that there is at most 1 vector of cointegration (r≤1). Hence, there are 2 vectors of cointegration for 28% of our sample.

Panel Cointegration Tests

In addition to time series cointegration tests *a la* Johansen, we compute homogeneous and heterogeneous panel cointegration tests for RER and its fundamentals. The tests applied are mostly residual-based tests of panel cointegration: some of these tests are homogeneous (McCoskey and Kao, 1998; Kao, 1999) and others allow some degree of heterogeneity either in the variance-covariance matrix or estimated parameters across countries (Pedroni, 1999). The results for the full sample of countries are reported in Table 6. The evidence shows that the null of no cointegration is rejected regardless of the panel cointegration test used. There is a cointegrating relationship between RER and its fundamentals in the panel data.

Panel Estimation of the Long-Run RER Equation: Homogeneous Techniques

In Table 8 we present the estimates of the panel cointegration techniques developed by Kao (1999) and Phillips and Moon (1999) —the dynamic least squares (*DOLS*) and the fully-modified OLS (*FM-OLS*) for panel data, respectively. Columns [1] and [2] include the ratio of traded to non-traded productivity while columns [3] and [4] include only productivity in the traded sector. We include only productivity in the non-traded sector in columns [5] and [6] and add productivity in traded and non-traded sectors in columns [7] and [8], separately. Our discussion of the results would be limited to the dynamic least squares estimation given that, according to Kao (1999), *DOLS* estimates are empirically more efficient than *FM-OLS* ones.

Column [2] shows the estimation results of our preferred specification. The coefficient of *NFAy* is negative but statistically not significant while the coefficient of both *TOT* and *Prod* are positive and statistically significant at the 5% level. Hence, favorable shifts in TOT and relative productivity surges in the traded sector are forces that lead to an appreciation of RER. This result is consistent with the predictions of our model. When we add separately traded sector productivity (column [4]) and non-traded productivity (column [6]), these coefficients are positive and significant. However, while adding both in the regression (column [8]), only the coefficient of productivity in the trade sector remains statistically different from zero. This implies that the result may be driven by the impact of the surges in productivity of the traded sector. These regression estimates assume that the coefficient estimates of our long run RER equation are constant across countries. To prove whether this assumption is valid or not we will test the homogeneity assumption across our long-run coefficients.

6.3. PMGE of the Long-Run RER Equation

We estimate the ARDL model for REER on its fundamentals using MGE (Pesaran, 1995), PMGE (Pesaran et al., 1999), and the dynamic fixed effects[21]. We estimate this relationship both for the full sample of countries (see Table 9) and for dividing the sample by level of development in Table 10.[22]

We also consider partitioning the sample of countries by the nature of their export structure. Groups of countries that are *major exporters* of specific categories of goods are by a major export category. This category accounts for 50% or more of total exports of goods and services.[23] Our regressions are with major exporters of *non-fuel*

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[21] We note while MGE does not impose any restriction on the long-run coefficients of the RER equation, PMGE imposes common long-run effects across countries. The fixed effect (FE) estimator constrains all of the slope coefficients and the variance-covariance matrix of the error terms to be homogeneous across countries.

[22] The sample of Asian countries includes Bangladesh, China, India, Indonesia, Korea, Malaysia, Pakistan, Papua New Guinea, Philippines, Singapore, Sri Lanka and Thailand.

[23] We consider the following categories: non-fuel primary exporters (SITC 0,1,2,4, plus 68) and fuel exporters (SITC 3). We also consider the group of primary exporters as a group (PRIM) which is the sum of the 2 groups mentioned before.

primary goods[24], major exporters of fuel (mainly oil)[25] and the group of primary exporters (PRIM) listed among major exporters of fuel and non-fuel primary products.

Full Sample of Countries

Overall if we impose no restrictions, only *TOT* is significant. With the PMG regression the ECM equation shows significant estimates; hence, we reject the null hypothesis of no long run relationship with REER, *TOT*, *NFAy* and *Prod*. The average speed of adjustment is faster with the MGE (-0.360) than with the PMGE (-0.171). According to the MGE results, on average, *TOT* and *NFAy* show a positive and statistically significant coefficient similar to the case in the PMGE. These cross-country average long-run coefficients by MG are larger than those by PMG.

The Hausman test[26] of the null hypothesis performed both variable by variable and jointly is not statistically significant (*i.e.* $\beta_{PMG}=\beta_{MG}$). The results show that there are no systematic differences between PMGE and MGE of our long-run RER equation. This evidence suggests that assuming homogeneity across countries for the long-run coefficients of the RER equation is a valid assumption. There are no systematic differences between MG and FE estimates either.

Industrial and Developing Countries

In industrial countries the PMGE shows that *TOT* and *NFAy* have a positive and significant coefficient (as expected by the theoretical model) whereas *Prod* shows a puzzlingly negative and significant coefficient. The significant ECM coefficient suggests that there is a significant error correction mechanism and that approximately 17% of the deviations from the ERER would be eliminated next period. *TOT* has a positive impact on RER in the short run with a coefficient of 0.117.

For developing countries the PMGE results show that *TOT* has a positive and significant coefficient while the coefficient of *NFAy* is positive although not statistically significant. *Prod* still shows a negative and significant coefficient. The

[24] The sample of major exporters of non-fuel primary goods include Argentina, Bolivia, Botswana, Chile, Dem. Rep. of Congo, Cote d'Ivoire, Ghana, Guatemala, Honduras, Iceland, Madagascar, New Zealand, Nicaragua, Niger, Papua New Guinea, Paraguay, Peru, Togo, Zambia and Zimbabwe.

[25] This group includes Algeria, Rep. of Congo, Iran, Trinidad and Tobago and Venezuela.

[26] This test examines whether the differences in the coefficient estimates by the MGE and the PMGE are statistically similar or different.

existence of a significant error correction mechanism confirms that approximately 21% of the deviations from the ERER would be eliminated next period. *TOT* has a positive impact on RER in the short run.

The MGE results in industrial countries find that, on average, *TOT* and *NFAy* show a positive and statistically significant coefficient similar to the PMGE. These cross-country average long-run coefficients of MG are larger than those of PMG. The ECM coefficient is also negative and significant, and it is more doubles than the one obtained by PMG. Movements in its fundamentals do not seem to affect RER in the short run. The MGE results in developing countries find qualitatively similar results to ones in the full sample. The average coefficient for *TOT* is positive and statistically significant similar to the magnitude of its coefficient by PMG. The average ECM coefficient is negative and significant and it is larger than the one obtained by PMG. Movements in *TOT* lead to a real appreciation in the short run.

Emerging Market Economies and Asia

The results of PMG in EMEs are also qualitatively similar to those obtained for industrial economies. We find a robust positive relationship between RER and *TOT* as well as between RER and the *NFAy*. The relationship between RER and *Prod* is negative and significant. The ECM coefficient in EMEs is significant and larger than that of industrial economies. This implies that the speed of reversion to the ERER is faster among EMEs than among industrial economies. The short-run shifts of its fundamentals do not seem to affect RER. The PMGE of Asian countries show that only the *NFAy* has a positive and significant coefficient (as expected by the theoretical model) whereas *Prod* and *TOT* show negative coefficients. The significant ECM coefficient suggests that approximately 20% of the deviations from ERER would be eliminated next period. *TOT* has a positive impact on RER in the short run.

The MGE in EMEs show that the coefficient estimates for all fundamentals are positive (as expected by theory) but only *TOT* is significant. Hence, the ECM is, on average, faster than the one computed by PMG. The MG estimates for Asia yield average positive coefficients for *NFAy* and *Prod* with the latter coefficient being statistically significant at the 10% level. The ECM is negative, significant and higher than the one obtained by PMG. The TOT shifts affect RER in the short run.

Countries Classified by Major Export Goods

We run the PMGE model for PRIM and non-PRIM. The results for both sub samples are qualitatively similar to those found in a full sample as the coefficient of *TOT* and *NFAy* is positive and significant (as expected in the model) while the coefficient of *Prod* is negative and significant. Approximately 20% of the deviations from ERER in PRIM would be eliminated next period while so would the ones in non-PRIM with approximately 16%. Movements in the fundamentals do not affect RER in the short run in either PRIM or non-PRIM.

With the MGE, on average, for both PRIM and non-PRIM the coefficient of *TOT* is positive and significant while the coefficient of *NFAy* and *Prod* is negative although not significant. The ECM is negative, significant and more doubles than the one by PMG. Shifts do not affect RER in the short run in either PRIM or non-PRIM.

Additional regression is for major exporters of non-fuel primary products. We exclude the major exporters of oil from our sample. Only the coefficient of *TOT* has the expected positive sign and statistically significant with the PMGE. The significant ECM coefficient suggests that approximately 20% of the deviations from ERER would be eliminated next period; hence, shifts in the fundamentals do not matter in the short run. We found no statistically significant fundamental with the MGE.

6.4. Estimations on RER Misalignments

Estimating the Fundamental Real Exchange Rate Equation

Table 7 presents the coefficient estimates for the long-run RER equation for the 79 countries from 1971 to 2005. The country-by-country estimates of the long run RER equation are consistent with predictions of the theoretical model. In almost 80% of the country estimates the relationship between *TOT* and REER is positive while it is positive in almost 50% of the cases for *NFAy*. Approximately 40% of the country estimates yield a positive relationship between RER and *Prod*.

Calculating Real Exchange Rate Misalignments

To calculate the RER misalignment we use first the estimated cointegrating vector (normalized in RER) obtained by Johansen (1988, 1991) and Johansen and Juselius (1992). Then we multiply the long run coefficients of *TOT*, *NFAy* and *Prod* with the permanent values of these variables which is the *trend* component of the series using the band-pass filter (Baxter and King, 1999)[27]. RER misalignments are computed as deviations of the actual RER from its equilibrium value.[28]

We report the charts of some selected economies for RER misalignments that signal not only undervaluation episodes but also currency crisis (see Figure 1.1-1.4).

China. We observe that the real value of the Remnibi has been undervalued by more than one-third (72 %) in 2005. This result confirms the findings of Chinn et al (2007) on the RER undervaluation in China and its tendency of keeping the RER undervalued in order to accelerate their economic growth (Cheung et al, 2007).

Argentina. We first observe a 32 % drop in the RER misalignment in 2002 due to the economic crisis. The government had to abandon the *convertibility system* (1-to-1 hard peg to the US dollar). After the currency crisis, Argentina has followed a more aggressive activist exchange rate policy, thus keeping its currency undervalued in real terms. Finally, the overvaluation of the RER by the end of the 1990s preceded the currency crisis and the fixation of the RER (*currency board* or convertibility system).

Other Countries. The Brazilian real experienced its currency crisis in 1999 as you can see the 7% fall in its misalignment while they reached its historic low of 4 Brazilian real per US dollar in 2002. We can also see these drops in RER misalignments before Asian crisis such as a 25% drop in Korea and about 50% in Thailand in 1998. In Mexican crisis its misalignment started to drop in 1994 (this happened in December) then a 28% drop in 1995.

Error Correction Modeling of RER Misalignments

Figure 2.1 shows the histogram of the estimated ECM, α coefficient, from equation *(4)*. Most of the estimated values are between 0.4 and 0.8 and the mode of the distribution[29] is around 0.7. This implies that, for most countries, 30% of the RER

[27] Linear (or quadratic) trend models as well as first-differences do not produce desirable business-cycle filters while moving-average analysis and HP filter produces a reasonable approximation in filtering. The problem with the latter is that it may be biased towards zero deviations from the trend at the end of period. The advantage of the band-pass filter is that it passes through components of the time series with periodic fluctuations between six and thirty two quarters while removing components at higher and lower frequencies. These cut-off points are selected using the business cycle analysis at the NBER. The band-pass filter produces more flexible and easier to implement more accurate approximation to the optimal filter.

