On the long-run determinants of real exchange rates for developing countries : Evidence from Africa, Latin America and Asia

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Abstract

The main goal of this paper is to tackle the empirical issues of the real exchange rate litterature by applying recently developed panel cointegration techniques to a structural long-run real exchange rate equation. We consider here a sample of 45 developing countries, divided into three groups according to geographical criteria: Africa, Latin America and Asia. Our investigations confirm that having a reference to assess the degree of distortion of real exchange rate is not as simple as it can be thought with the PPP concept. The real exchange rate is effectively at the centre of an economic spiral and its value depends on the economic specificities of each country. In other words, we don't have a fixed and general norm but, for each economy, the real exchange rate trajectory depends on its development level, on the way economic policy is conducted, and on its position on the international market.

Keywords : Real exchange rate, Developing country, E31, F0, F31, C15.

JEL Classification : E31, F0, F31, C15.

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1 Introduction

The relationship between real exchange rate and economic development is certainly an important issue, both from the positive (descriptive) and normative (policy prescription) perspectives. In recent years, policy discussions have included increasing references to real exchange rate stability and correct exchange rate alignment as crucial elements to improve economic performance in emergent countries. Real exchange rate misalignment affects economic activity in developing countries mainly due to the dependence on imported capital goods and specialization in commodity exports. Accessibility to world financial markets which helps to smooth consumption by financing trade imbalance, also plays an important role. Evidence from developing countries is often quoted to support the view that the link between real exchange rate misalignment and economic performance is strong. Cottani and al (1990) argued that in many emergent countries, persistently misaligned exchange rate harmed the development of agriculture, reducing domestic food supply. Besides, a number of researchers have also pointed out the importance of understanding the main determinants of real exchange rate.

Edwards (1989) for instance has developed a theoretical model of real exchange rate and has provided an estimation of its equilibrium value for a panel of developing countries using conventional cointegration tests on time series data (cf. Johansen, 1988). According to this estimation, only real variables affect real the exchange rate in the long-run, but in the short-run both real and nominal variables contribute to its variations. More precisely, the most important variables affecting the real exchange rate equilibrium level are the terms of trade, the level and the composition of public spending, capital movements, the control of exchange and the movements of goods, technical progress, and capital accumulation.

Following Edwards's pioneering works, applied studies using Johansen's cointegration tests to estimate equilibrium exchange rates have increased these last past years, both for developed countries (Stein, 1994; Faruqee,1995; Aglietta and al.,1997, MacDonald, 1997), and for developing countries (cf. for example Ghura and Grennes, 1993; Elbadawi and Soto, 1995; Aron and al, 1997). In these studies the main long-run determinants of the real exchange rate are the terms of trade, the openness degree of the economy, capital flows, and the nominal exchange rate.

The aim of this paper is to apply recent advances in the econometrics of non-stationary dynamic panel methods to examine the robustness of the conclusions obtained with conventional time series cointegration techniques, concerning the main long-run determinants of the real exchange rate. We consider a sample of 45 developing countries, divided into three groups according to geographical criteria: *Africa* (21 countries: Algeria, Benin, Burkina Faso, Burundi, Cameroon, Congo, the democratic Republic of Congo, Ivory Coast, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea Bissau, Kenya, Mali, Morocco, Mozambique, Niger, Senegal, Tunisia), *Latin America* (17 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica,the Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Paraguay, Uruguay, Venezuela) and *Asia* (7 countries: Bangladesh, Indonesia, South Korea, India, Malaysia, the Philippines, Thailand). The point is to go beyond the teachings of the Balassa-Samuelson's theory (cf. in particular Drine and Rault, 2003a and Égert, Drine, Lommatzsch and Rault, 2003b for these countries) and to determine if other factors, such as the demand factors, the economic policy or the capital movements, also have an influence on the equilibrium real exchange rate level determination. Our econometric methodology rests upon the panel data integration tests proposed by Im, Pesaran and Shin (1997) and on the panel data cointegration tests recently developed by Pedroni (1997, 1999, 2000). There does not exist to our best knowledge comparable studies using these new econometric techniques to investigate the main macroeconomic variables influencing the real exchange rate in the long run in developing countries.

The remainder of the paper is organized as follows. In the second section we present a simple theoretical model of real exchange rate determination, and carefully analyze the expected theoretical effects of the main real exchange rate determinants on the long-run real exchange rate level. In the third section we expose the panel data unit root tests and panel cointegration methodology that will be used in the empirical application. In the fourth section we report and comment on our econometric results for a panel of 45 developing countries. A final section reviews the main findings. We find in particular, that besides the Balassa-Samuelson effect, other macroeconomic variables, such as the terms of trade, public spending, investment, commercial policy, have a significant influence on the real exchange rate level in the long-run.

2 Real equilibrium exchange rate determinants

Following Edwards (1989), we estimate the equilibrium real exchange rate value using a theoretical model, where the simultaneous equilibrium of the current balance and the tradable good market is realized (see Emre *et al*, 2000). In the model short-run and long-run real exchange rate determinants are different, but only real variables affect the equilibrium value of the real exchange rate. However, in the short run, both nominal and real variables contribute to the real exchange rate variations.

