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Real exchange rate misalignments and economic performance for the G20 countries*

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Abstract

We evaluate the growth effects of real effective exchange rate misalignments for the G20 countries over the period 1980-2006. To this end, we first estimate real effective equilibrium exchange rates relying on the behavioral approach BEER, from which misalignments are derived. Second, we estimate a dynamic panel growth model in which among the traditional determinants of growth, our measure of misalignments is included. Our findings put forward some important differences between developed and emerging economies. The magnitude of the misalignments is more pronounced in the case of emerging countries, and the speed of convergence towards the estimated equilibrium exchange rate is slower for industrialized ones. Turning to our growth regression analysis, we find that misalignments have a negative effect on the economic growth. As a consequence, an appropriate exchange rate policy would close the gap between real exchange rates and their equilibrium level.

JEL classification : C23, F31, O47.

Keywords : Equilibrium Real Effective Exchange Rate, Group of Twenty, Growth, Misalignments, Panel Cointegration

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Contents

1 Introduction

The question of currencies misalignments, often viewed as a key indicator of external competitiveness have a strong interest for policy makers. Indeed, persistent misalignments, whatever we consider an over-or-under valuation of the currencies may generate instability and are likely to affect the economic performance of countries. As Kaminsky & al. (1997) and Razin & Collins (1997) underline, an overvaluation of the currencices is often the sign of the inconsistency of the decisions of macroeconomic policies that may lead to an unsustainable current account deficit, increasing external debt and the risk of possible speculative attacks.[1] On the opposite, in case of real exchange rate undervaluation, competitiveness is reinforced, which stimulates investment and exports, the current account is then improved, so is the GDP. Consequently, an important question concerns the mesure of misalignments, that is the evaluation of equilibrium exchange rates.

Currency misalignment measures are far from consensual. Between the two extreme views - market equilibrium (short term) and purchasing power parity (very long term) - a large research avenue has been developed to provide numerous equilibrium exchange rates concepts (Bénassy-Quéré & al., 2008). The analysis of the real equilibrium exchange rate could be divided into two main categories, the fundamentals (normative) et behavorial (positive) ones. The fundamental equilibrium exchange rate (FEER) developed by Williamson (1994) defines the equilibrium exchange rate as the one that satisfies simultaneously internal and external balances. Internal balance is identified as the level of output consistent with both full employment and sustainable rate of inflation, and external balance can be characterized by a current account which is consistent with external debt and sustainability (Clark & MacDonald, 1998). Aspect normativity of this approach, given by the slighty arbitrary definition of "medium-term" fundamentals led to the desired equilibrium exchange rate (DEER), where the real exchange rate is conditioned on some measure of optimal fiscal policy. Similar to the spirit of this approach is the natural rate of exchange rate (NATREX), that conversely to the FEER does not only consider the medium term but also the long run, when capital stock and foreign debt are assumed to converge to their long run steady-state (Frait & al. (2004)). The NATREX is considered as a "'positive"' conception to the extend the equilibrium real exchange rate is jointly determined by real fundamentals factors and macroeconomics policies that

[1] As illustrated by crisis in Latin American as well as in Asian Economies.

don't need to be optimal. Turning now to the behavioural models, the behavioural real exchange rate (BEER) supported by Clark & MacDonald (1998) is rather a statistical approach linking the real exchange rate to a set of macroeconomic variables through a single equation. This model offers advantages to use a modelling technique which captures movements in real exchange rate over time (Driver & Westaway, 2004) and to be easily implemented.

Although real exchange rate misalignments have not been a key variable of neo-classical growth models that traditionally focus on savings, investment or education among others, some authors shed in light its prominence role. Among the empirical studies dealing with the misalignment-growth nexus, many papers focus on developing countries. A great majority of them find a negative correlation between exchange rate misalignments and growth since the 1970s; the more overvalued the currency, the smaller the per capita growth rate. This is for instance the case of Ghura & Greenes (1993), who negatively link growth and misaligned currencies for Sub-Saharan Africa. They concluded that inappropriate domestic macroeconomic, trade, and exchange rate policies appear to be one of the important factors that contributed to the economic distress in all Sub-Saharan African countries. We also note the contributions of Cavallo & al. (1990), Dollar (1992), Easterly & al. (1996), Domaç & Shabsigh (1999), Bleany & Greenaway (2000), Toulaboe (2006) as well as Gala & Lucinda (2006) which still point the negative link between misalignments and growth for a large sample of emerging countries. While some empirical studies negatively link economic growth and misalignment volatility (see for example Ghura & Greenes (1993), Aghion & al. (2006)), others, as Razin & Collins (1997) and Béreau & al. (2009) show that it is the real exchange rate misalignment and not its volatility that can be associated with slower growth. More specifically, they found that while high overvaluations appear to be associated with slower growth, moderate to high undervaluations seem to stimulate growth. In this paper, we will investigate the impact of both the level and the volatility of the misalignment on economic growth.