[28] Note that: positive (negative) deviations from the equilibrium represent an overvaluation (undervaluation) of RER.

[29] According to the mode of distribution, the half life of RER deviations from the equilibrium is equal to $2.31 \approx \left(\frac{\ln 0.5}{-(1-0.7)} \right)$.

disequilibrium in the previous period would be corrected in the current period. Figure 2.2 plots the values of α coefficient which fluctuate from 0.0857 to 0.997. For example, while Singapore shows almost immediate correction of RER disequilibrium, the speed to adjustment is fairly low in Congo.

Table 11 shows the ECM estimations for eight selected countries[30]. Those selected countries have a statistically significant negative coefficient for lagged RER between 0.3 and 0.8. South Africa is the only exception: the RER reversion coefficient is statistically negligible. Mean reversion of RER is faster in China of -0.8 significant coefficient than in Argentina of -0.66. In addition, short-term TOT and productivity fluctuations —as measured by the estimated coefficients of the log differences of *TOT* and *Prod*— have a positive impact on log difference of RER in Argentina. This implies that it leads to an appreciation of the domestic currency. In China, on the other hand, only short-run movements in NFAs may lead to exchange rate appreciation. Most of selected countries show negative coefficient in lagged productivity differentials except China, South Africa and Germany which have a positive coefficient and Germany's coefficient is statistically significant.

The selected countries have mostly positive coefficient in lagged TOT except China which has a negative significant coefficient. Only China has a negative coefficient of lagged *NFAy* which is statistically significant. Other seven countries have positive coefficient estimates for the difference in TOT. Five countries show statistically significant coefficients while only China shows negative insignificant coefficient. In the most of countries temporary positive TOT shocks may appreciate the RER in the short run. The coefficients of difference in *NFAy* and *Prod* are mixed.

Figure 2.3 reports the histogram of the standard error of α coefficients. We observe that most of the standard errors fluctuate between 0.1 and 0.2 and that the mode of the distribution is around 0.125. It seems to be normally distributed. Therefore, most of estimated α coefficients are statistically significant.

Next we run a vector autoregression (VAR) model for the difference of RER on lagged RER, lagged *TOT*, lagged *NFAy*, lagged *Prod*, difference of *TOT*, difference of *NFAy* and difference of *Prod*. Figures 2.4 through 2.7 depict the response of change in RER to impulses/shocks to lagged RER, lagged fundamentals and change in fundamentals for the full sample in equation *(4)*. Figures 2.4 and 2.5 present the

[30] Argentina, Australia, Chile, China, Germany, New Zealand, United Kingdom and South Africa.

impulse-response function (IRF) of changes in RER on the different determinants for Argentina whereas Figures B6 and B7 present analogous results for China.

Figure 2.4 shows the response of the subsequent changes in RER to shocks to lagged RER and lagged fundamentals in period *t*. In response to the shock to *NFAy* the RER depreciates with a maximum decline occurring after period 2. The response of RER to period 8 is below -0.3 and not statistically significant. Surges in productivity, on the other hand, lead to a small real appreciation of the currency in the short run after period 2 with a statistically significance. Shocks that lead to a deviation from the equilibrium of lagged RER have a large initial impact up to the first period. Then it depreciates and statistically insignificant. Shocks to terms of trade shock appreciate the RER and the response is statistically significant.

Figure 2.5 shows the response of the changes in the RER to transitory shocks in the fundamentals. In response to a transitory shock to *NFAy* the RER depreciates with a maximum decline occurring in period 4. The response of RER to a one-standard deviation increase in *NFAy* is below -0.1 and insignificant. Temporary surges in productivity (proxied by a shock to changes in *Prod*) lead to a real appreciation of the currency in the short run (up to period 4) that is apparently insignificant. Temporary TOT shock have a large initial impact on RER. After generating an immediate (and statistically significant) appreciation of the domestic currency in real terms, the effect fades out after period 1, thus converging to a negligible impact in longer horizons.

Figure 2.6 shows the response of the subsequent changes in the RER to shocks to lagged RER and lagged fundamentals in period *t*. In response to the shock to *NFAy*, we observe that the RER depreciates with a maximum decline occurring after period 2. It seems to be statistically significant. Temporary surges in lagged *Prod* lead to a small depreciation of the currency in the short run after period 2 with a statistically insignificance. Temporary lagged RER shock has a large initial impact up to the first period. Then it depreciates up to period 3, appreciates up to the 5th period and then fluctuates with a 2-period cycle. It seems to be statistically insignificant. Temporary shock to lagged *TOT* appreciates gradually the RER and statistically significant.

Figure 2.7 shows the response of the changes in the RER to transitory shocks in the fundamentals. In response to a transitory shock to NFAs the RER depreciates overall. It seems to be statistically significant. Temporary surges in *Prod* lead to a real appreciation of the currency in the short run up to period 1 and fluctuate each period. Overall it declines and is not statistically significant. Temporary *TOT* have a small negative initial impact on the RER and fluctuate with a small degree of appreciation overall.

7. Conclusion

Characterizing the RER misalignment is crucial in academic and policy circles to guide and formulate exchange rate and monetary policy as well as industrial policy. Real exchange rate overvaluations are monitored by policymakers in order to design future exchange rate adjustments. However, RER undervaluations may be engineered to promote growth through exports.

Our goal is to complement and improve upon the existing literature on RER misalignments by: (a) formulating a theoretically-based model to compute ERER and modeling its misalignment, (b) estimating ERER using unit root, cointegration Jonansen (1988, 1991) and PMGE (Pesaran, Shin and Smith, 1999) and (c) calculating and estimating RER misalignments as deviations of the actual RER relative to ERER using the band-pass filter trend component of the RER fundamentals and the ECM by Bewley (1979) and Wickens and Breusch (1987).

Theoretically, we aim to combine the current account approach and the HBS productivity differentials with the RER equilibrium solving our intertemporal open economy model. One of the novelties is to derive for what we call intertemporal BOP equilibrium and equilibrium in the tradable and non-tradable goods market. This model provides us an analytical framework to conceptually measure RER misalignment and conduct economic policy discussion more accurately. Modeling the RER misalignments is another novelty. It relates the empirical modeling in a context of open economy macroeconomics with the intertemporal equilibrium of RER. Our determinants of ERER are net foreign assets, terms of trade, and *HBS* effect derived from our theoretical model. According to our empirical exercise PMGE of a heterogeneous panel data technique that outperforms non-stationary time series and the ECM allow us to calculate the RER misalignments which provide us more accurate benchmark to analyze the RER behaviors in economy and to draw better macroeconomic policy decisions.

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Table 1
Unit Root Testing on Real Exchange Rate and Fundamentals
Time-series augmented Dickey Fuller tests

Country		Levels				Differences			
		RER	NFA	TOT	PROD	RER	NFA	TOT	PROD
ARG	Argentina	-3.27 **	0.26	-3.34 **	-1.03	-7.25 **	-3.70 **	-6.341 **	-4.43 **
AUS	Australia	-1.11	-1.79	-1.48	-0.79	-5.13 **	-5.69 **	-4.747 **	-8.852 **
AUT	Austria	-1.56	-0.48	-0.90	1.81	-4.81 **	-5.52 **	-7.912 **	-6.85 **
BDI	Burundi	-0.67				-5.24 **			
BEL	Belgium	-1.82	-0.57	-1.66	0.38	-3.75 **	-3.08 **	-4.703 **	-6.491 **
BEN	Benin	-2.82 *				-3.90 **			
BFA	Burkina Faso	-1.21	-2.66 *	-1.24	-1.95	-7.36 **	-6.22 **	-6.16 **	-7.968 **
BGD	Bangladesh		-2.05	-2.41	-1.12	-4.40 **	-3.40 **	-10.541 **	-8.295 **
BHR	Bahrain	-0.58				-3.48 **			
BHS	Bahamas	-0.52				-3.20 **			
BLZ	Belize	-0.71				-3.75 **			
BOL	Bolivia	-1.11		-2.58	-1.94	-6.15 **		-7.163 **	-5.707 **
BRA	Brazil	-1.71	-1.66	-1.15	-1.57	-5.94 **	-4.62 **	-6.217 **	-9.669 **
BRB	Barbados	-1.70				-3.97 **			
BWA	Botswana	-2.27	-0.34	-2.10	-1.89	-4.64 **	-4.78 **	-5.856 **	-4.499 **
CAF	Central African Republic	0.56				-6.56 **			
CAN	Canada	-1.71	-0.23	-1.74	-0.15	-4.17 **	-3.52 **	-5.284 **	-6.338 **
CHE	Switzerland	-1.33	-2.01	-1.50	0.35	-6.51 **	-6.75 **	-6.275 **	-4.532 **
CHL	Chile	-1.56	-1.76	-1.61	-1.39	-5.63 **	-3.18 **	-6.892 **	-5.929 **
CHN	China	-1.32	-0.04	-0.99	-6.11 **	-5.77 **	-2.00	-3.622 **	-11.631 **
CIV	Cote d'Ivoire	-2.22	-1.70	-2.52	-0.26	-7.14 **	-6.35 **	-5.495 **	-6.222 **
CMR	Cameroon	-1.49				-6.14 **			
COG	Congo, Rep.	-2.58	-1.58	-1.71	-0.39	-8.91 **	-5.15 **	-6.939 **	-6.727 **
COL	Colombia	-1.36		-2.72 *	-1.54	-4.27 **		-7.232 **	-6.03 **
CRI	Costa Rica	-1.58	-1.44	-2.25	-0.68	-7.53 **	-4.21 **	-6.718 **	-7.087 **
CYP	Cyprus	-3.19 **				-4.68 **			
DEU	Germany	-2.08	-1.39	-2.07	-2.60	-5.41 **	-4.31 **	-5.521 **	-5.489 **
DNK	Denmark	-2.23	-0.06	-1.03	-0.82	-5.13 **	-5.27 **	-6.78 **	-7.598 **
DOM	Dominican Republic	-1.61	-2.18	-3.78 **	-1.15	-7.78 **	-8.19 **	-5.386 **	-6.694 **
DZA	Algeria	0.18	0.55	-1.72	-2.53	-4.61 **	-4.01 **	-5.875 **	-7.869 **
ECU	Ecuador	-1.61	-1.64	-1.41	-1.90	-5.46 **	-4.32 **	-7.413 **	-5.9 **
EGY	Egypt	-1.37	-1.06	-1.10	-0.82	-4.23 **	-5.28 **	-4.422 **	-4.714 **
ESP	Spain	-1.92	0.97	-1.36	1.86	-5.40 **	-5.00 **	-4.508 **	-3.57 **
ETH	Ethiopia	-0.49				-5.58 **			
FIN	Finland	-1.76	-1.91	-1.81	-1.38	-4.45 **	-3.76 **	-5.241 **	-5.518 **
FJI	Fiji	-0.83				-4.84 **			
FRA	France	-1.70	-1.76	-1.40	1.04	-6.60 **	-5.98 **	-6.89 **	-5.233 **
GAB	Gabon	-0.34				-6.83 **			
GBR	United Kingdom	-1.12	-0.67	-1.85	-1.37	-5.40 **	-5.42 **	-5.49 **	-4.318 **
GHA	Ghana	-0.92	0.34	-2.38	-1.67	-3.86 **	-4.33 **	-8.19 **	-7.084 **
GMB	Gambia	-1.58		-1.78	-0.78	-7.81 **		-6.51 **	-5.725 **
GRC	Greece	-2.11	0.72	-1.38	0.32	-6.20 **	-3.40 **	-6.494 **	-8.42 **
GTM	Guatemala	-1.79	-1.58	-2.08	1.41	-5.57 **	-7.01 **	-7.851 **	-4.981 **
HKG	Hong Kong	-0.26				-4.47 **			
HND	Honduras	-1.36	-1.12	-2.72 *	-1.88	-6.37 **	-5.04 **	-6.193 **	-9.181 **
HTI	Haiti	-1.44	-2.26	-4.31 **	-1.79	-4.67 **	-5.73 **	-7.395 **	-5.614 **
IDN	Indonesia	-0.78	-2.15	-1.10	-1.57	-6.36 **	-6.42 **	-7.761 **	-7.095 **
IND	India	-0.74	-0.67	-2.46	-2.80 *	-4.77 **	-3.15 **	-5.882 **	-7.63 **
IRL	Ireland	-1.79	-1.53	-1.39	-0.69	-5.67 **	-5.21 **	-6.892 **	-5.407 **
IRN	Iran	-2.13	-2.24	-1.65	-1.70	-6.81 **	-4.51 **	-4.636 **	-4.503 **
ISL	Iceland	-2.29	-0.28	-3.42 **	-1.33	-5.96 **	-6.52 **	-6.088 **	-5.877 **
ISR	Israel	-2.96 **	-1.71	-2.87 *	-0.96	-7.24 **	-4.56 **	-7.214 **	-9.058 **
ITA	Italy	-1.63	-2.18	-1.51	0.11	-5.72 **	-5.05 **	-5.563 **	-6.461 **
JAM	Jamaica	-1.49	-1.59	-1.29	-0.87	-5.29 **	-4.66 **	-8.005 **	-7.207 **
JOR	Jordan	-0.70	-1.33	-1.83	0.40	-3.58 **	-4.10 **	-8.187 **	-5.373 **
JPN	Japan	-2.01	-0.09	-1.40	-3.91 **	-5.50 **	-5.75 **	-4.758 **	-4.978 **
KEN	Kenya	-1.73	-1.67	-1.54	-2.27	-7.16 **	-6.93 **	-5.863 **	-5.236 **
KOR	Korea, Rep.	-5.26 **	-0.83	-0.37	-0.30	-9.02 **	-4.11 **	-6.569 **	-5.845 **
KWT	Kuwait	-1.14				-3.94 **			