2.1 The model

We consider a small, open economy model with three goods - exportable (X), importable (M) and non-tradable (N). The economy involves consumers. The country produces non-tradable and exportable goods and consumes non-tradable and importable goods.

The country has a floating exchange rate system, with E denoting the nominal exchange rate in all transactions. Let P_X and P_N be the prices of importable and non-tradable goods respectively. The world price of exportable goods is normalized to unity ($P_X^* = 1$), so the domestic price of exportable goods is $P_X = EP_X^* = E$. The world price of importable goods is denoted by P_M^*.

We define e_M and e_X as the domestic relative prices of importable and exportable goods with respect to non-tradable ones, respectively :

$$e_M = \frac{P_M}{P_N} \tag{1}$$

and

$$e_X = \frac{E}{P_N} \tag{2}$$

Then the relative price of importable goods with respect to non-tradable ones is :

$$e_M^* = \frac{EP_M^*}{P_N} \tag{3}$$

The country imposes tariffs on imports so that

$$P_M = EP_M^* + \tau \tag{4}$$

, where τ is the tariff rate.

The total output, Q, in the country is

$$Q = Q_X(e_X) + Q_N(e_X) \tag{5}$$

, where $Q_X^{'} > 0$ and $Q_N^{'} < 0$.

The private consumption, C, is given by

$$C = C_M(e_M) + C_N(e_M) \tag{6}$$

, where C_M and C_N are consumption on importable and non-tradable goods respectively, and $C_M^{'} < 0, C_N^{'} > 0$.

We define the real exchange rate as the relative price of tradable goods to non-tradable ones and denote it by e:

$$e = \alpha e_M + (1-\alpha)e_X = \frac{E(\alpha P_M^* + (1-\alpha)) + \tau}{P_N} \tag{7}$$

with $\alpha \in (0,1)$

Capital is perfectly mobile. The net foreign assets of the country are denoted by A. The country invests its net foreign assets at the international real interest rate r^*. The current account of the country in a given year is the sum of the net interest earnings on the net foreign assets and the trade surplus in foreign currency as the difference between the output of exportable goods and the total consumption of importable goods :

$$CA = r^* A + Q_X(e_X) - P_M^* C_M(e_M) \tag{8}$$

The change in the foreign currency reserves, R, of the country is then given by

$$\dot{R} = CA + KI \tag{9}$$

, where KI is the net capital inflows.

In the short and medium run, there can be departures from $\dot{R} = 0$, so that the country may gain or lose reserves. Current account is sustainable if the current account deficit plus the net capital inflows in the long run sum up to zero so that the official reserves of the country do not change.
We then say that the economy is in external equilibrium if the sum of the current account balance and the capital account balance equal to zero, i.e.

$$r^* A + Q_X(e_X) - P_M^* C_M(e_M) + KI = 0 \tag{10}$$

$$C_N(e_M) + G_N = Q_N(e_X) \tag{11}$$

where G_N denotes public spending in non-tradable goods.

A real exchange rate is then said to be in equilibrium if it leads to external and internal equilibria simultaneously. From (10) and (11) it is possible to express the equilibrium exchange rate, e^*, as a function of P_M^*, τ, r^*, A, KI and G_N, i.e.

$$e^* = e^*(P_M^*, \tau, r^*, A, KI, G_N) \tag{12}$$

The real exchange rate equilibrium level is thus a function of the terms of trade, of commercial policy, of the foreign interest rate, of foreign capital flows, and of public spending. Therefore, in addition to the Balassa-Samuelson effect, there exists other determinants which can have a permanent effect on real exchange rates.

This model can be completed by specification enrichments, which introduce new variables of the real exchange rate level. Among these determinants we find for instance investment rate and technical progress. Baffes and al (1999) present an extension of this model taking the rationing of foreign credits, the domestic price variations of tradable goods and the rigidity of wages and prices into account. As for Edwards, he identifies as determinants of the real exchange rate equilibrium those that depend on economic policy such as the composition of public spending, the limitation of imports, the taxes on exports, the control of exchange and capital movements and the other types of restrictions imposed by the State.

2.2 Analysis of the relation between the real exchange rate and its fundamentals

2.2.1 A terms-of-trade variation

We define terms of trade as the relative price of exports with respect to imports and denoted by

$$TOT = 1/P_M^*$$

Here we assume that the nominal exchange rate E is flexible but the prices of non-tradable goods, PN, is fixed. An improvement in the terms of trade (due to a decrease in P_M^*) leads to an increase in the nominal exchange rate E, and hence the relative prices of exportable goods with respect to non-tradable ones, (e_X). Then, the relative prices of importable goods with respect to non-tradable ones, e_M, must decrease to restore the internal equilibrium. The consumption of non-tradable goods and the output of non-tradable ones both decrease, and the internal sector remains in equilibrium, though at a higher nominal exchange rate. Meanwhile, the output of the exportable goods increases due to depreciation in the value of the domestic currency. The consumption of importable goods increases due to a fall in import prices. Moreover, the private expenditure on importable goods also rises, and hence the external sector remains in equilibrium.

