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DESPERATELY SEEKING THE POSITIVE IMPACT OF UNDERVALUATION ON GROWTH

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Abstract

This paper contributes to a current and intense debate among economists on whether real exchange rate undervaluation can boost growth. It focuses on addressing econometric and empirical issues that casts doubt about the validity of such positive impact. It also allows for the possibilities that the effect of undervaluation on growth operates with delay or dependence on the persistence or the level of undervaluation. We didn’t find any convincing support to the claim that a depreciated equilibrium real exchange rate promotes economic growth. We argue that the contrast between our results and the documented examples of a successful adoption of undervaluation strategy reported in the literature reveals that undervaluation alone is not enough to boost growth. The simultaneous adoption of companion policies may be behind the claimed success.

ملخص

يساهم هذا البحث في الجدل الحاد الموجود حاليا بين علماء الاقتصاد بشأن ما إذا كان تخفيض سعر الصرف الحقيقي يمكنه دفع النمو أم لا. ويركز هذا البحث على محاولة حل مشاكل الاقتصاد القياسي و القضايا التجريبية التي تلقي بالشك حول صحة مثل هذا الأثر الايجابي. كما يسمح أيضا هذا البحث للإمكانيات التي تؤثر على تخفيض النمو الذي يعمل مع التأخير أو المعولات علي الاستمرار أو مستوى التخفيض. ولم نجد أي سند مقنع للإدعاء بأن سعر الصرف الحقيقي للتوازن المُخفض يشجع النمو الاقتصادي. ونوضح بأن التباين بين نتائجنا والأمثلة الموثقة للتبني الناجح لإستراتيجية التخفيض التي وردت في الأبحاث السابقة قد اظهر أن عملية التخفيض غير كافية بمفردها لدفع النمو. وقد يكون السبب وراء النجاح المُدعي هو التبني الفوري للسياسات المصاحبة.

1. Introduction

The impact of the exchange rate on a country's economic performance is now widely acknowledged. Early researches saw exchange rate changes as means to compensate producers for tariff removals or to maintain the balance of trade equilibrium. For instance, Krueger (1978) examined exchange rate modification aiming at partially or fully compensating producers for the financial impact of tariff removal. Balassa (1982) showed that devaluation of the domestic currency can be interpreted as the parallel of imposing import tariffs and export subsidies at equal rates. Then, a move to free trade and devaluation can be viewed as a replacement for the existing protective measures with a uniform rate of tariff and subsidy that will maintain the balance of trade unchanged.

In the 1980s and the 1990s the focus shifted to the consequences of the real exchange rate (RER) misalignment; that a country's actual RER deviates from its equilibrium level. The contrast between the economic performance of Latin American, Asian, and African countries motivated a renewed and strong interest in the link between RER behavior and economic performance. Very often, the misalignment took the form of domestic currency overvaluation. A number of developing countries in Africa and Latin America were of the opinion that maintaining overvalued exchange rates would facilitate the development of their industries and foster growth through the reduced cost of importing machinery and other inputs for domestic firms. However, the experience showed that these countries witnessed factor misallocations, low efficiency, higher inflation and lower GDP growth. At the same time, the stable and better aligned exchange rate strategy was fundamental in promoting East Asian expansion (see, inter alia, Cottani et al., 1990 and Ghura and Grennes, 1993).

While many studies convincingly made the case against overvalued exchange rates, they didn't broach the impact of undervaluation on growth. Actually, the samples used in all the relevant studies were composed, in the majority, of overvaluation episodes. Recently a new view claiming that a depreciated equilibrium real exchange rate promotes economic growth has become popular (e.g. Hausmann et al., 2005; Freund and Pierola, 2008 and Rodrik, 2008). However, the claim remains fragile at both the theoretical and the empirical level. At the theoretical level the research addressing this issue is still at the beginning and the precise channels through which the effect might operate are yet unclear (Montiel and Servén, 2009). At the empirical level, the evidence on which the claim is based raises a number of questions that cast doubt on its validity. This paper is concerned with the latter aspect. It provides a thorough investigation of the relationship between undervaluation and growth that addresses such questions.

Note that some critics of the idea — the positive impact of undervaluation on growth— questioned the status of the RER as a policy instrument (see, Woodford, 2008 and Henry, 2008). This remains a strongly debated issue between economists (Bhalla, 2008) but the present paper doesn't tackle this issue. It rather takes an agnostic position in this respect. If the RER is not an instrument, the debate about the impact of undervaluation on growth becomes irrelevant from an economic policy point of view. If, in contrast, the RER is a policy instrument, the question about the impact of undervaluation on growth becomes relevant as does the rest of the analysis in this paper. Interestingly, our results show that even in this case the positive impact of undervaluation on growth is not strongly supported.

We consider three main problems with the empirical evidence used to support the claim that undervaluation promotes growth. First, overvaluation episodes seem to dominate the samples. Hence, the results are better interpreted as the impact of a lower overvaluation on growth rather than the impact of undervaluation. Although mathematically one can interpret a 1% overvaluation as -1% undervaluation, saying that since overvaluation hurts growth, then undervaluation facilitates it is neither mathematically nor economically founded.

Mathematically, one should assume symmetry and linearity of the effects of undervaluation and overvaluation on the whole economy in order to state that as overvaluation hurts growth, undervaluation facilitates it. Economically, both undervaluation and overvaluation reflect disequilibrium situations and unless one incorporates specific frictions in the economy under study, one cannot ascertain that disequilibrium has a negative impact in one case and a positive impact in the other. Incorporating frictions was the way pursued by Rodrik (2008) to show how undervaluation could benefit growth at a theoretical level, especially in developing countries. He showed that since the tradable sector in these countries suffers disproportionately from government and market failures—which is supported by empirical evidence—undervaluation of the currency is a second best option to stimulate economic growth. Rodrik conducted various econometric estimations to confirm that undervaluation is, indeed, beneficial to growth. However, the number of overvaluation episodes seems to dominate his sample too[1] and we found no results distinguishing between the impacts of undervaluation and overvaluation in the paper.

Second, the definition of undervaluation (in general Purchasing Power Parity (PPP) corrected for the Balassa-Samuelson effect) is based on price comparisons and differs substantially from the alternative definition that emphasizes macroeconomic equilibrium (see, inter alia, Cottani et al., 1990; Ghura and Grennes, 1993 and Razin and Collins, 1997). The resulting undervaluation indicator mainly reflects the potential positive impact on exporters leaving aside the potential negative impact on the rest of the economy. Since it is now widely accepted that exports foster growth (Frenkel and Romer, 1999), the positive association between the indicator of undervaluation and growth is not surprising. Should one use indicator(s) taking account of both the positive and the negative effects of undervaluation on the whole economy, the net impact might be negative.

Third, the measure of undervaluation might suffer from endogeneity. Generally, authors admit that endogeneity is an issue and propose two ways of dealing with it. One consists of expanding their specification to include additional explanatory variables (e.g. inflation rate, government consumption and gross domestic saving) while the other uses the generalized method of moments (GMM) estimation method. The implicit idea behind the introduction of additional variables is that at least a part of undervaluation is policy driven. Hence, controlling for such a source of endogeneity and still finding a positive effect of undervaluation on growth grants further reliability to the results. However, such an exercise corrects for a possible correlation between undervaluation and policy measures that falls in the error term in the non-expanded specification. Yet this is hardly proof that the remaining variation in the indicator of undervaluation is exogenous. The main problem is also the exogeneity (at least the "weak exogeneity" as shown by Engle et al., 1983) of undervaluation with respect to the growth rate itself (Bhalla, 2008).

Beside the GMM estimation which tackles the problem of the validity of the instruments (Murray, 2006), the exchange literature suggests another way of tackling the problem of exogeneity of undervaluation with respect to the growth rate and, at the same time, addresses the second criticism outlined above. It consists of separating the evolution of the RER into two components: one reflects the evolution of the equilibrium real exchange rate (ERER) while the other captures the deviation of the observed RER from the equilibrium (i.e. misalignment). This is the path followed by Cottani et al. (1990), Ghura and Grennes (1993) and Razin and Collins (1997) among others. They used models where exchange evolution depended on a set of "fundamentals" reflecting the requirements of internal and external equilibrium of the economy on one hand, and on policy and non-policy exogenous shocks

[1] Since we did not find indications about the number of episodes of undervaluation/overvaluation in the paper, this is inferred from Table 2 and Figure 1 in the paper.

that drive the RER out from its equilibrium level on the other hand (e.g. Edwards, 1998). The latter is associated with misalignment and is considered as exogenous with respect to the fundamentals that determine ERER. It is therefore used to examine the impact of misalignment on economic performance. This is the approach we adopt in this paper.