Notes: RER is the real exchange rate index (in logs), NFA is the ratio of net foreign assets to GDP, TOT is the (log of the) terms of trade index, and PROD is the ratio of the traded to non-traded productivity in the Home country (in logs).
** (**) indicates that the test is significant at the 10 (5)% level. That is we reject the null of unit root at the 10(5)% level.*

continued

continued

Table 1
Unit Root Testing on Real Exchange Rate and Fundamentals
Time-series augmented Dickey Fuller tests

Country		Levels				Differences			
		RER	NFA	TOT	PROD	RER	NFA	TOT	PROD
LKA	Sri Lanka	-1.51	-1.67	-3.52 **	-2.64 *	-5.03 **	-5.07 **	-6.283 **	-7.458 **
LSO	Lesotho	-1.93				-4.61 **			
LUX	Luxembourg	-2.19				-4.29 **			
MAR	Morocco	-1.54		-3.60 **	-1.58	-3.77 **		-7.009 **	-7.9 **
MDG	Madagascar	-0.73	-1.40	-1.45	-1.50	-5.25 **	-6.65 **	-7.13 **	-6.288 **
MDV	Maldives	-1.84				-2.76 *			
MEX	Mexico	-2.80 *	-2.12	-0.86	-0.52	-6.07 **	-5.84 **	-6.861 **	-7.706 **
MLI	Mali	-1.80				-4.81 **			
MLT	Malta	-2.78 *				-3.76 **			
MMR	Myanmar	3.33 **				-3.57 **			
MRT	Mauritania	0.56				-4.07 **			
MUS	Mauritius	-1.11				-6.66 **			
MWI	Malawi	-0.71	-1.72	-0.03		-6.02 **	-5.35 **	-6.052 **	
MYS	Malaysia	-0.27	-1.29	-2.74 *	-2.20	-4.90 **	-3.41 **	-6.274 **	-7.07 **
NAM	Namibia	-1.75				-4.05 **			
NER	Niger	-0.39	-1.84	-0.14	-1.13	-6.39 **	-9.56 **	-6.765 **	-8.251 **
NGA	Nigeria	-1.81	-1.21	-1.64	0.67	-4.14 **	-4.33 **	-6.687 **	-4.908 **
NIC	Nicaragua	-2.13	-1.58	-3.13 **	-1.11	-6.71 **	-4.29 **	-7.939 **	-6.238 **
NLD	Netherlands	-2.08	-1.50	-1.29	-0.57	-5.35 **	-7.67 **	-6.629 **	-7.713 **
NOR	Norway	-1.98	2.59	-1.20	-2.16	-5.40 **	-2.87 *	-4.719 **	-6.032 **
NPL	Nepal	-1.19				-5.09 **			
NZL	New Zealand	-2.30	-1.38	-2.25	-0.94	-4.54 **	-4.70 **	-5.414 **	-6.995 **
OMN	Oman	0.26				-4.50 **			
PAK	Pakistan	-0.95	-2.31	-1.22	-1.31	-5.43 **	-4.96 **	-8.398 **	-7.24 **
PAN	Panama	-0.31	-1.30	-1.84	-0.72	-4.86 **	-5.44 **	-6.005 **	-4.791 **
PER	Peru	-0.96	-2.87 *	-2.95 **	-1.67	-6.37 **	-6.21 **	-7.738 **	-5.787 **
PHL	Philippines	-2.93 *	-0.97	-2.32	-1.61	-7.39 **	-4.36 **	-5.331 **	-6.584 **
PNG	Papua New Guinea	-0.67	-0.57	-1.54	-3.38 **	-6.28 **	-3.54 **	-6.342 **	-4.88 **
PRT	Portugal	-0.87	-0.63	-1.74	-0.68	-3.95 **	-3.04 **	-5.786 **	-5.609 **
PRY	Paraguay	-0.75	-2.21	-2.08	-1.93	-7.38 **	-5.45 **	-9.192 **	-6.393 **
QAT	Qatar	-5.59 **				-3.06 **			
RWA	Rwanda	-0.33				-3.73 **			
SAU	Saudi Arabia	-0.23				-3.02 **			
SDN	Sudan	-2.97 **				-6.76 **			
SEN	Senegal	-0.84	-1.24	-2.28	-1.51	-6.77 **	-4.26 **	-7.858 **	-12.719 **
SGP	Singapore	-1.95	0.28	-1.98	-2.47	-3.87 **	-4.45 **	-3.863 **	-7.985 **
SLE	Sierra Leone	-1.77		-0.76	0.81	-6.15 **		-8.593 **	-6.578 **
SLV	El Salvador	-0.60	0.27	-3.40 **	1.20	-6.94 **	-4.41 **	-6.91 **	-4.901 **
SUR	Suriname	-2.93 *				-8.07 **			
SWE	Sweden	-0.64		-0.79	2.01	-5.61 **		-7.002 **	-4.631 **
SWZ	Swaziland	-1.94				-5.38 **			
SYC	Seychelles	-3.13 **				-4.72 **			
SYR	Syria	-1.17	-1.28	-1.60	-1.10	-7.48 **	-5.56 **	-6.912 **	-9.808 **
TAZ	Tanzania	-0.66				-3.34 **			
TCD	Chad	-0.64				-5.77 **			
TGO	Togo	-1.05	-1.24	-2.96 **	-0.38	-6.71 **	-1.29	-11.113 **	-7.197 **
THA	Thailand	-0.31	-1.51	-1.14	1.34	-5.22 **	-4.95 **	-6.53 **	-7.887 **
TTO	Trinidad & Tobago	-1.74	-0.63	-1.45	-1.17	-5.72 **	-3.85 **	-6.384 **	-4.539 **
TUN	Tunisia	-1.40	-1.39	-1.98	-1.84	-4.61 **	-5.67 **	-5.147 **	-7.688 **
TUR	Turkey	-3.46 **	-0.46	-1.24	1.28	-9.21 **	-5.45 **	-5.431 **	-7.237 **
TWN	Taiwan	-2.74 *				-6.61 **			
UGA	Uganda	-4.64 **	-1.59	-1.33		-6.06 **	-3.46 **	-4.095 **	
URY	Uruguay	-2.14	-1.56	-1.93	-3.91 **	-6.87 **	-4.68 **	-7.16 **	-10.467 **
USA	United States	-1.68	0.24	-1.40	0.56	-3.76 **	-5.07 **	-5.318 **	-5.923 **
VEN	Venezuela	-2.02	-0.84	-0.76	-1.29	-6.96 **	-3.64 **	-7.085 **	-5.018 **
WSM	Samoa	-1.24				-6.62 **			
ZAF	South Africa	-1.25	-1.48	-1.35	0.59	-5.89 **	-5.99 **	-4.606 **	-1.793
ZAR	Congo, Dem. Rep.	-1.28	-1.31	-2.37	0.01	-6.35 **	-5.18 **	-7.413 **	-5.951 **
ZMB	Zambia	-1.91	-1.80	-0.99	-0.71	-4.38 **	-3.93 **	-6.887 **	-4.083 **
ZWE	Zimbabwe	-1.51	1.28	-2.77 *	-3.89 **	-4.72 **	-0.85	-4.597 **	-9.998 **

Notes: RER is the real exchange rate index (in logs), NFA is the ratio of net foreign assets to GDP, TOT is the (log of the) terms of trade index, and PROD is the ratio of the traded to non-traded productivity in the Home country (in logs).
** (**) indicates that the test is significant at the 10 (5)% level. That is we reject the null of unit root at the 10(5)% level.*

Table 2

Time-Series Unit Root Testing: Summary of Results

Percentage of the sample of countries that reject null of unit root

Annual information: *RER and TOT (1960-2005)*

NFA/GDP and Productivity (1970-2005)

	Test in levels			Test in differences			
	% sample significant at						Number of
	1%	5%	10%	1%	5%	10%	countries
Real exchange rate (RER)	3%	8%	14%	93%	99%	100%	118
Terms of trade (TOT)	2%	12%	18%	100%	100%	100%	82
Productivity (PROD)	5%	6%	9%	98%	99%	99%	81
Net foreign assets to GDP (NFA)	4%	4%	7%				81

Note. The table reads as follows: At the 5 percent significant level, only 8% of the sample of countries rejected the null of unit root in levels for the RER. That is, there RER is stationary in levels for only 8% of the countries in our sample. On the other hand, 99% of the sample of countries reject the null of unit root in differences. That is, for 99% of the countries in our sample, we can say that the RER differences are stationary.

The summary results are based on the findings reported in Table 2.

