Does the choice of an exchange rate regime limits exchange rate misalignments? The example of sub-Saharan African countries

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Does the choice of an exchange rate regime limits exchange rate misalignments? The example of sub-Saharan African countries

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Abstract: This article examines the incidence of exchange rate regime on the real exchange rate misalignments in Sub-Saharan African countries. To this end, we compare misalignments of 17 countries classified into two groups according to the exchange rate regime. For the equilibrium real exchange rate determination, we rely on a NATREX-based approach which we compare to the behavioral model (BEER), to prove results consistency. Relying on annual data between 1980 and 2011, our estimates made simultaneously by the Pooled Mean Group method (PMG), the Dynamic OLS (DOLS) and the Fully Modified OLS (FMOLS) show that misalignments do not differ in average from one group to another. Put another way, no exchange rate regime is going to bail an economy out of deviations of its exchange rate.

Keywords: Real Exchange Rate, Misalignments, Exchange Rate Regime
JEL Classification: C23 ; F31 ; F43 ; O24

Mésalignements du taux de change réel: le choix d'un régime de change permet-il de limiter les mésalignements du taux de change ? L'exemple des pays d'Afrique subsaharienne

Résumé : Cet article traite de l'incidence du régime de change sur les mésalignements du taux de change réel. À cet effet, nous comparons les mésalignements de 17 pays d'Afrique Subsaharienne répartis en fonction de leur régime de change. Nous utilisons deux approches pour déterminer le taux de change d'équilibre : une approche de type NATREX et une approche de type BEER afin de s'assurer de la robustesse des résultats. Les estimations effectuées par les méthodes du groupe médian (PMG), des MCO dynamiques et modifiés (DOLS et FMOLS), sur des données annuelles allant de 1980 à 2011, montrent que les mésalignements observés d'un groupe de pays à l'autre ne présentent aucune différence significative en moyenne. Autrement dit, aucun régime de change (fixe ou flexible) ne protège mieux les pays de l'Afrique subsaharienne des déviations soutenues de son taux de change.

Mots clés : Taux de change réel, Mésalignements, Régime de change
Codes JEL : C23 ; F31 ; F43 ; O24

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Non-Technical Summary

This article analyses the impact of the exchange rate regime in the formation of real exchange rate imbalances in relation to an equilibrium level. More explicitly, the objective is to answer the question whether the current exchange rate regime is a limiting factor of these imbalances, also called "misalignments", in the particular case of sub-Saharan African countries. Our interest in the countries of this region is explained by the need to compare the performances which can be credited to each exchange regime used within the region, with the ultimate aim of providing elements of analysis to the debate on the future of the member countries of the Franc Zone. Those countries have been concerned and worried about the appreciation of the euro against the dollar, whose expected impact would have harmed their economies in terms of price competitiveness, thus leading some to consider the solution of exit from the monetary union.

Under these conditions, we propose a simple approach which consists in evaluating and comparing the misalignments of 17 countries in sub-Saharan Africa according to their exchange rate regime, within the limits imposed by the availability of data. It appears that the misalignments do not depend on the exchange rate regime, and losses or gains of competitiveness induced depend more on the intrinsic and structural characteristics of the countries concerned. From this point of view, the solution of exit from the monetary union would be inappropriate and would not resolve the structural problems faced by these economies. The main recommendation from such work is to call on the authorities of sub-Saharan African countries on the need to emphasize on quality competitiveness (structural). If the misalignments do not significantly affect the developed countries as Dubas (2009) points out, it is probably because the latter use quality-based competitiveness more in their commercial strategies. Indeed, this is a long-term competitiveness that materializes the ability of an economy to be competing at the international level by other means than the price. It is therefore a matter of making a structural transformation of the economies by focusing on the diversification of productive structures, but above all on the quality of products, with particular emphasis on the image and reputation conveyed on markets.

Introduction

The exchange rate is a key variable in an economy whose instability can be detrimental to the activity by affecting the investment decisions of the economic agents given the resulting uncertainty. As such, the end of the "Bretton Woods" International Monetary System in 1971 and the advent of financial globalization resulted in renewed interest in studies on the choice of an appropriate exchange rate regime. Although the Bretton Woods system was designed to provide some degree of stability in the exchange rate, because of its failure, many countries decided to migrate to more flexible regimes. However, in practice, very few countries have a purely flexible exchange rate regime, and even in developed countries that are more supportive of the effects of floating, central banks sometimes are forced to intervene to limit exchange rate fluctuations. However, in both forms of regime (fixed and flexible), countries are exposed to misalignments of their exchange rates.

The exchange rate misalignments are reflected in the continuous deviations of the observed real exchange rate from its long-run equilibrium value (Edwards 1989), and are likely to revise the resource allocation, disrupt pricing as well as investment decisions and thereby jeopardize long-term growth. They determine exchange rate effectiveness as an adjustment variable because they refer to the knowledge of the equilibrium level of the exchange rate, that is, the one that ensures simultaneous realization in the medium and long term of the internal and external equilibrium of the economy (Thibault et al., 1998).

The determination of the misalignments requires the identification of the equilibrium exchange rate and the calculation of that "equilibrium" level of the exchange rate is hardly unanimous and remains a major concern within the international macroeconomics. Razin and Collins (1997) describe it as an "ideal exchange rate". An overvaluation would therefore be a situation where the real effective exchange rate is above the ideal level, while undervaluation would be exactly the reverse. There is indeed a debate about the determinants of the equilibrium exchange rate and more so with regard to the appropriate approach to determining its level, particularly with regard to the proposed approaches in the literature (Williamson, 1983, Razin and Collins, 1997, Clark and McDonald, 1998, Stein and Allen, 1998).

Regardless of the approach adopted, it remains important to identify the level of exchange rate equilibrium in order to assess its imbalances or misalignments. Moreover, although the issue of the idiosyncratic nature of misalignments under the current exchange rate regime has recently been of concern for economists (Coudert and Couharde, 2009; Dubas, 2009), it has not been sufficiently developed to reach results that are useful for economic policy. This issue is crucial for

developing countries, particularly those in the Franc Zone, whose currency is set at a fixed parity to the euro and which are extremely vulnerable to exogenous shocks with low economic performance compared to emerging countries.

Exchange rate misalignments are generally costly in terms of growth and especially external equilibrium. When they are positive (overvalued exchange rate), they jeopardize exports, reduce foreign exchange reserves and aggravate the current account deficit. The situation may be worsened if the country concerned chose a rigid nominal anchor. This situation was observed during the Asian crisis in 1997 in Malaysia, Philippines, Indonesia and South Korea. It was also observed in Argentina in 2001 and recently with the financial crisis in 2008 in Europe and United States[3]. On the other hand, when they are negative (undervalued exchange rate), they can be a source of inflationary pressure by making imports expensive and exports profitable. It can result an improvement of the current account.

If the misalignments therefore concern both developed and developing countries, regardless of their exchange rate regimes, the question is whether the choice of a foreign exchange regime makes it possible to limit the misalignments of exchange rate.

The aim of this article is therefore to determine and compare real exchange rate misalignments for sub-Saharan African countries according to the exchange rate regime adopted. The interest of such a study is to provide additional arguments for the debate on the choice of a fixed exchange rate regime for the African countries of the Franc Zone.

In this perspective, our approach is based on a dual theoretical approach to the determination of the equilibrium exchange rate. First, we propose a NATREX (Natural Real Exchange Rate) equation adapted to developing economies and, secondly, a Behavioral Equilibrium Exchange Rate (BEER) equation, which makes it possible to prove the robustness of results. Then, econometrically we apply both the Pooled Mean Group methods, the dynamic OLS (DOLS)[4] and modified OLS (FMOLS)[5] methods, to estimate the equilibrium exchange rate while testing the robustness of the results.

The rest of the article is organized into three sections. After the literature on misalignments and the conduct of exchange rate policy in a first section, the second section presents the methodology for determining misalignments. Section 3 focuses on estimation methods and the comparison of results according to the exchange rate regime.