The aim of this paper is to investigate the relationship between real exchange rate misalignments and economic growth for the group of twenty (hereafter G20). The choice to work on this sample is caused by the willigness to work on a sample that accounts for approximatively 80% of the world GDP. Furthermore, its allows us to take the context of growing global imbalances into consideration. To this end, we proceed in three steps. First, we investigate the impact of various potential determinants of the real exchange rate using the more recent panel unit root and cointegration techniques for the (G20). Second, based on cointegration results, we estimate equilibrium paths for the G20 real exchange rates and then compute the degree of misalignment between the observed and the equilibrium real exchange rates. Third, we assess the relationship between economic growth and a set of explanatory variables, by paying a special attention to the impact of real exchange rate misalignments.

The rest of the paper is organized as follows. Section 2 briefly presents the potential determinants of exchange rates in a BEER context. Section 3 outlines the data. Section 4 presents the panel unit root and cointegration tests. Section 5 deals with the empirical estimation of both real equilibrium exchange rates and currency misalignments. Section 6 is devoted to the growth model and presents the empirical results. Finally, Section 7 provides some concluding remarks.

2 The BEER framework

We rely on the BEER approach introduced by Clark and MacDonald (1998), and more specifically on the stock-flow model developed by Alberola & al. (1999, 2003), where the real exchange rate is jointly determined by external balance as well as internal balance. The real exchange rate q is defined as the relative price of domestic goods. With p^* denoting the foreign price index and p the domestic one, and s standing for the nominal exchange rate defined as the price of foreign currency in terms of domestic currency, all variables being in logarithms, we have:

$$q = s - p^* + p \tag{1}$$

Denoting[2] α the share of tradable goods in the price index, p^T the price level of tradable goods, and p^{NT} the price level of non-tradable goods, the real exchange rate can also be written as follows :[3]

$$q = \underbrace{(p^T - (s + p^{T*})}_{q^T} + \underbrace{\left[\alpha\left(p^{NT} - p^T\right) - \alpha^*(p^{NT*} - p^{T*})\right]}_{q^{NT}} \tag{2}$$

The first term denoted q^T, refers to the relative price of tradable goods accross countries. It is determined by the equilibrium condition of the balance of payments when net capital flows

[2]We refer to foreign variables with a star.

[3]Thus, an increase in q represents an appreciation of the real exchange rate.

correspond to normal adjustment of the net foreign asset position f towards its desired level $\widetilde{f}$. Defining the equilibrium for the external exchange rate q^T as the exchange rate consistent with $f = \overline{f}$ i-e the exchange rate consistent with asset holdings at their targeted level, it follows that :[4]

$$\overline{q}^T = \frac{(i^* - g)}{\gamma}\overline{f} \qquad \gamma > 0 \tag{3}$$

where g is the growth rate of nominal GDP and i^* the international interest rate. The second term, q^{NT} refers to the Balassa-Samuelson effect, which is driven by relative productivity in the tradable relative to non-tradable sector. The internal contribution to the equilibrium exchange rate $\overline{q}^{NT}$ can be expressed as:

$$\overline{q}^{NT} = (1 - \alpha)\left[\left(y^T - y^{NT}\right) - \left(y^{T*} - y^{NT*}\right)\right] \tag{4}$$

where y^i stands for labor productivity in sector i, $(i = NT, T)$.

From (3) et (4), we get the real equilibrium exchange rate, denoted $\overline{q}$:

$$\overline{q} = \frac{(i^* - g)}{\gamma}\overline{f} + (1 - \alpha)\left[\left(y^T - y^{NT}\right) - \left(y^{T*} - y^{NT*}\right)\right] \tag{5}$$

The real exchange rate $\overline{q}$ is expected to be a positive function of both the net foreign asset position f and the relative productivity differential.

3 Data: sources and construction

As mentioned in the introduction, we consider both industrial and emerging countries by concentrating on fifteen countries or areas belonging to the group of the twenty (G20).[5] More specifically our sample includes Argentina (ARG), Australia (AUS), Brazil (BRA), Canada (CAN), China (CHN), the United Kingdom (GBR), Indonesia (IND), India (IND), Japan (JPN), Korea (KOR), Mexico (MEX), South Africa (ZAF), Turkey (TUR), the United States (USA) and the Euro area (ZZM).[6] Data are annual and cover the period 1980-2006.

The dependent variable is the real effective echange rate q and the explanatory variables are (i) the stock of net foreign assets nfa and the relative productivity in the tradable relative to non-tradable

[4] See Alberola & al. (2003) for details.

[5] Our sample covers all G20 countries except Russia ans Saudi Arabia because of data availability.