Table 3

Panel Unit Root Testing on Real Exchange Rate and Fundamentals

Time-series augmented Dickey Fuller tests

	Levels				Differences			
Country	RER	NFA	TOT	PROD	RER	NFA	TOT	PROD
I. Im, Pesaran and Shin (2003)	H_0: *Null of unit root (heterogeneous panels)*							
t-bar	-2.20	-1.28	-2.01	-2.04	-3.05 **	-4.44 **	-3.31 **	-3.07 **
W(t-bar)	-0.85	8.78	1.13	0.54	-9.79 **	-23.99 **	-12.40 **	-9.95 **
II. Pesaran (2007)	H_0: *Null of unit root (heterogeneous panels)*							
t-bar	-2.26	-2.39	-2.20	-2.04	-2.99 **	-2.68 **	-3.52 **	-2.82 **
Z(t-bar)	0.70	-0.62	1.36	2.60	-6.62 **	-3.45 **	-12.00 **	-4.85 **
III. Levin, Lin and Chu (2002)	H_0: *Null of unit root (homogeneous panels)*							
t-star	0.54	2.00	-0.71	-0.13	-2.23	-25.03	-7.48	-13.24353
(*p-value*)	(0.71)	(0.98)	(0.24)	(0.45)	(0.01)	(0.00)	(0.00)	(0.00)
IV. Maddala and Wu (1999)	H_0: *Null of unit root (homogeneous panels)*							
Chi-square statistic	153.4	50.8	261.5	173.1	1459.7	199.9	1875.4	480.0783
(*p-value*)	(0.54)	(1.00)	(0.00)	(0.20)	(0.00)	(0.01)	(0.00)	(0.00)

Notes: RER is the real exchange rate index (in logs), NFA is the ratio of net foreign assets to GDP, TOT is the (log of the) terms of trade index, and PROD is the ratio of the traded to non-traded productivity in the Home country (in logs).

** (**) indicates that the test is significant at the 10 (5)% level. That is we reject the null of unit root at the 10(5)% level for homogeneous panels (Levin, Lin and Chu, 2002; Maddala and Wu, 1999) and for heterogeneous panels (Im, Pesaran and Shin, 2003; Pesaran, 2007)*

References

Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu (2002) "Unit root tests in panel data: asymptotic and finite-sample properties," Journal of Econometrics 108, 1-24

Maddala, G.S., and Shaowen Wu (1999) "A comparative study of unit root tests with panel data and a new simple test," Oxford Bulletin of Economics and Statistics (Special Issue), 631-652

Im, Kyung So, M. Hashem Pesaran, and Yongcheol Shin (2003) "Testing for unit roots in heterogeneous panels," Journal of Econometrics 115, 53-74

Pesaran, M. Hashem (2007) "A simple panel unit root test in thepresence of cross-section dependence," Journal of Applied Econometrics 22, 265-312

Table 4
Testing for Cointegration among RER and Fundamentals
Trace test (Johansen, 1988, 1991)

		Null hypothesis: Number of cointegrating vectors (r) is:			
		None	At most 1	At most 2	At most 3
		vs. Alternative hypothesis: Number of cointegrating vectors (r) is:			
Country		r = 1	r = 2	r = 3	r = 4
ARG	Argentina	36.1 *	13.9	2.6	0.0
AUS	Australia	55.1 **	18.6	9.1	1.9
AUT	Austria	36.2 *	22.0 *	9.6	0.9
BEL	Belgium	38.2 *	17.0	4.1	0.1
BFA	Burkina Faso	23.7	13.4	7.5	2.5
BGD	Bangladesh	69.2 **	21.8 *	6.2	0.2
BOL	Bolivia	40.4 *	20.0	9.6	1.5
BRA	Brazil	39.2 *	22.8 *	11.4 *	4.6 **
BWA	Botswana	61.5 **	16.1	8.6	3.1 *
CAN	Canada	26.2	11.7	6.7	2.2
CHE	Switzerland	42.3 *	23.3 *	8.8	0.1
CHL	Chile	71.9 **	28.2 *	8.4	0.8
CHN	China	76.6 **	30.5 **	7.5	0.6
CIV	Cote d'Ivoire	49.5 **	20.1	7.6	1.9
COG	Congo, Rep.	40.3 *	14.4	3.0	0.1
COL	Colombia	46.5 *	25.3 *	6.4	1.9
CRI	Costa Rica	30.1	14.2	6.6	0.7
DEU	Germany	41.9 *	18.4	9.2	2.0
DNK	Denmark	46.6 *	26.8 *	10.1	0.1
DOM	Dominican Rep.	64.6 **	21.2	9.1	3.5 *
DZA	Algeria	45.2 *	19.5	7.4	0.2
ECU	Ecuador	51.0 **	22.8 *	13.2 *	5.2 **
EGY	Egypt	54.8 **	25.8 *	11.0 *	3.3 *
ESP	Spain	33.4 *	9.1	2.7	0.1
FIN	Finland	19.1	10.3	2.5	0.2
FRA	France	38.5 *	18.9	7.0	0.6
GBR	United Kingdom	48.0 **	17.9	5.5	0.1
GHA	Ghana	39.3 *	10.1	3.0	0.5
GRC	Greece	47.2 *	20.5	5.4	1.7
GTM	Guatemala	44.5 *	16.9	8.5	2.4
HND	Honduras	31.8	15.5	5.7	0.6
HTI	Haiti	41.0 *	17.5	9.1	3.3 *
IDN	Indonesia	35.7 *	16.9	5.6	0.7
IND	India	52.0 **	17.2	8.2	3.1 *
IRL	Ireland	36.8 *	17.0	6.7	0.2
IRN	Iran	34.1 *	19.2	9.8	2.5
ISL	Iceland	49.0 **	25.8 *	7.0	0.0
ISR	Israel	39.9 *	15.9	5.7	0.4
ITA	Italy	38.4 *	19.9	7.2	0.6
JAM	Jamaica	27.1	11.2	4.0	0.2
JOR	Jordan	37.5 *	17.5	8.9	0.6

We test the existence of cointegration in the vector conformed by {RER, NFA, TOT, PROD} using the trace test developed by Johansen (1988, 1991)
** (**) indicates that the test is significant at the 10 (5)% level. That is we reject the null hypothesis at the 10(5)% level.*

continued

continued

Table 4
Testing for Cointegration among RER and Fundamentals
Trace test (Johansen, 1988, 1991)

Country		None	At most 1	At most 2	At most 3
		Null hypothesis: Number of cointegrating vectors (r) is:			
		vs. Alternative hypothesis: Number of cointegrating vectors (r) is:			
		r = 1	r = 2	r = 3	r = 4
JPN	Japan	41.3 *	15.2	3.6	0.6
KEN	Kenya	63.7 **	28.8 *	13.8 *	3.3 *
KOR	Korea, Rep.	45.1 *	11.2	3.0	0.1
LKA	Sri Lanka	31.2	17.0	8.5	3.4 *
MAR	Morocco	65.9 **	31.1 **	11.9 *	2.4
MDG	Madagascar	36.3 *	16.4	7.3	0.2
MEX	Mexico	40.6 *	20.7	4.5	0.2
MYS	Malaysia	44.3 *	18.9	8.6	2.2
NER	Niger	51.0 **	20.1	9.0	1.9
NGA	Nigeria	25.8	12.7	3.7	1.1
NIC	Nicaragua	44.9 *	14.8	4.9	1.9
NLD	Netherlands	47.3 **	18.3	7.0	2.0
NOR	Norway	50.7 **	18.9	6.5	0.0
NZL	New Zealand	41.5 *	19.5	8.2	2.4
PAK	Pakistan	48.7 **	23.0 *	10.4	2.2
PAN	Panama	44.8 *	15.4	4.2	0.4
PER	Peru	54.4 **	20.6	8.7	0.5
PHL	Philippines	48.7 **	29.0 *	13.6 *	2.4
PNG	Papua New Guinea	39.4 *	16.2	8.9	2.8
PRT	Portugal	39.4 *	14.3	3.0	0.0
PRY	Paraguay	46.1 *	21.7 *	7.5	2.8
SEN	Senegal	37.4 *	16.6	4.2	0.1
SGP	Singapore	55.4 **	22.7 *	6.8	3.0 *
SLV	El Salvador	33.5 *	14.7	2.7	0.0
SWE	Sweden	49.9 **	19.5	8.3	2.8
SYR	Syria	27.9	16.8	6.0	1.1
TGO	Togo	56.7 **	14.6	6.3	0.2
THA	Thailand	23.5	13.0	4.3	0.6
TTO	Trinidad and Tobago	35.2 *	13.4	6.4	0.0
TUN	Tunisia	43.3 *	23.9 *	9.4	2.2
TUR	Turkey	35.3 *	14.5	7.1	2.2
URY	Uruguay	38.4 *	23.3 *	10.8 *	5.1 **
USA	United States	35.7 *	19.2	4.5	0.1
VEN	Venezuela	33.1	15.4	8.0	2.0
ZAF	South Africa	62.1 **	22.1 *	9.0	0.0
ZAR	Congo, Dem. Rep.	43.3 *	23.2 *	7.7	2.3
ZMB	Zambia	52.9 **	22.5 *	8.3	3.8 **
ZWE	Zimbabwe	39.6 *	19.5	8.0	1.1

We test the existence of cointegration in the vector conformed by {RER, NFA, TOT, PROD} using the trace test developed by Johansen (1988, 1991)
** (**) indicates that the test is significant at the 10 (5)% level. That is we reject the null hypothesis at the 10(5)% level.*

Table 5

Testing the Long-run Validity of the Fundamental Real Exchange Rate Equation

Time Series Cointegration Test: Summary of Results

Percentage of countries where we reject the null hypothesis

Sample of 79 countries, 1970-2005 (Annual)

Null Hypothesis		Alternative Hypothesis	Null Hypothesis	% countries significant at:		
				10%	5%	1%
r <= 0	vs.	r = 1	*No cointegration*	86%	32%	15%
r <= 1	vs.	r = 2	*1 cointegrating vector*	28%	3%	0%
r <= 2	vs.	r = 3	*2 cointegrating vectors*	9%	0%	0%
r <= 3	vs.	r = 4	*3 cointegrating vectors*	6%	0%	0%

Note. Using the critical values of the trace test at the 10% significance level, we find that there is at most 1 cointegrating vector for 86% of the sample of countries, and at most 2 cointegrating vectors for 28% of the sample.

The summary results are based on the findings reported in Table 3

Table 6

Panel Cointegration Tests

Sample of 79 countries, 1970-2005 (Annual)

Test	Statistic	p-value
Homogenenous test (Kao, 1997)		
DF_Rho	-97.257	(0.000)
DF_t_Rho	-48.887	(0.000)
DF_Rho_Star	-96.346	(0.000)
DF_t_Rho_Star	-48.884	(0.000)
Heterogeneous test (Pedroni, 1990)		
panel v stat	0.778	(0.000)
panel rho stat	-311.925	(0.000)
panel t stat (nonparametric)	-11.632	(0.000)
panel t stat (parametric)	-71.006	(0.000)
group rho stat	-243.953	(0.000)
group t stat (nonparametric)	-20.290	(0.000)
group t stat (parametric)	-39.720	(0.000)

Note. All tests reject the null of no cointegration. That is, evidence from panel cointegration tests show that there is evidence of a long-run relationship between the real exchange rate and its fundamentals (say, terms of trade, net foreign assets to GDP, and relative productivity).