The purpose of this paper is to examine the robustness of the positive effect of RER undervaluation on growth. Like the majority of related literature, this paper focuses on developing countries. It uses a panel of 30 to 50 countries over the period 1980–2005. Since economic growth is a long-term phenomenon, the econometric analysis uses Panel-Cointegration methodology in addition to the GMM and the simple ordinary least squares (OLS) methods. Furthermore, in order to establish convincing results pertaining to exchange rate undervaluation per se (i.e. not only misalignment) it allows for the possible asymmetry of the effects of undervaluation and overvaluation on growth. Finally, the paper also examines the possibilities that the effect of exchange rate undervaluation is possibly delayed or dependent on the persistence or the level of undervaluation.

The rest of the paper is organized as follows. Section 2 presents the relation to the literature. Section 3 is devoted to computing the exchange rate misalignment. Section 4 analyzes the relationship between our measure of undervaluation and the growth rate of real per capita income. Section 5 concludes.

2. Relation to the Literature

Several studies explored the link between exchange rate misalignment and economic growth. Given the purpose of the present paper, we split the previous literature following two aspects: the first is concerned with the misalignment indicator used and the second is concerned with the distinction between the effects of under and overvaluation on growth.

Regarding the misalignment indicator, most of the studies used measures of misalignment based on PPP, available from the World Bank (WB). Sometimes the PPP measure is corrected for the Balassa-Samuelson effect and/or combined with the Black Market Premium (BMP). Studies along this line include Dollar (1992), Easterly (1993, 2001, 2005), Acemoglu et al. (2002) and Polterovich and Popov (2003). Fewer studies (Cottani et al., 1990; Ghura and Grennes, 1993; Razin and Collins, 1997 and Aguirre and Calderón, 2005) used a model-based measure of misalignment.

Regarding the distinction between the effects of under and over valuation on growth, only Razin and Collins (1997) and Aguirre and Calderón (2005) allowed for a possible asymmetry of the effects; although Polterovich and Popov (2003) focused on undervaluation.

Dollar (1992) tested the relation between growth and misalignment using a sample of 95 developing countries over the period 1976–1985. He highlighted the negative effect of misalignment on economic growth. Using the indicator of the RER misalignment from the WB and the BMP on foreign exchange markets (an alternative measure of misalignment), Easterly (1993), considering a sample of 51 countries over the period 1970–1985, also showed that overvaluation has a negative effect on economic growth. Easterly (2001) extended Dollar (1992)'s RER series for developed and developing countries and subsequent years. He confirmed the negative correlation between exchange rate overvaluation and per capita growth rates. However, the main determinants of growth seemed to be education and infrastructure, which contribute to growth, and inflation, which hampers growth. The findings were confirmed in Easterly (2005) on a larger sample including 82 countries over the period 1960–2000 although he was cautious about the use of BMP as an indicator of misalignment. Although their main focus was the link between institutions and growth with 96 countries from 1970 to 1997, Acemoglu et al. (2002) also examined the issue of overvaluation and growth using Easterly's (2001) index of RER. They could not reject that overvalued exchange rates induced lower growth.

Polterovich and Popov (2003) followed a distinct path from the rest of the literature. They were concerned with the possible positive effect of exchange rate undervaluation on long-run growth rather than the problem of overvaluation. Arguing for a strong positive correlation between foreign exchange reserves accumulation and undervaluation measured as deviations from PPP and drawing on the experience of some countries (e.g. China, Hong Kong, Taiwan, Singapore, Malaysia and Thailand), they used reserve accumulation as a proxy for situations of relative RER undervaluation. With a sample of 100 developed and developing countries over the period 1960–1999, the authors found that the accumulation of foreign exchange reserves is a relevant factor in explaining per capita growth rates even after controlling for the initial level of per capita income, investment rates over GDP and population growth. Their results also showed strong positive correlations between foreign exchange reserves accumulation and investment rates over GDP, trade volume over GDP and levels of foreign direct investment (FDI).

A major weakness of the PPP measure of ERER to compute misalignment is the fact that changes in the sustainable ERER caused by changes in economic fundamentals such as terms of trade, capital inflows, technology and trade policies could be considered as misalignment (Ghura and Grennes, 1993). Moreover, as stated by Easterly (2005), the BMP could also be a misleading measure of RER misalignment. An overvalued RER will not show up in the BMP on foreign exchange in the absence of tight capital controls. This is especially true in the CFA zone in Africa where, because of convertibility at a fixed rate pledged by France, the BMP on foreign exchange is on average almost nil and uniform among countries. Moreover, the BMP on foreign exchange can display large swings in the short run, arising from expected changes in macroeconomic policies or instability in political and social conditions. Such short-run fluctuation reflects more the asset market characteristics of the parallel market for foreign exchange than changes in economic fundamentals inducing real exchange misalignment (Sekkat and Varoudakis, 2000).

To avoid such shortcomings, Cottani et al. (1990), Ghura and Grennes (1993), Razin and Collins (1997) and Aguirre and Calderón (2005) used a model-based measure of misalignment. The model implies that the evolution of the exchange rate depends on a set of "fundamentals" reflecting the requirements of internal and external equilibrium of the economy on the one hand, and on policy and non-policy exogenous shocks that drive the RER out from its equilibrium level on the other hand. The latter is associated with misalignment and considered as exogenous with respect to the fundamentals that determine the ERER. It is used, therefore, to examine the impact of misalignment on economic performance.

Cottani et al. (1990) focused on a sample of 24 developing countries over the period 1960 – 1983 and estimated a RER model combining time series with cross-sectional data. The resulting measure of misalignment was combined with control variables (average export growth, agriculture growth, net investment and the incremental capital-output ratio) to estimate a cross-section regression of growth. The empirical results showed strong negative correlation between growth and RER misalignment. Ghura and Grennes (1993) conducted a similar exercise focusing on Sub-Saharan Africa (33 countries). They confirmed that RER misalignment and instability had adversely affected real income growth.

While the above analyses assumed a linearity or a symmetry of the effects of under and overvaluation, Razin and Collins (1997) and Aguirre and Calderón (2005) relaxed this assumption. Like the two previous papers, they explored the relation between exchange rate misalignment and per capita growth rates using a model-based measure of misalignment.

With a sample of 93 countries over the period 1975–1993, Razin and Collins (1997) showed that misalignment was negatively associated with growth. However, the result was only weakly significant.

To examine if misalignment had a different effect on growth depending on whether it reflected under or overvaluation of the RER, Razin and Collins (1997) split the misalignment series into two subsets. One included positive values of misalignment and was labeled "overvaluation" while the other included negative values and was labeled "undervaluation". The two series were introduced separately into the growth regression. The results showed that overvaluation had an economically and statistically significant negative effect on economic growth while undervaluation did not have any significant effect on growth. The authors further divided the subsets of overvalued RERs and undervalued RERs into low, medium, high and very high. The results showed that very high overvaluation slowed growth, smaller overvaluation did not and high (but not very high) undervaluation promoted growth. However, this finding is not consistent across specifications.

Aguirre and Calderón (2005) addressed a similar question for a sample of 56 developing countries over 1965– 2003. They used panel cointegration methods to compute exchange rate misalignment and GMM-IV system estimation to investigate the impact of misalignment on growth. They found that RER misalignments hindered growth but that the effect was non-linear; growth declines were larger, the larger the size of the misalignments. Large undervaluation appeared to hurt growth but small to moderate undervaluation enhanced it.

In this paper, we reexamine the relationship between RER misalignment and growth taking into account shortcomings of previous literature. We allow for possible asymmetry and delay of the effects of under and overvaluation on growth and for possible dependence of such effects on the persistence or the level of misalignment. We use used panel cointegration methods to compute exchange rate misalignment. This method is also used to examine the impact of misalignment on growth because economic growth is mainly a long term phenomenon. For comparison purposes with previous studies, we also use the GMM and the simple OLS methods.

