Currency Misalignments and Growth: A New Look using Nonlinear Panel Data Methods

Sophie Béreau† Antonia López Villavicencio‡ Valérie Mignon§

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Abstract

The aim of this paper is to investigate the link between currency misalignments and economic growth. Relying on panel cointegration techniques, we calculate real exchange rate (RER) misalignments as deviations of actual RERs from their equilibrium values for a set of advanced and emerging economies. Estimating panel smooth transition regression models, we show that RER misalignments have a differentiated impact on economic growth depending on their sign: whereas overvaluations negatively affect economic growth, real exchange rate undervaluations significantly enhance it. This result indicates that undervaluations may drive the exchange rate to a level that encourages exports and promotes growth.

JEL Classification: F31, O47, C23

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1 Introduction

There has recently been a revival of interest in equilibrium exchange rates’ assessment due to the current context of global imbalances. Indeed, since the end of the 1990s, the accelerating financial integration process accompanied with the preeminence of capital movements over trade in goods between countries, has engendered a growing disconnection between exchange rate fluctuations and the real economic activity.

In order to better understand the sources of exchange rate movements, it may be useful for monetary authorities to rely on specific tools allowing assessment of long-run values for the

*Corresponding author: Valérie Mignon, EconomiX-CNRS, University of Paris Ouest, 200 avenue de la République, 92001 Nanterre Cedex, France. E-mail: valerie.mignon@u-paris10.fr. Phone: +33 (0)1 40 97 58 60. Fax: +33 (0)1 40 97 77 84. We thank Agnès Bénassy-Quéré and Jacques Melitz for very useful and stimulating remarks and suggestions.
†EconomiX-CNRS, University of Paris Ouest, France. E-mail: sophie.bereau@u-paris10.fr
‡CEPN-CNRS, University of Paris 13, France. E-mail: lopezvillavicencio@univ-paris13.fr
§EconomiX-CNRS, University of Paris Ouest and CEPH, Paris, France. E-mail: valerie.mignon@u-paris10.fr
real exchange rates that would be consistent with the realization of a long-run stable macro-
economic equilibrium. Yet, currency misalignment measures are far from being consensual
and numerous “equilibrium exchange rate” concepts have been developed. Among the most
popular approaches, there are the “Fundamental Equilibrium Exchange Rate” (FEER), the
“NATural Real Exchange Rate” (NATREX) and the “Behavioral Equilibrium Exchange Rate”
(BEER), respectively introduced by Williamson (1985), Stein (1994) and Clark and MacDon-
ald (1998). Various other alternative approaches of equilibrium exchange rates have also been
proposed in the literature. They all go beyond standard concepts of uncovered interest parity
or purchasing power parity, and differ in their methodology and in the time horizon they deal
with.

If numerous contributions have explored the links between exchange rate volatility on different
exchange rate regimes and growth, the influence of long-run exchange rate misalignments on
real economic activity remains an open question. Yet, it seems particularly interesting to
focus on the impact of currency misalignments on growth since persistent real exchange rate
gaps are likely to affect the economic performance of countries. Indeed, persistent misalign-
ments may induce distortions in relative prices of traded over non-traded goods that may be
misinterpreted by economic agents and, as a consequence, may generate instability (see e.g.
Edwards (1989)).

In addition, the effects may be differentiated in case of an over- or under-valuation of curren-
cies. Indeed, it has been argued that, when the currency is undervalued, competitiveness is
reinforced, stimulating domestic production, investment and exports, and reducing imports
(see, among others, Bresser-Pereira (2002) and Dooley, Folkerts-Landau and Garber (2005)).
The current account is then improved, so are GDP and employment. Conversely, currency
overvaluations are rather interpreted as proofs of incoherent macroeconomic policy decisions
(Razin and Collins (1997)), point to an increasing probability of balance of payment crises
and of possible currency crashes (Krugman (1979), Frankel and Rose (1996), Kaminsky and
Reinhart (1999) and Loayza, Fajuzyler and Calderón (2004)), and contribute to deteriorate
growth. Therefore, the growth effects of real exchange rate misalignments may vary with the
level and/or the sign of the current misalignment.

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1 The misalignment is defined as the deviation of the observed real exchange rate from its equilibrium level.
2 Indeed, since there is not a unique model to explain the real exchange rate dynamics, equilibrium or
disequilibrium assessments are not homogeneous. An important effort to provide consistent exchange rate
assessments comes from the Consultative Group on Exchange Rate Issues (CGER) from the IMF which, based
on three alternative methodologies, gives complementary perspectives on exchange rate misalignments.
3 For an extensive survey, see Driver and Westaway (2004).
4 Among them, we can mention the seminal paper of Baxter and Stockman (1989), and more recently those
of Levy-Yeyati and Sturzenegger (2003); Husain, Mody and Rogoff (2005); Dubas, Lee and Mark (2005);
The interest of studying the link between currency misalignments and growth is particularly notable for China. Chinese authorities have been frequently accused of maintaining the value of the yuan against major currencies at a very low level to finance China’s spectacular growth. Among other things, such long-lasting misalignment would facilitate China’s exports and thus economic growth. As Eichengreen (2008) mentions, “a competitive real exchange rate is at the heart of the authorities’ development strategy”. It should be noted that this exchange rate policy has a great effect not only on the Chinese economy but also on other countries. Indeed, the export-led growth has generated surging Chinese current account surpluses, creating a major source of tension among trading partners who experienced important current account deficits with China (especially the United States and the European union).

Among empirical studies dealing with the misalignment-growth nexus, many papers find a negative link between currency misalignments and economic growth in developing countries. This is the case of Ghura and Grennes (1993) showing a negative correlation between currency misalignments and 33 Sub-Saharan African countries’ economic performance. As noticed by Cottani, Cavallo and Khan (1990), persistent misaligned currencies tend to slow the development of agriculture in African countries, leading to a reduction of their food supply. In the same vein, Domaç and Shabsigh (1999), Benaroya and Janci (1999), Acemoglu, Johnson, Robinson and Thaiwcharoen (2003), Loayza et al. (2004), Toulaboe (2006), or Gala and Lucinda (2006), obtain similar results on extended panels of emerging economies. Turning now to the noticeable contribution of Aguirre and Calderón (2005), the authors assume possible differentiated countries’ behaviors depending on the size and/or sign of their currency misalignments. By estimating a standard growth equation on a large panel of emerging economies they show that misalignments hinder growth but the effect is non-linear: growth declines are larger, the larger the size of the misalignments. Although large undervaluations hurt growth, small to moderate undervaluations can enhance it. Studying Latin American countries, Frenkel (2004) finds that the overvaluation of their currencies constitutes one of the main explanation of crises and stagnation affecting these countries during the 1990s and 2000s. The importance of accounting for the sign of the misalignment is also highlighted by Polterovich and Popov (2004) showing the existence of a positive relationship between economic growth and undervalued currencies. Relying on the endogenous growth literature, those authors argue that accumulation of foreign exchange reserves allows a country to keep an undervalued currency, inducing a rise in the aggregate demand, stimulating technological innovations and improving productivity growth in the export sectors, increasing profits in the non-tradable sector and stimulating investment. On the whole, the export-led growth model is developed, and coun-

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5 See also Easterly (2001) and Loayza et al. (2004).