Table 7
Estimating the Fundamental RER Equation

Estimation method: Johansen's (1988, 1991) vector error correction model
Sample of 79 countries, 1970-2005 (Annual)

Country		Terms of Trade	Net Foreign Assets	Relative Productivity
DZA	Algeria	8.337 **	-7.189 **	-8.267 **
ARG	Argentina	0.339	0.136	0.626 **
AUS	Australia	0.737 **	0.977 **	0.375
AUT	Austria	1.286 **	-1.292 **	-0.413
BGD	Bangladesh	1.427 **	0.316	-0.397
BEL	Belgium	1.213 **	0.113	-0.241
BOL	Bolivia	0.564 **	-0.162	0.434
BWA	Botswana	3.862 **	1.910 **	-3.246 **
BRA	Brazil	0.702 **	0.602 **	0.296
BFA	Burkina Faso	-0.602 **	3.956 **	1.933 **
CAN	Canada	1.209 **	-1.068 **	-0.245
CHL	Chile	1.016 **	-2.274 **	-0.235
CHN	China	-0.012	1.732 **	1.077 **
COL	Colombia	1.914 **	3.651 **	-0.793 **
ZAR	Congo, Dem. Rep.	4.504 **	2.935 **	-3.749 **
COG	Congo, Rep.	-0.695 **	1.466 **	2.461 **
CRI	Costa Rica	2.181 **	1.175 **	-0.957 **
CIV	Cote d'Ivoire	0.869 **	-0.529 **	0.049
DNK	Denmark	1.402 **	0.015	-0.402
DOM	Dominican Rep.	2.167 **	1.577 **	-1.005 **
ECU	Ecuador	0.315	-0.013	0.675 **
EGY	Egypt	1.155 **	0.282	-0.181
SLV	El Salvador	2.190 **	-4.836 **	-1.725 **
FIN	Finland	0.784 **	0.557 **	0.283
FRA	France	0.947 **	-1.138 **	0.055 *
DEU	Germany	0.119	0.638 **	0.846 **
GHA	Ghana	6.363 **	0.510 **	-5.381 **
GRC	Greece	2.346 **	1.082 **	-1.621 **
GTM	Guatemala	1.772 **	-1.546 **	-0.839 **
HTI	Haiti	1.264 **	-1.721 **	-0.327
HND	Honduras	2.181 **	-0.293	-1.204 **
ISL	Iceland	-0.194	-0.931 **	-0.899 **
IND	India	-2.188 **	2.269 **	3.287 **
IDN	Indonesia	0.124	2.685 **	1.227 **
IRN	Iran	1.663 **	-9.341 **	-0.328
IRL	Ireland	0.598 **	-0.200	0.401
ISR	Israel	1.200 **	0.470	-0.161
ITA	Italy	2.385 **	-3.288 **	-1.472 **
JAM	Jamaica	-12.878 **	-2.800 **	13.459 **

** (**) indicates that the test is significant at the 10 (5)% level.*

continued

continued

Table 7
Estimating the Fundamental RER Equation

Estimation method: Johansen's (1988, 1991) vector error correction model
Sample of 79 countries, 1970-2005 (Annual)

Country		Terms of Trade	Net Foreign Assets	Relative Productivity
JPN	Japan	1.039 **	1.415 **	-0.061 *
JOR	Jordan	1.026 **	-1.098 **	-0.184
KEN	Kenya	54.503 **	95.589 **	-37.663 **
KOR	Korea, Rep.	0.860 **	-0.837 **	0.086 *
MDG	Madagascar	-1.463 **	2.033 **	2.896 **
MYS	Malaysia	29.423 **	-15.727 **	-29.822 **
MEX	Mexico	0.336	0.474	0.794 **
MAR	Morocco	1.796 **	0.661 **	-0.710 **
NLD	Netherlands	1.118 **	0.030	-0.127
NZL	New Zealand	5.276 **	-1.108 **	-4.512 **
NIC	Nicaragua	-2.822 **	-0.174	3.800 **
NER	Niger	0.997 **	0.006	0.006
NGA	Nigeria	1.046 **	0.861 **	0.031
NOR	Norway	0.610 **	-0.253	0.439
PAK	Pakistan	1.096 **	20.184 **	2.037 **
PAN	Panama	-5.110 **	-7.546 **	4.842 **
PNG	Papua New Guinea	0.984 **	-0.258	-0.069 *
PRY	Paraguay	-1.272 **	-0.672 **	2.175 **
PER	Peru	-0.124	-11.076 **	-0.218
PHL	Philippines	-17.395 **	4.922 **	19.347 **
PRT	Portugal	1.047 **	-0.081 *	-0.055 *
SEN	Senegal	1.662 **	0.144	-0.674 **
SGP	Singapore	1.099 **	-0.009	-0.098 *
ZAF	South Africa	1.019 **	-1.005 **	-0.064 *
ESP	Spain	9.308 **	-7.836 **	-9.166 **
LKA	Sri Lanka	4.485 **	4.928 **	-2.902 **
SWE	Sweden	1.457 **	0.037	-0.507 **
CHE	Switzerland	1.083 **	-0.064 *	-0.093 *
SYR	Syria	0.727 **	-1.520 **	-0.027
THA	Thailand	1.059 **	-0.249	-0.049
TGO	Togo	1.281 **	-0.076 *	-0.311
TTO	Trinidad and Tobago	-1.338 **	-0.246	2.341 **
TUN	Tunisia	2.636 **	-0.026	-1.647 **
TUR	Turkey	0.993 **	-4.442 **	-0.186
GBR	United Kingdom	6.505 **	-1.579 **	-5.612 **
USA	United States	-0.517 **	3.955 **	1.517 **
URY	Uruguay	1.753 **	0.381	-0.725 **
VEN	Venezuela	-3.614 **	-13.577 **	4.180 **
ZMB	Zambia	-0.114	0.678 **	1.362 **
ZWE	Zimbabwe	9.119 **	0.028	-8.031 **

** (**) indicates that the test is significant at the 10 (5)% level.*

Table 8
Estimating the fundamental RER equation: Homogeneous panel data techniques

Variables	FM-OLS [1]	D-OLS [2]	FM-OLS [3]	D-OLS [4]	FM-OLS [5]	D-OLS [6]	FM-OLS [7]	D-OLS [8]
Net Foreign assets	-1.043 *	-0.622	-0.765 *	-0.687 *	-0.694 *	-0.630	-0.765 *	-0.686 *
(as % of GDP)	(1.64)	(1.16)	(1.48)	(1.29)	(1.33)	(1.18)	(1.48)	(1.29)
Terms of Trade	0.797 **	0.791 **	0.777 **	0.780 **	0.787 **	0.791 **	0.777 **	0.781 **
(*in logs*)	(90.17)	(213.95)	(214.32)	(209.23)	(219.08)	(213.92)	(214.32)	(209.27)
Relative productivity	0.207 **	0.212 **	..	..	..	..		
(*in logs*)	(27.66)	(67.97)						
Traded sector productivity	..	..	0.218 **	0.222 **	..	..	0.2145 **	0.2199 **
(*in logs*)			(70.75)	(70.14)			(15.06)	(15.01)
Non-traded sector productivity	..	..	..	..	0.209 **	0.213 **	0.0032	0.0022
(*in logs*)					(68.66)	(67.97)	(0.23)	(0.15)
Adjusted R**2	0.9289	0.6506	0.9298	0.6551	0.9289	0.6506	0.9297	0.655

*Numbers in parentheses represent t-statistics. * (**) implies significance at the 10 (5) % level.*

Table 9

Estimating the Fundamental RER Equation: Heterogeneous Panel Data Techniques

Estimation method: Pesaran (1995), Pesaran, Shin and Smith (1999)

Sample of 79 countries, 1970-2005 (Annual)

	Panel data estimators			Hausman Homogeneity tests	
Coefficients	Pooled Mean Group (PMG)	Mean Group (MG)	Dynamic FE	PMG=MG	MG=DFE
A. Long-run coefficients					
Terms of Trade (TOT)	0.764 **	0.653 **	0.531 **	0.24	0.00
(*in logs*)	(0.06)	(0.19)	(0.21)	(0.63)	(0.96)
Net Foreign Assets (NFA)	0.200 **	0.576 **	0.108	1.22	0.02
(*as a ratio to GDP*)	(0.03)	(0.28)	(0.17)	(0.27)	(0.89)
Traded-nontraded Productivity (PROD)	-0.137 **	0.117	-0.214 **	0.72	0.01
(*in logs*)	(0.02)	(0.24)	(0.09)	(0.40)	(0.91)
B. Error-correction mechanism	-0.171 **	-0.360 **	-0.135 **	..	..
	(0.02)	(0.02)	(0.02)		
C. Short-run coefficients					
L.(D.(TOT))	0.145 **	0.095 **	0.090	..	..
	(0.05)	(0.05)	(0.10)		
L.(D.(NFA))	0.084	-0.304 **	0.115 **	..	..
	(0.10)	(0.15)	(0.04)		
L.(D.(PROD))	-0.029	-0.005	-0.005	..	..
	(0.06)	(0.07)	(0.04)		
Constant	0.316 **	1.138 **	0.434 **	..	..
	(0.03)	(0.33)	(0.17)		
Overall Hausman homogeneity test					
Statistic	..	..	..	1.71	0.03
(*p-value*)				(0.64)	(1.00)

** (**) indicates that the test is significant at the 10 (5)% level.*

Hausman homogeneity tests reports the Chi-square statistics that examines the equality between the: (a) pooled mean group (PMG) and mean group (MG) estimation, and (b) Mean group (MG) and dynamic fixed effects (DFE) estimation. The numbers in parenthesis below the statistics reported are the p-values.

Table 10

Pooled Mean Group Estimation of RER Equation: Robustness across Samples

Sample period: 1970-2005 (Annual)

Coefficients	All Countries	Sub-samples by level of development: Industrial Countries	Developing Countries	Emerging Markets	Asian Countries	Sub-samples by major exports: Primary Goods	Non-fuel Primary	Manufacturing Goods
I. Pooled mean group								
Terms of Trade (TOT)	0.764 **	0.285 **	1.188 **	0.270 **	-0.220 *	0.922 **	0.720 **	0.488 **
(*in logs*)	(0.06)	(0.07)	(0.12)	(0.10)	(0.12)	(0.11)	(0.10)	(0.07)
Net Foreign Assets (NFA)	0.200 **	0.643 **	0.022	0.675 **	0.645 **	0.099 **	-0.033	0.561 **
(*as a ratio to GDP*)	(0.03)	(0.05)	(0.04)	(0.09)	(0.00)	(0.04)	(0.05)	(0.04)
Traded-nontraded Productivity (PROD)	-0.137 **	-0.203 **	-0.079 **	-0.195 **	-0.233 **	-0.172 **	-0.387 **	-0.185 **
(*in logs*)	(0.02)	(0.04)	(0.03)	(0.05)	(0.00)	(0.05)	(0.06)	(0.03)
Error-correction mechanism	-0.171 **	-0.174 **	-0.209 **	-0.212 **	-0.204 **	-0.202 **	-0.195 **	-0.161 **
	(0.02)	(0.02)	(0.04)	(0.03)	(0.00)	(0.04)	(0.04)	(0.02)
II. Mean group estimation								
Terms of Trade (TOT)	0.653 **	0.457 **	1.195 **	0.919 **	-0.123	0.732 **	0.614	0.616 **
(*in logs*)	(0.19)	(0.22)	(0.36)	(0.42)	(0.79)	(0.35)	(0.43)	(0.23)
Net Foreign Assets (NFA)	0.576 **	0.793 **	-0.025	0.987	1.739 **	-0.185	-0.299	0.928 **
(*as a ratio to GDP*)	(0.28)	(0.37)	(0.18)	(0.94)	(0.14)	(0.55)	(0.69)	(0.30)
Traded-nontraded Productivity (PROD)	0.117	0.243	-0.229 *	0.403	1.886 **	-0.377	-0.624	0.346
(*in logs*)	(0.24)	(0.33)	(0.12)	(0.36)	(0.10)	(0.47)	(0.56)	(0.28)
Error-correction mechanism	-0.360 **	-0.366 **	-0.345 **	-0.332 **	-0.315 **	-0.451 **	-0.451 **	-0.318 **
	(0.02)	(0.03)	(0.03)	(0.05)	(0.00)	(0.04)	(0.04)	(0.02)
C. Hausman homogeneity test (p-values) 1/								
Terms of Trade (TOT)	(0.628)	(0.522)	(0.986)	(0.181)	(0.856)	(0.675)	(0.851)	(0.607)
Net Foreign Assets (NFA)	(0.270)	(0.742)	(0.829)	(0.780)	(0.420)	(0.696)	(0.774)	(0.280)
Traded-nontraded Productivity (PROD)	(0.397)	(0.275)	(0.292)	(0.157)	(0.112)	(0.737)	(0.750)	(0.092)
Overall test	(0.635)	(0.631)	(0.736)	(0.384)	(0.399)	(0.838)	(0.939)	(0.319)
Number of countries	79	21	58	21	12	25	20	54
Number of observations	2630	709	1921	700	391	818	651	1812

** (**) indicates that the test is significant at the 10 (5)% level.*

1/ The Hausman homogeneity tests reports the p-value of the Chi-square statistic that examines the equality between the pooled mean group (PMG) and mean group (MG) estimators.