[6] France, Germany and Italy are grouped into the Euro area. EUR/USD exchange rate is extracted from datastream.

rprod, q and *rprod* are in logarithms, nfa being expressed as share of GDP in percentage points.

$$q_t = f(nfa_t, rprod_t) \tag{6}$$

The real effective exchange rate for each country, extracted from the International Financial Statistics, is calculated as a weighted average of real bilateral exchange rate against each partner. We apply the usual definition of a real effective exchange rate:[7]

$$rer_i = \sum_{j=1, j\neq i}^{n} w_{ij}(s_{j\$} - p_j - (s_{i\$} - p_i)) \tag{7}$$

where $s_{j\$}$ (resp $s_{i\$}$) is currency j (resp i)'s bilateral exchange rate (defined as the price of foreign currency in terms of domestic currency). p_j (resp p_i) is country j (resp i)'s consumer price index[8] (CPI) and n denotes the number of partner countries. All variables are based 100 in 2000 and taken in logarithms. w_{ij} are the weights put on currency j for country $i's$ real effective exchange rate. Here we define them on the whole period 1980-2006, as country $j's$ share in the world gross domestic product[9] (GDP) in USD, which is calculated excluding country i. This can be written as follows:

$$w_{ij} = \frac{GDP_j}{\sum_{k=1, k\neq i}^{n} GDP_k} \tag{8}$$

The weights w_{ij} are reported in Appendix. The net foreign asset position is built using the Lane and Milesi-Ferretti database.[10] According to portfolio-balances considerations, this variable influences the real exchange rate. For instance, 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 which, in order to adjust their portfolio, demand a higher yield. At a given interest rate, this can be only achieved through an immediate depreciation of the currency of the debtor country. The 2005 and 2006 data are calculated by adding the current account position to the 2004 and 2005 nfa value.

[7] We define real exchange rate as the price of foreign currency in term of domestic one using CPI deflator. Other narratives, as Rodrik (2007) or Carrera & Restout (2008) use a definition of relative price. To what extend the large majority of studies use the same definition as ours, we implement real exchange rate misalignments with it.

[8] CPI are from World Development indicators.

[9] GDP are from World Development indicators.

[10] http://www.imf.org/external/pubs/cat/longres.cfm?sk=18942.9

Concerning the relative productivity of tradables versus non-tradables, we follow Alberola & al. (1999) in using a proxy given by the ratio of the consumer price index (CPI) to the producer price index (PPI).[11] The reason for such approximation is that the CPI contains more non-tradable goods than the PPI. According to the IMF International Financial Statistics, the producer price index doesn't include services. In this sense, it makes it an acceptable proxy for tradable good prices. For each country, we calculate the ratio *rprod* both for the domestic economy and for an aggregate foreign economy which is a weighted average of foreign partners, using the same weights as for the real effective exchange rate:

$$rprod_{it} = \ln\left(\frac{CPI}{PPI}_{it}\right) - \sum_{j\neq i} w_{ij} \ln\left(\frac{CPI}{PPI}_{jt}\right) \tag{9}$$

rprod refers to the Balassa-Samuelson effect which states that relatively larger increases in productivity in the traded goods sector are associated with a real appreciation of the currency of a country.

Having introduced macroeconomic fundamentals for calculating real exchange rate misalignments, we are now in position to investigate the impact of real exchange rate misalignments on the economic performance. From this perspective, we add misalignments among explanatory variables in our growth regression. We consider a model of the following form:

$$y_{i,t} - y_{i,t-1} = \alpha y_{t-1} + \beta X_{i,t} + \mu_t + \eta_i + \epsilon_{i,t} \tag{10}$$

The dependent variable is the growth rate of real GDP per capita, extracted from the Penn World Table 6.2. Turning to the growth determinants, we follow Béreau & al. (2009) and rely on the neoclassical growth theory by considering the usual determinants: initial value of GDP per capita, a proxy of human capital, trade openess, terms of trade, government burden and investment. The initial value of GDP per capita proxies for conditional convergence. We expect, according to the theory, the sign of this variable to be negative. Our mesure of cyclical reversion is the difference between (the log of) the actual GDP and (the log of) potential (trend) GDP. To this end we im-

[11] PPI are from Datastream.

plement the Hodrick-Prescott filter[12] to decompose GDP in trend and cycle.[13] Human capital is proxied by the gross-secondary school enrollment rate. Our source is the Barro & Lee's educational attainment data, 1960-2000.[14] Trade openness is the log of the ratio of exports and imports to GDP, and the terms of trade are defined as the home country's export price to import price ratio. The data are respectively obtained from the PWT 6.2 and the World Development Indicators. Government burden is proxied as the ratio of government consumption to GDP and the data are extracted from the PWT. Importance of capital accumulation is proxied by investment (as percentage of GDP) and data are from the PWT 6.2. Volatility of both the terms of trade and the real exchange rate misalignments is estimated from a GARCH (1,1).[15]

4 Panel unit root and cointegration tests

The econometric methodology used in this paper is based on panel unit root and cointegration tests. Fisrt, we test for unit root in various series. Second, we test for cointegration between the real effective exchange rate and the underlying macroeconomic fundamentals. Finally, we estimate the long-run parameters that we later use for computing the real equilibrium exchange rates and the corresponding misalignements. Given our relatively short time span (T = 27), examining the long run behavior of real exchange rates by using non stationarity panel econometrics instead of relying on individual time series yields substantial benefits. Firstly, as underlined by Carrera & Restout (2008) panel unit root and cointegration tests outperform their conventional time series counterparts.[16] Secondly, recent panel unit root and cointegration tests take account of the heterogeneity

[12] Other methodologies are routinely used in pratice (see Cette & al., 2003 for details.) such as the Baxter-King filter. Since the litterature is somewhat divided over the choice of this two filters (see for instance Guay & St-Amant (1997) or Woitek (1998)) we made the choice to enforce the H-P filter.