6 When a currency is undervalued, monetary authorities may react to upward pressures on the exchange rate by expanding their own money supply to buy foreign currencies, leading to an accumulation of foreign exchange reserves. This explains why reserves accumulation is used as a proxy for undervalued exchange rates by Polterovich and Popov (2004).
tries are rewarded with high economic growth.

The aim of this paper is to investigate the relationship between real exchange rate misalignments and economic growth, by paying a special attention to the potential differentiated effects previously described. Our contribution is threefold. First, while most of the previous studies consider developing countries, we rely on a wider sample of countries, including both developed and developing economies. Accounting for a large sample of countries is of particular importance in the current context of global imbalances, that calls for a consistent set of equilibrium exchange rates. Second, we conduct a detailed analysis to derive robust measures of currency misalignments by relying on the BEER methodology. In this sense, we go further than most of the existing literature investigating the link between currencies and economic growth based on PPP measures of exchange rates. Third, we specifically account for the sign (and the size) of the misalignment by estimating a panel nonlinear model. More specifically we rely on the estimation of a Panel Smooth Transition Regression (PSTR) model, allowing for a differentiated impact of currencies’ overvaluations and undervaluations on economic growth.

The remainder of the paper is organized as follows. Section 2 outlines our methodology relating to (i) the estimation of currency misalignments, (ii) the choice of the growth determinants, and (iii) the PSTR models aiming at accounting for potential differentiated impacts of exchange rate misalignments on economic growth. Section 3 briefly describes the data and Section 4 presents the results. Finally, Section 5 provides some concluding remarks.

2 Methodology

2.1 Estimation of currency misalignments

Most of the previous studies that aim at investigating the link between exchange rates and economic growth rely on PPP-based measures of misalignments (see Dollar (1992), Benaroya and Janci (1999), Easterly (2001), Loayza et al. (2004), Acemoglu et al. (2003)). However, PPP is relevant only in the very long run (see Rogoff (1996)) and does not provide any insight of exchange-rate adjustments that would be consistent with world imbalances being unraveled. To circumvent these drawbacks, we rely here on the “Behavioral Equilibrium Exchange Rate” approach introduced by Clark and MacDonald (1998). This approach consists in estimating a long-term relationship between the real effective exchange rate and its fundamentals such as (i) the relative productivity shifts, (ii) the net foreign asset position, and (iii) the terms of

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7For robustness checks, we also present results derived from two alternative measures of currency misalignments: a PPP-based measure and a measure relying upon deviations of the real exchange rate from its permanent component obtained from a Hodrick-Prescott filter.

8An exception is Gala and Lucinda (2006) who use real exchange rate corrections for productivity differentials. Cottani et al. (1990) also consider various determinants of real exchange rates for a sample of less developed countries. The latter study, however, does not control for usual determinants of economic growth when evaluating the impact of the currency misalignments on the economic performance.
trade. In this sense, the equilibrium exchange rate is allowed to change over time, reflecting changes in economic fundamentals and domestic policies.9

More precisely, the impact of productivity differentials is expected to follow the well-known Balassa-Samuelson (BS) doctrine. Roughly speaking, according to this hypothesis, the recurrent deviations of the real exchange rate from its long-run value come from the link between currency appreciation and productivity catch-up in developing economies. The real exchange rate is also supposed to depend on capital flows, as well as imbalances between national savings and investment.10 Indeed, there are several channels through which the stock of foreign assets can influence the real exchange rate. For instance, portfolio-balances considerations suggest that a deficit in the current account creates an increase in the net foreign debt of a country, which has to be financed by international investors who demand a higher yield to adjust their portfolio. At given interest rates, this can only be achieved through a depreciation of the currency of the debtor country. The balance of payments channel also assumes that current deficits come along with interests that have to be paid. The debtor country needs to increase the attractiveness of its exports. It must then strengthen its international competitiveness through a depreciation of its currency (see Maeso-Fernandez, Osbat and Schnatz (2004)). We therefore expect an increase of the net foreign asset position of a country (i.e. a reduction of the foreign debt) to have a positive effect on the currency (i.e. an appreciation). Finally, the real exchange rate can also be affected by commodity price shocks through their impact on the terms of trade. Overall, a lasting deterioration of the terms of trade of a country should result in a depreciation of the real exchange rate of that country.

Based on these theoretical considerations, we estimate the following relationship:

\[ q_{i,t} = \alpha_i + \beta_1 nfa_{i,t} + \beta_2 tot_{i,t} + \beta_3 prod_{i,t} + \varepsilon_{i,t} \]  

where \( i = 1, ..., N \) denotes the country, and \( t = 1, ..., T \) the time. \( q_{i,t} \) denotes the real effective exchange rate (in logarithms), \( nfa_{i,t} \) is the net foreign asset position expressed as percentage of GDP, \( tot_{i,t} \) is the logarithm of terms of trade, and \( prod_{i,t} \) stands for the relative productivity in the traded-goods sector (relative to the non-traded goods one) in logarithms. \( \varepsilon_{i,t} \) is an error term and \( \alpha_i \) accounts for country-fixed effects. The estimation of Equation (1) gives the real equilibrium exchange rate values (\( \hat{q}_{i,t} \)) for each considered country. Misalignments \( m_{i,t} \) are then obtained as follows:

\[ m_{i,t} = q_{i,t} - \hat{q}_{i,t} \]  

To estimate Equation (1), we rely on panel cointegration techniques. We first test for the existence of a unit root for each series using various panel unit root tests and then proceed

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9See Bénassy-Quéré, Béreau and Mignon (2009) for a review of possible specifications.
10Lane and Milesi-Ferretti (2004), among others, explore the theoretical link between the real exchange rate and the net foreign assets, and provide evidence that the net foreign asset position is an important determinant of the real exchange rate for developing as well as developed countries.
to panel cointegration tests. If series are found to be cointegrated, we estimate the long-term relationship (1) using efficient estimation procedures, such as Fully-Modified OLS (FM-OLS, see Phillips and Hansen (1990), Pedroni (1999) and Pedroni (2000)) and the Pooled Mean Group method (PMG, see Pesaran, Shin and Smith (1999)).