3. Exchange Misalignment

3.1 The economic model

To examine how exchange rate misalignment affects growth we first compute the Real Effective Exchange Rate (*REER*) as:

$$Log(REER) = \sum_{j=1}^{j=10}\left[w_j * Log\left(e_j * \left({CPI}/{CPI_j} \right)\right)\right] \quad (1)$$

where *CPI* is the consumer price index of the country; CPI_j is the consumer price index of the country's partner *j*; e_j is the nominal bilateral exchange rate of the country with regards to partner *j*; w_j is the weight of the *j*-th partner in the bilateral trade of the country. We consider the 10 largest trade partners over the period 1999–2005 excluding oil exporting countries. The *REER* is constructed such that an increase means appreciation.

The *REER* can be decomposed into two components: The Equilibrium Real Effective Exchange Rate (*EREER*) and misalignment. Edwards (1988) was the first to propose an approach that makes it possible to distinguish between the two sources of *REER* variations. The latter is regressed on external and domestic fundamentals, which are assumed to induce changes in the *EREER.* The resulting coefficients are used together with sustainable levels of the explanatory variables to compute a series of *EREER.* The difference between the *REER* and the *EREER* is associated with misalignment. To estimate the impact of the fundamentals, we use the following empirical model:

$$\text{Log}(REER) = \alpha_0 + \alpha_1 \text{Log}(Open) + \alpha_2 \text{Log}(Cap) + \alpha_3 \text{Log}(ToT) + \alpha_4 \text{Log}(rDebt) + \alpha_5 \text{Log}(Gov) + \alpha_6 \text{Log}(GDPgap) + \alpha_7 \text{Log}(BalSam) + \varepsilon \quad (2)$$

For clarity, we drop the year and country indices. The *REER* is defined in Equation (1). *ToT* is the terms of trade (the ratio of export to import prices). *Open* is the ratio of export plus imports to GDP. *Cap* is the net capital inflow scaled by GDP. *Gov* is government consumption in percentage of the GDP. *rDebt* is the country debt services including interest payments and reimbursements as a share of GDP. *GDPgap* is the difference between the country's growth rate and the average growth rate over the whole sample. *BalSam* is the ratio between the country's real per capita GDP and the geometric mean (weighted in a similar way as the *REER*) of the same variable in trading partners.

We expect a rise in the terms of trade to appreciate the equilibrium *REER* to the extent that it improves the trade balance; the income effect dominating the substitution effect; and α_3 is expected to be positive. It is expected that restricted trade openness will exert downward pressure on the relative price of tradable to nontradable goods, thereby leading to an appreciation in the equilibrium *REER*; α_1 is expected to be negative. Higher capital inflows involve stronger demand for both tradables and nontradables and lead to a higher relative price of nontradables and *REER* appreciation. This is needed for domestic resources to be diverted toward production in the non-tradable sector in order to meet increased demand; α_2 is expected to be positive. Government consumption has a similar effect. Stronger demand for nontradables increases their relative prices leading to an appreciation in the equilibrium *REER*; α_5 is expected to be positive. The higher the country debt services the higher the demand for foreign currencies inducing depreciation of exchange rate; α_4 is expected to be negative. The variable BalSam reflects a productivity gap and aims at capturing the potential Balassa-Samuelson effect. Assuming that the prices for tradable sectors are homogeneous across countries and that their productivity is higher than in nontradable sectors, the increase in wages in the tradable sectors due to higher productivity spills over the wages in nontradable sectors. The latter induces an increase in inflation and an appreciation of the *REER*; α_7 is expected to be positive.

3.2 The econometric analysis

Equation (2) will be used to estimate the *EREER* and potential misalignment considering a panel dataset of 52 developing countries from Africa, Asia and Latin America over the period 1980–2005 (See Appendix A). The sample is determined according to the availability of data with the major source of information we used (e.g., the World Development indicators of the World Bank).

Pooling the data potentially improves the robustness of estimations with misalignments being determined according to a normal behavior given by the average estimated coefficients over the sample. Moreover, panel data being vulnerable to countries heterogeneity, country-fixed effects can be introduced in the empirical model. However, as explained above, the *EREER* concerns the long-term relationship between the *REER* and the fundamentals. In order to determine such a relationship, one should use the cointegration methodology. The latter allows separating the long and short term relationships between the *REER* and the fundamentals.

Cointegration analysis has for a long time been applied to "pure" time series (e.g. a given country over time), in this paper we take advantage of the time series and the cross-section dimensions of the sample to study the relationship in Equation (2) using recent developments of panel-data cointegration analysis which allows for more efficient estimation and testing, especially when the number of time periods is limited (e.g. Levin, Lin and Chu, 2002; Im, Pesaran and Chin, 2003; Moon and Perron, 2004; Chang, 2002; Pesaran, 2007; Pedroni 2004 and Kao and Chiang, 1998).

To present cointegration simply, consider two time series *x* and *y* that are integrated of order one [I (1)]. This means that their first differences (Δx and Δy) are stationary [I (0)]. If the regression of *x* on *y* (that is I (1)) gives a time series of residuals that is I (0), the two series are called cointegrated. This means that a long-term relationship between them exists. The latter is given by the regression coefficients of *x* on *y*. However, the OLS estimate of the coefficient is convergent but not efficient and other estimation techniques need to be used. Then, the cointegration approach involves three major steps. First, test whether the variables are I (1). Second, test whether the variables are cointegrated. Third, estimate the long-term relationship.

First developed in a “pure” time series context, cointegration analysis has been subsequently extended to data combining both the time series and the cross-section (commonly referred to as panel data) dimensions. The three steps for the analysis are the same as above except that the nature of the data (i.e. time series and the cross-section) involves a preliminary check regarding whether individuals (e.g. countries) are interdependent or not. This is important for the choice of the test to be used in the cointegration analysis. In what follows, we apply the four steps to Equation (2).

3.2.1 Interdependence among countries

To examine whether individuals are interdependent, we use a test suggested by Pesaran (2004). The test is based on the average of the correlations between the residuals from a regression on each individual separately. Practically, consider the variable y_i pertaining to the individual *i*. The variable is regressed on its first lag and the residuals are collected to compute ρ_{ij} which is the correlation coefficient between the residuals from individual *i* and *j* regressions. The statistic is shown to have a N (0, 1) distribution under the null hypothesis of independence, where N is the number of individuals and T is the number of years.

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \qquad (3)$$

The results of the test applied to our sample are presented in Table 1. For all variables, the tests reject the null hypothesis of independence of individuals.

3.2.2 Stationarity tests

To examine stationarity, we should use a test that incorporates the interdependence of individuals. Among the existing tests, the one by Pesaran (2007) is the most adequate because it targets a situation where N (the number of individuals) is higher than T (the number of years). In addition, the test allows analyzing non-stationarity within a heterogeneous panel framework, i.e. a panel in which each country is allowed to evolve according to its own dynamics. The test builds on the well-known augmented Dickey-Fuller regressions. Practically, consider y_{it} pertaining to the individual *i* at time *t*. Run the regression:

$$\Delta y_{it} = \alpha_i + \rho_i y_{it-1} + \gamma_i \bar{y}_{t-1} + \delta_i \Delta \bar{y}_t + \vartheta_{it} \qquad (4)$$

and take the calculated Student statistics of ρ_i ; t_i. Where $\bar{y}$ is the average of y_{it} over all individuals at time *t*. The statistic

$$CIPS(N,T) = \frac{1}{N}\sum_{i=1}^{N} t_i \qquad (5)$$

is used to test for stationarity but it does not have a standard distribution. We follow Pesaran (2007) and simulate the critical values using the Monte Carlo approach. If the computed statistic (*CIPS*) is above the critical value, one cannot reject the null hypothesis of stationarity.

Table 2 presents the results. The tests reveal that all variables are I (1). Hence, if we find a relationship among the variables which gives stationary residuals, these variables will be considered as cointegrated.