Table 11
Estimation of RER Equation
Sample period: 1970-2005 (Annual)

Coefficients	Argentina	Australia	Chile	China	Germany	New Zealand	United Kingdom	South Africa
I.								
Real Exchange Rate	-0.666 **	-0.538 **	-0.338 *	-0.814 **	-0.502 **	-0.350 **	-0.278 **	-0.230
(*in logs; lag*)	(0.18)	(0.16)	(0.17)	(0.21)	(0.16)	(0.15)	(0.13)	(0.17)
Terms of Trade (TOT)	1.465	0.644 **	0.041	-2.104 **	0.093	0.548 **	0.493	0.802 **
(*in logs; lag*)	(0.92)	(0.17)	(0.17)	(0.77)	(0.08)	(0.16)	(0.39)	(0.26)
Net Foreign Assets (NFA)	0.249	0.023	0.243	-3.571 **	0.240	-0.038	0.093	0.023
(*as a ratio to GDP; lag*)	(0.54)	(0.18)	(0.23)	(1.47)	(0.17)	(0.07)	(0.20)	(0.35)
Traded-nontraded Productivity (PRD)	-0.056	-0.413	-0.834 **	0.448	0.365 **	-0.271	-0.425 *	0.156
(*in logs; lag*)	(0.45)	(0.26)	(0.23)	(0.36)	(0.13)	(0.18)	(0.22)	(0.22)
II.								
Terms of Trade (TOT)	2.186 **	0.326 *	0.909 **	-1.721	0.103	0.499 **	0.767 **	0.750 **
(*in logs; difference*)	(0.76)	(0.18)	(0.17)	(1.29)	(0.08)	(0.18)	(0.35)	(0.28)
Net Foreign Assets (NFA)	0.882	0.291	-2.123 **	3.235 *	-1.831 **	-0.181	-1.123	-1.214
(*as a ratio to GDP; difference*)	(1.89)	(0.70)	(0.85)	(1.91)	(0.71)	(0.33)	(0.88)	(1.29)
Traded-nontraded Productivity (PRD)	1.745 *	-0.029	-0.883 **	-0.016	0.368	0.216	-0.649 **	-0.684 **
(*in logs; difference*)	(0.94)	(0.28)	(0.39)	(1.18)	(0.24)	(0.25)	(0.32)	(0.33)
Constant	-3.437	1.465	5.243 **	11.298 **	0.126	0.292	0.930	-3.415 *
	(4.34)	(1.28)	(1.46)	(4.66)	(0.52)	(0.78)	(1.15)	(1.96)
Number of observations	34	34	34	24	34	33	34	34

** (**) indicates that the test is significant at the 10 (5)% level.*

Table 12
Sample of Countries

No.	Code	Name	Region	No.	Code	Name	Region
1	DZA	Algeria	MENA	41	JOR	Jordan	MENA
2	ARG	Argentina	AMER	42	KEN	Kenya	SSA
3	AUS	Australia	INDC	43	KOR	Korea, Rep.	EAP
4	AUT	Austria	INDC	44	MDG	Madagascar	SSA
5	BGD	Bangladesh	SA	45	MYS	Malaysia	EAP
6	BEL	Belgium	INDC	46	MEX	Mexico	AMER
7	BOL	Bolivia	AMER	47	MAR	Morocco	MENA
8	BWA	Botswana	SSA	48	NLD	Netherlands	INDC
9	BRA	Brazil	AMER	49	NZL	New Zealand	INDC
10	BFA	Burkina Faso	SSA	50	NIC	Nicaragua	AMER
11	CAN	Canada	INDC	51	NER	Niger	SSA
12	CHL	Chile	AMER	52	NGA	Nigeria	SSA
13	CHN	China	EAP	53	NOR	Norway	INDC
14	COL	Colombia	AMER	54	PAK	Pakistan	SA
15	ZAR	Congo, Dem. Rep.	SSA	55	PAN	Panama	AMER
16	COG	Congo, Rep.	SSA	56	PNG	Papua New Guinea	EAP
17	CRI	Costa Rica	AMER	57	PRY	Paraguay	AMER
18	CIV	Cote d'Ivoire	SSA	58	PER	Peru	AMER
19	DNK	Denmark	INDC	59	PHL	Philippines	EAP
20	DOM	Dominican Rep.	AMER	60	PRT	Portugal	INDC
21	ECU	Ecuador	AMER	61	SEN	Senegal	SSA
22	EGY	Egypt	MENA	62	SGP	Singapore	EAP
23	SLV	El Salvador	AMER	63	ZAF	South Africa	SSA
24	FIN	Finland	INDC	64	ESP	Spain	INDC
25	FRA	France	INDC	65	LKA	Sri Lanka	SA
26	DEU	Germany	INDC	66	SWE	Sweden	INDC
27	GHA	Ghana	SSA	67	CHE	Switzerland	INDC
28	GRC	Greece	INDC	68	SYR	Syria	MENA
29	GTM	Guatemala	AMER	69	THA	Thailand	EAP
30	HTI	Haiti	AMER	70	TGO	Togo	SSA
31	HND	Honduras	AMER	71	TTO	Trinidad and Tobago	AMER
32	ISL	Iceland	INDC	72	TUN	Tunisia	MENA
33	IND	India	SA	73	TUR	Turkey	ECA
34	IDN	Indonesia	EAP	74	GBR	United Kingdom	INDC
35	IRN	Iran	MENA	75	USA	United States	INDC
36	IRL	Ireland	INDC	76	URY	Uruguay	AMER
37	ISR	Israel	MENA	77	VEN	Venezuela	AMER
38	ITA	Italy	INDC	78	ZMB	Zambia	SSA
39	JAM	Jamaica	AMER	79	ZWE	Zimbabwe	SSA
40	JPN	Japan	INDC				

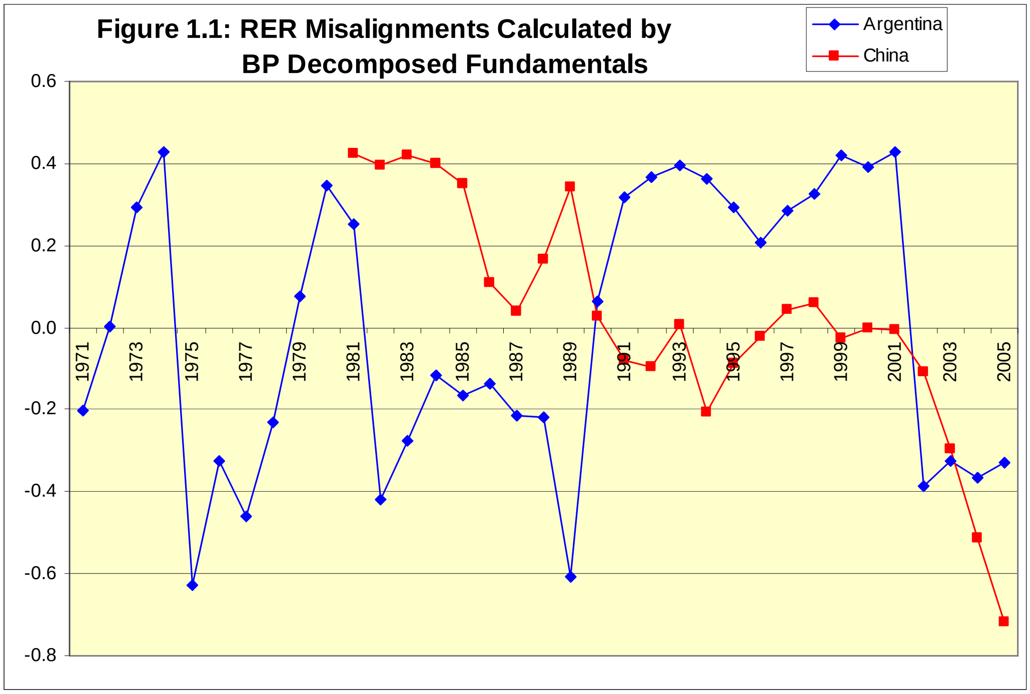


Figure 1.1: RER Misalignments Calculated by
BP Decomposed Fundamentals
Argentina
China
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

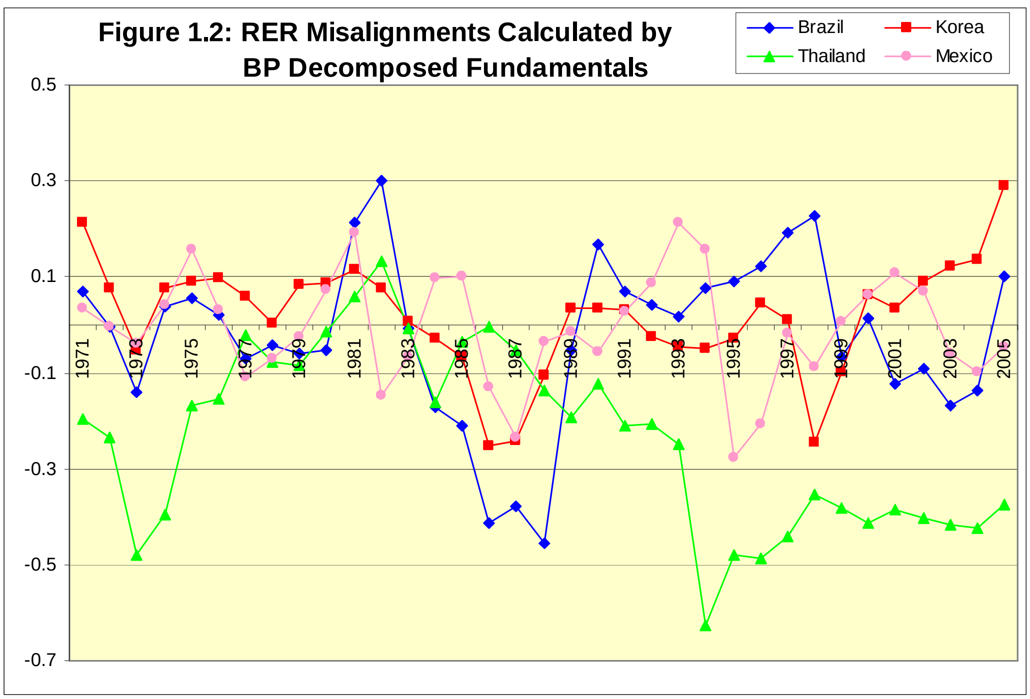


Figure 1.2: RER Misalignments Calculated by
BP Decomposed Fundamentals
Brazil
Korea
Thailand
Mexico
0.5
0.3
0.1
-0.1
-0.3
-0.5
-0.7
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005