[3] For more details, see Bénassy-Quéré et al (2009) : « Taux de change de l'euro : perspectives à moyen et long termes » dans : L'économie mondiale 2009.

[4] Dynamic Ordinary Least Squares.

[5] Fully Modified Ordinary Least Squares.

1. Misalignments and exchange rate regime: literature review

Few studies have addressed the influence of exchange rate choice on exchange rate misalignments, however, the pioneer analysis can be attributed to the work of Baxter and Stochman (1989). The issue of the determinants of the choice of an exchange rate regime will not be addressed here.

Studies that analyze the effects of misalignments include comparisons of effects related to the exchange rate regime chosen. The first drafts of this analysis are those of Baxter and Stochman (1989) who show, through a sample of 49 countries, that the exchange rate regime significantly influences the behaviour of the main macroeconomic variables and international trade. However, their analysis does not allow to take a position on the efficiency of fixed or flexible regimes in misalignments situation.

In connection with the crises[6] related to the fixed exchange rate regimes, studies have been conducted to show that the fixed regimes are generally favorable to overvalued exchange rates, thus resulting in appreciations of the real exchange rate detrimental to the external competitiveness and the current account. They thus appear to be vulnerable to crises. Valdes (1996), Kasminsky et al. (1998), Burkart and Coudert (2000), Bussière and Fratzscher (2006) are among the contributors to this analysis. However, these studies do not explain why migration to flexible regimes does not necessarily resolve crises or problems of misalignment of the exchange rate, especially for developing countries.

Coudert and Couharde (2008) try to correct this limitation by analyzing the misalignments in 128 emerging and developing countries according to their respective exchange rate regimes. According to these authors, emerging or developing countries that have opted for a fixed exchange rate regime are characterized on average by an overvaluation of their real exchange rate. Given that overvaluation is harmful to growth, it is tempting to believe that fixed exchange rate regimes represent a real brake on activity, even though States that opted for a flexible regime sometimes seek a dose of fixity to avoid a very large volatility of their exchange rates. In this regard, Hausmann et al. (1999), Calvo and Reinart (2002, 2003) estimate that floating regimes do not always protect against shocks but can even amplify them, increasing the occurrence of misalignments.

Unlike previous studies, some work show that, regardless of the exchange rate regime chosen, developed countries are more resilient to exchange rate misalignments than developing countries. Dubas (2009) thus shows that, under certain conditions, the exchange rate regime is of little

[6] Mexico (1994-1995), South East Asia (1997), Russia (1998), Brazil (1999), Turkey (2001), Argentina (2002).

importance in the face of the effects of misalignments. With a sample of 102 developed and developing countries, he concludes that the effects of the misalignments would be asymmetric between developed and developing countries. In his opinion, overvaluations can seriously hamper the growth of developing countries, especially when they are persistent, irrespective of the exchange rate regime adopted, which is not necessarily the case for developed countries.

This is not surprising because many developed countries build their competitiveness on quality rather than on price. Indeed, in most developed countries, commodities subject to international exchange (tradable goods) are generally very capital intensive. Because of this, they are demanded much more for their quality and not necessarily for their price. The reverse is true for developing countries, which generally have productive structures that are essentially commodity-based and highly price-dependent. This analysis was confirmed by Sallenave[7] (2009) which states that the effects of misalignments on growth may be different depending on whether the country is developed or emerging. According to this author, the misalignments would have a smaller amplitude in the advanced countries with a lower convergence towards the equilibrium exchange rate.

In most studies, there is a consensus that exchange rate misalignments can have both positive and negative effects depending on their magnitude. Considering an open economy, studies have shown that an overvaluation of the exchange rate results in a loss of price competitiveness for firms exporting goods, causing a fall in growth and an external deficit (Dornbush, 1988; Ghura and Greenes 1993, Razin and Collins 1997, Easterly, 2005) and that, on the other hand, moderate undervaluation may be accompanied by rapid growth in economic activity (Razin and Collins 1997; Rodrik , 2008) due to an increase in exports and a surplus in the trade balance, sometimes accompanied by inflationary pressures. Other studies have established a nonlinear relationship between misalignments and growth, but show that only very high overestimations would negatively affect growth (Razin and Collins, 1997).

2. The methodology for determining misalignments

The assessment of the equilibrium exchange rates is a prerequisite for the determination of misalignments. It is therefore important to pay particular attention to the equilibrium exchange rate approach, especially since its ideal character makes it a difficult concept to grasp. Although the concept of an equilibrium exchange rate dates back to Nurkse (1944), it was popularized by Williamson (1985) and there are generally three approaches to its determination: a

[7] The equilibrium exchange rate is estimated using the BEER approach.

macroeconomic approach with FEER[8] and DEER[9], an econometric approach with BEER[10], and a dynamic approach with NATREX[11].

The results of the equilibrium exchange rate often differ according to the methods used. That is why we adopt a dual approach: first, we propose a NATREX equation developed by combining the Lim and Stein presentations (1995), and that of Bouoiyour et al. (2004), in order to better justify the use of the real effective exchange rate as a substitute for the internal real exchange rate in the estimates. By way of comparison, we then apply the behavioural equilibrium exchange rate (BEER) approach of Clark and MacDonald (1998), since it more suitable for the empirical assessment of the exchange rate balance.

2.1. The « Modified » NATREX

The "natural real exchange rate" introduced by Stein and Allen (1998) corresponds to the exchange rate that is compatible with the equilibrium of the balance of payments in the absence of cyclical and speculative factors, the unemployment rate being at its NAIRU (Non Accelerating Inflation Rate of Unemployment)[12] level. In other words, it guarantees the simultaneous long-term realization of the internal and external balances of the economy[13]. It is therefore a first-order reference for determining the misalignments of the exchange rate because of its dynamic characteristic.

Indeed, in its classical form, it suggests that it is possible to decompose the exchange rate trajectory along three horizons: the short, the medium and the long term. All the conditions for achieving macroeconomic equilibrium, as well as the dynamics of transition between different horizons are expressed by a set of equations with a solid microeconomic foundation. However, this presentation has been amended to take account of small open economies where the distinction between tradable and non-tradable goods is valid (Lim and Stein, 1995). The starting point of this variant is the idea that in the long term any excess investment relative to national savings must be financed by external debt, so that the real market equilibrium coincides with the external balance of the economy, through the real exchange rate fluctuations.

Formally, let assume the following fundamental market equation:

$$I - S + CA = 0 \qquad (1)$$

[8] Williamson (1985).
[9] Artis and Taylor (1993).
[10] MacDonald (1998).
[11] Stein (1997).
[12] This is in fact a natural or structural unemployment rate compatible with stable inflation
[13] The first equilibrium corresponds to a situation of non-inflationary growth, while the second refers to the sustainability of the current account.

where I is investment; S is saving; and CA represents the current account. If we assume the equilibrium of the system at the initial period (S-I = CA), then any external shock that creates a negative difference between saving and domestic investment, in turn, leads to capital inflows. These in turn lead to real appreciation of the exchange rate as well as the deterioration of the current account until the return to the initial equilibrium situation. The real exchange rate is thus the variable that achieves the long-run equilibrium adjustment[14].