[13] Here we use a smoothing parameter value of 100 (λ=100) Our choice is motivated by the statistical view of Hodrick-Prescott filter according which it is great adviced to choose a λ consistent with the frequency of the data (Hodrick & Prescott (1997)). Note that recent studies as Agenor & al. (1999) implemented a modified version of the Hodrick-Prescott using specific smoothing parameters for their series. However, the arbitrariness of the decision of requiring variant value for λ led us to impose the same exogenous smoothing parameter for our database.

[14] http://www.cid.harvard.edu/ciddata/ciddata.html

[15] Here we follow the methodology enforced by Bleany & Greenaway (2000) and Wong (2008) based on annual data where the GARCH (1,1) model is estimated using a regression of a change in the logarithm of the variables on a constant.

[16] See Carrera & Restout for details.

accross different members of the panel (see Hurlin & Mignon, 2005). This allows us to test the presence of unit root and the existence of a cointegration relationship in the panel while permitting the short run dynamics or fixed effects to be heterogeneous among individuals countries. Finally, here, panel estimation permits us to take into account the rising share of emerging countries in global imbalances since the mid-1990s.

4.1 Panel unit root

Levin & Lin (1992, 1993), Breitung (2000) and Hadri (2000) tests are based on a common unit root process, except the Hadri test which uses the null of unit root. All these tests are designed for cross sectionally independent panels, i-e there is no cointegration between pairs or groups of individuals in the cross section dimension. Im & al. (2003) (hereafter IPS) proposed a test that allows for residual correlation, and heterogeneity of the autoregressive root and error variance accross individual members of the panel. IPS is based on the augmented Dickey-Fuller (ADF) test to each individual series. If we consider a sample of N individuals observed over T time periods, ADF estimation for each individual $i = 1, ...N$ is:

$$\Delta y_{i,t} = \gamma z_{i,t} + \rho_i y_{i,t-1} + \sum_{j=1}^{p_i} \theta_{i,j} \Delta y_{i,t-j} + \epsilon_{i,t} \tag{11}$$

where $z_{i,t}$ is the deterministic component, $\epsilon_{i,t}$ are assumed to be *i.i.d*. The null and alternative hypotheses are defined as:

$$\begin{cases} H_0 : \rho_i = 0 \quad \forall_i = 1, ..., N. \\ H_1 : \rho_i < 0 \quad \text{for i=N}_1 + 1, N_1 + 2, ..., N. \end{cases} \tag{12}$$

Thus, under the alternative hypothesis, IPS allows for ρ_i to be individual specific, and in this sense, is more general than the homogeneous alternative, i-e $\rho_i = \rho < 0$ for all i.

The results of the panel unit root tests applied to the (log) of real exchange rate q, net foreign asset position nfa and relative productivity *rprod* are reported in **table 1**.

In accordance with empirical studies such as Calderon (2002), Carrera & Restout (2008) or Coudert & Couharde (2008) both nfa and *rprod* contain a unit root at the 10% significance level for the four tests.[17] Concerning the effective real exchange rate, the unit root hypothesis is rejected only by the

[17] Note that Coudert & Couharde (2008) provide som extensive panel unit root.

Table 1: Panel unit root tests

	q_t	$rprod_t$	nfa_t
	N=15		
LL	-0.39 (0.34)	-0.95 (0.17)	-0.89 (0.18)
Breitung	-1.07 (0.12)	-1.09 (0.86)	-0.43 (0.33)
IPS	-2.81 (0.002)***	-0.70 (0.24)	-0.61 (0.26)
Hadri	6.33 (0)***	7.25 (0)***	8.62 (0)***

Note: This table reports the results of the following panel unit root tests: Levin & Lin (LL); Breitung; Im, Pesaran and Shin (IPS); Hadri. All tests but Hadri are based on the unit root null hypothesis. p-value are given in parentheses. * (resp.**,***): rejection of the null hypothesis at 10% (resp. 5%, 1%) significance level.

IPS $t-bar$. The three other tests indicate that this series is non stationary at the 10% significance level.