From (7), one can write

$$\frac{\partial e^*}{\partial P_M^*} = \alpha \frac{\partial e_M}{\partial P_M^*} + (1-\alpha)\frac{\partial e_X}{\partial P_M^*}.$$

Since τ is constant. From (10) one can also write

$$\frac{\partial Q_N}{\partial e_X} * \frac{\partial e_X}{\partial P_M^*} = \frac{\partial C_N}{\partial e_M} * \frac{\partial e_M}{\partial P_M^*}$$

So, combining the last two equations we obtain

$$\frac{\partial e^*}{\partial P_M^*} \geq 0 \; si \; \frac{1-\alpha}{\alpha} \geq -\frac{Q_N^{'}}{C_N^{\prime}} = -\frac{\partial e_M}{\partial e_X} \text{ and } \frac{\partial e^*}{\partial P_M^*} < 0 \text{ otherwise.}$$

The impact of the terms of trade on the real exchange rate is theoretically ambiguous (cf. notably Edwards, 1989; Elbadawi and Soto, 1995; as well as Baffes and al, 1999). A terms of trade improvement generates a direct income effect, which leads to an increase of the non-tradable goods demand, and an indirect substitution effect which induces a variation of the offer and demand of the non-tradable goods. Consequently, according to the relative magnitude of these two effects there will be either an appreciation or a depreciation of the real exchange rate.

To illustrate the income effect let us assume an improvement of the terms of trade following for example a price increase of the exported goods and assume that the prices of imported goods remain unchanged. The increase of domestic income which results from it, will lead to an increase of the non-tradable and imported goods demand. As the price of imported goods is constant, the demand increase entails an increase of non-tradable goods price and then a real exchange rate appreciation. A terms of trade deterioration entails, on the other hand, a decrease of income and demand and consequently a real exchange rate depreciation.

A real exchange rate improvement can have an opposite effect on the real exchange rate if the indirect substitution effect is higher than the income effect. For instance, a terms of trade improvement provides currency resources necessary to produce more non-tradable goods. Given the strong dependence of developing countries with respect to imports with intermediate goods, an increase of available resources permits to produce more and then to lower the price of non-tradable goods. Thus, a terms of trade improvement leads to a real exchange rate depreciation and *vice versa*. Elbadawi and Soto (1995) studied 7 developing countries and found that for three of them a terms of trade improvement entails of a real exchange rate appreciation, while for the four others, it led to a depreciation. Feyzioglu (1997) found that a terms of trade improvement entailed a real exchange rate appreciation in Finland.

Consequently, the real exchange rate response to a positive shock on the terms of the trade crucially depends on the relative response of the nominal exchange rate to a variation of the domestic price of imports and thus the sign of the terms of trade coefficient is *a priori* undefined.

2.2.2 A tariff decrease

A decrease in τ decreases the domestic price of importable goods. This leads to an increase in the nominal exchange rate, E, and hence the relative prices of exportable goods with respect to non-tradable ones, e_X. Then, the relative prices of importable goods with respect to non-tradable ones, e_M, must decrease to restore the internal equilibrium. The adjustment in the internal and external sectors is exactly the same as in the case of a terms of trade improvement.

From (7), it follows that :

$$\frac{\partial e^*}{\partial \tau} = \alpha \frac{P_M^*}{P_N} \frac{\partial E}{\partial \tau} + (1-\alpha) \frac{1}{P_N} \frac{\partial E}{\partial \tau} > 0.$$

Faso, Baffes and al (1999) found results in accordance with the theory : the efforts of trade liberalization in several developing countries came along with a real exchange rate depreciation.

2.2.3 An Increase in foreign assets and capital flows

An increases in the interest earnings on the foreign assets of the country (if the country is a net creditor, that is, $A > 0$) and an increase in the net capital flow of the country have the same effect on the equilibrium exchange rate. An exogenous rise in r^*A (assuming $A > 0$) or KI (in absolute value) leads to a short-run improvement in the balance of payment account. Since the net change of the official reserves must be zero in equilibrium, the current account deficit is expected to rise.

So, the equilibrium in the external sector implies a higher trade deficit and this is only possible with a change in the nominal exchange rate and/or non-tradable prices. However, if only one of them adjusts the internal equilibrium cannot be attained, since we assume that the functional forms of Q_N and C_N are such that for each E there exists a unique level of PN.

One can show that starting from an equilibrium situation, the only possible adjustment in PN and E, in response to an increase in foreign assets or net capital flows, can be a simultaneous decrease. Furthermore, the decrease in E must be relatively higher than that in PN so that e_X must decrease, too. On the other hand, e_M rises. Therefore, the output of exportable goods, Q_N increases while consumption and hence the expenditure on importable goods decreases. As a result, trade surplus decreases and the equilibrium in the external sector is restored.