3.2.3 Cointegration tests

The best-known tests are due to Pedroni (1995, 2004). They allow for taking account of heterogeneity among individuals. The author proposed seven versions of the cointegration test: four are suitable when studying the relationship of the variables within countries and three pertain to the relationship between variables of different countries. The former set of tests is the most suitable for our study. The procedure is the following. Consider a dependent variable y_{it} and set of explanatory variables x_{kit} observed for individual *i* at time *t*. To conduct the test, five steps are followed:

1. Estimate the following cointegration regression over the panel

   $$y_{it} = \alpha_i + \delta_i t + \beta_{1t} x_{1it} + \beta_{2t} x_{2it} + \ldots + \beta_{kt} x_{Kit} + \varepsilon_{it}$$

2. Differentiate the original series for each member, and estimate the following regression over the panel

   $$\Delta y_{it} = b_{li} \Delta x_{1it} + \ldots + b_{Ki} \Delta x_{Kit} + \eta_{it}$$

3. Calculate L^2_{11i} as the long-run variance of η_{it} using, for instance, the Newey and West (1987) estimator.
4. Apply DF and ADF regressions to the residuals ε_{it} and compute the long-run (σ_i^2) and the simple variances ($s\ i^2$) from of the residuals of the DF regression as well as the simple variances ($s_i{*}^2$) from of the residuals of the ADF regression.
5. Using the above parameters, the following four statistics can be computed to test for cointegration.

Panel *v*- statistic:

$$T^2 N^{3/2} Z_{vN,T} \cong T^2 N^{\frac{3}{2}} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \hat{\varepsilon}_{i,t-1}^2 \right)^{-1}$$

Panel ρ- statistic:

$$T\sqrt{N} Z_{\hat{\rho}N,T^{-1}} \cong T\sqrt{N} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \hat{\varepsilon}_{i,t-1}^2 \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \left(\hat{\varepsilon}_{i,t-1} \Delta \hat{\varepsilon}_{i,t} - \hat{\lambda}_i \right)$$

Panel t- statistic:

$$Z_{tN,T} \cong \left(\tilde{\sigma}_{N,T}^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \hat{\varepsilon}_{i,t-1}^2 \right)^{-\frac{1}{2}} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \left(\hat{\varepsilon}_{i,t-1} \Delta \hat{\varepsilon}_{i,t} - \hat{\lambda}_i \right)$$

Panel ADF statistic:

$$Z^*_{tN,T} \cong \left(\tilde{s}^{*2}_{N,T} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \hat{\varepsilon}^{*2}_{i,t-1} \right)^{-\frac{1}{2}} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{1li}^{-2} \left(\hat{\varepsilon}^{*}_{i,t-1} \Delta \hat{\varepsilon}^{*}_{i,t} - \hat{\lambda}_i \right)$$

where $\lambda_i = 0.5\ (\sigma_i^2 - s_i^2)$

Pedroni (1995, 1997) showed that, with a slight correction, the statistics converge toward a normal distribution. Actually

$$\frac{x_{NT} - \mu\sqrt{N}}{\sqrt{\nu}} \sim N(0,1)$$

where x_{NT} is one of the four statistics and μ and ν are tabulated by Pedroni (1999). The results of the cointegration tests applied to Equation (4) are presented in Table 3. Two tests suggest that the variables are cointegrated but two others suggest the reverse. We follow Pedroni (2004) who being faced with the same type of results concluded that the variables are cointegrated (See also Barisone et al., 2006).

3.2.4 Estimation of the coefficients

Although the variables are cointegrated, the OLS estimates of the parameter are convergent but not efficient (Kao, Chiang and Chen, 1999). Two methods are available to get efficient estimates of the parameters. One, labeled dynamic OLS (DOLS), was developed by Kao and Chiang (1998) and consists of adding to the cointegration equation lags of the explanatory variables in order to clean the error term from any autocorrelation and heteroskedasticity. The other, called Fully Modified OLS (FMOLS), was proposed by Pedroni (2000). It is a bit complicated to explain in a non-technical way. Roughly explained, it consists of running an OLS estimate of the cointegration equation and using the residuals to compute their variance-covariance matrix. This is then used to perform a sort of GLS on the cointegration equation. Both methods were applied to Equation 2 and the results are presented in Table 4. The overall quality of fit is good. Except for the variable *Cap*, the sign, level and significance of the coefficients are broadly similar. In the text, we will focus on the DOLS results.

Using the coefficients in Table 4, one can compute the extent of the *REER* misalignment. Recall, however, that misalignment refers to the difference between the *REER* and its equilibrium level, the *EREER*. The latter is given by the fitted values using together the estimates in Table 4 and the long-run values of the explanatory variables. To get such long-run values, some authors draws on theory (e.g. Cottani et al., 1990 and Ghura and Grennes, 1993). We think, however, that such an approach might be influenced by the judgment of each individual author. Therefore, we prefer to stick to a purely econometric approach as adopted in all of this paper. We use the Hodrik-Precsott filter to separate the permanent and temporary components of each variable.

We define misalignment as:

$Mis = (REER\ /\ EREER - 1) * 100$ (6)

the positive values of which correspond to overvaluations.

Table 5 and Figure 1 describe the obtained misalignment series. On average, exchange rates have been overvalued by around 11 percent but with high variations across countries and time. The standard deviation was around 19 percent. Figure 1 shows that average overvaluation decreased steadily until the mid 1990s when they started increasing slowly. Finally, Table 1 shows that episodes of overvaluation represent a large majority of observations in the sample but nonetheless those of undervaluation represent a considerable share (33%) which should allow us examining the asymmetry in the impact of misalignment on growth.

4. Undervaluation and Growth

4.1 The economic model

The developments in growth theory and the availability of rich datasets have fostered considerable empirical analysis. Most of the studies have been conducted in the framework of the single cross-country regression suggested by Barro (1991). Briefly summarized, the approach consists of estimating the following equation.

$$\begin{aligned}\ln(y_{i,t})-\ln(y_{i,t-1}) = \beta_0 - \beta_1 \ln(y_{i,t-1}) + \beta_2 \ln(S_{Ki,t}) + \beta_3 \ln(S_{H_{i,t}}) - \beta_4 \ln(\delta + g^* + n_{i,t}) \\ + \beta_5 \ln(X_{i,t}) + \varepsilon_{i,t}\end{aligned} \quad (7)$$

where y is real income per capita, S_K is the rate of savings in physical capital, S_H the rate of saving in human capital, g^* is the rate of exogenous technical progress, n is the population growth rate, δ is the depreciation rate of physical capital and β_0, β_1, β_2, β_3, β_4 and β_5 are parameters. Indices i and t refer to country and time respectively.

The lagged per capita income $y_{i,t-1}$ captures the possible conditional convergence of income. This was suggested by the recent empirical growth literature under the assumption of diminishing marginal returns to capital: the lower the initial level of income the greater is the growth rate. The variable S_K is measured by the investment ratio which is expected to have a positive impact on the growth rate. The proxy of S_H is the school enrolment ratio which should have a positive impact on growth. Hence, β_1, β_2, β_3 and β_4 are expected to be positive.

The equation is generally augmented with additional variables (X_{it}) to control for other determinants of growth. The choice of such additional variables is very complicated however. Duarluf et al. 2005 showed that the number of regressors that can be potentially added to the regression approaches the number of countries available in the broadest samples. This plethora of potential regressors illustrates one of the fundamental problems with empirical growth research, namely, the absence of any consensus on which growth determinants should be included in a regression. A number of economists suggest that one focuses on a core set of explanatory variables that have been shown to be consistently associated with growth and evaluate the importance of the variable of interest (here misalignment) conditional on inclusion of the core set (Woo, 2009). In what follows, we will therefore stick to the core variables presented in Equation (7). Given data availability, the estimation will be conducted on a sample of 46 developing countries over the period 1980–2005.

4.2 Estimation issues

Previous estimations of Equation (7) consisted of running a simple OLS on the time average of the variables for each country (i.e. cross-section data). However, this has the inconvenience of not using the information contained in the time dimension of the sample. Moreover, Islam (1995) argued that such approach rests on the assumption of identical aggregate production functions for all the countries. He advocates for, and implements, a panel data approach to deal with this issue. The panel data framework makes it possible to allow for differences in production functions across countries in the form of "country fixed effects." Many of the subsequent papers adopted the framework advocated by Islam (1995) and used either annual data or, more frequently, five-year averages together with country fixed affects.

However, in dealing with the impact of misalignment another econometric issue was raised, namely the potential endogeneity of misalignment. The literature adopts, in general, the

GMM as the estimation method.[2] The approach uses lagged values of regressors as instruments for right-hand-side variables and also introduces lagged endogenous (left-hand-side) variables as regressors. Although, our measure of misalignment is constructed in such a way that essentially reflects exogenous policy and non-policy shocks, we will use the GMM for comparison purposes.