4.2 Cointegration tests

To test for cointegration between real exchange rate, the sectoral productivity differential and the net foreign asset position, we follow the methodology proposed by Pedroni (1999).[18] He developed tests that allow for considerable heterogeneity across individuals and also allow the cointegration vector to differ across members under the alternative hypothesis. These tests are based on the null hypothesis of no cointegration. Pedroni (1999) considers the following cointegration model with k regressors for a panel:

$$y_{it} = \gamma z_{it} + \beta_{1,i} x_{1,it} + \beta_{2,i} x_{2,it} + ... + \beta_{k,i} x_{k,it} + \epsilon_{it} \tag{13}$$

where z_{it} is the deterministic component and x_{it} are the k regressors which are assumed to be $I(1)$ and no cointegrated with each other. Pedroni's (1999, 2004) approach focuses on testing for unit roots in panel estimates of:

$$\hat{e}_{i,t} = \rho_i \hat{e}_{i,t-1} + \upsilon_{i,t} \tag{14}$$

[18] Kao (1999) also proposed residuals based test for panel cointegration, see for instance Calderon (2002) for an implementation of this test.

where $\hat{e}_{i,t}$ are the estimated residuals and $v_{i,t}$ are assumed to be *iid*. Pedroni (1999, 2004) considered seven tests based on residuals from the regression below. Four are based on pooling data along the within dimension and three are calulated by pooling data along the between dimension of the panel. Using the within approach, the test of the null of no cointegration is $H_0 : \rho_i = 1 \forall i$ against the alternative hypothesis $H_1 : \rho_i = \rho < 1 \forall i$. Thus, all within statistics presume a common value $\rho_i = \rho$, whereas the between estimators are less restrictive in that they allow for considerable heterogeneity since the alternative hypothesis is $H_1 : \rho_i = \rho_i < 1 \forall i$. The between statistics provide an additional source of heterogeneity since the autoregressive coefficients, ρ_i, are allowed to vary across individual members of the panel. Pedroni (2004) explored finite sample performances of the seven statistics. He showed that in terms of power all the proposed statistics do fairly well for $T > 90$ and $N = 20$. Moreover Pedroni's (1997) simulations showed that for small time span ($T < 20$), the between group *parametric-t* statistic is the most powerful. Given our relatively short time span ($T = 27$), we will pay a particular atention to the group *parametric-t* statistic when testing for cointegration. The result of panel cointegration tests are displayed in **table 2**.

Table 2: Panel cointegration tests

Panel cointegration tests			
$v - stat$	$rho - stat$	$pp - stat$	$adf - stat$
-0.41 (0.36)	3.51*** (0.00)	-0.80 (0.28)	-1.83 (0.07)*
Group mean cointegration tests			
	$rho - stat$	$pp - stat$	$adf - stat$
	4.58*** (0.00)	-1.56 (0.11)	-2.00** (0.05)

Note: This table reports the results of the seven tests proposed by Pedroni (1999). All tests are based on the null hypothesis of no cointegration. p-value are given in parentheses. *(resp.**,***): rejection of the null hypothesis at the 10% (resp. 5%, 1%) significance level.

As it can be seen below, the results are somewhat mixed (see among others Bénassy-Quéré & al. (2006, 2008)).[19] Since simulations made by Pedroni (1997) show that, in small samples, the group-mean parametrict-test is more powerful than the other tests, we can conclude that the null

[19]Where Benassy-Quéré (2006) derive panel cointegration test for a closed G20 dataset and an another with the rest of the World.

hypothesis of no cointegration is rejected in our study, and now turn to the estimation of the long run relationship between the real effective exchange rate and its determinants.

5 Equilibrium exchange rates and currency misalignments

Having established that the variables are integrated and that a cointegration relation indeed exists, the long run parameters can be estimated. Various procedures exist, such as the Ordinary Least Squares (OLS), [20] the Fully-Modified Ordinay Least Squares (FM-OLS) [21] method proposed by Phillips & Hansen (1990), the error correction pooled mean-group (PMG) [22] by Pesaran & al. (1999) or the Dynamic Ordinay Least Squares (DOLS) [23] method introduced by Saikkonen (1991). Here, we propose to use the panel DOLS[24] procedure that consists in augmenting the cointegrating relationship with lead and lagged differences of the regressors to control for the endogeneous feedback effect, that is:

$$y_{it} = \beta x_{it} + \sum_{k=-\infty}^{\infty} \delta x_{it+k} + \epsilon_{it} \tag{15}$$

where x_{it} are the k regressors and ϵ_{it} are assumed to be *i.i.d*. The cointegration vector estimated through the DOLS method with country fixed effects are reported in **table 3**.

Table 3: Cointegration vector

	coefficient	t-stat
nfa	0.57	5.97
$rprod$	0.54	8.11

Note: This table reports the estimation of the cointegration vectors using the DOLS procedure.

[20] See Caderon (2002) and Bénassy-Quéré & al. (2004).

[21] see for instance Calderon (2002).

[22] See Lopez-Villavicencio (2006) for details, and Béreau & al. (2009).

[23] Note that DOLS estimator allows to correct the asymptotic biais contained in OLS estimates. Moreover, it has the same asymptotic distribution as the FM-OLS one but has smaller size distortion. We consquently enforce the former.

[24] See Calderon (2002), Aguirre & Calderon 2005 as well as Bénassy-Quéré & (2006, 2008).