On the other hand, the consumption of non-tradable goods increase at a higher e_M and a lower P_N. This increase is matched with an equal amount of increase in the output of non-tradable goods due to a lower level of e_X. So, the internal equilibrium is also restored.

Defining B as a variation of r^*A or KI, one can write from (7)

$$\frac{\partial e^*}{\partial B} = -\alpha\frac{\partial e_M}{\partial B} + (1-\alpha)\frac{\partial e_X}{\partial B} + \frac{\alpha\tau}{P_N^2}\frac{\partial P_N}{\partial B}$$

From (11) one can also write

$$\frac{\partial Q_N}{\partial B} = \frac{\partial C_N}{\partial B}$$

Combining these two equations and using $\partial P_N/\partial B < 0, \partial e_X/\partial B < 0$ and $\partial e_M/\partial B > 0$, we get that $\partial e^*/\partial B < 0$ if (1-α)/α $> -Q_N^{'}/C_N^{'}$. That is to say, when α is sufficiently low, an increase in the earnings on net foreign assets or an increase in net capital flows leads to an equilibrium real exchange rate appreciation. If, on the other hand, the country is a net debtor a rise in the world real interest will result in a depreciation of the equilibrium real exchange rate.

2.2.4 A public spending variation

Public spending can also have an impact on the real exchange rate as it is extensive in tradable or non-tradable goods. We proceed as Edwards (1989) and we suppose a horizon of two periods. As a simplification we ignore the tax distortion effect. If the State increases its spending in non-tradable goods in the first period by financing these additional spending by loans, the equilibrium real exchange rate will be affected in two ways. During the first period, the demand increase entails a rise in the price of non-tradable goods and hence a real exchange rate appreciation. However, for the second period the State can increase taxes to pay for its debts, which reduces the available income and then demand falls[1]. This fall in demand leads to a decrease of the non-tradable goods price and hence to a real exchange rate depreciation. Thus, it is *a priori* hard to forecast the effect of a public spending variation on the equilibrium real exchange rate. The result will be the same if the State increases its spending in tradable goods.

[1] Effect is null if the Ricardienne equivalance is verified

Edwards (1989) estimated six econometric models of real exchange rate determination for developing countries and found that for four of them, an increase of public spending entailed a real exchange rate appreciation. On the other hand, the two other models revealed that a public spending increase led to a real exchange rate depreciation.

2.2.5 An Increase in domestic investment share

Here again the impact of an investment increase depends on its composition in tradable and non-tradable goods. If the increase of the investment rate entails a rise of the share of the non-tradable goods, there will be real a exchange rate appreciation (Edwards, 1989; Baffes and al, 1999). On the contrary, if the relative share of tradable goods go up, one will get a real exchange rate depreciation.

Baffes and al (1999) found that an increase of the investment rate led to a real exchange rate depreciation in the Ivory Coast. Edwards (1989) obtained the same result for a group of 12 developing countries.

2.2.6 The Impact of technical progress

Ricardo was the first to evoke a negative relation between economic growth (a proxy of technical progress) and the relative price of tradable goods with regard to non-tradable ones. Other authors also noted that the real exchange rate tends to appreciate with time (Balassa, 1964).

Edwards (1989) took technical progress into account in his model and showed that its effect on the real exchange rate both depended on its nature and on its effect in the various sectors of the economy. A positive productivity shock induces an income effect which entails an increase of the demand of non-tradable goods, which leads to a non-tradable price increase and hence a real exchange rate appreciation. However, technical progress can also induce a real exchange rate depreciation if the offer effect which results from it, exceeds the demand effect. Edwards (1989) found that a technical progress increase led to a real exchange rate depreciation. On the other hand, Aron and al (1997) found that an increase of the technical progress level had entailed a real exchange rate appreciation in South Africa.

3 The non-stationary dynamic panel econometric methodology

Before the development of econometric techniques adapted to non-stationary dynamic panels, previous studies on panel data implicitly supposed that the variables used were stationary. This constitutes a serious limitation to their results given the considerable bias existing in this case on the parameter estimates when the non-stationarity properties of data are not taken into account. Due to the recent developments of econometrics, it is henceforth possible to test stationarity on panel data as well as the degree of integration of set of variables. We now present the panel unit root tests and panel cointegration tests that we will used in the empirical application reported in section 4.

3.1 Panel unit root tests

Initial methodological work on non-stationary panels focused on testing unit roots in univariate panels. Quah (1994) derived standard normal asymptotic distributions for testing unit roots in homogeneous panels as both time series and cross sectional dimension grow large. Levin and Lin (1993) derived distributions under more general conditions that allow for heterogeneous fixed effects and time trend. More recently, Im, Pesaran and Shin (1997), studied the small properties of unit root tests in panels with heterogeneous dynamics and proposed alternative tests based on the mean of individual unit-root statistics. In this paper we shall apply Im, Pesaran and Shin (1997) unit-root test (called IPS after) since it is more powerful than those of Quah (1994) and Levin and Lin (1993) used in existing studies.