A third estimation issue concerns the time series properties of the variables. The GMM approach is valid when the variables are stationary. It is recommended, therefore, to check for the stationarity of the variables. It they are not, one should apply the panel cointegration approach outlined in Section 3. In addition to tackling stationarity issues, such an approach allows a better use of the information contained in the time dimension of the sample and a better control for the cycle component of the variables. The main determinants of the long-run components of growth are accurately identified.

In the estimation phase we will consider the results of the three estimation approach outlined above: Fixed effects estimation over five-year averages, GMM estimation over five-year averages and panel cointegration using yearly observations. The two first approaches have the advantage of allowing comparisons with other papers. The third one addresses the issue of data stationarity. However, some variables are impacted by the existence of missing observations through time in some countries. Hence, when we use the panel cointegration methodology, the number of countries in the sample is reduced to 30 instead of 46.

4.3 The cointegration analysis

The panel cointegration approach applied to Equation (7) will proceed in four steps as in Section 3 using similar tests: A test for interdependence among individuals (e.g. countries), a test for the stationarity of variables and a test of cointegration and estimation of the long-term relationship. The three first steps are presented in this subsection while the results of the fourth step are analyzed in details in the following subsection.

Table 6 reports the results of the tests of individuals' interdependence and the stationarity tests. The hypothesis of independence of individuals is rejected for three of five variables. In this case, it is recommended to use Pesaran (2007) test for the whole panel. The latter shows that all variables are I(1). We then proceed with testing for the existence of cointegration relationships among the variables. To this end, we use a similar test to Section 3. In Table 7, three statistics out of four suggest that the variables are cointegrated and one suggests the reverse. We follow Pedroni (2004) in concluding that the variables are cointegrated.

4.4 The impact of undervaluation on growth

As a preliminary step, we first estimate Equation 7 using our indicator of misalignment (i.e. without distinguishing under and overvaluations). Table 8 presents the results of the estimation using the three different methods discussed in Section 4.2 (OLS, GMM and panel cointegration (DOLS)). With each method, there are four variants of Equation 7 depending on whether country and time dummies are introduced (2*2=4). Note that, as in some papers, we have run the estimation of Equation 7 with only lagged income and misalignment as explanatory variables. The main conclusions from the analysis below do not change at all.

Based on the adjusted R^2, the fourth variant seems to better fit the data irrespective of the estimation method; it exhibits much higher adjusted R^2 than the other variants. When significant, the coefficients of the control variables have, in general, the expected sign. Exchange rate misalignment has a consistent significantly negative coefficient across the four

[2] Authors argued that the conventional instrumental variables approach should be ruled out in this context because it is difficult to think of exogenous regressors that influence the real exchange rate without plausibly also having an independent effect on growth.

variants using the OLS method. The magnitude of this coefficient is also consistent across the four variants. However, the coefficient is not significant with the other estimation methods.

For comparison, we focus on papers having used similar indicators of misalignments to ours. With a closer estimation method, although different (i.e. OLS fixed effects on a panel instead of OLS on a cross-section), we uncover the negative impact of misalignment on growth found by Cottani et al. (1990) and Ghura and Grennes (1993). These results are also similar to Razin and Collins (1997) and Aguirre and Calderón (2005). However, with GMM we find no effect of misalignment on growth contrary to Aguirre and Calderón (2005) which also used GMM. More interestingly, none of the estimated coefficients of the long-run relationship (cointegration) pertaining to misalignment is significant. Although with caveats due to the reduced number of countries in the panel cointegration's sample, this result does not exclude that misalignment might affect growth in the short/medium term but rejects the possibility of an effect over the long run. The important role granted to misalignment in previous studies might be overstated.

Table 9 presents the results of similar variants as Table 8. Now, however, the indicator of misalignment is split into two series: one includes observations of undervaluation only while the other includes observations of overvaluation only. For clarity we recoded undervaluation figures to be positive. Our purpose being to test the hypothesis that undervaluation boosts growth, the recoding allows an easy interpretation of the coefficient, which should be significantly positive, if the hypothesis is not rejected. In Table 9, the coefficient of overvaluation is negative in almost all variants but significant in only five instances out of 12. The coefficient of undervaluation is significant and positive in two cases, significant and negative in three cases and non-significant in the other cases.

If one focuses on the fourth variant which fits the data the best irrespective of the estimation method (it exhibits much higher adjusted R2 than the other variants), overvaluation appears to negatively affect growth only with the OLS estimation. No evidence of an effect of undervaluation or overvaluation on growth is found with the two other estimation methods, which is consistent with the results in Table 8.

So far, the evidence is not supporting any positive impact of undervaluation on growth. However, it might take time before such an effect materializes. For instance, Hausmann et al. (2005) examining growth episodes (i.e. growth acceleration by at least two percentage points lasting for at least eight years) found that real depreciation is among the factors significantly associated with these episodes. An increase of undervaluation by around 10% which is sustained for five years precedes growth episodes. Freund and Pierola (2008) found a surge in manufacturing exports following episodes of RER undervaluation. Since manufactured exports and economic growth are positively related (Sachs and Warner, 1995), this supports the possibility of a positive relationship between undervaluation and subsequent growth.

In order to allow for a time lag between undervaluation and subsequent growth, we rerun Equation 7 using the lagged values of undervaluation and overvaluation. The results in Table 10 show that the coefficient of overvaluation is consistently negative when the OLS and the panel cointegration estimation methods are used but it is significant only when the OLS is used. The coefficient of undervaluation is significant and negative when the OLS is used, significant and positive in one case with GMM and non-significant in the other cases. Here, none of the results strongly support the positive impact of undervaluation on growth.

However, using lagged values of undervaluation and overvaluation means that the exchange rate was undervalued (or overvalued) on average during the past five years or the past year (when cointegration is used). It does not mean that the exchange rate was undervalued (or overvalued) during several successive years (i.e. persistent undervaluation). To take into account the persistence dimension, we construct two new variables: Persistent Undervaluation and Persistent Overvaluation. If during the past five years, exchange rate was always undervalued (overvalued) Persistent Undervaluation (Persistent Overvaluation) takes as a value the average undervaluation (overvaluation). Otherwise, the variable takes the value 0. We end up with the following split in the sample: 18% of Persistent Undervaluation, 40% of Persistent Overvaluation and 42% where there is no persistent over or undervaluation. Like in Tables 9 and 10, we consider the contemporaneous and the lagged observations of the two new variables.

Out of the 24 coefficients pertaining to persistent undervaluation in Tables 11 and 12, only two are positive and significant while three are negative and significant. In contrast, the coefficients pertaining to persistent overvaluation are significant and negative in eight instances out of 24. Focusing on the fourth variant which fits the data best (i.e. exhibiting the highest adjusted R^2), no positive effect of undervaluation emerges irrespective of the estimation method.

As a final investigation for non-linearity in the relationships between growth and undervaluation, we subdivide the variables of interest into low, medium and high like in Razin and Collins (1997). Having recoded undervaluation to get positive values, low refers to values below 4%, medium concerns values between 4% and 12% and high refers to values above 12%. For instance the variable "Low Undervaluation" is equal to values of undervaluation below 4% and zero otherwise. The same thresholds are used for overvaluation. This gives six subsets each comprising around one sixth of the total number of non-zero observations.

The results in Table 13 show that only high undervaluation might have a positive impact on growth. But, this result does not seem robust because the relevant coefficient is significantly positive in only one specification out of 12. Interestingly, low overvaluation might also have a positive impact on growth, although the result does not seem robust. For the rest, high overvaluation seems associated with low growth.

5. Conclusion

This paper contributes to a current and intense debate among economists concerning the impact that real exchange rate (RER) undervaluation can have on economic growth. Many authors support the view that that a depreciated equilibrium RER promotes economic growth. However, such a view is fragile at both the theoretical and the empirical level. At the theoretical level, the precise channels through which the effect might operate are unclear. At the empirical level, the evidence on which the claim is based raises a number of questions that cast doubt on the validity of the positive impact of undervaluation on economic growth. This paper is concerned with the latter aspect.