From these results, consistent with the literature named above using the DOLS methodology, [25] we can highlight that both nfa and *rprod* are significant and correctly signed. A rise in the nfa position (i-e an improvement in the current account) as well as in the CPI to PPI ratio (Balassa-Samuelson effect) leads to a real exchange rate appreciation.

The estimation of equation (6) gives the real equilibrium exchange rate (hereafter $\hat{q}_{it}$) for each considered country. The misalignments m_{it} are then obtained as the deviation of the real exchange rate from its equilibrium level:

$$m_{it} = q_{it} - \hat{q}_{it} \tag{16}$$

Figure 1 reports the real exchange rate misalignments for each country. Our results highlight two points. First, average misalignments in emerging economies are higher than in advanced countries (Aguirre & Calderon, 2005), meaning that real exchange rates in industrial countries are closer to macroeconomic fundamentals. Second, the adjustment to equilibrium seems to be smoother in advanced economies than in emerging ones.

Regarding the particular countries, the United States know a phase of overvaluation between 1982 and 1987 where the dollar reaches a value at 23 %, then followed by a period of undervaluation about ten years between 1988 and 1998 (bénassy-Quéré & al., 2006 or Lopez-Villavicencio, 2006), period characterized by a trade gap in constant increase.

Symetrically the euro is undervalued over the period 1982-1987. Then the European currency knew phases of successive under and overvaluations (Maeso-Fernandez & al., 2001). At the beginning of 1999, the euro is overvalued by 5 % but in January 2002, wich coincides with the period around the launch of the euro and the moment when the European Central Bank took over responsability for the monetary policy of the EMU members states, the euro is strong. In the last few years, the real equilibrium exchange rate reaches a level similar to the ones observed during the nineties.

India, Indonesia and Korea have all the same profile before the 1997 crisis, their currencies are overvalued then fall brutally during the explosion of the crisis. [26] However this overvaluation does not last and most of the currencies show a return towards their equilibrium value or, at least to their initial level, as underlined by Lopez-Villavicencio (2006). By the end of the period, esti-

[25] For instance, cointegration's coefficient of both nfa and *rprod* respectively vary from 0.001 to 0.149 for Aguirre & Calderon (2005) and from 0.484 to 0.771 for Bénassy-Quéré & al. (2006) who considered the same database as ours.

[26] With the exception of India.

mated misalignments in China, Japan, Indonesia are quite insignificant compared with the other countries.[27]

Turning to the pound sterling, after a peak of appreciation in 1985, it depreciates from 1987 to 2001. At the end of the period the currency is undervalued by around 21%.

Among the Latin American countries of our sample, Argentina, Brazil and Mexico, the two first present the most important misalignments, both before the explosion of the crisis and just after. Mexico departs from the two other countries seems to be an exception because since the 2000s it is close to its equilibrium value. The case of Mexico is however similar to that of Brazil because the *Tequila crisis* has carried along an undervaluation of the peso about 37%, to finish at the end of the period with a 2% appreciation.

Given these misalignment series, let us now investigate their impact on the economic performance of the different countries.

[27] With the exception of Korea.

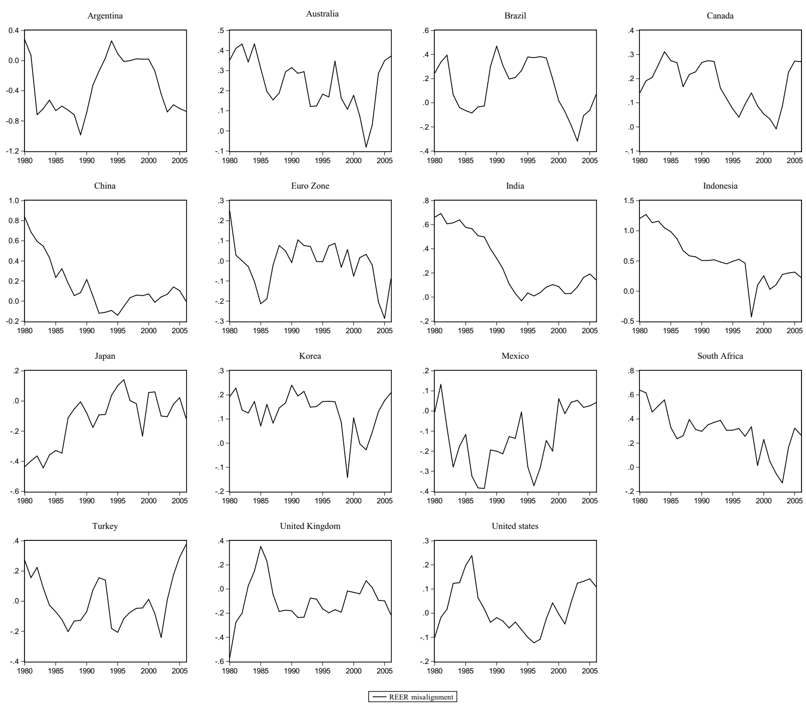

Figure 1: Real exchange rate misalignments, 1980-2006

Note: positive misalignment: overvaluation, negative misalignment: undervaluation.