Specifically, it is the "Internal" real exchange rate [15] (e) defined as the relative price of non-tradable goods (P_N) relative to the price of tradable goods (P_T).It is defined by the following relation (2):

$$e = \frac{P_N}{P_T} \tag{2}$$

An increase in (e) reflects real appreciation and vice versa. Indeed, any decline in the production of tradable goods generates, at the domestic level, an excess of the demand for these goods, resulting in an increase in their prices and hence the increase in the exchange rate. The description of the internal and external balances, respectively, through the market equilibrium of non-tradable goods and the approach to long-term stock equilibrium[16], leads to the following formulation of the real internal equilibrium exchange rate (e^*) :

$$e^* = h(\overset{+}{g_N}, \overset{-}{g_T}, [z + \overset{-}{r}.f], \overset{+}{\rho}) \tag{3}$$

avec g_N et g_T government expenditures on non-tradable and tradable goods, respectively; z is the total net amount of aid received by the government, r is the real rate of return on foreign assets expressed in terms of tradable goods, f is the stock of foreign net assets, and ρ is a productivity indicator. The equation (3) is an expression of the long-run equilibrium exchange rate[17] which does not include major fundamentals such as terms of trade or trade policy. Following Baffes et al. (1999), it can be modified to incorporate these fundamentals. We have the following equation:

$$e^* = f(\overset{+}{g_N}, \overset{-}{g_T}, [z + \overset{-}{r}.f], \overset{+}{\rho}, \overset{-}{\eta}, \overset{?}{\tau}) \tag{4}$$

[14] The real interest rate cannot act as an adjustment variable because of the assumption of perfect long-term capital mobility which makes it an exogenous variable.

[15] See for instance Hinkle and Montiel, 1999.

[16] The interested reader may refer to Baffes et al. (1999) or Khan and Lizondo (1987).

[17] The signs above each variable are those of the respective partial derivatives.

where η and τ represent trade policy measures and external terms of trade[18] respectively. Equation (4) means that increases in public spending on non-tradable goods, productivity, and trade restrictive measures lead to an increase in e (real appreciation). In fact, the increase in public spending on non-tradable goods and trade restrictive measures lead to an increase in the demand for these goods and an increase in their prices; whereas a productivity shock causes a reduction in the supply of non-tradable goods and finally, a rise in their price. On the other hand, an improvement in the trade balance and an increase in public spending on tradable goods result in a real depreciation. As for the effect of external terms of trade, this is not known a priori. On the one hand, the increase in the terms of trade may result in an increase in national income in terms of imported goods and an expenditure effect, with an increase in demand for all goods and an increase in real exchange rate. On the other hand, the effect of expenditure can be supplanted by a substitution effect in favour of exported goods, with the consequence of the real depreciation.

From a practical point of view, some authors estimate Equation 4 by substituting the Real Effective Exchange Rate (REER) with the Internal Real Exchange Rate (RTAC) to offset the constraint of data unavailability. Such a process is likely to bias the results obtained, as there is no clear justification for the equality between the REER and the fundamentals of the internal TCR. However, the expression of the REER may be decomposed so as to revert to a formulation similar to that of equation 4. Formally, let TCR_t^j the bilateral real exchange rate between a country and its partner j, TCR_0^j the same rate in the reference period and θ_j the share of the partner j in the total trade of the country concerned. The REER is given by the relation (5) :

$$TCER = \prod_{j=1}^{N} \left[\frac{TCR_t^j}{TCR_0^j} \right]^{\theta_j} \qquad (5)$$

with $TCR^j = \frac{S^j.P}{P^j}$; S^j, P and P^j representing respectively the nominal exchange rate quoted through indirect quotation, the prices of domestic goods and that of foreign goods. Knowing that P and P^j can be expressed in terms of tradable and non-tradable goods[19] and if we assume that $P_T \equiv P_X$ and $P_T^j \equiv P_M^j$, one can express the TCR as follows:

[18] The interested reader may refer to Baffes et al. (1999) p. 412, for details on the introduction of the variable "external terms of trade".

[19] Respectively PT and PN. The interested reader can consult Bouoiyour et al. (2004) for more details.

$$TCR^{j} = \frac{S^{j}.P_X}{P_M{}^{j}} . \frac{\left(P_T / P_N\right)^{(\alpha-1)}}{\left(P_M{}^{j} / P_N{}^{j}\right)^{(\beta-1)}} \quad (6)$$

where $P_M{}^{j}$ is the import price of the country in question from partner j ; α and β represent the share of the price of tradable goods in the domestic and foreign price respectively. The relative price of foreign non-tradable goods is $c = P_M^j / P_N^j$ and it is assumed that the latter is equal to 1, following Lim and Stein (1995). By introducing this relation in Equation 5, a new expression of the REER is obtained:

$$TCER = P_X . \left(P_T / P_N\right)^{(\alpha-1)} \prod_{j=1}^{N} \left[\frac{S^{j}}{P_M{}^{j}} \right]^{\theta_j} = \frac{TCEN.P_X}{\left(P_M\right)_{eff}} . e^{(\alpha-1)} \quad (7)$$

where $TCEN$ is the nominal effective exchange rate, $TCEN.P_X$ is a synthetic index of the unit price of the country's exports, and $\left(P_M\right)_{eff}$ a synthetic index of the unit price of imports from that country.

Finally, we obtain the following relation of the REER against an indicator of the relative price of non-tradable goods:

$$TCER \equiv TOT . e^{(\alpha-1)} \quad (8)$$

with TOT the terms of trade. From this equation, we proceed to the determination of the long-term NATREX in two steps. We first estimate an indicator of the relative price of non-tradable equilibrium goods $e^{(\alpha-1)*}$ as a function of the fundamentals identified by Equation (4), in particular, setting: $ln\, e^{(\alpha-1)} = ln\, TCER - ln\, TOT$.

Then we determine the long-term NATREX using the following relation:

$$ln\, \overline{e^{(\alpha-1)}} = ln\, TCER - ln\, \overline{TOT} \quad (9)$$

Where $\overline{TOT}$ represents the equilibrium terms of trade.

While the complexity of this relationship makes it possible to better explain theoretically the relationship between the exchange rate and its long-term fundamentals, it is likely to weaken the results because of the difficulties in its application. It is for this reason that we complement it

with a BEER approach, which is commonly used because it is based on a simpler theoretical framework that is more easily assessed empirically.

2.2. The behavioral approach of the equilibrium exchange rate (BEER)

The concept of Behavioral Equilibrium Exchange Rate (BEER) is part of the so-called "underlying macroeconomic equilibrium" models. Clark and MacDonald (1998).

Unlike other models in the same class (FEER [20] and the NATREX[21] for example), it focuses on accounting for exchange rate movements empirically.

The starting point of the analysis is the condition of financial equilibrium defined by the uncovered parity of interest rates. This has often been used as a basis for modeling the equilibrium exchange rate. Formally, considering a horizon of maturity of securities « $t+k$ » and under the assumption of risk neutrality, the model is declined in the following way:

$$E_t\left(\Delta s_{t+k}\right) = -\left(i_t - i_t^*\right) \tag{10}$$

with s_t the logarithm of the nominal exchange rate under indirect quotation; it is the nominal domestic interest rate; i_t^* the foreign nominal interest rate; Δ the difference operator and E_t the mathematical expectation. The integration of the expected inflation differential $E_t(\Delta p_{(t+k)} - \Delta p_{(t+k)}^*)$ leads to a relationship between real variables. The equation (11) of the ex-ante real exchange rate is then derived:

$$q_t = E_t(q_{(t+k)}) + (r_t - r_t^*) \tag{11}$$

with $r_t = i_t - E_t\left(\Delta P_{t+k}\right)$ the ex-ante real interest rate; $q_t = s_t + p_t - p_t^*$ the ex-ante real exchange rate. Equation (11) means that the current real exchange rate q_t is determined by the expected exchange rate of the period $t+k$ ($E_t(q_{(t+k)})$), and the interest rate differential $(r_t - r_t^*)$. However, $E_t(q_{(t+k)})$ is interpreted as the long-run component of the real exchange rate, resulting from the influence of past values of medium and long-term fundamentals. By assuming $\bar{q}_t = E_t\left(q_{t+k}\right)$, equation (11) becomes:

$$q_t = \bar{q}_t + \left(r_t - r_t^*\right) \tag{12}.$$

[20] *Fundamental Equilibrium Exchange Rate*.
[21] *Natural Real Exchange Rate*.