The paper offered a thorough investigation of the relationship between undervaluation and growth addressing the following problems: definition, measurement and endogeneity of undervaluation using the notion of equilibrium real effective exchange rate (EREER) three methods of estimation of the relationship between undervaluation and growth (using OLS, GMM and panel cointegration), non linearity of such a relationship and the balance between episodes of undervaluation and overvaluation in the sample. Having also allowed for the possibility that the effect of undervaluation on growth may operate with delay or dependence on the persistence or the level of undervaluation, we didn't find any convincing support to the claim that a depreciated equilibrium real exchange rate promotes economic growth.

Although our cross-country analysis didn't support the existence of a positive effect of undervaluation on growth in general, the literature provides various examples of the adoption and the success of undervaluation strategy aimed at fostering growth. Our interpretation is that undervaluation alone is not enough to boost growth. Its success in some countries may result from the simultaneous adoption of companion policies. We, therefore, recommend the use of individual country case studies to draw valuable lessons on the use of undervaluation as a driver of growth rather than taking it as a general rule.

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Figure 1: Average Misalignment over Time

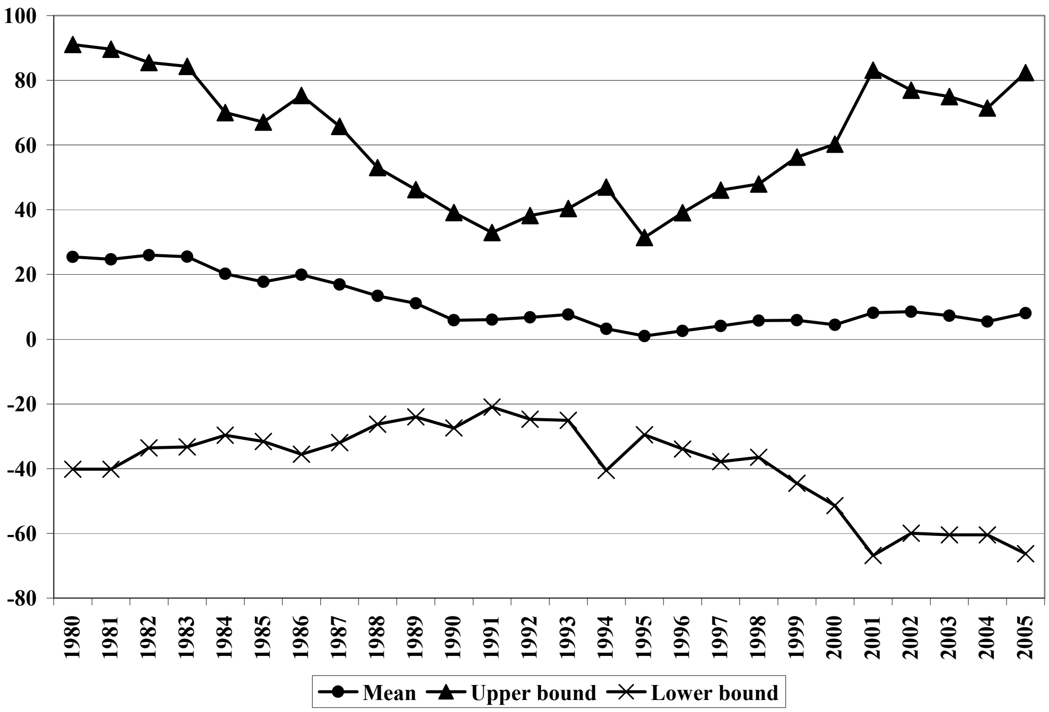

Table 1: Tests of the Independence of the Variables across Individuals

Variables	Calculated Statistics
Capital Inflow / GDP	7.28***
Openness	16.06***
Debt Services	6.48***
Government Consumption / GDP	3.34***
Terms of Trade	2.43**
REER	14.32***
Growth Gap	12.04***
Balassa Samuelson	10.09***
	Critical values: 1.96 (5%)
	2.80 (1%)

Notes: ** = Significant at 5%, *** = Significant at 1%

Table 2: Test of the Stationarity of the Variables

Variable	Stationarity in Level	First difference
Capital Inflow / GDP	-2.01	-5.78
Openness	-2.06	-4.89
Debt Services	-1.75	-5.24
Government Consumption / GDP	-1.80	-4.55
Terms of Trade	-1.93	-5.33
REER	-1.98	-4.65
Growth Gap	-2.09	-4.03
Balassa Samuelson	-1.92	-4.15
	Critical values: 2.10 (5%)	
	2.20 (1%)	

Notes: ** = Significant at 5%, *** = Significant at 1%

Table 3: Test of Cointegration

Statistics	Calculated value
Panel v- statistic	-3.18***
Panel ρ- statistic	4.37
Panel t- statistic	-1.10
Panel ADF statistic	0.28
	Critical values: 1.65 (5%)
	2.33 (1%)

Notes: ** = Significant at 5%, *** = Significant at 1%

Table 4: Estimation Results of Equation (2)

Variables	Estimation methods	
	DOLS	FMOLS
Capital Inflow / GDP	0.00 **4.02** ***	0.00 **0.25**
Openness	-0.52 **14.01** ***	-0.55 **7.48** ***
Balassa Samuelson	0.38 **7.90** ***	0.34 **6.64** ***
Debt Services	-0.11 **6.11** ***	-0.05 **3.12** ***
Government Consumption / GDP	0.25 **6.25** ***	0.17 **11.67** ***
Terms of Trade	0.12 **3.31** ***	0.10 **6.83** ***
Growth Gap	-0.01 **1.75** *	-0.01 **2.45** **
A-R^2	0.60	0.57

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 5: Descriptive Statistics of Misalignment

Mean	Standard Deviation	Minimum	Maximum	Negative Values	Positive Values
11.21	18.75	-41.80	223.52	382	810

Table 6: Test on Individual Series

Variables	Test of Interdependence [a]	Test of Stationarity [b]	
	Calculated Statistics	Level	First Difference
GDP	1.25	-1.34	-3.74***
Investment/GDP	3.67***	-2.03	-4.92***
School Enrolment	1.10	-1.72	-3.99***
Population	2.21**	-1.82	-2.80***
Misalignment	5.17***	-1.98	-4.01***
	Critical values: 1.96 (5%) 2.80 (1%)	Critical value: -2.103 (5%) -2.204 (1%)	

Notes: a = Pesaran (2004), b = Pesaran (2007); * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 7: Test of Cointegration

Statistics	Calculated Value
Panel *v*- statistic	2.88**
Panel ρ- statistic	-0,31
Panel t- statistic	-7,39***
Panel ADF statistic	-7,5***
	Critical values: 1.65 (5%) 2.33 (1%)

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 8: The Effect of *REER* Misalignment on the Growth Rate of Per Capita Income

Variables	OLS				GMM				Panel Cointegration			
	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	7.10	7.11	7.12
Initial GDP Per Capita	-0.01	-0.02	-0.01	-0.03	-0.01	-0.14	-0.01	-0.04	-0.34	-0.38	-0.32	-0.39
	3.55	**2.83**	**3.55**	**4.69**	**3.60**	**2.36**	**3.27**	**5.11**	**1.93**	**2.70**	**1.92**	**5.39**
	***	***	***	***	***	***	***	***	*	**	*	***
Investment/GDP	0.02	0.04	0.02	0.03	0.02	0.04	0.02	0.03	0.01	0.09	0.01	0.02
	3.20	**4.42**	**3.31**	**3.64**	**3.26**	**5.39**	**3.37**	**3.74**	**4.15**	**1.20**	**3.43**	**3.39**
	***	***	***	***	***	***	***	***	***		***	***
School Enrolment	0.03	0.02	0.03	-0.01	0.02	0.02	0.02	-0.03	-0.00	0.05	-0.01	-0.01
	4.68	**1.74**	**4.43**	**0.58**	**4.67**	**2.14**	**4.47**	**1.99**	**0.72**	**0.26**	**1.99**	**1.41**
	***	*	***		***	**	***	**			**	
Population	0.02	0.07	0.03	0.14	0.02	0.08	0.03	0.15	-0.01	-0.12	-0.01	-0.00
	1.04	**1.36**	**1.41**	**2.63**	**1.08**	**1.37**	**1.52**	**3.84**	**2.94**	**0.93**	**2.76**	**0.436**
				***				***	***		***	
Misalignment	-0.01	-0.02	-0.01	-0.01	-0.01	-0.02	-0.01	0.03	-0.00	-0.00	-0.00	-0.00
	2.16	**2.20**	**2.33**	**1.69**	**1.55**	**1.45**	**0.61**	**1.38**	**1.00**	**0.63**	**0.57**	**0.38**
	**	**	**	*								
Country Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Number of Countries	46	46	46	46	46	46	46	46	30	30	30	30
Number of Observations	178	178	178	178	178	178	178	178	780	780	780	780
Adjusted R^2	0.20	0.36	0.21	0.48	0.19	0.24	0.19	0.30	0.26	0.28	0.25	0.36