6 Growth regression analysis

6.1 Econometric methodology

The econometric framework follows the traditional litterature of growth regressions (see for instance Barro (1991) and Barro & Sala-I-Martin (1996)). As mentioned before, GDP per capita growth rate is the dependent variable which is expected to depend on a vector of variables representing growth determinants X_{it}, together with the initial GDP per capita level for each country i on a given time period t. The theoretical model is given by:

$$y_{i,t} - y_{i,t-1} = \alpha y_{t-1} + \beta X_{i,t} + \mu_t + \eta_i + \epsilon_{i,t} \tag{17}$$

where η_i represents unobserved country-specific factors and μ_t is a period specific effect. As underlined by Gala & Lucinda (2006), using the initial level of per capita income on the right hand side of the previous equation for convergence analyses might cause possible biases on the estimators in a panel context. Thus, we chose to use the Generalized-Method-of-Moment (GMM) estimators developped for dynamic models of panel data that were introduced by Arellano & Bond (1991). Taking advantage of the data's panel nature, these estimators are based on, first, differencing regressions and/or instruments to control for unobserved effects, and second, using previous observations of explanatory and lagged-dependent variables as instruments.

6.2 Estimation

Following Dufrénot & al. (2009), we estimate our growth model first on the whole period and on two sub-periods, namely 1980-1995 and 1996-2006.[28] In **table 4** we report our regression estimates using the GMM difference estimation technique.

For the three regressions, we find evidence of conditional convergence, i-e, all things being equal, countries with lower income per capita tend to grow faster. Over the periods 1980-2006 and 1980-1995, speeds of convergence are respectively given by 7.2% and 16.7% corresponding to half-lives of 10 and 4.5 years respectively. Our estimates, although close to those obtained by Easterly & al.

[28] As underlined by Dufrénot & al. (2009), justifications for these sub-periods come from different trade policies. Up until the first half of the 1990s, trade policies concentrated on market-oriented development and led to only short-lived recoveries in Latin America countries and a few take offs in Africa. As a consequence, from the mid-nineties, trade policies were complemented by reforms putting a stronger focus on other macroeconomic and social policies.

(1996), Bleany & Greenaway (2000), and Aguirre & Calderon (2005) seem to be somewhat too high compared to other empirical studies (see Barro & Sala-I-Martin (1996), Ramey & Ramey (1995) and Easterly (2005)) where the speed of convergence is between 2% and 5% corresponding to half-lives of 25 to 40 years. Our results over the last sub-period are consistent with those obtained by Barro & Sala-I-Martin (1996) and Loayza & al. (2005) with a speed of annual convergence of 1.7% and a half-life of 40 years. Estimated output gap coefficients are negative, but non significant, over the whole period and the 1980-1995 sub-period and significant with a positive sign over the 1996-2006 period. Therefore we don't find any cyclical reversion.

The trade openness coefficient is positive and statistically significant for all estimations. Thus, the more countries are outward-oriented the more this contributes favorably to economic growth. The estimated coefficients of the *open* variable vary from 0.001 in 1980-2006 to 0.07 over the period 1996-2006, and these results are in line with those found by Cavallo & al. (1990), Calderon & al. (2004) and Dufrénot & al. (2009), and, more generally with the neoclassical approach according to which the positive impact of trade on growth is explained by comparative advantages, be they in ressource endowment or differences in technology (see Béreau & al., 2009). The terms of trade,[29] which capture both changes in international demand for a country's export and the cost of production (Loayza & al., 2004), are negative and statistically insignificant except on the 1996-2006 sub-period. Toulaboe (2004) and Gala & Lucinda (2006) also reported a negative and statistically insignificant coefficient for the terms of trade. On the other hand, this same variable enters significantly on the third regression but with the opposite sign, just like Cavallo & al. (1990) and Bleany & Greenaway (2000). In the perspective to be oversubtle, we included in our estimation a measurement of the volatility of the terms of trade. The results are conform with those obtained by Bleany & Greenaway (2000) since our variable *voltot* enters significantly and positively over all the periods.