Levin and Lin's test is considered as more general than those of Quah since it explicitly takes heterogeneity and correlation between units into account.

However as shown by Papell (1997) it suffers from size distortion without being able to correct serial correlation adequately. Using Monte Carlo simulations, he showed that the finite sample critical values are greater than those in Levin and Lin (1993). For quarterly data, the critical values are 11% higher (on average) than those reported by Levin and Lin and for monthly data, they are 3% higher.

The test proposed by Im, Pesaran and Shin (1997) permits to solve Levin and Lin's serial correlation problem in assuming heterogeneity between units in a dynamic panel framework. Furthermore as shown by Im and al via Monte Carlo simulations it has higher power than that of Levin and Lin. IPS (1997) proposed two statistics : a Maximum Likelihood Statistics, called Lbar, and a Student statistic tb. These two statistics are based on individual Augmented Dickey-Fuller (ADF) regressions. Since an appropriate ADF regression will correct the serial correlation in data, the IPF panel unit-root test takes care of serial correlation automatically. In our empirical work of section 4 we shall use the tb statistic instead of the Lbar one since IPS's Monte Carlo experiments have shown that it is the more powerful even for a value of N inferior to 5. This statistic can be expressed as :

$$t_b = \frac{\sqrt{N}(t_{NT} - E(t_T)}{\sqrt{Var(t_T)}}$$

where $t_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}$ is an average of the t individual student statistic in a conventional time series unit-root analysis, Et_T and $V(t_T)$ are respectively the mean and variance of t_{iT} under the null hypothesis that the series are integrated of order one with N$\rightarrow \infty$.

IPS show that under the null hypothesis of non-stationarity, the t_b statistic follows the standard normal distribution asymptotically.

3.2 Panel cointegration tests

In the empirical application we shall apply Pedroni's cointegration test methodology (1995a, 1997 and 1999) to analyze the Balassa-Samuelson hypothesis. Pedroni (1995a) studied the properties of spurious regressions and tests for cointegration in heterogeneous panels and derived appropriate distributions for these cases. These allow us to test for the presence of long run equilibria in multivariate panels while permitting the dynamic and even the long run cointegrating vectors to be heterogeneous across individual members. Like the IPS panel unit-root test, the panel cointegration tests proposed by Pedroni also take heterogeneity into account using specific parameters which of course are allowed to vary across individual members of the sample. Pedroni (1997 and 1999) derived the asymptotic distributions and explored the small sample performances of seven different statistics to test panel data cointegration. Of these seven statistics, four are based on pooling along, which is often referred to as the Within dimension (called "panel" after), and the last three are based on the Between dimension (called "group" after). These different statistics are based on a model that assumes that cointegration relationships are heterogeneous between individual members and are defined as :

For the Within statistics

$$Z_{\rho}^{w} = (\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}\hat{e}_{it-1}^{2})^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}(\hat{e}_{it-1}\Delta\hat{e}_{it} - \widehat{\lambda}_{i}) : \textbf{Panel Rho\_stat}$$

$$Z_{t}^{w} = (\widetilde{s}_{NT}^{*2} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}\hat{e}_{it-1}^{*2})^{-1/2} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}(\hat{e}_{it-1}^{*}\Delta\hat{e}_{it}^{*}) : \textbf{Panel Adf\_stat}$$

$$Z_{pp}^{w} = (\widetilde{\sigma}^{2} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}\hat{e}_{it-1}^{2})^{-1/2} \sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}(\hat{e}_{it-1}\Delta\hat{e}_{it} - \widehat{\lambda}_{i}) : \textbf{Panel PP\_stat}$$

$$Z_{v}^{w} = (\sum_{i=1}^{N}\sum_{t=1}^{T} L_{11i}^{-2}\hat{e}_{it-1}^{2})^{-1} : \textbf{Panel V\_stat}$$

For the Between statistics

$$Z_{\rho}^{B} = \sum_{i=1}^{N}(\sum_{t=1}^{T} \hat{e}_{i,t-1}^{2})^{-1} \sum_{t=1}^{T}(\hat{e}_{it-1}\Delta\hat{e}_{it} - \widehat{\lambda}_{i}) : \textbf{Group Rho\_stat}$$

$$Z_t^B = \sum_{i=1}^{N}(\widehat{\sigma}_i^2 \sum_{t=1}^{T} \hat{e}_{i,t-1}^2)^{-1} \sum_{t=1}^{T}((\hat{e}_{it-1}\Delta\hat{e}_{it} - \widehat{\lambda}_i) : \textbf{Group Adf\_stat}$$

$$Z_{pp}^B = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \widehat{s}^{*2} \hat{e}_{it-1}^{*2} \right)^{-1} \sum_{t=1}^{T}(\hat{e}_{it-1}^{*}\Delta\hat{e}_{it}^{*}) : \textbf{Group PP\_stat}$$

with,

$\widehat{\lambda} = \frac{1}{T}\sum\limits_{s=1}^{k_i}(1 - \frac{s}{k_i+1})\sum\limits_{t=s+1}^{t}\widehat{\mu}_{it}\widehat{\mu}_{it-s}$,