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 9: The Separate Effect of *REER* Undervaluation and Overvaluation on the Growth Rate of Per Capita Income

Variables	**OLS**				**GMM**				**Panel Cointegration**			
	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	8.10	8.11	8.12
Initial GDP Per Capita	-0.01	-0.02	-0.01	-0.03	-0.01	-0.01	-0.01	-0.04	-0.34	-0.42	-0.30	-0.45
	3.61	**2.80**	**3.67**	**4.60**	**3.69**	**2.42**	**3.58**	**5.4**	**1.84**	**2.08**	**1.92**	**5.31**
	***	***	***	***	***	***	***	***	*	**	**	***
Investment/GDP	0.02	0.04	0.02	0.03	0.02	0.04	0.02	0.03	0.01	0.08	0.01	0.02
	3.22	**4.50**	**3.38**	**3.43**	**3.30**	**5.41**	**3.52**	**3.62**	**4.16**	**3.79**	**3.44**	**3.49**
	***	***	***	***	***	***	***	***	***	***	***	***
School Enrolment	0.03	0.02	0.02	-0.01	0.02	0.02	0.03	-0.03	-0.00	0.06	-0.01	-0.01
	4.74	**1.54**	**4.57**	**0.51**	**4.89**	**2.09**	**5.06**	**1.93**	**0.79**	**0.43**	**1.98**	**1.43**
	***		***		***	**	***	**			**	
Population	0.02	0.08	0.03	0.13	0.02	0.08	0.03	0.15	-0.01	-0.04	-0.01	-0.01
	1.01	**1.43**	**1.45**	**2.63**	**1.01**	**1.41**	**1.64**	**3.9**	**2.95**	**1.78**	**2.77**	**0.53**
				***			*		***	*	***	
Undervaluation	-0.02	0.05	-0.04	-0.01	-0.09	0.03	-0.11	-0.04	0.00	0.03	0.01	0.01
	0.75	**1.65**	**1.73**	**0.30**	**1.74**	**0.93**	**2.32**	**1.49**	**1.17**	**1.90**	**0.68**	**0.8**
		*	*		*		**			*		
Overvaluation	-0.02	-0.02	-0.02	-0.02	-0.04	-0.03	-0.04	0.01	-0.00	-0.00	-0.00	-0.00
	2.13	**1.46**	**2.70**	**1.85**	**1.67**	**0.96**	**1.84**	**0.50**	**0.67**	**0.23**	**0.38**	**0.10**
	**		***	*	*		*					
Country Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Number of Countries	46	46	46	46	46	46	46	46	30	30	30	30
Number of Observations	178	178	178	178	178	178	178	178	780	780	780	780
Adjusted R^2	0.20	0.36	0.22	0.47	0.16	0.24	0.17	0.30	0.31	0.36	0.29	0.38

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 10: The Separate Effect of *REER* Lagged Undervaluation and Overvaluation on the Growth Rate of Per Capita Income

Variables	OLS				GMM				Panel Cointegration			
	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	9.10	9.11	9.12
Initial GDP Per Capita	-0.01	-0.02	-0.01	-0.04	-0.01	-0.01	-0.01	-0.03	-0.32	-0.41	-0.32	-0.40
	3.42 ***	**2.76** ***	**3.49** ***	**4.74** ***	**2.44** ***	**1.84** *	**2.80** **	**4.54** ***	**1.91** **	**2.01** **	**1.89** *	**5.34** ***
Investment/GDP	0.02	0.04	0.02	0.03	0.02	0.03	0.02	0.03	0.01	0.10	0.01	0.02
	3.31 ***	**4.12** ***	**3.4** ***	**3.4** ***	**2.49** ***	**4.2** ***	**3.01** ***	**4.16** ***	**4.15**	**2.97** ***	**3.45** ***	**3.36** ***
School Enrolment	0.03	0.02	0.03	-0.01	0.02	0.00	0.02	-0.02	-1.00	0.07	-0.01	-0.01
	4.41 ***	**1.15**	**4.3** ***	**0.64**	**3.19** ***	**0.07**	**3.66** ***	**1.95** **	**0.74**	**0.41**	**1.93** **	**1.42**
Population	0.02	0.07	0.03	0.13	0.02	0.06	0.03	0.15	-0.01	-0.07	-0.01	-0.00
	1.00	**1.25**	**1.28**	**2.66** ***	**0.64**	**1.01**	**1.43**	**3.47** ***	**2.93** ***	**1.77** *	**2.76** ***	**0.36**
Undervaluation $_{t-1}$	-0.06	-0.05	-0.06	-0.08	0.19	0.13	0.1	0.06	0.00	0.00	0.00	0.00
	2.01 **	**1.12**	**2.35** **	**2.08** **	**0.74**	**1.75** *	**1.28**	**1.51**	**0.98**	**0.36**	**0.62**	**0.51**
Overvaluation $_{t-1}$	-0.02	-0.02	-0.02	-0.00	0.03	0.02	0.02	0.03	-0.00	-0.00	-0.00	-0.00
	2.34 **	**1.70** *	**1.90** *	**0.17**	**0.28**	**0.65**	**0.8**	**0.92**	**1.03**	**0.01**	**0.74**	**0.71**
Country Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Number of Countries	46	46	46	46	46	46	46	46	30	30	30	30
Number of Observations	178	178	178	178	178	178	178	178	780	780	780	780
Adjusted R^2	0.21	0.35	0.22	0.48	0.033	0.10	0.12	0.33	0.32	0.32	0.30	0.36

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 11: The Separate Effect of *REER* Persistent Undervaluation and Overvaluation on the Growth Rate of Per Capita Income

Variables	**OLS**				**GMM**				**Panel Cointegration**			
	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	10.10	10.11	10.12
Initial GDP Per Capita	-0.01	-0.02	-0.01	-0.03	-0.01	-0.02	-0.01	-0.04	-0.36	-0.44	-0.34	-0.39
	3.60	**2.97**	**3.66**	**4.79**	**3.73**	**2.42**	**3.58**	**5.36**	**1.84**	**1.68**	**2.03**	**4.17**
	***	***	***	***	***	***	***	***	*	*	***	***
Investment/GDP	0.02	0.04	0.02	0.03	0.02	0.04	0.02	0.03	0.01	0.12	0.01	0.04
	3.24	**4.47**	**3.39**	**3.49**	**3.33**	**4.94**	**3.53**	**3.54**	**3.81**	**3.08**	**3.06**	**4.90**
	***	***	***	***	***	***	***	***	***	***	***	***
School Enrolment	0.03	0.02	0.02	-0.01	0.02	0.02	0.03	-0.02	-0.00	0.12	-0.00	-0.01
	4.69	**1.39**	**4.54**	**0.56**	**4.86**	**1.74**	**4.98**	**1.76**	**0.48**	**0.306**	**1.55**	**0.61**
	***		***		***	*	***	*				
Population	0.02	0.08	0.03	0.13	0.02	0.09	0.03	0.14	-0.01	-0.04	-0.01	-0.02
	0.98	**1.39**	**1.40**	**2.62**	**0.94**	**1.49**	**1.61**	**3.63**	**3.02**	**0.61**	**3.16**	**1.81**
				***			*	***	***		***	*
Persistent Undervaluation	-0.01	0.06	-0.04	-0.00	-0.07	0.02	-0.10	-0.03	0.00	0.00	0.00	0.00
	0.47	**1.86**	**1.59**	**0.01**	**1.55**	**0.34**	**2.04**	**0.52**	**0.69**	**1.73**	**0.23**	**1.15**
		*					**			*		
Persistent Overvaluation	-0.02	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	0.02	-0.00	-0.00	-0.00	-0.00
	2.02	**1.45**	**2.58**	**1.83**	**1.74**	**1.10**	**1.81**	**0.57**	**1.06**	**0.11**	**1.01**	**0.53**
	**		***	*	*		*					
Country Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Number of countries	46	46	46	46	46	46	46	46	30	30	30	30
Number of observations	178	178	178	178	178	178	178	178	660	660	660	660
Adjusted R^2	0.20	0.36	0.22	0.47	0.16	0.24	0.17	0.33	0.34	0.35	0.38	0.40