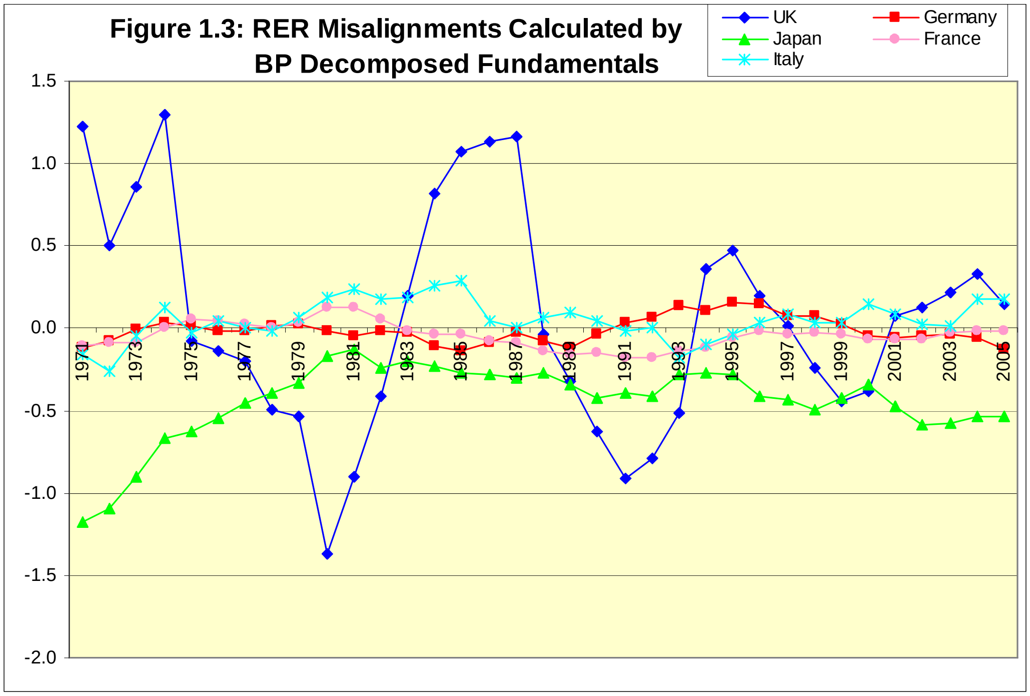


Figure 1.3: RER Misalignments Calculated by BP Decomposed Fundamentals

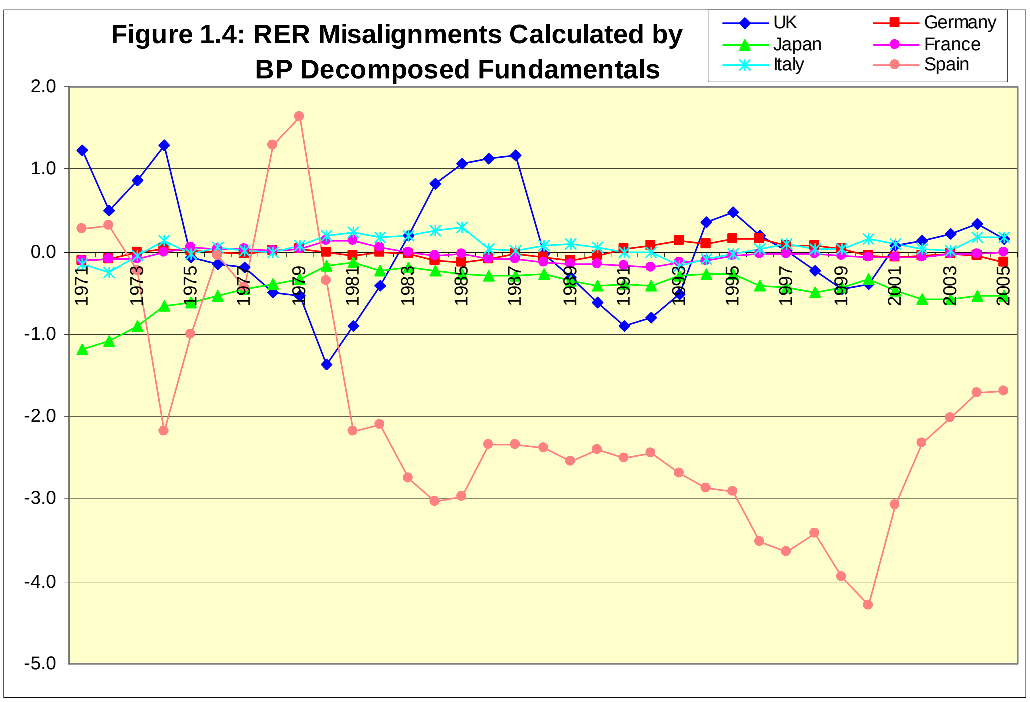


Figure 1.4: RER Misalignments Calculated by BP Decomposed Fundamentals

Figure 2.1: Histogram of α Coefficients for 79 Countries from 1970 to 2005

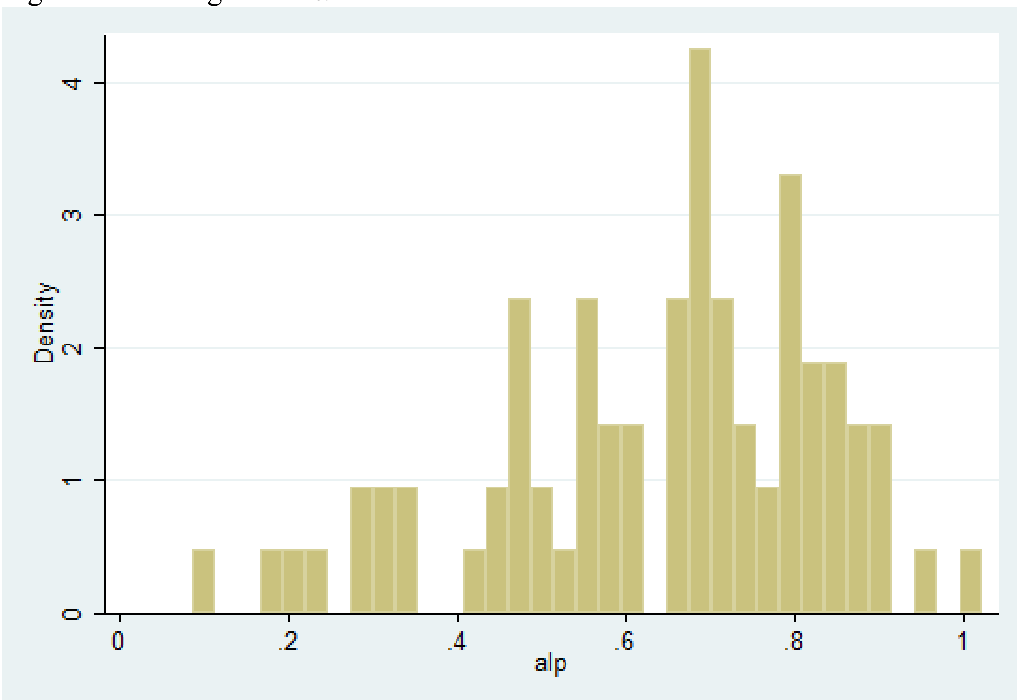


Figure 2.2

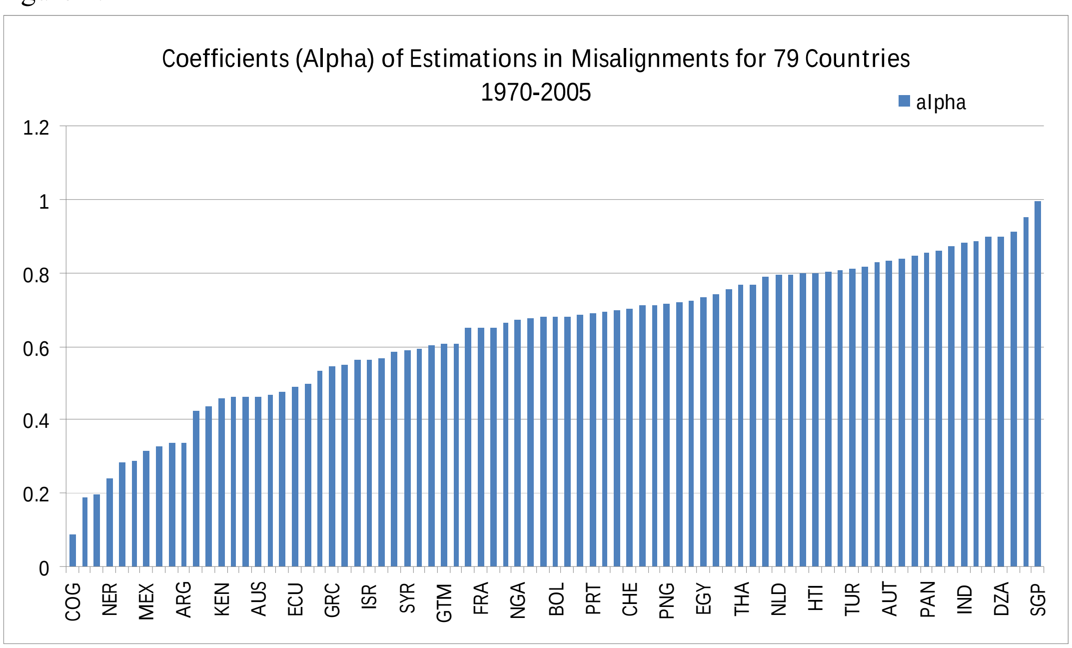


Figure 2.3: Histogram of Standard Errors in Lagged Real Exchange Rates