2.2 Augmented growth equation

To investigate the impact of currency misalignments on economic growth, we add alternative misalignment measures to the right-hand side variables that are usually considered in growth equations. More specifically, not accounting for nonlinearities, we consider a model of the following form:

$$\Delta y_{i,t} = \mu_i + \Omega X_{i,t} + \theta m_{i,t} + u_{i,t}$$  \hspace{1cm} (3)

where $y_{i,t}$ is the real GDP per capita, $X_{i,t}$ is a vector of contemporaneous and lagged values of growth determinants, $m_{i,t}$ denotes currency misalignments and $u_{i,t}$ is an error term. $\mu_i$ is a vector of individual fixed effects. It has to be noticed that despite the vast number of cross-country growth studies that followed the seminal papers of Barro (1991) and Mankiw, Romer and Weil (1992), there remains a broad number of possible specifications concerning the choice of the regressors. As mentioned by Sala-i Martin (1997), “variables like the initial level of income, the investment rate, various measures of education, some policy indicators, and many other variables have been found to be significantly correlated with growth in regressions like (3). I have collected around 60 variables which have been found to be significant in at least one regression.” Indeed, due to the lack of consensus on the key determinants of growth, several regressors are used. They belong to various categories: policy variables (fiscal, exchange rate and trade policies), political variables (rule of law, political rights, ...), religious variables, regional variables, type of investment (equipment/non equipment), variables relating to the macroeconomic environment (inflation—which is also a policy variable—, initial level of GDP, ...), variables accounting for the international environment (terms of trade, ...), etc.

Based on previous studies, we retain various potential determinants. According to the neoclassical growth theory, the economic growth rate is a function of the initial position of the economy. The conditional convergence hypothesis states that, other things being equal, countries with lower GDP per capita are expected to grow more due to higher marginal returns on capital stock. We account for the initial position of the economy through the initial level of real GDP per capita to control for conditional convergence (see Barro and Sala-i Martin (1995) among others). Turning to other variables that may characterize the specificities of the various considered countries, we consider a measure of human capital given

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11See Sala-i Martin (1997) for a complete list. See also Loayza et al. (2004) for a detailed review of the main determinants and studies on economic growth.

12See the reference papers by Barro (1991), Mankiw et al. (1992) and Sala-i Martin (1997).
by the rate of gross secondary-school enrollment (see Barro (1991), Mankiw et al. (1992) and Easterly (2001) among others). Relying on some developments of the endogenous growth theory, we include determinants reflecting trade and macroeconomic stabilization policies, and institutions. Among those potential determinants, we consider the following variables: (i) trade openness (measured as the sum of exports and imports, in percentage of GDP),\(^\text{13}\) (ii) government consumption in percentage of GDP, used as an indicator of fiscal policy (see Barro (1991); Barro and Sala-i Martin (1995)), (iii) fixed investment (in percentage of GDP), (iv) the inflation rate to account for price level stability and (v) population growth.\(^\text{14}\) Finally, in addition to these usual determinants, we include currency misalignments in order to investigate the impact of exchange rate overvaluations and undervaluations on economic growth.

### 2.3 Dealing with nonlinearities: the PSTR approach

Let \(\{z_{i,t}, s_{i,t}, x_{i,t}; t = 1, ..., T; i = 1, ..., N\}\) be a balanced panel with \(z_{i,t}\) denoting the dependent variable, \(s_{i,t}\) the threshold variable, and \(x_{i,t}\) a vector of \(k\) exogenous variables. The panel smooth transition regression (PSTR) model introduced by González, Teräsvirta and van Dijk (2005)\(^\text{15}\) can be written as follows:

\[
z_{i,t} = \mu_i + \beta_0' x_{i,t} + \beta_1' x_{i,t} g(s_{i,t}; \gamma, c) + v_{i,t}
\]  

where \(\mu_i\) denotes the individual fixed effects, \(g(s_{i,t}; \gamma, c)\) is the transition function, normalized and bounded between 0 and 1, \(\gamma\) the speed of transition from one regime to the other and \(c\) the threshold parameter. The threshold variable \(s_{i,t}\) may be an exogenous variable or a combination of the lagged endogenous one (see van Dijk, Teräsvirta and Franses (2002)).

In this model, the observations in the panel are divided into two regimes\(^\text{16}\) depending on whether the threshold variable is lower or larger than the threshold \(c\). The error term \(v_{i,t}\) is independent and identically distributed. The transition from one regime to another is smooth and gradual.

Following Granger and Teräsvirta (1993) and Teräsvirta (1994) in the time series context or González et al. (2005) in a panel framework, the logistic specification can be used for the transition function:

\(^{\text{13}}\)For a recent study of the trade-growth nexus, the reader may refer to Dufrénot, Mignon and Tsangarides (2009).

\(^{\text{14}}\)Note that we do not consider terms of trade, which allows to account for cross-country differences in the external environment, since this determinant is already included in our misalignment variable. As a robustness check, we have however dropped terms of trade from the cointegrating relationship and included them in the growth equation, see Subsection 4.3.3.

\(^{\text{15}}\)See also He and Sandberg (2004) and Fok, van Dijk and Franses (2005) who have introduced dynamic nonlinear panel models through the development of panel logistic smooth transition autoregressive models.

\(^{\text{16}}\)Of course, it is possible to extend the PSTR model to more than two regimes.
\[ g(s_{i,t}; \gamma, c) = \left[ 1 + \exp \left( -\gamma \prod_{j=1}^{m} (s_{i,t} - c_j) \right) \right]^{-1} \] (5)

with \( \gamma > 0 \) and \( c_1 \leq c_2 \leq ... \leq c_m \). When \( m = 1 \) and \( \gamma \to \infty \), the PSTR model reduces to the panel threshold regression (PTR) model introduced by Hansen (1999), characterized by an abrupt change from one regime to the other. González et al. (2005) mention that from an empirical point of view, it is sufficient to consider only the cases of \( m = 1 \) or \( m = 2 \) to capture the nonlinearities due to regime switching.\(^\text{17}\)

Following the methodology used in the time series context, González et al. (2005) suggest a three step strategy to apply PSTR models:\(^\text{18}\)

- **Specification.** The aim of this step is to test for homogeneity against the PSTR alternative. To this end, we rely on the LM-test statistic provided by González et al. (2005) that can be used to select (i) the appropriate transition variable as the one that minimizes the associated \( p \)-value and (ii) the appropriate order \( m \) in Equation (5) in a sequential manner.

- **Estimation.** Nonlinear least squares are used to obtain the parameter estimates, once the data have been demeaned.\(^\text{19}\)

- **Evaluation and choice of the number of regimes.** We apply misspecification tests in order to check the validity of the estimated PSTR model. We follow González et al. (2005) who propose to adapt the tests of parameter constancy over time and of no remaining nonlinearity introduced by Eitrheim and Teräsvirta (1996) in the time series context.