Finally, under this approach, the current exchange rate includes a systematic component ($\bar{q}_t$) plus the differential of the real interest rate. It is important to note that the factors likely to influence the exchange rate in the long term are discussed extensively in the literature. Most authors take into account the intrinsic characteristics of the entities they are studying, in order to identify the fundamentals of the exchange rate. In this study, we assume equality of real interest rates in the medium term, so that the medium- and long-term equilibrium exchange rate is determined solely by the fundamentals of the equation (13):

$$\bar{q}_{it} = \alpha.Open + \beta.Nfa_{it} + \delta.Prod_{it} + \gamma.Gov_{it} + \omega.Tot_{it} + \theta.Reg1 + \rho.Reg2 \quad (13).$$

In this equation, Open is the rate of openness of the economy, which reflects the influence of the country's trade policy. Its increase leads to a moderation in the rise of domestic prices, which tends to depreciate the currency (Goldfajn and Valdes, 1999). The variable Nfa is the net external position, defined by the determinants of domestic saving and investment. It is assumed that there is a positive relationship between this variable and the REER. The relative productivity of the country (*Prod*) captures the Balassa-Samuelson effect. This consists of a real appreciation following an increase in productivity in the exposed sector, compared to the rest of the world. There is a positive relationship between this variable and the TCR (Béreau et al., 2010). *Gov*, represents government consumption expenditure. Most public spending is considered to be for the purchase of non-tradable goods, so that an increase in public consumption leads to an increase in the demand for these goods, leading to an increase in their prices and a real appreciation (Chinn, 1999). For the variable *Tot* which represents the terms of trade, defined as the ratio of export prices to import prices, it is difficult to determine their a priori effect on the TCR. Moreover, we introduce two indicator variables *Reg1* and *Reg2*, to capture the heterogeneity of the panel linked to the belonging or not to a fixed exchange rate regime. Thus, *Reg1* = 1 if the country is under a fixed exchange rate regime and *Reg1* = 0 otherwise (inversely for *Reg2*). Due to the controversy over the effect of the exchange rate regime on real exchange rate volatility (Obstfeld and Rogoff, 1995), we do not expect any particular signs about these variables.

The methodology for the determination of the misalignments which has just been presented allow carrying out estimates of the equilibrium exchange rate and the misalignments. The results compared by exchange rate regime are presented in the next section.

3. Estimates and results compared by exchange rate regimes

In this section, we present the estimation methods used and the misalignments obtained, which we compare according to the exchange rate regime of the different countries.

3.1. The estimation methods

The above theoretical analysis shows that the calculation of misalignments depends upon the identification of a long-term relationship between the REER and its fundamentals. To this end, we mainly use the Pooled Mean Group (PMG)[22] to determine the equilibrium exchange rate. In order to check the robustness of the results, we also use two alternative methods, notably DOLS and modified (FMOLS).

- The Pooled Mean Group (PMG)

The choice of the main method of estimation is motivated by the advantages it offers from a practical point of view. Indeed, the *Pooled Mean Group* estimator allows an efficient processing of the dynamic panels for which it is assumed that the number of temporal observations T is as large as that of the individuals N[23] (Pesaran, Shin et Smith, 1999). Its major asset is the possibility that it offers to estimate a long-term relationship between different variables without prior precautions about the stationarity or even the existence of a cointegration relation between them. To do so, the estimator is designed on the assumption that the model constant, as well as short-run coefficients and error variances, may differ depending on the individual, although the long-run coefficients are constrained to be identical[24].

Formally, we consider the following model $ARDL(p,q,q,....,q)$ [25]:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}' X_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (14)$$
$$i = 1, 2...., N; t = 1, 2, ..., T$$

where X_{it} is a matrix of explanatory variables of format (kx1); μ represents the individual fixed effects; the λ_{ij} are coefficients assigned to the lagged individual dependent variables ($y_{i,t-j}$), and

[22] The interested reader may refer to (Pesaran, Shin and Smith, 1999).

[23] It should be recalled that there are a large number of dynamic panel estimators. However, these must be grouped according to three specific cases. The first is that of panels composed of a small number of individuals N for a large number of periods T. In this case, an ARDL or SUR can be used as a basis for the estimates. The second case is that of a large N and a low T. Conventional estimator can thus be used (dynamic fixed effects, GMM etc.). The last case concerns panels consisting of both a large N and a large T.

[24] Notably due to the absence of trade-off or the long-term technological catch-up

[25] *Auto Regressive Distributed Lags* .

$\delta_{ij}^{'}$ is a scalar matrix of size $(1\times k)$. Equation (14) can be reformulated in order to obtain an error correction representation which proves to be more advantageous[26]. En empilant toutes les observations par individu « i », By stacking all observations per individual "i", equation 14 is equivalent to the following equation (15):

$$\Delta \mathbf{y}_i = \phi_i \mathbf{y}_{i,-1} + \mathbf{X}_i \boldsymbol{\beta}_\mathbf{i} + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta \mathbf{y}_{i,-j} + \sum_{j=0}^{q-1} \Delta \mathbf{X}_{i,-j} \boldsymbol{\delta}_\mathbf{ij}^{*} + \mu_i \boldsymbol{\tau} + \boldsymbol{\varepsilon}_{it} \tag{15}$$

where $\mathbf{y}_i = (y_{i1}, y_{i2}, ..., y_{iT})'$ is a matrix of format $(T\times 1)$, $\mathbf{X}_i = (X_{i1}, ..., X_{iT})'$ a matrix of format $(T\times k)$, et $\boldsymbol{\tau} = (1,1,...,1)'$ is a matrix of format $(T\times 1)$.

The fundamental difference with the aforementioned alternative estimators lies in the technique of estimating the long-term relationship between the variables considered.

- The Dynamic Ordinary Least Squares (DOLS)

While the PMG method imposes strict equality of the individual long-term coefficients, that of the dynamic OLS proposes to include in addition to the explanatory variables[27], the forward and / or lagged values of the latter (in first differences), with the aim of eliminating the nuisances related to endogeneity and within group correlation.

Formally, we consider a model with fixed effects whose triangular representation is given by equations (16) and (17):

$$y_{1it} = \alpha_i + \gamma' x_{it} + \mu_{it} \tag{16}$$

$$\Delta x_{it} = \nu_{it} \tag{17}$$

where $\left(y_{it}, x_{it}^{'}\right)' = \mathbf{Y}_{it}$ is a vector of dimension $(k+1)$. If we assume that the μ_{it} are correlated with at least p_i lags or forward values of ν_{it}, then one way of eliminating such a nuisance is to carry out the following projection:

$$\mu_{it} = \sum_{j=-p_i}^{p_i} \varphi_{i,j}^{'} \nu_{it-j} + \eta_{it} = \sum_{j=-p_i}^{p_i} \varphi_{i,j}^{'} \Delta x_{it-j} + \eta_{it} \tag{18}$$

[26] For this, it is enough to use the Bewley transformation.

[27] These must necessarily be of the same order of integration. In other words, they are not required to be stationary.

where $\varphi_{i,j}^{'}$ represents the vector $(k+1)$ of projected coefficients. By introducing this last relation in relation (16), it becomes:

$$y_{it} = \alpha_i + \gamma' x_{it} + \sum_{j=-p_i}^{p_i} \varphi_{i,j}^{'} \Delta x_{it-j} + \eta_{it} \tag{19}$$

Finally, the estimation of the vector of coefficients $\beta = (\gamma', \varphi_1^{'}, ..., \varphi_N^{'})$ is done by the MCO. This estimator is efficient and converges asymptotically to a normal distribution, as is the maximum likelihood estimator (MLE). As can be seen, the correction of the OLS obtained by this technique is sensitive to the number of lags included in the specification. This is why it is common practice to use an alternative correction of the OLS panel estimator.