$\widehat{s}_i^2 = \frac{1}{T}\sum\limits_{t=s+1}^{t}\widehat{\mu}_{it}^2$, $\widehat{\sigma}^2 = s_i^2 + 2\widehat{\lambda}_i$,

$\widetilde{\sigma}_i = \widehat{s}_i^2 + 2\widehat{\lambda}_i$,

$\widetilde{\sigma}_{NT}^2 \frac{1}{T}\sum\limits_{i=1}^{N}\widehat{L}_{11i}^{-2}\widehat{\sigma}_i^2$,

$\widehat{s}_i^{*2} = \frac{1}{T}\sum\limits_{t=s+1}^{t}\widehat{\mu}_{it}^{*2}, \widetilde{s}_{NT}^{*2} = \frac{1}{T}\sum\limits_{t=s+1}^{t}\widehat{s}_{it}^{*2}, \widehat{L}_{11i}^2\sum\limits_{t=1}^{T}\widehat{\eta}_{it}^2 + \frac{2}{T}\sum\limits_{s=1}^{k_i}(1 - \frac{s}{k_i+1})\sum\limits_{i=1}^{T}\widehat{\eta}_{it}\widehat{\eta}_{it-s}$

and where the residuals are extracted from the above regressions :

$\widehat{e}_{it} = \widehat{\rho}\widehat{e}_{it-1} + \widehat{u}_{it}$,

$\widehat{e}_{it} = \widehat{\rho}\widehat{e}_{it-1} + \sum\limits_{k=1}^{K_i}\widehat{\gamma}_{ik}\Delta\widehat{e}_{it-k} + \widehat{u}_{it}$,

$\Delta y_{it} = \sum\limits_{m=1}^{M}\widehat{b}_{mi}\Delta X_{mit} + \widehat{\eta}_{it}$,

Note that in the above writings L_i represents the i^{th} component of the Cholesky decomposition of the residual Variance-Covariance matrix , $\widehat{\lambda}$ and $\widetilde{\sigma}_{NT}^2$ are two parameters used to adjust the autocorrelation in the model, σ_i and s_i^2 are the contemporaneous and long-run individual variances.

Pedroni has shown that the asymptotic distribution of these seven statistics can be expressed as :

$$\frac{\chi_{NT} - \mu\sqrt{N}}{\sqrt{v}} \to N(0,1)$$

where χ_{NT} is the statistic under consideration among the seven proposed, N and T are the sample parameter values and μ and ν are parameters tabulated in Pedroni (1999).

In terms of power Pedroni (1997) showed that for values of T larger than 100, all the proposed seven statistics do fairly well and are quite stable. However for smaller samples (T inferior to 20) the Group ADF-Statistic (non-parametric) is the most powerful, followed by the Panel v-Statistic and the Panel rho-Statistic. For this reason, *only the group ADF-statistic will be considered in our study for panel cointegration testing.* The finite sample distribution for the seven statistics were tabulated by Pedroni (1997) via Monte Carlo simulations. The calculated test statistics must be larger (in absolute value) than the tabulated critical value to reject the null hypothesis of absence of cointegration.

4 Empirical investigation of long term real exchange rate determinants

4.1 The econometric relation to be tested and the data set

The theoretical model developed in section 2 defines a long-run relationship between the real exchange rate and macroeconomic variables. The aim of this section is to test this relationship on panel data by taking explicitly the non-stationarity properties of the variables into account, and to identify the long term real exchange rate determinants.

Given the theoretical framework of section 2, the cointegrating relationship to be tested between the real exchange rate and its fundamentals can be written as:

$$\log(\mathrm{ei}_t) = \alpha_{1i} + \beta_{1i} inv_{it} + \beta_{2i} g_{it} + \beta_{3i} ouv_{it} + \beta_{4i} pib_{it} + \beta_{5i} ide_{it} + \beta_{6i} te_{it} + \varepsilon_{it} \tag{13}$$

$i = 1, 2, .., N\ et\ t = 1, 2, ..., T$

with :

e : the real exchange rate,

inv : domestic investment,

g : the share of public spending in the GDP, ouv : trade policy,

pib : GDP per capita,

ide : foreign direct investments flows,

te : the terms of trade.

We consider a sample of 45 developing countries, divided into three groups according to geographical criteria: *Africa* (21 countries: Algeria, Benin, Burkina Faso, Burundi, Cameroon, Congo,the democratic Republic of Congo, Ivory Coast, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea Bissau, Kenya, Mali, Morocco, Mozambique, Niger, Senegal, Tunisia), *Latin America* (17 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Paraguay, Uruguay, Venezuela) and *Asia* (7 countries: Bangladesh, Indonesia, South Korea, India, Malaysia, the Philippines, Thailand).

The sample period is based on data availability and it covers16 years for Africa (from 1980 to 1996), 23 years for Latin America (from 1973 to 1996) and 21 years for Asia (from 1975 to 1996). All the data are annual and are extracted from the world Bank data base for the fundamental and from the French database of the CEPII for the real exchange rate. The real exchange rate is defined with respect to the American dollar and an increase implies an appreciation.