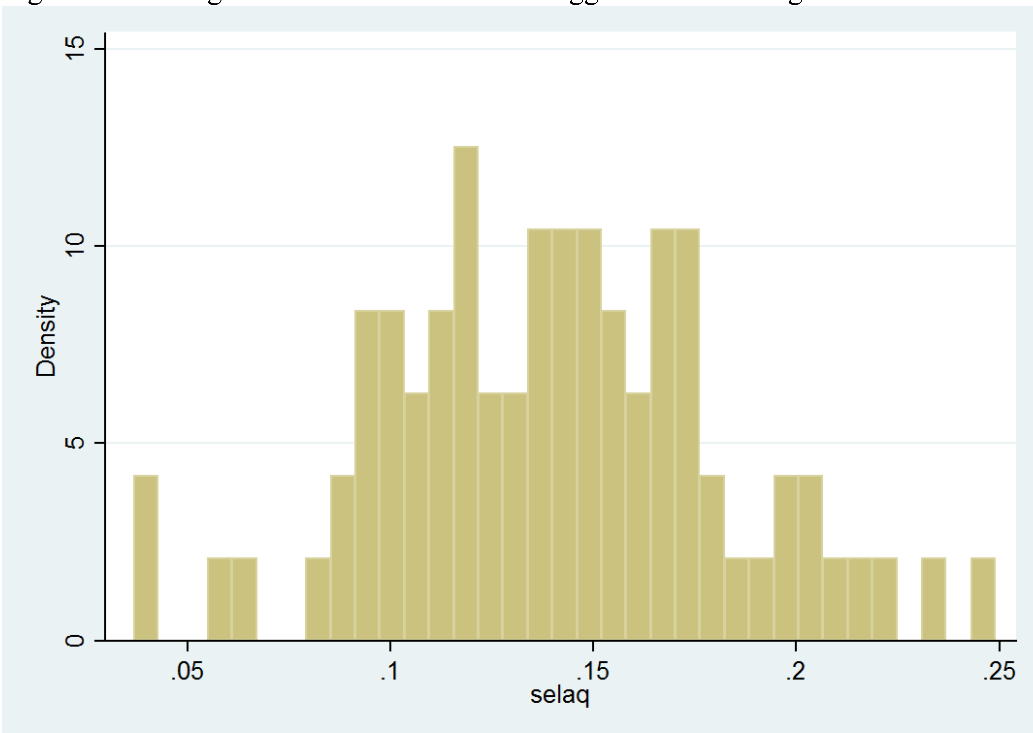


Figure 2.4

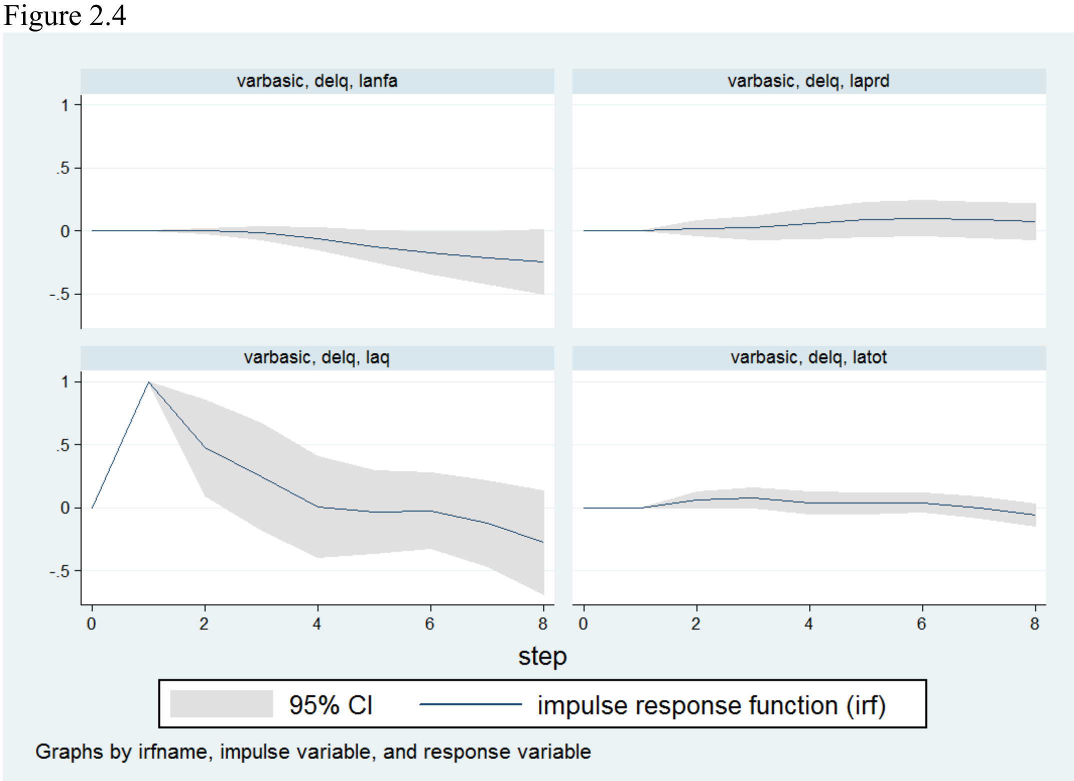


Figure 2.5

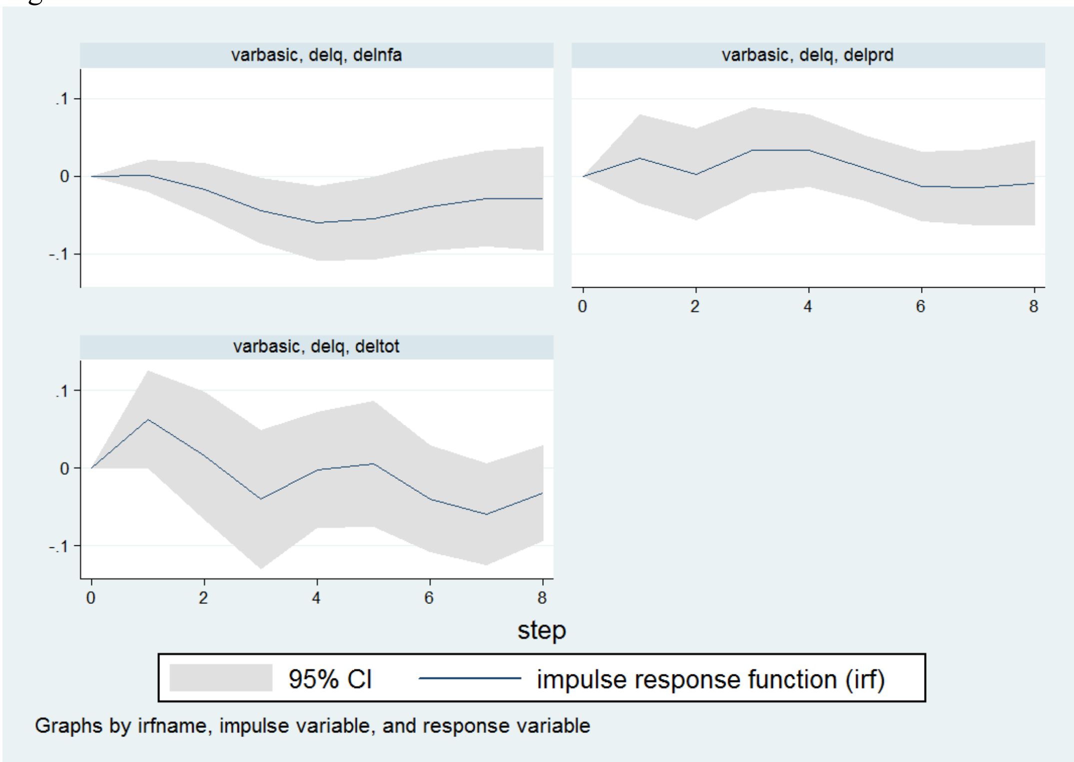


Figure 2.6

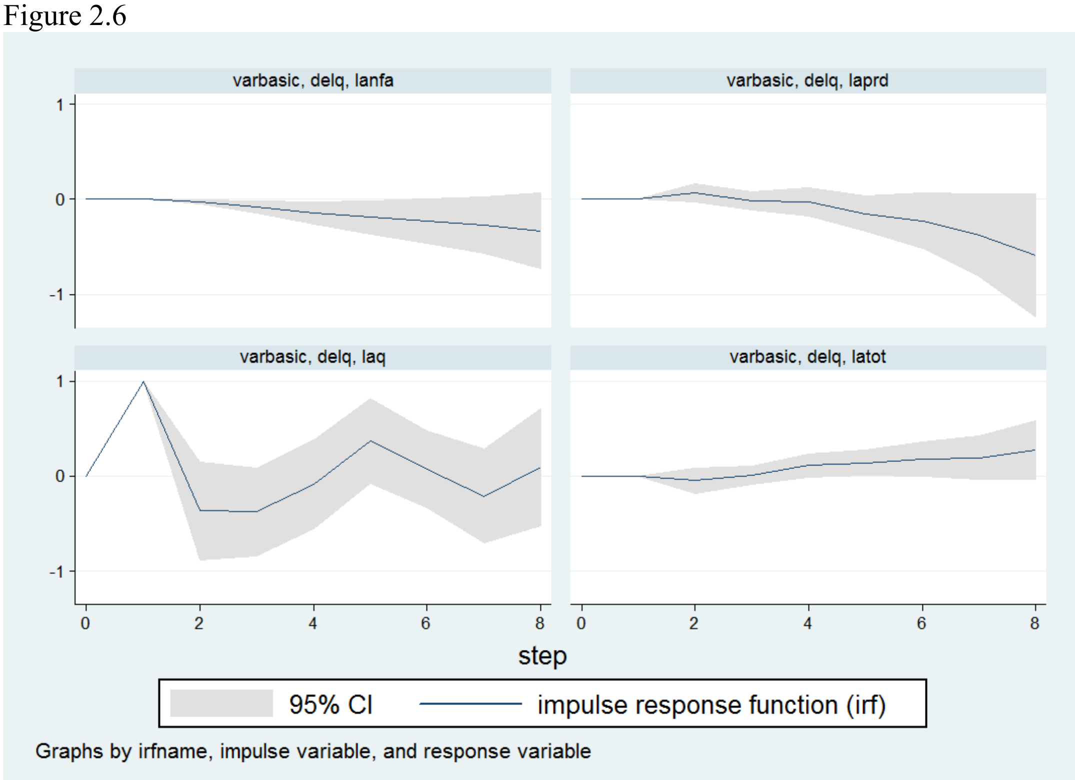
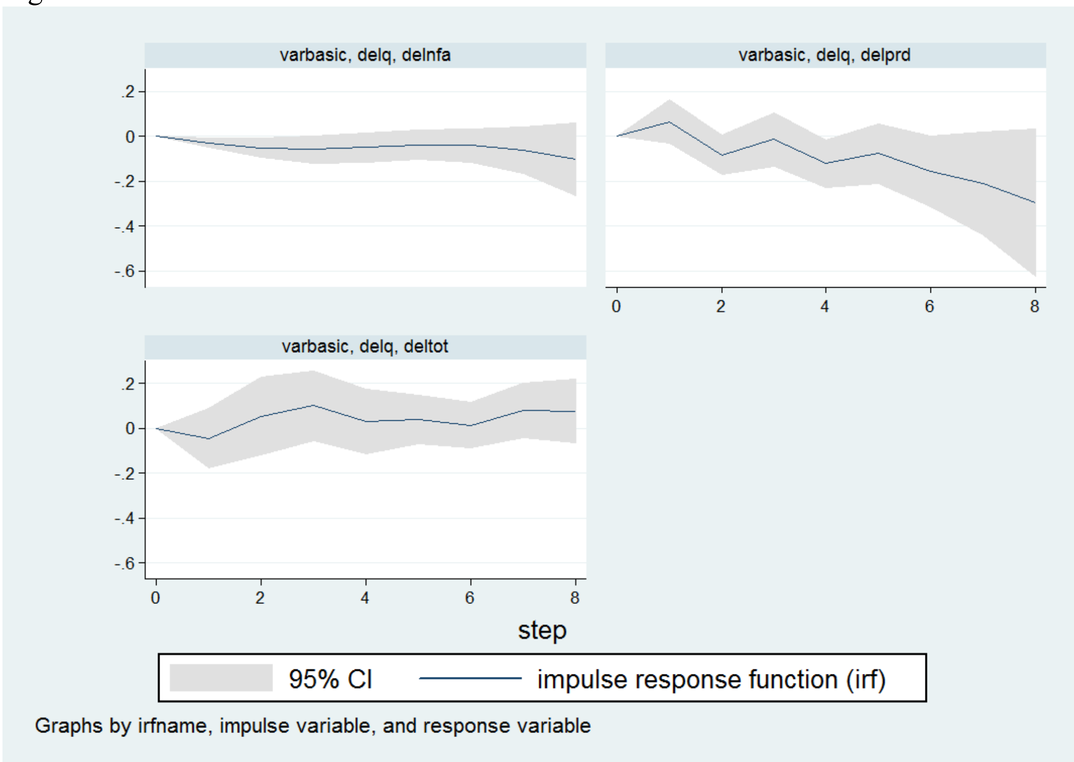


Figure 2.7


varbasic, delq, delnfa
varbasic, delq, delprd
varbasic, delq, deltot
.2
0
-.2
-.4
-.6
0
2
4
6
8
step
95% CI
impulse response function (irf)
Graphs by irfname, impulse variable, and response variable