- The Fully Modified Ordinary Least Square (FMOLS)

As before, the fully modified OLS estimator (FMOLS) corrects the asymptotic bias of OLS [28] and the long-term correlation problem by transforming the dependent variable and the error term using a matrix of variance-covariance. The starting point is the definition of a vector of innovations $w_{it} = \left(\mu_{it}, \nu_{it}^{'}\right)^{'}$ which respects the Philips error condition (1995, p.1030). In this way, we define the matrix Ω of the long-term covariance variances associated with equations 16 and (17) given by:

$$\Omega = \sum_{j=-\infty}^{\infty} E\left(w_{ij} w_{i0}^{'}\right) = \begin{bmatrix} \Omega_{\mu} & \Omega_{\mu\nu} \\ \Omega_{\nu\mu} & \Omega_{\nu} \end{bmatrix} \tag{20}$$

Thus, to correct the OLS estimator, we define the following new variables:

$$\begin{cases} \mu_{it}^{+} = \mu_{it} - \Omega_{\nu\mu}\Omega_{\nu}^{-1}\nu_{it} \\ \hat{\mu}_{it}^{+} = \mu_{it} - \hat{\Omega}_{\nu\mu}\hat{\Omega}_{\nu}^{-1}\nu_{it} \\ \hat{y}_{it}^{+} = y_{it} - \hat{\Omega}_{\nu\mu}\hat{\Omega}_{\nu}^{-1}\nu_{it} \end{cases} \tag{21}$$

where the sign « ˆ » indicates the consistent estimator of the variable under consideration. Consequently, the correction of equation 16 is given by the following equation:

$$\hat{y}_{it}^{+} = \alpha_i + \gamma' x_{it} + \mu_{it} - \hat{\Omega}_{\nu\mu}\hat{\Omega}_{\nu}^{-1}\nu_{it} \tag{22}$$

[28] The interested reader can consult Kao and Chiang (2000, p.6) for a formal expression of this asymptotic bias.

Unlike the PMG method, estimates based on the two alternative estimators must necessarily be preceded by the conventional approach of verifying the presence of unit roots and the existence of a cointegration relation between the variables.

- Unit root and cointegration tests

We perform first generation (Maddala and Wu, 1999, Im, Pesaran and Shin, 2003) and second generation (Pesaran, 2007) unit root tests, as well as two unit root test of third generation (Clemente et al., 1998; Lee and Strazicich, 2003) in order to take into account the presence of structural breaks. Moreover, we carry out the cointegration tests: 1st generation (Pedroni, 1999), 2nd generation (Westerlund, 2007), and 3rd generation (Gregory and Hansen, 1996), which verifies the hypothesis of a long term relationship between variables, and the presence of one or more structural breaks.

- Practical implementation

These preliminary precautions allow us to make all estimates of the equilibrium exchange rate. The data come from the World Bank and IMF databases (see Table I in the appendices). Given the low availability, we retain proxies for some variables. In particular, we cannot distinguish between government expenditures on tradable goods and expenditures on non-tradable goods. Therefore, we consider only the "government expenditure" variable, measured as a share of GDP. Thus, its effect on the internal exchange rate becomes unknown a priori. The variable $[z + r.f]$ that we rename "Trans" is obtained by the difference between the current balance and the trade balance at each period[29]. In addition, the trade openness as measured by the ratio of total exports and imports to GDP is taken as an indicator of trade policy. The external terms of trade considered are those of advanced economies[30] and the equilibrium terms of trade are obtained by using a Hodrick-Prescott filter. The productivity indicator is approximated by the ratio of a country's real GDP per capita to that of the OECD countries. This measure of productivity is similar to that used by Baffes et al. (1999) for the Ivory Coast and Burkina Faso. However, given the difficulties in measuring this indicator, it is common in the literature to consider US GDP per capita as an approximate measure of the productivity of the rest of the world (Coudert, 1999), but this method seems limited because it really does not take into account the importance of different partners in a country's trade relations.

[29] In line with the stock equilibrium approach, this variable is assumed to be equivalent to the trade balance at the medium-term equilibrium, with the current balance being zero by assumption at this horizon.

[30] It should be noted that this is a default choice, imposed by the availability of data in the different databases used.

Les variables ainsi obtenues nous permettent de procéder aux estimations du NATREX (équation 4) et du BEER (équation 13) pour un échantillon de 17 pays d'Afrique subsaharienne, pour la période allant de 1980 à 2011. L'échantillon retenu a été conditionné par l'inexistence des données requises pour certains pays et sur une période plus récente. Notons également que toutes les variables considérées sont exprimées en logarithmes à l'exception de la position extérieure nette qui est exprimée en proportion du PIB.

The resulting variables allow us to provide estimate of NATREX (equation 4) and BEER (equation 13) for a sample of 17 countries in sub-Saharan Africa for the period 1980 to 2011. The selected sample was conditioned by the lack of data required for some countries and over a more recent period. Note also that all variables considered are expressed in logarithms with the exception of the net external position which is expressed as a proportion of GDP.

The results of these estimates are set out below. For the calculation of misalignments, the countries are grouped according to the exchange rate regime (see table 8 in appendices). This classification differs from the IMF's official classification, which distinguishes eight types of exchange rate regimes, grouped together in fixed, intermediate and floating exchange rates. The countries of the Franc Zone (fixed exchange rate regime), the countries of the common monetary area (fixed exchange rate regime without a separate official currency) and countries with independent exchange regimes (floating exchange rate regime) are used here. On the one hand, this choice allows us to have as many countries as possible in view of the availability of data, and to cover the two main types of exchange rate regimes according to recent trends in the practice of exchange rate regimes. On the other hand, it allows us to focus on the particular case of the Franc Zone and to enrich the debate on the monetary regionalization solution with regard to the developing countries. Furthermore, it should be pointed out that the classification we have carried out is not fortuitous. It is inspired by the "raw" classification of Reinhart and Rogoff (2004).

From the exchange rates estimated by the NATREX and BEER approaches, we estimate the misalignments in percent (% mis) from the following formula :

$$\%mis = \frac{TCER - \overline{TCER}}{TCER} \times 100 \qquad (14)$$

with $TCER$, the real effective exchange rate and $\overline{TCER}$ the real equilibrium exchange rate.

3.2. Comparative results and robustness analysis

We *first* present the results obtained from the determination of the equilibrium exchange rate, using the adopted approach (NATREX and BEER), and by estimator (PMG, DOLS and FMOLS, see Tables 1 and 2). The results of the unit root tests are presented in appendices (Tables 9, 10 and 13). The first two generations tests show that the variables considered are all integrated of order 1, with the exception of the variable NFA. However, taking into account structural breaks through third generation tests (individual and panel) allow to clearly decide about the order of integration of each of the variables. The cointegration tests (Tables 11 and 12 in the appendices) illustrate the need for structural breaks to be taken into account. Indeed, the first two generations of tests fail to identify the existence of a long-term relationship, while the third-generation test applied to different combinations of variables suggests that there is at least one.

Then, to justify the relevance of the PMG estimator and our specifications, we perform a likelihood ratio test which confirm the validity of the model and we choose the best possible specification thanks to the AIC and BIC information criteria. *Finally*, we calculate, for each country, the percentage of misalignment (% mis) from the formula presented above.

Main results

The results obtained from the two approaches (NATREX and BEER) show that an increase in trade openness generates a depreciation of the TCRE, as in Dufrenot and Yehoue, (2005), with however a significant difference in amplitude with respect to the NATREX model[31]. The existence of a Balassa-Samuelson effect is also reinforced by our analysis: an improvement in productivity in the exposed sector leads to an appreciation of the TCRE. This appreciation[32], is however more important when we consider the NATREX (0.16%), rather than the BEER model (0.035%).

The effect of public expenditure on the TCRE is negative, whatever the approach taken. In other words, the increase in public spending leads to the depreciation of the TCRE. This result contrasts with the most widespread conclusion in the literature that an increase in public spending leads to an appreciation of the TCRE, assuming that the majority of public expenditures are directed to the non-tradable goods sector (Mongardini and Rayner, 2009). The

[31] Dufrenot and Yehoue, (2005) find 0.2% depreciation against 0.81% for our NATREX model.
[32] See among others : Chinn (1999), Coudert (1999) and Elbadawi et al. (2012).

discrepancy may be due to the questioning of this hypothesis for the countries studied. Indeed, for the latter, the actual increase in public expenditure does not necessarily translate into variations in terms of supply and demand for non-tradable goods, insofar as this expenditure is mainly directed towards consumption. As such, and in light of the reports of organizations such as Transparency International on the level of corruption in the countries studied, it is possible that part of this expenditure is captured by a privileged class whose consumption is directed towards the products of luxury and high technology [33].