On the whole, putting together Equations (3) and (4), our considered model of growth is given by:

\[ \Delta y_{i,t} = \mu_{i} + \underbrace{\Omega_{1}X_{i,t} + \theta_{1}m_{i,t}}_{\text{Regime 1}} + \underbrace{\left[ \Omega_{2}X_{i,t} + \theta_{2}m_{i,t} \right]}_{\text{Regime 2-1}} g(s_{i,t}; \gamma, c) + u_{i,t} \] (6)

Depending on the realization of \( s_{i,t} \), the link between \( \Delta y_{i,t} \) and its determinants will be specified by a continuum of parameters, namely \( \Omega_{1} \) and \( \theta_{1} \) in Regime 1 (when \( g(.,) = 0 \), and

\(^{17}\) Note that the case \( m = 1 \) corresponds to a logistic PSTR model and \( m = 2 \) refers to a logistic quadratic PSTR specification.

\(^{18}\)See also Béreau, López Villavicencio and Mignon (2008).

\(^{19}\)The reason for using demeaned data is to eliminate the individual effects by removing individual-specific means. Note, however, that even though this is a standard step in linear models, it calls for a more careful treatment in nonlinear specifications (see González et al. (2005)).
\( \Omega_1 + \Omega_2 \) and \( \theta_1 + \theta_2 \) in Regime 2 (Regime 1 + Regime 2−1) when \( g(\cdot) = 1 \). Our main threshold variable of interest will be the misalignment \( m_{i,t} \) or its lagged values. If two distinct growth regimes are associated with the misalignment as threshold variable, this would mean that exchange rate over- and under-valuations have a different impact on economic growth, especially if the threshold value is close to zero. In other words, this model allows us to investigate if nonlinearity in economic growth could be associated with changes in the magnitude and sign of the misalignment.

3 Data

To estimate our real misalignments and growth equations we use annual data over the 1980-2007 period for the following countries: Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Egypt, United Kingdom, Hong-Kong, Indonesia, India, Israel, Japan, Korea, Mexico, Malaysia, Norway, New Zealand, Peru, Philippines, Singapore, Sweden, Switzerland, Thailand, Turkey, Uruguay, United States, Venezuela and the Euro area. Using such an extensive panel of both industrialized and emerging economies is a critical point to properly assess the impact of currency misalignments on growth. Indeed, if prior studies have focused either on developing countries or on developed ones, the need to derive consistent values of equilibrium exchange rates calls for a broader sample, including both types of economies.

Regarding the long-run BEER equation, from which we derive our measures of currency misalignments, the dependent variable is the real effective exchange rate \( (q) \). It is CPI based, and expressed such that when it rises (resp. falls), it corresponds to an appreciation (resp. depreciation) of the considered currency in effective terms. The explanatory variables are the stock of net foreign assets \( (nfa) \), the relative labor productivity of tradables to non tradables \( (prod) \), and the terms of trade \( (tot) \). All series are in logarithms, except \( nfa \) which is expressed as share of GDP in percentage points. The detailed definitions and sources for all these variables are given in Appendix A.

Turning now to our growth equation, the dependent variable is the growth rate of real GDP per capita and the explanatory variables are real investment, trade openness, population growth, gross-secondary school enrollment rate, government consumption and the inflation rate (see Appendix A).

4 Results

The first part of the analysis consists in the estimation of equilibrium exchange rates and the corresponding real effective misalignments for the 32 countries (or areas) of our sample. In a
second step, a panel nonlinear model is estimated, linking the growth rate of real GDP per capita to our measure of currency misalignment and the set of our control variables.

### 4.1 Estimating equilibrium exchange rates

As revealed from panel unit root and cointegration tests, our series are integrated of order 1 and cointegrated. Relying on the FM-OLS and PMG approaches, we then proceed to the estimation of the long-run relationship between the real exchange rate and the explanatory variables. Roughly speaking, the FM-OLS methodology is based on a static regression which, in a country-by-country set-up, corresponds to the Engle-Granger procedure. The PMG methodology, proposed by Pesaran et al. (1999) combines two procedures that are commonly used in panels. The first one, known as the ‘mean group estimate’, consists in estimating separate relationships for each country (or group) and averaging the group specific coefficients. The second one is based on the traditional pooled estimators that allow only the intercepts to differ freely across countries, while all the other coefficients are constrained to be the same. The PMG estimator can be viewed as an intermediate estimator since it combines both pooling and averaging. Given that we are dealing with advanced and emerging economies, some degree of heterogeneity between countries would be recommended. In this sense, the advantage of the PMG estimation procedure over the FM-OLS technique is that, while slope homogeneity is imposed, short-run heterogeneity is allowed for each member of the panel.

#### Table 1: PMG and panel FM-OLS estimates for the equilibrium exchange rate equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>PMG Coeff.</th>
<th>t-stat</th>
<th>FM-OLS Coeff.</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity (log)</td>
<td>0.187</td>
<td>3.27</td>
<td>0.085</td>
<td>3.76</td>
</tr>
<tr>
<td>NFA (% GDP)</td>
<td>0.177</td>
<td>5.02</td>
<td>0.231</td>
<td>4.78</td>
</tr>
<tr>
<td>Terms of trade (log)</td>
<td>0.15</td>
<td>4.716</td>
<td>0.447</td>
<td>10.81</td>
</tr>
</tbody>
</table>

Notes: (a) PMG denotes the pooled mean group estimates; (b) FM-OLS denotes the fully modified OLS estimates.

The results from both panel cointegration estimations (Table 1) appear consistent with the theory since the coefficients have the expected signs. Indeed, the real exchange rate appreciates \(q\) increases in the long run if the net foreign asset position rises, the relative productivity

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20 Results from panel unit root and cointegrations tests are available upon request to the authors.
21 In this case, we use the estimated slope coefficients (which are the same for all the countries) to estimate the equilibrium exchange rate.
increases, and the terms of trade improve.

As mentioned before, our theoretical measure of the real exchange rate misalignment, $m_{i,t}$, is defined as the difference between the actual real exchange rate and its equilibrium value ($m_{i,t} = q_{i,t} - \hat{q}_{i,t}$), as obtained from the two cointegrating relationships. According to our definition, the currency is undervalued when the real exchange rate (RER) has to appreciate to reach its equilibrium value (i.e. when $q_{i,t} < \hat{q}_{i,t}$), and overvalued when the RER has to depreciate (i.e. when $q_{i,t} > \hat{q}_{i,t}$).