In accordance with the theoretical model of Solow, population growth is negative and significant. The coefficient of the investment (as a percentage of GDP) variable is positive and significant,

[29] There is no consensus about the impact of terms of trade and terms of trade volatility on economic growth. While some studies point the fact that an increase in terms of trade lead to an increase in investment and thus economic performance (Bleany & Greenaway (2001), Blattman & al. (2003)), other, as Eicher & al. (2008) show that an improvement in terms of trade decreases economic growth in the long term. In this sudy, we expect a positive sign of this both variables, reflecting the income effect according which a rise in terms of trade lead to foster accumulation and thus economic growth (Wong (2008)).

reflecting the importance of capital accumulation for developing countries.
Gross secondary school enrollment variable is, following Barro & Sala-I-Martin (1996), Toulaboe (2004), and Gala & Lucinda (2006) significant but with a negative sign, which means that obtaining a secondary diploma seems to adversely impact economic growth. For Barro & Sala-I-Martin (1996), the affected sign of schooling variable depends on the sex (male or female) [30] and of the level of schooling. It is worth noting that Barro (1994) reported a positive coefficient for male secondary schooling, but found the initial level of female secondary education to be negatively correlated with economic growth. Government spending enters positively and non significantly, although, as underlined by Toulaboe (2004), there seems to be a consensus that consistent and increasing government balance in a economy can hinder economic growth.
Regarding now our variable of interest, both the global period and 1980-1995, only the volatility misalignment contracts economic growth, with estimated coefficients of -0.01 and -0.003 respectively. On the other hand, over the period 1996-2006, the volatility misalignment is non significant and positive, but we find a negative and significant relationship between growth and real exchange rate misalignment (as in Cavallo & al. (1990), Dollar (1992), Bleany & Greenaway (2000), Toulaboe (2004), Aguirre & Calderon (2005) and Haussmann & al. (2004)). This result implie that growth would decline in response to increase in the real exchange rate misalignment.
More generally, this result corroborates the view that exchange rate policies continue to play a vital role in the economic growth, and an appropriate exchange rate policy should to focus on the real exchange rate misalignment reduction.

[30] Here we considered a sample including both men and women.

Table 4: GMM Regressions 1980-2006, 1980-1995 and 1996-2006

Dependent variable: per-capita real growth rate			
	(1)	(2)	(3)
	GMM		
Real GDP (-1)	-0.29* (0.107)	-3.16* (0.02)	-0.01* (0.04)
Output gap	-0.15 (0.149)	-0.02 (-0.11)	0.39* (0.121)
Government balance	18.17 (9.406)	14.25 (6.89)	-0.01 (0.26)
Investment share	0.02* (0.040)	0.01* (0.003)	0.01* (0.003)
Misal	0.01 (0.01)	0.03 (0.01)	-0.06* (0.02)
VolMisal	-0.01* (0.004)	-0.003 (0.005)	0.001 (0.003)
Terms of trade	-0.04 (0.75)	-0.08 (0.07)	0.004* (0.03)
VolTot	0.05* (0.014)	0.008* (0.020)	0.004* (0.005)
Open	0.02* (0.010)	0.001* (0.001)	0.007* (0.007)
Population growth	-0.96* (0.864)	-0.97* (0.66)	-1.50* (0.68)
School	-0.01* (0.019)	-0.02* (0.118)	0.01* (0.014)
No. countries	15	15	15
No. observations	345	345	345
R^2	0.24	0.25	0.78
Specification test p-value			
- 2nd Order Correlation	0.41	0.50	0.61

Note:

1. *(resp.**,***): rejection of the null hypothesis at the 10% (resp. 5%, 1%) significance level.
2. Standard deviations are given in parentheses.
3. (1) (resp. (2), (3)): 1980-2006 (resp. 1980-1995, 1996-2006)
4. Instruments used for GMM are lagged values of the endogenous and explanatory variables.

7 Conclusion

This paper investigates the link between real exchange rate misalignments and economic growth for a panel of countries including both emerging and industrial economies. As the real exchange rate misalignment is not observable, equilibrium exchange rates have been estimated relying on the BEER methodology. Misalignment series are then obtained by the deviation of the observed real exchange rate from its equilibrium level. We have then assessed their impact on economic growth using dynamic panel data techniques in order to address both the issue of unobserved country-specific effects and the possibility of endogeneous regressors. Explaining the real effective exchange rate by the net foreign asset position and the Balassa-Samuelson effect, our results show that average misalignments in emerging countries are higher than in advanced ones. Moreover the adjustment towards equilibrium tends to be smoother in industrial economies. Turning to the growth regression analysis, our finding puts forward a negative and significant relationship between growth and real exchange rate misalignments on the recent 1996-2006 period. This result highlights that countries that pursue major and appropriate exchange rate reforms to reduce real exchange rate misalignment are very likely to record gains in real per-capita GDP. In other words, it should be relevant for countries, especially emerging countries, to maintain their real exchange rate at its appropriate level.

There are many directions in which the present analysis can be extended. In particular, it would be interesting (i) to pay a special attention of the asymetric imact of under and overvaluations on economic growth (Béreau & al. (2009), (ii) to take into account the rest of the world in the analysis, and (iii) to rely on higher frequency data and other exchange rate determinants.

A Appendix

Country	Weight
Argentina	0.0106
Australia	0.0144
Brazil	0.0247
Canada	0.0262
China	0.0356
Euro area	0.2343
India	0.0153
Indonesia	0.0058
Japan	0.1808
Korea	0.0161
Mexico	0.0208
South Africa	0.0053
Turkey	0.0093
United Kingdom	0.0541
United States	0.3467
Sum	1

Table 5: Weights (1980-2006)

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