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 12: The Separate Effect of *REER* Lagged-Persistent Undervaluation and Overvaluation on the Growth Rate of Per Capita Income

Variables	**OLS**				**GMM**				**Panel Cointegration**			
	11.1	11.2	11.3	11.1	11.2	11.3	11.1	11.2	11.3	11.1	11.2	11.3
Initial GDP Per Capita	-0.01	-0.02	-0.01	-0.04	-0.01	-0.02	-0.01	-0.03	-0.34	-0.41	-0.31	-0.38
	3.40	**2.59**	**3.45**	**4.55**	**2.94**	**2.92**	**3.02**	**5.89**	**2.30**	**1.88**	**1.91**	**4.50**
	***	***	***	***	***	***	***	***	**	*	**	***
Investment/GDP	0.02	0.04	0.02	0.03	0.02	0.04	0.02	0.03	0.01	0.09	0.01	0.04
	3.33	**4.17**	**3.41**	**3.60**	**3.06**	**4.47**	**3.27**	**4.29**	**3.69**	**2.90**	**2.99**	**4.88**
	***	***	***	***	***	***	***	***	***	***	***	***
School Enrolment	0.03	0.02	0.03	-0.01	0.02	0.01	0.02	-0.02	-0.00	0.10	-0.00	-0.01
	4.41	**1.12**	**4.27**	**0.83**	**3.87**	**1.20**	**3.94**	**1.77**	**0.39**	**0.28**	**1.52**	**0.60**
	***		***		***		***	*				
Population	0.02	0.07	0.03	0.14	0.02	0.07	0.03	0.14	-0.01	-0.03	-0.01	-0.01
	1.02	**1.31**	**1.32**	**2.65**	**0.83**	**1.26**	**1.44**	**3.56**	**3.02**	**0.54**	**3.03**	**1.76**
				***				***	***		***	*
Persistent Undervaluation $_{t-1}$	-0.04	-0.03	-0.05	-0.05	0.06	0.19	0.04	0.06	0.00	0.06	-0.00	0.02
	1.75	**0.91**	**2.03**	**1.47**	**0.62**	**1.32**	**0.68**	**0.59**	**0.09**	**0.27**	**0.23**	**0.56**
	*		**									
Persistent Overvaluation $_{t-1}$	-0.02	-0.02	-0.01	0.00	0.00	0.02	0.18	0.03	-0.00	-0.00	-0.00	-0.00
	2.20	**1.73**	**1.76**	**0.15**	**0.01**	**0.42**	**0.62**	**0.90**	**0.96**	**1.03**	**0.61**	**0.21**
	**	*	*									
Country Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Number of Countries	46	46	46	46	46	46	46	46	30	30	30	30
Number of Observations	178	178	178	178	178	178	178	178	660	660	660	660
Adjusted R^2	0.20	0.35	0.21	0.47	0.15	0.17	0.14	0.37	0.31	0.38	0.41	0.42

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Table 13: The Separate Effect of the Degree of *REER* Undervaluation and Overvaluation on the Growth Rate of Per Capita Income

Variables	**OLS**						**GMM**			**Panel Cointegration**		
	12.1	12.2	12.3	12.1	12.2	12.3	12.1	12.2	12.3	12.1	12.2	12.3
Initial GDP Per Capita	-0.01	-0.02	-0.01	-0.03	-0.01	-0.01	-0.02	-0.03	-0.38	-0.41	-0.38	-0.38
	3.44	**2.79**	**3.51**	**4.58**	**1.30**	**1.22**	**1.71**	**1.01**	**1.82**	**1.94**	**2.47**	**2.8**
	***	**	***	***			*		*	**	**	***
Investment/GDP	0.02	0.04	0.02	0.03	0.03	0.04	0.04	0.02	0.01	0.05	0.01	0.02
	3.16	**4.23**	**3.28**	**3.26**	**1.50**	**3.92**	**1.81**	**1.74**	**3.92**	**3.47**	**3.21**	**3.43**
	***	***	***	***		***	*	*	***	***	***	***
School Enrolment	0.03	0.02	0.03	-0.01	0.04	0.05	0.04	-0.04	-0.00	0.15	-0.01	-0.01
	4.72	**1.29**	**4.46**	**0.69**	**2.01**	**0.34**	**1.53**	**0.55**	**0.68**	**1.98**	**2.12**	**1.46**
	***		***		**						**	
Population	0.02	0.07	0.03	0.13	0.08	0.05	0.09	0.17	-0.01	-0.07	-0.01	-0.01
	0.82	**1.28**	**1.27**	**2.42**	**0.86**	**0.71**	**0.97**	**1.65**	**2.9**	**1.29**	**2.55**	**0.49**
				***				*	***		**	
Low Undervaluation	0.01	-0.11	0.26	-0.05	-0.36	0.18	-1.96	0.35	0.00	0.02	0.00	0.00
	0.19	**0.31**	**0.48**	**0.12**	**0.04**	**0.09**	**0.46**	**0.08**	**0.31**	**0.33**	**0.49**	**0.70**
Medium Undervaluation	0.00	0.00	0.00	0.00	0.08	-0.02	0.08	0.01	0.00	0.73	0.01	0.00
	0.00	**0.00**	**0.00**	**0.00**	**1.15**	**0.12**	**1.17**	**0.10**	**0.54**	**0.03**	**0.65**	**0.51**
High Undervaluation	-0.01	0.07	-0.03	0.01	-0.19	0.05	-0.06	-0.05	-0.01	0.11	-0.01	-0.01
	0.54	**1.83**	**1.54**	**0.24**	**0.95**	**0.63**	**0.34**	**0.66**	**1.52**	**1.28**	**1.01**	**1.02**
		**										
Low Overvaluation	0.29	0.28	0.32	0.34	-4.03	-0.51	-5.53	0.77	0.01	-0.01	0.02	0.01
	1.61	**1.39**	**1.75**	**1.86**	**0.73**	**0.28**	**0.53**	**0.26**	**1.46**	**0.14**	**2.05**	**0.95**
			*	*							**	
Medium Overvaluation	-0.03	0.08	-0.04	0.00	0.74	-0.24	1.74	0.14	0.00	0.78	0.00	0.00
	0.45	**0.17**	**0.66**	**0.02**	**0.68**	**0.20**	**1.13**	**0.16**	**0.64**	**0.37**	**0.47**	**0.12**
High Overvaluation	-0.01	-0.01	-0.02	-0.01	0.00	0.00	0.00	0.00	0.01	0.09	0.01	0.00
	1.84	**1.22**	**2.36**	**1.31**	**0.00**	**0.00**	**0.00**	**0.00**	**1.33**	**0.09**	**1.92**	**1.27**
	**		***								*	
Country Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Number of Countries	46	46	46	46	46	46	46	46	30	30	30	30
Number of Observations	178	178	178	178	178	178	178	178	780	780	780	780
Adjusted R^2	0.19	0.36	0.22	0.47	0.00	0.05	0.00	0.003	0.41	0.48	0.46	0.57

Notes: t-statistics are in bold; * = Significant at 10%, ** = Significant at 5%, *** = Significant at 1%

Appendix A: Countries in the Sample Used to Compute the EREER

Africa	Latin America	Asia
Algeria	Argentina	China
Benin	Bolivia	Iran
Burkina-Faso	Brazil	Thailand
Cameroon	Columbia	Pakistan
Chad	Costa-Rica	India
Comoros	Ecuador	Philippines
Congo, Rep	Mexico	Malaysia
Cote d'Ivoire	Paraguay	Jordan
Egypt	Venezuela	Syria
Gabon	Haiti	
Gambia	Honduras	
Ghana	Panama	
Guatemala	Uruguay	
Guinea-Bissau	Chile	
Kenya		
Lesotho		
Madagascar		
Malawi		
Mali		
Mauritania		
Mauritius		
Morocco		
Niger		
Panama		
Rwanda		
Senegal		
Sierra-Leone		
Sri Lanka		
Swaziland		