4.2 Estimating the nonlinear growth equation

We start by testing the null hypothesis of linearity in model (6) using, as the relevant transition variable, our two alternative derived series of misalignments. In other words, we test if there exists some difference in the response of growth to positive and negative RER misalignments and if the transition from one regime to another depends on the size and the sign of the deviation of the RER from its equilibrium level.

The results from a test based on a first-order Taylor series expansion of a nonlinear smooth transition regression (STR) model show that linearity can be rejected at the 5% significance level for our panel of countries. We therefore proceed to the estimation of the nonlinear growth relationship (Equation (6)), using the growth rate in real GDP per capita as our dependent variable. As previously mentioned, for the explanatory variables we consider the initial value of the GDP per capita (in logarithms), the investment rate (as share of GDP), a measure of trade openness given by the sum of exports and imports (as share of GDP), average annual CPI inflation, government consumption (in proportion of GDP), the rate of gross-secondary school enrollment, population growth and real exchange rate misalignment.

A typical concern when dealing with growth regressions is relating to the short-run or cyclical effects. To control for cyclical output movements, a possible approach consists in averaging the data over time (typically, 5-year averages) and consider these averages of data series in the growth equation. While this method has the advantage to remove business cycles effects from the growth rate, it reduces considerably the number of degrees of freedom by diminishing the number of available observations for each country. This is of course especially true when the time period is short or when the frequency of the original data is low. To avoid this drawback, we consider here the dataset with annual observations without averaging over time periods, thus gaining a more comfortable number of observations (32 countries, 28 years). In addition, it should be noticed that while averaging out needs not always capture the steady

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22 Test results are available from the authors upon request.
23 Denoting the inflation rate as $\pi_{i,t}$, we retain the following expression for inflation in the growth regression: $\log(1 + \pi_{i,t})$. This choice may be notably justified by the fact that the logarithmic transformation reduces the asymmetry of the distribution of $\pi_{i,t}$—which is known to be highly skewed.
state equilibrium, smoothing out of time series removes useful variation from the data, which could help to identify more precisely the parameters of interest.\footnote{See Christoffersen and Doyle (1998), Ghosh and Phillips (1998), Khan and Senhadji (2000), Burdekin, Denzau, Keil, Sithiyot and Willett (2004) and Baltagi and Law (2009). For robustness checks, we have also run our estimations on 5-year average series. Since the results were very similar, we only report here our findings without averaging the series. All the results are available upon request to the authors.}

In Table 2, we report the regression estimates of the PSTR model using a specification with a logistic transition function and two regimes.\footnote{Some of the variables have been excluded from the final estimation since they were not significant (see below). Also, the choice between a logistic and a logistic quadratic model was based on information criteria and the lowest $p$-value in the linearity tests.} When the transition variable (i.e. the misalignment) is below the estimated threshold parameter $c$ in Equation (6), growth is defined by the estimated equation reported in Column labeled “Regime 1” in Table 2. On the contrary, if the transition variable exceeds the threshold parameter, growth is defined by the estimates reported in Column labeled “Regime 2” in the table. Our results show that our estimated threshold is equal to 2.4\% (9\% for FM-OLS). This means that the first regime, characterized by $g(.) = 0$, corresponds to undervaluations and small overvaluations, i.e. overvaluations less than 2.4\% (9\% for FM-OLS). The second regime, corresponding to $g(.) = 1$, is relating to overvaluations more than 2.4\% (9\% for FM-OLS). There are, however, a continuum of points between these two extreme cases.

### Table 2: PSTR model for the growth rate of GDP per capita

<table>
<thead>
<tr>
<th>Variable</th>
<th>PMG</th>
<th>FM-OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regime 1</td>
<td>Regime 2</td>
</tr>
<tr>
<td></td>
<td>$t$-stat</td>
<td>$t$-stat</td>
</tr>
<tr>
<td>Misalignment</td>
<td>0.052</td>
<td>2.00</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.048</td>
<td>-4.41</td>
</tr>
<tr>
<td>Initial GDP per capita (log)</td>
<td>-0.033</td>
<td>-5.58</td>
</tr>
<tr>
<td>Investment (% of GDP)</td>
<td>0.033</td>
<td>2.55</td>
</tr>
<tr>
<td>Openness (% of GDP)</td>
<td>0.022</td>
<td>3.38</td>
</tr>
<tr>
<td>Pop. Growth</td>
<td>-0.699</td>
<td>-2.11</td>
</tr>
<tr>
<td>Transition parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\hat{c}$</td>
<td>0.024</td>
<td>0.090</td>
</tr>
<tr>
<td>$\hat{\gamma}$</td>
<td>8.874</td>
<td>8.436</td>
</tr>
</tbody>
</table>

Notes: (a)-(b) idem notes Table 1; (c) Regime 1 corresponds to $\Omega_1$ and $\theta_1$ in Equation (6); (d) Regime 2 corresponds to $\Omega_1 + \Omega_2$ and $\theta_1 + \theta_2$ in Equation (6); (e) $\hat{c}$ and $\hat{\gamma}$ are the estimated location and slope parameters, respectively, in Equation (5).
have the expected sign, whatever the sign and the size of the misalignment, and whatever the retained procedure (PMG or FM-OLS). Indeed, in both extreme regimes (i.e. when \( g(.) = 0 \) and \( g(.) = 1 \)) the initial GDP per capita coefficient is negative, meaning that the conditional convergence hypothesis is evidenced: holding constant other growth determinants, countries with lower GDP per capita tend to grow faster. The initial position of the economy is thus a significant determinant of growth, as preconised by the neoclassical theory. As indicated before, we also included the rate of gross secondary-school enrollment as another characteristic of initial conditions, but this variable has been dropped from the final estimation since it was not significant. This result is in accordance with those of Romer (1989) and de Gregorio (1992) who report non significant impact of human capital proxy on growth. Turning to the other control variables, our findings show that the coefficient of the inflation rate is significantly negative, meaning that price instability tends to hamper growth. In other words, low inflation, as part of a broad macroeconomic stabilization policy, is an important condition to promote growth.\(^{26}\) The investment variable has also the right sign since there exists a positive relationship between capital accumulation and growth. Trade openness positively affects growth, a fact that is in line with both the neoclassical approach and the endogenous growth theory. Indeed, according to the former, the positive impact of trade on growth is explained by comparative advantages, be they in resource endowment or differences in technology. Turning to the endogenous growth literature, it asserts that trade openness positively affects growth through economies of scale and technological diffusion between countries. Finally, as predicted by the Solow growth model, the population growth coefficient is negative in both specifications.