Table 1 – Estimation of the equilibrium exchange rate (NATREX type approach)

	Pooled Mean Group (PMG) ARDL (1,1,2,3,2,1)
Trade Openness	-0.81*** (-7.46)
External terms of trade	1.04*** (7.84)
Productivity	0.16*** (3.33)
Government expenditure	-0.53*** (-3.66)
Trans	0.02** (2.16)
Adjustment Coefficient	-0.11*** (-2.69)

Source : Authors'construction.*, ** and *** are respectively significance at 10%, 5% and 1%.

Table 2 – Estimation of the equilibrium exchange rate $\overline{TCER}$ (BEER approach)

	Estimateurs		
Variables	**Pooled Mean Group (PMG)** ARDL (1,1,2,1,1,1,1,1)	**Dynamic Ordinary Least Squares (DOLS)**	**Fully Modified Ordinary Least Squares (FMOLS)**
Productivity	0.28*** (4.55)	0.035** (2.23)	0.044* (1.83)
Net external position	-0.005** (-1.96)	-0.003* (-1.73)	-0.023*** (-3.10)
Terms of Trade	0.26*** (3.46)	0.145*** (4.34)	0.106* (1.85)
Trade openness	-0.15** (-2.19)	-0.130*** (-4.88)	-0.100** (-2.48)
Government expenditures	-0.24** (-2.31)	0.019 (0.65)	-0.478* (-1.77)
Reg1 (fixed regime)	5.58*** (11.26)	4.696*** (20.18)	4.782*** (12.51)
Reg2 (floating regime)	5.99*** (11.65)	4.876*** (20.13)	5.043*** (12.72)
Adjustment Coefficient	-0.11** (-2.00)	– – –	– – –

Source : Authors'construction. *, ** and *** are respectively significance at 10%, 5% and 1%.

Moreover, in line with theoretical expectations, the widening gap between the current account and the trade balance (increase in Trans variable) leads to an appreciation of the TCRE. The

[33] According to Transparency International, in developing countries, public spending is subject to massive diversions for personal enrichment. This is illustrated in particular by the corruption perception indices (IPC) for the years 2013 and 2014 (the ranking can be consulted at www.transparency.org/cpi).

improvement in the terms of trade, both external and national, leads to a real appreciation, suggesting that there would be a superiority of the spending effect in all the studied countries. Such a conclusion has already been confirmed by the work of Bouoiyour and al. (2004), or Coudert and al. (2012). Similarly, the effect of the net external position is negative, contrary to our theoretical expectations as well as the results obtained by Aydin (2010) or Elbadawi, and al. (2012)[34]. Our result exactly shows that the 1% increase in the net foreign investment position (widening of the deficit for the debtor countries) generates 0.005% of real depreciation of the local currency. A plausible explanation for this appears to be the national preference for foreign tradable goods. Indeed, if this preference is proved, a transfer to the domestic country generates a wealth effect which increases the demand for foreign exchangeable goods and depreciates the national currency. However, with respect to the external terms of trade, it is important to clarify that there is doubt about the interpretation of the effects of this variable because of the uncertainty about the meaning of causality with the TCRE.

Although the results obtained by the DOLS and FMOLS estimators generally confirm those of the PMG estimator, it is necessary to judge the validity of the latter. To do this, we test the hypothesis of equality of long-term coefficients (Table 3). In addition, we validate the choice of the optimal number of lags for each variable using the AIC and BIC information criteria. This choice involves several significant specifications, allowing only those that minimize the values of these criteria to be retained (Table 4).

Table 3 – LR Test for the validity of the PMG model

Null hypothesis: Equality of long term coefficients	**Test Statistic**	**Probability**
Chi2 (75)	*-224.02*	*1.00*

Source : Authors' estimates.

Table 4 – Selection of the best PMG specification

Information criteria	**Significant specification of the NATREX model**		
	ARDL (1, 1, 2, 3, 2, 1)	*ARDL (1, 1, 2, 3, 2, 1)*	*ARDL (1, 1, 2, 3, 4, 1)*
AIC	-404.61*	-378.92	-393.51
BIC	-362.56*	-366.83	-351.88
	Significant specification of the BEER model		
	ARDL (1,1,2,1,1,1,1,1)	*ARDL (1,3,3,1,1,1)*	*ARDL (1,1,1,1,3,1,1)*
AIC	-986.7505*	-679.807	-901.1081
BIC	-933.771*	-642.6848	-855.6886

Source : Authors' estimates. * indicate the lowest value of the criteria used.

[34] For your information, Elbadawi et al. (2012), The value of the coefficient is 0.0037.

Analysis of exchange rate misalignments

Concerning the misalignments, the average values of the different countries according to their exchange rate regime are shown in Table 5. By way of illustration, the different estimates of the equilibrium exchange rates are represented according to the exchange rate regimes in Figures A and B. It can thus be observed that there is not a logical evolution of the misalignments according to the exchange rate regimes of the different countries studied. In other words, overvalued and undervalued exchange rates are as strong in countries with fixed exchange rates as in countries with a floating exchange rate regime.

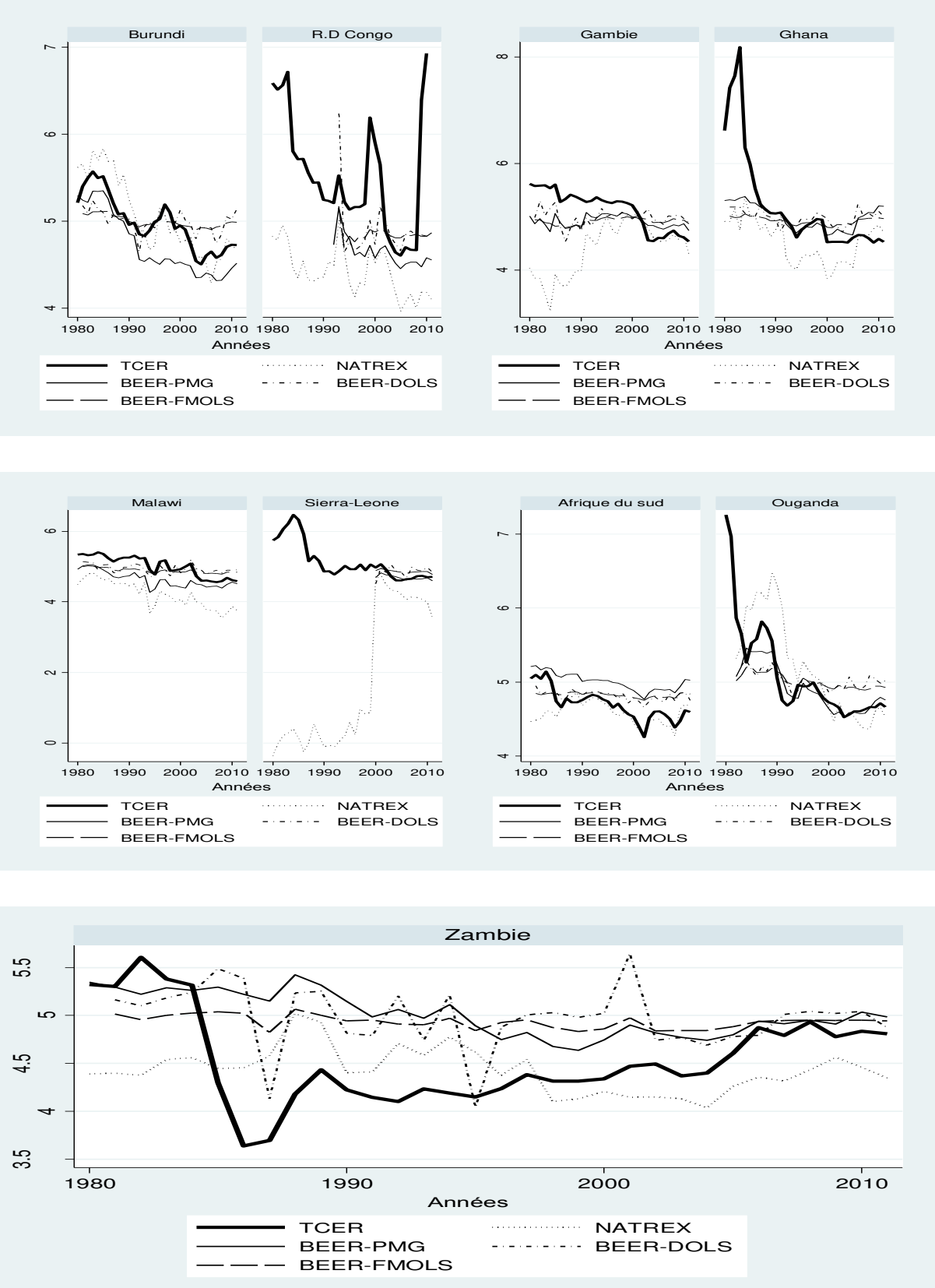
Table 5 – Average percentage of misalignments by country