The econometric methodology used is exposed in section 3. Let us indicate that the cointegration coefficients are estimated by the fully modified least square method (Fmols), developed by Pedroni (1996). The advantage of this method with regard to the standard MCO is that it corrects distortions related to the correlation between regressors and residuals and that it is less sensitive to possible bias in small size samples (cf. Pedroni 2000).

Let us underline that the unavailability of data for some macroeconomic variables led us to proceed to some approximations. The first one is related to public spending in non-tradable goods : as we cannot decompose them into tradable and non-tradable goods, we used the global public spending share in

GDP as a proxy.

The second one concerns trade policy. Generally, in literature, the openness degree of the economy is approximated by the share of foreign trade in GDP. This approximation justifies itself by the fact that *ceteris paribus*, a greater tradable liberalization allows to intensify trade and the convergence of prices. In our case we used the share of total imports in total domestic spending. Long-run capital movements are approximated by foreign direct net flows (IDE). This choice justifies itself by the fact that contrary to other financial flows, the IDE are related to output motivations and are therefore more stable.

The per capita income is used as a proxy to measure the wealth effect which is generated by technical progress. One expects the coefficient of the per capita income to be positive, given that an increase of the global demand following the wealth effect ends in an increase of the price of non-tradable goods and hence a real exchange rate appreciation.

4.2 The econometric results and their economic interpretation

The analysis first step is simply to look at the data univariate properties and to determine their integratedness degree. As indicated by the table in the appendix, panel data unit-root tests do not reject the unit-root null hypothesis. Furthermore, tests on the series in first differences confirm the hypothesis of stationarity. In other words, the real exchange rate and its potential determinants expressed in level are all integrated of order 1.

Afterwards, having confirmed the non-stationarity of our series, it is natural to test the existence of a long-run relationship between the real exchange rate and its determinants. Table 1 reports the results of the panel data cointegration tests developed by Pedroni (1997, 1999, 2000)[2].

[2] Let us underline that at the chosen significativity level, a calculated statistic larger than the critical value will lead to reject the null hypothesis of absence of a cointegration relationship between the variables. Let us also indicate that β_j represents the average of the estimated β_{ij} for j varying from 1 to 6 (cf. equation 13).

Table 1 : Equilibrium real exchange rate estimation

	β_1	β_2	β_3	β_4	β_5	β_6	Group-ADF-stat (Z_t^B)
				Africa			
Coeff	0.17	-0.05	-0.16	0.07	0.06	0.56	
t-stat	3.04	-2.92	-2.38	3.62	2.76	8.58	5.91
				Latin America			
Coeff	0.17	0.10	-0.09	0.23	0.02	ns	
t-stat	3.04	2.43	-2.97	3.35	3.21		3.82
				Asia			
Coeff	0.37	-0.13	-0.39	0.39	0.07	0.53	
t-stat	2.11	-3.53	-11.01	10.08	4.58	2.94	12.16

Compared with the (1.65) critical value at the 5 % level, the calculated statistics Z_t^B of Pedroni's cointegration test clearly indicates the existence of a long-run relationship between the real exchange rate and its fundamentals for the three sets of countries. For these three groups the cointegration coefficients of the IDE confirm the theoretical predictions. The estimated coefficient (β_5) is positive, implying that a capital flow increase entails a domestic spending rise and a reallocation of output factors towards the non-tradable goods sector; the long-run demand increase of the non-tradable goods entails a real exchange rate appreciation. Furthermore, the coefficients are very close for the three groups of countries. Indeed, an increase of 1 % of foreign investments flows leads to an average real exchange rate appreciation of 0.05 %.

The per capita GDP contributes to the long-run variations of the real exchange rate for the three groups of countries. Coefficient (β_4) is positive, which implies that economic development is accompanied by a real exchange rate appreciation (Balassa-Samuelson effect). The effect of economic development on the long-run evolution of the real exchange rate is relatively low in Africa. Indeed, an increase of 1 % of per capita GDP entails a real exchange rate appreciation of only 0.07 %. On the other hand, this effect is relatively high in Asia and Latin America because real exchange rate appreciates respectively of 0.39 % and 0.23 % for these countries following an increase of 1 % of the per capita GDP.

The effect of public spending on real exchange rates of (β_2) is different for the three groups of countries. Indeed, estimations indicate that an increase of public spending entails a real exchange rate appreciation in Latin America and a depreciation in Asia and Africa. According to the theoretical predictions the coefficient must be positive given that the increase of the global demand of the non-tradable goods entails an increase of their price. The negative coefficient in Asia and Africa can reflect a strong eviction effect which induces a fall in private non-tradable goods demand. If public spending is extensive in tradable goods, an expansionist budget policy entails a tax increase or/ and an interest rate rise, which reduces the private demand of non-tradable goods. The fall in demand then entails a price decrease and hence a real exchange rate depreciation (cf. Edwards, 1989). The effect of public spending on the real exchange rate in Latin America and in Asia is comparable and relatively higher than in Africa.