Turning now to our main variable of interest, our results show that the misalignment has also the expected sign in the case of undervaluations. Indeed, in this first regime, the coefficient is equal to 0.052 in the case of the PMG estimation and 0.036 when using the FM-OLS methodology, meaning that, other things being equal, a depreciation of the real exchange rate of 10% contributes for an increase in GDP per capita growth of 0.52 or 0.36 percentage points. Undervaluations have thus a positive impact on economic growth, as expected. This result is consistent with those of Bresser-Pereira (2002), Aguirre and Calderón (2005) and Dooley et al. (2005) and illustrates the fact that competitiveness is reinforced when the currencies are undervalued. More importantly, our findings put forward a differentiated effect of real exchange rate misalignments on growth, depending on whether they reflect over- or under-valuations of the considered currency. Indeed, considering the PMG estimates, this impact varies between 0.52 pp. (Regime 1) and -0.38 pp. (Regime 2) on GDP per capita growth.\(^{27}\) In other words,

\(^{26}\)Note that, as mentioned before, we have also introduced another proxy for fiscal policy, namely government consumption in percentage of GDP. Since the inclusion of this variable has led to very similar results, we have removed it from the final estimation (but results are available upon request to the authors). As expected, the sign of the coefficient was negative, reflecting the fact that the ratio of government consumption to GDP can be viewed as a proxy for the government burden (see Barro (1991), Barro and Sala-i Martin (1995) and Loayza et al. (2004) among others).

\(^{27}\)Remember that these are the extreme cases, but there is a continuum of values in between.
while undervalued currencies stimulate growth, overvalued exchange rates hamper it. Put differently, the lower the overvaluations, the lower the negative impact on growth.

This different impact of the exchange rate misalignment on growth clearly highlights the interest of our nonlinear specification and shows that exchange rate policy may play a key role in economic growth: appropriate exchange rate policies that limit currency overvaluation could be used to promote economic growth.

4.3 Robustness checks

Our findings evidence a different impact of currency misalignments on economic growth, depending on the size and sign of the exchange rate deviation from equilibrium. Our results also show that control variables have the expected effects, since they are correctly signed. To test the robustness of our main conclusion regarding the effects of misalignments, we conduct some additional regressions, investigating the issues of nonlinear versus linear specifications, endogeneity, inclusion of terms of trade in the growth equation and choice of the misalignment measure.

4.3.1 Nonlinear versus linear growth equation

To put forward the interest of our nonlinear specification, we estimate a linear growth equation. For this purpose, we estimate the log-linear Equation (3) using the dynamic panel GMM estimator developed in Arellano and Bond (1991) and Arellano and Bover (1995), using our two measures of misalignments. Basically, the GMM estimation consists in differencing the model to get rid of country specific effects or any time-invariant country specific variable. This also eliminates any potential endogeneity that may be due to the correlation of these country specific effects and the right-hand side regressors in Equation (3). Results reported in Table 3 indicate that all the control variables have the expected signs. Indeed, the initial GDP per capital level impacts negatively growth—as predicted by the conditional convergence hypothesis—and the effect of inflation is also negative—putting forward the importance of price stability in promoting growth. Investment and openness positively affect economic growth, as expected. Turning to our main variable of interest, our findings show that the coefficient of the exchange rate misalignment—in both the PMG and the FMOLS equations—is negative indicating that, whereas an overvalued currency tends to slow growth on average, undervaluations have a positive effect.

These linear specifications are able to capture the differentiated effect of real exchange rate misalignments depending on the sign of the deviation, but are not able to capture other features, such as, for instance, size effects. Indeed, a linear specification has several drawbacks that are worth mentioning. First, by definition, in a linear equation, the growth-misalignment
elasticity is constant. In our case, the estimated elasticity is equal to -2.3%, meaning that, if the currency is overvalued (resp. undervalued), an appreciation (resp. depreciation) of the real exchange rate of 10% would have a negative (resp. positive) effect on growth of about 0.23 pp., independently of the size of the misalignment (see Figure 1 in Appendix B). Second, the threshold value that divides positive from negative effects is, by construction, zero. Third, and related to the previous points, there is a symmetric—but opposite in sign—effect of under and over-valuations. For instance, an undervaluation (resp. overvaluation) of 10% has a positive (resp. negative) impact of approximately 0.30 pp. on GDP per capita growth. In this situation, a country which decides to depreciate its real exchange rate will “gain” exactly the same as a country facing an undervaluation of 50% of its currency. Finally the higher the misalignment, the more positive (in the case of undervaluations) or negative (in the case of overvaluations) the final effect on growth.

However, there is no reason to think that this is necessarily the case, and such effects may come from the restrictive nature of the linear specification. Indeed, as captured by our nonlinear specification (Figure 1 in Appendix B), small scale overvaluations might have slightly positive effects on growth. At the same time, whereas high undervaluations have important positive effects on growth (with an elasticity of about 5-6%), high overvaluations have less important negative effects (elasticity no higher than -4%). Finally, it is important to mention that the “gains” or the “losts” of small to medium scale under and over-valuations are more important than those of big scale misalignments. Indeed, according to the nonlinear specification, a country with an undervaluation of, say, 10%, will gain more from a depreciation of 1% than a country with an undervaluation of 50% which also depreciates by 1% its real exchange rate. In other words, nonlinear models are able to capture a differentiated impact of an exchange rate appreciation depending on the initial misalignment—especially on whether the currency is overvalued or undervalued.

4.3.2 Endogeneity issues in the PSTR model

An important concern in growth regressions is the issue of endogeneity. Indeed, some of the explanatory variables, namely openness and fixed investment, could potentially be explained by unobserved common factors and, therefore, engender endogeneity problems that must be taken into account to avoid potential bias in the estimated parameters. Various methods exist to deal with the issue of endogeneity such as instrumental variables methodology, quantile regressions... (see Dufrénot et al. (2009) among others). Since trade openness and invest-
Table 3: **Linear growth equation (GMM estimation)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>PMG</th>
<th></th>
<th>FM-OLS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff.</td>
<td>t-stat</td>
<td>Coeff.</td>
<td>t-stat</td>
</tr>
<tr>
<td>Misalignment</td>
<td>-0.029</td>
<td>-4.51</td>
<td>-0.035</td>
<td>-4.79</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.027</td>
<td>-11.93</td>
<td>-0.024</td>
<td>-12.21</td>
</tr>
<tr>
<td>Initial GDP per capita (log)</td>
<td>-0.167</td>
<td>-3.77</td>
<td>-0.176</td>
<td>-4.81</td>
</tr>
<tr>
<td>Investment (% of GDP)</td>
<td>0.104</td>
<td>6.30</td>
<td>0.106</td>
<td>9.88</td>
</tr>
<tr>
<td>Openness (% of GDP)</td>
<td>0.044</td>
<td>7.16</td>
<td>0.047</td>
<td>5.07</td>
</tr>
<tr>
<td>Pop. Growth</td>
<td>-0.467</td>
<td>-1.19</td>
<td>-0.443</td>
<td>-1.90</td>
</tr>
<tr>
<td><strong>Specification test (p-value)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Sargan test</td>
<td>1.000</td>
<td></td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>(2) Serial correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First order</td>
<td>0.000</td>
<td></td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Second order</td>
<td>0.260</td>
<td></td>
<td>0.030</td>
<td></td>
</tr>
</tbody>
</table>

Notes: (a) All regressions are estimated using the dynamic GMM estimator; (b) Significant time dummies are included in all regressions; (c) Sargan test: test of the null hypothesis that the over-identifying restrictions are satisfied.