Countries	**Average percentage of misalignment**			
Countries of the Franc zone	**NATREX**	**BEER**		
		PMG	**DOLS**	**FMOLS**
Cameroon	-0.38	-0.015	-0.557	-1.271
Central African Republic	-12.24	5.51	0.491	-0.413
Gabon	6.72	-5.67	-2.603	-2.890
Equatorial Guinea	87.38	-1.66	-2.901	-1.851
Ivory Coast	2.08	-3.07	1.624	0.823
Togo	26.25	11.54	1.187	1.349
Countries of Common Monetary Area				
South Africa	2.53	-6.24	-2.692	-2.908
Lesotho	12.34	24.06	4.789	4.390
Countries with independent exchange rate				
Burundi	0.64	5.58	-0.691	-0.479
R.D Congo	---	14.04	8.495	9.268
Gambia	21.32	4.69	2.903	4.260
Ghana	12.29	3.91	3.475	4.773
Malawi	21.36	8.07	1.244	2.324
Sierra Leone	---	1.48	-2.032	-2.135
Ouganda	-3.06	1.28	-1.655	-0.685
Zambia	8.54	-9.43	-9.150	-8.615

Source : Authors' Estimates.

Figure A – Equilibrium exchange rate (fixed exchange rate regime)

Figure B – Equilibrium exchange rate (floating exchange rate regime)



However, it is observed that the average percentage of misalignment is higher with the NATREX model, but the different average values do not allow any intuitive conclusion on the effectiveness of a particular exchange rate regime. For this reason, we carry out a mean comparison test (Table 6), which does not reveal a significant difference in the average percentage of misalignments between countries belonging to a monetary area (fixed exchange rate regime) and those under floating exchange rate regime. This result is similar to that of Dubas (2009) for the developed economies. The latter shows that for the countries considered, the choice of an exchange rate regime is of little importance in limiting misalignments. However, another argument may be the price taker situation of African countries combined with a poorly diversified productive structure. These countries are mainly producers of raw materials whose prices are denominated in foreign currencies and fixed on international markets. This common feature may justify the similarities observed in the misalignment of the countries grouped in a monetary union and those that are not.

Table 6 – Mean comparison test

	NATREX		**BEER**					
	Moyenne	**Écart-type**	**Mean**			**Standard deviation**		
			PMG	**DOLS**	**FMOLS**	**PMG**	**DOLS**	**FMOLS**
Country under fixed exchange rate regime (Fixed)	10.72	1.72	3.39	0.401	0.532	11.41	5.78	6.43
Country under floating exchange rate regime (Floating)	10.87	1.26	3.32	0.055	0.887	10.72	10.74	11.01
Alternative hypothesis: Difference in mean		**Probability**	**Probability**					
			PMG		**DOLS**		**FMOLS**	
Floating – Fixed < 0		0.53	0.472		0.659		0.339	
Floating – Fixed # 0		0.94	0.944		0.681		0.678	
Floating – Fixed > 0		0.47	0.528		0.341		0.661	

Source : Author' construction.

Conclusion

The objective of this study was to verify whether the exchange rate regime is a factor limiting misalignments, based on the case of sub-Saharan African countries. It appears that the misalignments are independent of the exchange rate regime in the countries concerned. In other words, there is no exchange rate regime that allows to permanently reduce the misalignments of the exchange rates. In our view, such a conclusion represents an additional element of analysis in the debate on the future of the member countries of the Franc Zone. They have been concerned by the phenomenon of appreciation of the euro, which is supposed to be detrimental to their economies in terms of price competitiveness (short term), and which led some economists to consider the solution of exit from the union to migrate toward a floating exchange rate regime. Our result shows that this solution is unfounded, especially since earlier work has shown for the Eurozone case that the euro's developments are not at the origin of the misalignments observed in the area (Gnimassoun, 2014). And even if the peg to a basket of currencies may seem like a non-negligible alternative to the Franc Zone, this solution cannot solve the structural problems that the African countries face.

The main recommendation emanating from such work is to call on the authorities of sub-Saharan African countries on the need to put more emphasis on (structural) quality competitiveness. If the misalignments do not significantly affect the developed countries (Dubas, 2009), it is probably because the latter use quality competitiveness more in their commercial strategies. Indeed, it is a long-term "out of price" competitiveness that represents the ability of an economy to compete internationally by means other than price. There is therefore a need for a structural transformation of the economies, focusing on the diversification of productive structures, but above all on the quality of the products while insisting on the image and reputation conveyed on the markets. A good quality product, sold by an entity renowned for its know-how and experience, will always find potential buyers regardless of the exchange rate regime and even in case of overvaluation of the currency.

This work also sheds light on the debate on the Franc Zone and on its choice of the fixed exchange rate regime, since losses or competitiveness gains induced by misalignments do not depend on the chosen exchange rate regime but on the intrinsic and structural characteristics of the countries. Unlike the Asian countries (Malaysia, Philippines, Indonesia, South Korea), which suffered severely from the crisis in the late 1990s, partly because of their fixed exchange rate regime and exchange rate misalignments, the peculiarity of the exchange regime of the countries of the Franc Zone lies in the level of the international monetary agreements which they have signed and which give the central bank room for action. This feature is an asset for the countries of the Franc Zone, which they must retain as long as their economic and financial structures are not sufficiently diversified and developed to face real international competition.

Appendices

Table I – Variables description

Variables	Description
Open	Trade openness
Nfa	Net external position
Prod	Productivity indicator, approximated by the ratio of a country's real GDP per capita to that of the OECD countries (Baffes et al. [1999])
Gov	Government spending in percentage of the GDP.
Tot	Terms of trade
Trans	Difference between current balance and trade balance at any period
Source	*World Development Indicators 2014* (World Bank); International Financial Statistics 2012 (International Monetary Fonds).

Table II – Classification of Countries

Groups	Noms des pays
Group of countries under a fixed exchange rate regime	Cameroon, Central African Republic, Ivory Coast, Gabon, Equatorial Guinea, Lesotho, Togo
Group of countries with an independent exchange rate regime	Burundi, Congo, Gambia, Ghana, Malawi, Nigeria Sierra Leone, Uganda, Zambia, South Africa

Table III – First generation unit root tests

	Maddala and Wu Test (1999)			IPS Test (2003)		
	Variables in level					
	Lags	No trend	With trend	*Lags*	No trend	With trend
TCER	1	0.053	0.009**	1	0.048**	0.154
	2	0.147	0.453	2	0.105	0.432
PROD	1	0.089	1.000	1	0.029**	1.00
	2	0.042**	1.000	2	0.008**	1.00
NFA	1	0.160	0.028**	1	0.603	0.066
	2	0.958	0.296	2	0.789	0.068
TOT	1	0.480	0.885	1	0.694	0.825
	2	0.00**	0.010**	2	0.603	0.764
OPEN	1	0.171	0.008**	1	0.019**	0.012**
	2	0.441	0.012**	2	0.078	0.019
GOV	1	0.066	0.111	1	0.052	0.048**
	2	0.245	0.733	2	0.165	0.417
	Variables in first difference					
	Lags	No trend	With trend	*Lags*	No trend	With trend
D.TCR ; D.OPEN ; D.PROD ; D.GOV; D.TOT ; D.NFA	1, 2	0.00**	0.00**	1, 2	0.00**	0.00**

NOTE : In this table, the indicated variables refer to *P-values* ** Indicate that at 5% threshold, we cannot reject the hypothesis of no unit root.