Empirical results confirm that an improvement of the terms of trade entails a real exchange rate appreciation in Africa and in Asia, which means that the wealth effect dominates the income effect. Furthermore, the elasticity of the real exchange rate with respect to the terms of trade is compatible with previous studies. The difference between the economic structures of the two groups of countries partially explains the difference of response of real exchange rates to a shock on the terms of trade (an improvement of 10 % of the terms of trade entails an appreciation of 5.3 % in Africa and 5.6 % in Asia). The absence of the effect of the terms of trade on the real exchange rate in Latin America confirms that the wealth effect compensates for the substitution effect.

Negative coefficients (β_3) for the three groups of countries suggest that trade liberalization is accompanied with a real exchange rate depreciation. The elasticity is different for the three groups of countries: it is of -0.16 in Africa, of -0.39 in Asia and of -0.09 in Latin America. Nevertheless, this elasticity remains relatively low for these countries in comparison to the previous results of literature (Elbadawi and Soto, 1995; Baffes and al, 1999). A possible explanation is that the estimated coefficients are averages of individual coefficients.

Finally, an increase of 10 % on the share of domestic investments entails an average depreciation of 1.7 % in Africa and in Latin America and of 3.7 % in Asia. This result is compatible with that of Edwards (1989) which also found a low elasticity (of 7 %) for a group of 12 developing countries. Indeed, an increase of investments often leads to an increase of non-tradable goods spending and hence to a decrease of the relative price of non-tradable goods.

Finally, let us notice that in Africa and in Asia external factors (openness degree and terms of trade) contribute most to the long-run dynamics of the real exchange rate; internal demand also plays an important role in Asia. In Latin America on the other hand, external factors seem to have a relatively limited effect on equilibrium real exchange rate, the economic development (GDP per capita) having on the contrary an important role.

5 Conclusion

The aim of this paper was to identify the determinants of the equilibrium real exchange rate, others than the Balassa-Samuelson effect. On the basis of theoretical approaches generally used in literature, we have exposed a simple theoretical model which describes the interaction between some macroeconomic variables and the equilibrium real exchange rate level. Then, this model has been estimated by recent non-stationary dynamic panel techniques. We have in particular used the panel data integration tests recently proposed by Im, Pesaran and Shin (1997) as well as the panel data co-integration tests developed by Pedroni (1997, 1999, 2000), which has enabled us to put in evidence the existence of several sources of impulsions influencing the real exchange rate in the long-term.

Our investigations show that an improvement of the terms of trade, an increase of per capita GDP and of capital flows entail a long-run appreciation of the real exchange rate. On the other hand, an increase of the domestic investment and of the openness degree of the economy entails a real exchange rate depreciation; the effect of public spending increase being ambiguous.

Our investigations confirm that having a reference to assess the degree of distortion of the real exchange rate is not as simple as it can be thought with the PPP concept. The real exchange rate is effectively at the centre of an economic spiral and its value depends on the economic specificities of each country. In other words, we don't have a fixed and general norm but, for each economy, the real exchange rate trajectory depends on its development level, on the way economic policy is conducted, and on its position on the international market. Besides,the variations of the real exchange rate do not necessarily reflect a disequilibrium. Indeed, equilibrium adjustments related to fundamental variations can also generate real exchange rate movements.

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Appendix :
Panel unit-root test results (Im, Pesaran and Shin, 1997) for Africa, Latin America and Asia

1) Africa

Real exchange rate				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-1.34[1]	1.7[2]	-2.30	2.38
GDP per capita				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.09	1,70	-2.30	2.38
Terms of trade				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.66	0.17	-7.77	-5.72
Openness degree				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.55	0.063	-2.33	-7.77
Public spending				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.79	-1.79	-3.45	-4.05
Foreign direct investments				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.19	-1.62	-2.63	-4.35
Domestic investments				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.23	-1.14	-3.89	-3.23

2) Latin America

Real exchange rate				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.23	1.43	-3.32	4.32
GDP per capita				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend

[1] The critical value is of -1.65.
[2] The critical value is of -1.65.

	-0.12	1,43	-2.21	2.54
Terms of trade				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.32	0.43	-5.45	-5.21
Openness degree				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.43	0.98	-3.23	-6.47
Public spending				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-1.32	-1.12	-2.31	-3.21
Foreign direct investments				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.12	-1.43	-2.12	-5.22
Domestic investments				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.41	-1.21	-3.32	-4.23

3) Asia

Real exchange rate				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.32	1.67	-2.54	2.12
GDP per capita				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.19	1,45	2.31	3.45
Terms of trade				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.36	0.32	-5.47	-6.32
Openness degree				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.12	0.43	-2.54	-3.34
Public spending				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-0.86	-1.68	-3.32	-4.65
Foreign direct investments				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend

	-0.21	-1.42	-2.55	-3.21
Domestic investments				
	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
	-1.32	-1.35	-3.21	-4.67