The results are not our main variables of interest here, we only proceed to robustness checks by instrumenting these two variables by their own lagged values. Results are reported in Table 4. Using two lags for each variable, our estimations show that the effects of the misalignment on economic growth are highly similar to those obtained in Table 2. Indeed, we found that a depreciation of the real exchange rate of 10% increases the GDP growth by about 0.50 pp, whereas a 10% appreciation reduces it by about 0.24 pp. Our findings that undervaluations tend to enhance growth, while overvaluations have a negative impact are thus robust to endogeneity issues.

These findings can be linked to those of Aghion et al. (2009). As argued by the authors, our empirical analysis has some characteristics that reduce the potential endogeneity problem. Indeed, our aim is to put forward contrasting growth effects of misalignments for different levels and signs of the real exchange rate deviations from equilibrium. We are thus in presence of interaction terms that reduce the endogeneity bias (see Aghion et al. (2009) for more details). Moreover, similar results were obtained with the lagged values of control variables (see above) and with an alternative measure of misalignment (see below).
4.3.3 Terms of trade and misalignment measure

As previously indicated, terms of trade have not been included in the growth equation since this variable was used as a determinant of the real exchange rate in the cointegrating relationship. As a robustness check, we estimate a new misalignment series by dropping the terms of trade from the cointegrating relationship, and adding them into the growth equation. From a theoretical viewpoint, the direction of the impact of terms of trade on economic growth depends on the relative influence of substitution versus income effect. In case of a negative terms of trade shock, such as an increase in the price of imports, the relative price of nontradables falls due to the decrease in the permanent income together with the fall in the demand for nontradables, leading to an exchange rate depreciation. If the substitution effect dominates the income one, price of nontradables will increase, inducing a real appreciation.

Results reported in Table 5 justify our choice to consider terms of trade in the cointegrating relationship as a determinant of the real exchange rate rather than in the growth equation. Indeed, considering PMG results, terms of trade are not significant in the growth equation at the 5% significance level, whereas this variable was significant in the long-term relationship.

As a final robustness check, we consider alternative measures of real exchange rate misalignments. Indeed, given that currency misalignment measures are far from being consensual, it would be interesting to investigate if our previous results are consistent with other definitions of misalignments. To this end, we calculate the misalignment in two different ways: (i) instead of relying on fundamentals, we consider the deviation of the actual real exchange

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### Table 4: Robustness checks. PSTR model for the growth rate of GDP per capita, with lagged values for trade openness and investment

<table>
<thead>
<tr>
<th>Variable</th>
<th>PMG</th>
<th>FM-OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regime 1</td>
<td>Regime 2</td>
</tr>
<tr>
<td></td>
<td>Coef.</td>
<td>t-stat</td>
</tr>
<tr>
<td>Misalignment</td>
<td>0.049</td>
<td>2.40</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.047</td>
<td>-5.64</td>
</tr>
<tr>
<td>Initial GDP per capita (log)</td>
<td>-0.026</td>
<td>-4.64</td>
</tr>
<tr>
<td>Investment (% of GDP)</td>
<td>-0.027</td>
<td>-2.48</td>
</tr>
<tr>
<td>Openness (% of GDP)</td>
<td>0.023</td>
<td>3.61</td>
</tr>
<tr>
<td>Pop. Growth</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Transition parameters**

<table>
<thead>
<tr>
<th></th>
<th>PMG</th>
<th>FM-OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{c} )</td>
<td>0.109</td>
<td>0.051</td>
</tr>
<tr>
<td>( \hat{\gamma} )</td>
<td>10.514</td>
<td>8.253</td>
</tr>
</tbody>
</table>

Notes: (a)-(e) idem notes Table 2; NS: non significant.
Table 5: Robustness checks. PSTR model for the growth rate of GDP per capita, including terms of trade

<table>
<thead>
<tr>
<th>Variable</th>
<th>PMG</th>
<th>FM-OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regime 1</td>
<td>Regime 2</td>
</tr>
<tr>
<td></td>
<td>Coef. t-stat</td>
<td>Coef. t-stat</td>
</tr>
<tr>
<td>Misalignment</td>
<td>0.056</td>
<td>2.50</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.031</td>
<td>-3.56</td>
</tr>
<tr>
<td>Initial GDP per capita (log)</td>
<td>-0.022</td>
<td>-3.90</td>
</tr>
<tr>
<td>Investment (% of GDP)</td>
<td>0.032</td>
<td>2.78</td>
</tr>
<tr>
<td>Openness (% of GDP)</td>
<td>0.026</td>
<td>3.95</td>
</tr>
<tr>
<td>Pop. Growth</td>
<td>-0.588</td>
<td>-2.03</td>
</tr>
<tr>
<td>Terms of trade growth</td>
<td>0.053</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Transition parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coef.</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{c} )</td>
<td>0.156</td>
<td></td>
</tr>
<tr>
<td>( \hat{\gamma} )</td>
<td>4.530</td>
<td></td>
</tr>
<tr>
<td>( \hat{\gamma} )</td>
<td>9.191</td>
<td></td>
</tr>
</tbody>
</table>

Notes: (a)-(e) idem notes Table 2.

rate from its Hodrick-Prescott detrended value as in Goldfajn and Valdes (1999) and Aghion et al. (2009), and (ii) following Chinn (1999), we rely on a PPP-based measure. In the first case, the filtered series represents the predicted equilibrium real exchange rate and captures the permanent changes in the series. In the second case, the equilibrium exchange rate is associated with an international version of the law of one price and is obtained by regressing the real exchange rate on a constant plus a time trend (when significant).

As shown in Table 6, while the impact of some variables on economic growth may slightly differ from the results reported in Table 2—which is not surprising given that the misalignment series does not account for the fundamental determinants of the exchange rate—our findings are qualitatively similar. In particular, the effect of currency misalignment on growth is positive in case of undervaluations and negative for overvaluations, confirming our previous findings.