Table IV – Second generation unit root tests

Test CIPS de Pesaran (2007)			
Variables en niveau	*Retards*	Sans trend	Avec trend
TCER	1	0.016**	0.461
	2	0.117	0.810

PROD	1	0.000**	0.004**
	2	0.009**	0.339
NFA	1	0.070	0.593
	2	0.667	0.985
TOT	1	0.242	0.018**
	2	0.708	0.202
OPEN	1	0.001**	0.092
	2	0.032**	0.450
GOV	1	0.046**	0.021**
	2	0.526	0.823
Variables en différences premières	*Retards*	Sans trend	Avec trend
D.TCR ; D.OPEN D.PROD ; D.GOV; D.TOT	1, 2	0.00**	0.00**
D.NFA	1, 2	0.00**	0.289

NOTE : In this table, the indicated variables refer to *P-values* ** Indicate that at 5% threshold, we cannot reject the alternative hypothesis of no unit root.

Tableau V – First & second generation of cointegration tests

Variable dépendante : *TCER*			**Variables indépendantes:** *PROD, NFA, TOT, OPEN, GOV*		
Test de Pedroni (1999)			**Test de Westerlund (2007)**		
Statistique de test	**Panel**	**Group**	**Statistique de test**	**Coefficient**	**Probabilité robuste**
v	-1.311	…	G_t	-1.019	1.00
ρ	2.279	3.758	G_a	-3.177	1.00
t	-1.1	-0.886	P_t	0.551	1.00
adf	-0.412	0.697	P_a	0.374	1.00

Note : The null hypothesis of the two tests is the absence of cointegration for the whole sample. Thus, G_t and G_a test the alternative cointegration hypothesis for at least one individual, while P_t and P_a test the cointegration for the entire sample. The robust probability is obtained by bootstrap to account for the cross sectional correlation.

Table VI – Cointegration test with structural break (Gregory et Hansen, 1996)

Dependent variable: *TCER*		
Independent variables	**Minimum test statistics**	**Minimum breaking date**
PROD, NFA, TOT, OPEN	-7.821	1984 (Nigeria)
PROD, NFA, TOT, GOV	-7.535	1991 (Ghana)
PROD, NFA, TOT, TRANS	-7.846	2005 (Ghana)
PROD, OPEN, TOT, TRANS	-7.631	1996 (Ghana)

Note : The null hypothesis of the test is the absence of cointegration for the whole sample. To perform the test, we select the optimal number of lags by the "general-to-specific" procedure, and then perform the estimation on the basis of the trendless model with regime change (C / S). The statistic obtained is compared with the critical thresholds of -6,920 and -6,410 respectively at 1% and 5%.

TableVII – Third generation unit root tests

Variables in level	Clemente and al. Individual test 1998											
	TCER		PROD		NFA		TOT		OPEN		GOV	
Countries	t-statistics	*Breaking dates*	t-statistics	*Breaking dates*	t-statistics	*Breaking dates*	t-statistics	*Breaking dates*	t-statistics	*Breaking dates*	t-statistics	*Breaking dates*
Cameroon	-0,878	*1985, 1991*	-5,007	*1991,1996*	-2,946	*1987,2003*	-6,079**	*2001,2005*	-4,422	*2002*	-3,375	*2003*
Central African Republic	-2,421	*1991, 1995*	-4,15	*1991,1995*	-2,545	*1991,2000*	-6,07**	*1995,1999*	-1,749	*1989,1991*	-5,711**	*1992,2004*
Ivory Coast	-1,156	*1986, 1991*	-4,412	*1985,1991*	-5,162	*1995,2003*	-3,154	*1990,2001*	-4,337	*2001*	-4,888	*1994*
Equatoriale Guinea-	-4,829	*1991, 2003*	-3,423	*1998,2004*	-3,611	*1996,2003*	-3,639	*2000,2006*	-3,408	*1992*	-5,431	*1996,2001*
Gabon	-6,837**	*1991, 1995*	-2,156	*1988*	-5,357	*1986,2004*	-4,154	*1987,2007*	-3,76	*1985,199*	-3,234	*1990,2001*
Togo	-5,048	*1991*	-4,522	*1990*	-5,03	*1993,2001*	-2,427	*1998,2002*	-2,18	*1991,1995*	-6.627**	*1985,1995*
South Africa	-5,96**	*1986, 1997*	-1,792	*1987,1995*	-4,014	*2003*	-3,342	*2005*	-1,616	*1997,2003*	-2.703	*1986*
Lesotho	-1,274	*1997, 2000*	-1,231	*2005*	-4,968	*1994*	-6,965**	*1985,2004*	-5,275	*1989*	-0,747	*1984,1988*
Burundi	-3,714	*1987, 2000*	-4,16	*1989,1995*	-4,217	*1990,1999*	-1,131	*1986,1997*	-5,436	*2004*	-5,493**	*1989,2004*
D.R Congo	-5,592**	*1985*	-3,031	*1991,1996*	-8,873**	*1995,2006*	-4,262	*2000*	-4,441	*2003*	-1,473	*2005*
Gambia	-5,114	*1985, 2004*	-3,16	*2000*	-0,404	*1989*	-0,957	*1985*	-4,19	*1992,2003*	-4,466	*1982,1995*
Ghana	-5,889**	*1985, 1991*	-3,19	*1989,2007*	-2,613	*1992,2003*	-3,589	*1990,2003*	-4,039	*1998*	-5,136	*1988*
Malawi	-6,85**	*1991, 2002*	-3,766	*1985,1991*	-4,023	*1992*	-4,357	*1989,1999*	-7,027	*1988,2005*	-1,637	…
Nigeria	-6,377**	*1988*	-3,035	*1987,2003*	-3,352	*2000*	-3,801	*1985,2001*	-4,229	*1985,2001*	…	…
Sierra Leone	-6,151**	*1988*	-1,543	*1982,1987*	-2,02	*1984,1997*	-3,195	*2004*	-5,572**	*1994,2001*	-3.586	*1995*
Ouganda	-4,673	*1990*	-4,367	*1990*	-4,136	*1994,2*	-0,68	*1988,1999*	-3,426	*1987,1993*	-3.606	*1993*
Zambia	-5,304	*1982, 2003*	-3,469	*1991,2005*	-4,721	*1992*	-2,274	*1988*	-4,453	*1992,1995*	-2.999	*1991,2005*

Lee and Strazicich panel LM test (2003)

Variables	Maximum number of lags	Coefficient of S(-1)	Statistics LM
TCER	6	-1.3075	-3.7237
D.NFA	0	-0.6557	-2.9911

Note: In this table, ** indicate that it is not possible to reject the alternative hypothesis of absence of unit root with structural change. The individual test is carried out using the additive structure model, with *kmax* = 5. Thus, by 5%, the computed statistics are to be compared to the corresponding tabulated value, that is to say 5,490. As for the panel test, it is carried out using the "C" model, with the general-to-specific procedure of Perron (1989) and Ng and Perron (1997). The calculated statistic is therefore to be compared to -5.823; -5.286 and -4.989 at 1%, 5% and 10%, respectively. A greater accuracy could be obtained by considering the location of the rupture, but this does not alter the conclusion of the test.

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