5 Conclusion

Various empirical studies have investigated the importance of variables such as the initial level of GDP, investment, human capital, trade openness and population growth, in explaining economic growth. However, not much has been done regarding the importance of real exchange rate misalignments as a potential determinant of growth. Our aim in this paper is to fill this gap by paying a special attention to the influence of exchange rate over- and under-valuations.
Table 6: Robustness checks. PSTR model for the growth rate of GDP per capita, HP filter and deviations from PPP equilibrium exchange rates

<table>
<thead>
<tr>
<th></th>
<th>HP Regime 1</th>
<th>HP Regime 2</th>
<th>PPP Regime 1</th>
<th>PPP Regime 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>t-stat</td>
<td>Coef.</td>
<td>t-stat</td>
</tr>
<tr>
<td>Misalignment</td>
<td>0.231</td>
<td>3.52</td>
<td>-0.049</td>
<td>3.52</td>
</tr>
<tr>
<td>Inflation</td>
<td>-0.067</td>
<td>-4.85</td>
<td>0.031</td>
<td>-4.85</td>
</tr>
<tr>
<td>Initial GDP per capita (log)</td>
<td>-0.025</td>
<td>-3.35</td>
<td>-0.024</td>
<td>-3.35</td>
</tr>
<tr>
<td>Investment (% of GDP)</td>
<td>0.011</td>
<td>0.72</td>
<td>0.115</td>
<td>0.71</td>
</tr>
<tr>
<td>Openness (% of GDP)</td>
<td>0.009</td>
<td>0.57</td>
<td>0.076</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Transition parameters

<table>
<thead>
<tr>
<th></th>
<th>(\hat{c})</th>
<th>(\hat{\gamma})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.071</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>6.763</td>
<td>3.326</td>
</tr>
</tbody>
</table>

Notes: (a)-(e) idem notes Table 2; (f) PPP is calculated as the difference between the actual log real exchange rate and the predicted one, the predicted value being obtained from a regression of the real exchange rate series on a constant plus a time trend.

on the economic growth for a large set of countries, including both developing and advanced economies.

To this end, by estimating panel smooth transition regression models, we show that the impact of exchange rate misalignments on economic growth depends on the sign and the size of the misalignment. Indeed, we find that there exists a positive and significant relationship between growth and exchange rate misalignment when the currency is undervalued, whereas overvaluations negatively affect economic growth.

The previous result would imply that undervaluations, which could be attributed to competitive devaluations, may drive the exchange rate to a level that encourages exports and promotes growth. On the contrary, overvaluations discourage economic growth. These findings show that exchange rate policy may play a key role in economic growth and suggest that to boost performance, policymakers may undervalue their currencies.

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URL: [http://ideas.repec.org/p/nbr/nberwo/11771.html](http://ideas.repec.org/p/nbr/nberwo/11771.html)


URL: [http://ideas.repec.org/a/kap/jecgro/v6y2001i2p135-57.html](http://ideas.repec.org/a/kap/jecgro/v6y2001i2p135-57.html)


Frenkel, R. (2004), Real exchange rate and employment in argentina, brazil, chile and mexico, Paper for the g-24, Washington DC.


He, C. and Sandberg, R. (2004), Testing for unit roots in a panel smooth transition autoregressive model where the time dimension is fixed. Mimeo, Department of Economic Statistics, Stockholm School of Economics.


A Data definitions and sources

The real effective exchange rate for each country $i$ is calculated as a weighted average of real bilateral exchange rates against each $j$ trade partner. Bilateral real exchange rates are derived from nominal rates and consumer price indices (CPI); they are based in 2000.\textsuperscript{30} The weights have been calculated as the share of each partner in average values of imports and exports of goods and services over the 2000-2007 period.\textsuperscript{31} Intra-Eurozone flows have been excluded and trade weights have been normalized to sum to one across the partners included in the sample.

The net foreign asset position is built using the Lane and Milesi-Ferretti database from 1980 to 2004.\textsuperscript{32} To complete the database from 2005 to 2007, we rely on the information provided by IFS (\textit{International Financial Statistics}, IMF) and WDI (\textit{World Development Indicators}, World Bank) on gross foreign assets and liabilities by applying the corresponding growth rates first on 2004 gross values, and then by reconstruction, to both sides of the international investment position for each country of the panel. Finally, the net foreign asset positions are obtained by difference.\textsuperscript{33} We do the same for the Euro zone aggregate for which no data were available before 1999. To correct for intra-zone flows before 1999, we assumed that the share of external wealth accumulation due to intra-zone financial flows was the same than that due to intra-zone trade flows. By doing so, we obtain figures that can be easily linked to Lane and Milesi-Ferretti’s estimations over the 1999-2004 period.

Turning to the other explanatory variables, the terms of trade are excerpted from WDI, except for the Euro zone and Chile (IFS). Concerning the proxy for relative productivity, we use the relative labor productivity of tradables to non tradables, measured by output per worker. It is calculated on the basis of a dataset for output and employment for a 6-sector classification (or 3- sector when the 6-sector data were not available).\textsuperscript{34}

\textsuperscript{30}Source: World Bank \textit{World Development Indicators} (WDI) for nominal exchange rates and CPI data except for the EUR/USD exchange rate which was extracted from Datastream and China’s real exchange rate which was calculated with GDP deflator (WDI).

\textsuperscript{31}Source: IMF \textit{Direction of Trade Statistics} (DOTS). For robustness checks, we have considered two additional weighting schemes: average weights over the whole period and weights in 2007 (the last point of our sample). The results were very similar, and we only report those obtained using the weighting matrix based on the 2000-2007 mean trade flows.

\textsuperscript{32}Source: \url{http://www.imf.org/external/pubs/cat/longres.cfm?sk=18942.0}, see Lane and Milesi-Ferretti (2007).

\textsuperscript{33}Source: IMF (IFS), February 2009, and World Bank (WDI).

\textsuperscript{34}We rely on the IMF classification (see IMF (2006)). In the 6-sector classification, the tradable sector includes: agriculture, hunting, forestry, and fishing; mining, manufacturing, and utilities; and transport, storage, and communication. The non-tradable sector includes: construction; wholesale and retail trade; and other services. In the 3-sector classification, the tradable sector includes agriculture and industry. The sources are the following: the United Nations Statistics Division, International Labor Office Bureau of Statistics, Eurostat, World Bank and Groningen Growth and Development Centre.
The growth rate of real GDP per capita is extracted from the Penn World Table 6.1. The explanatory variables are taken from IFS (inflation rate and government consumption), the Penn World Table 6.1 (real investment, trade openness—measured as the sum of exports and imports—and population growth), and the United Nations’ database (gross-secondary school enrollment rate).

B Figures
Figure 1: Estimated elasticity versus misalignment in the linear (stars) and nonlinear (circles) models (PMG estimation for the PSTR specification)