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Kuikeu, Oscar

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Oscar KUIKEU[1]

École Supérieure des Sciences Économiques et Commerciales (ESSEC), Université de Douala, CAMEROUN

Abstract :

In cfa franc zone, the exchange rate was devalued, in 1994, in order to deal with the major macroeconomic imbalances that have affected the members during the 1980 decade. Thus, the aim of this paper is to know if this devaluation was relevant for Gabon an member state of the cfa franc zone, and, in the sense that the devaluation is relevant only if the real exchange rate is overvalued, we will assess the degree of the real exchange rate misalignment in Gabon.

JEL Classification : C33, F31
Keywords : equilibrium real exchange rate, cfa franc zone

Résumé :

En zone franc, la monnaie a été dévaluée en 1994 face aux difficultés rencontrées par ses members dès le debut de la decennie 1980. Ceci dit, l'objectif de cette etude est d'évaluer si cette dévaluation était pertinente pour le Gabon, l'un des Etats membres de la zone franc, et, dans l'idée qu'il est pertinent de dévaluer uniquement lorsque le taux de change reel est surévalué, nous allons évalué les phases de sur/sous-évaluation du taux de change reel de l'économie gabonaise avant et après 1994.

JEL Classification : C33, F31
Mots-clés : taux de change reel d'équilibre, zone franc

[1] BP 1931 douala (Cameroun), email : projetlivre@yahoo.fr.

1. Introduction

Immediatly after the independence in 1960, the growth of Gabon's economy is notable, primarily driven by the petroleum sector (agriculture, forestry, fishing). Between 1965 and 1980 the rate of income growth (GDP) per capita has averaged 2.5% per annum.

Yet in the middle of the decade, after the surge of large external shocks, there was a sharp and well document reversal in Gabon's economic performance. In 1986 the GDP trend breaks with growth and decline of about 1.5% in real terms.

In order to deal with the deepening macroeconomic imbalances, the Gabon's authorities committed themselves in 1990, under pressure of the Bretton – Woods institutions, to the path of "internal adjustments". This term refers to the various attempts aimed at the restoration of macroeconomic balance without changing the nominal exchange rate, implemented by various developing countries among which those of the cfa franc zone (see box 1 below for a brief presentation of the cfa franc zone). The main component of these measures includes controlling aggregate demand. Overall effectiveness of structural adjustment measures in Gabon seems relatively poor. In fact, in 1993, the per capita income represents the declines of about 1.7%.

The inefficiency of internal adjustment measures, to eliminate the major macroeconomic imbalances forced the Gabon's authorities to accept together with their partners members of the cfa franc zone, the devaluation of the common currency of 50% compared to the french franc, intervened in 1994. The main effect of this measure focuses on restoring the competitive position of the country and relaunch the process of economic growth. Indeed between 1994 and 2001, the real exchange rate depreciated by an average of 4.42% compared to the PPP assumption while the real GDP per capita grew by an average of 0.08% per annum.

Box 1 : cfa franc zone in brief

The cfa franc zone is a monetary area which includes fourteen countries in Sub – Saharan Africa having signed, in 1972 and 1973, agreements on monetary cooperation with France ; eight, of these members countries, are in West Africa : Benin, Burkina Faso, Côte d'Ivoire, Guinea – Bissau, Mali, Niger, Senegal, Togo ; six, of them, in Central Africa : Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Gabon.

The area has a common currency, the cfa franc, defines as *franc de la coopération financière* in Central Africa and *franc de la communauté financière africaine* in West Africa, issued by the BCEAO (Banque Centrale des Etats de l'Afrique de l'Ouest) in West Africa and the BEAC (Banque des Etats de l'Afrique Centrale) in Central Africa ; the fifteenth member of the cfa franc zone, the Islamic Republic of Comoros, has its own currency (the Comorian franc) and its own central bank (Banque Centrale des Comores).

On january 12, 1994, the cfa franc was devalued against the french franc by 50%. Since the advent of the European Monetary Union (EMU), the cfa franc is now pegged to the euro at a fixed rate of 655.957 cfa franc to 1 euro.

In this paper, our aim is to assess if the cfa franc devaluation of January 1994 was relevant for the Gabon's economy, and, in the sense that an devaluation is relevant only if the real exchange rate is overvalued or when the country's external competitiveness deteriore (see the box 2 below), we will estimate the degree of misalignment of the Gabon's real exchange rate.

Following Edwards (1989), MacDonald (1997), Clark and MacDonald (1998), it is now well admitted that, the dynamism of the real exchange rate arises from movements over time of the macroeconomic variables called "fundamentals" :

$$RER(t) = G\{F(t)\}$$

where RER is the real exchange rate, F a vector of "fundamentals", G a specific functional form.

When these "fundamentals" have reached their *sustainable* level (broadly defined as value of "fundamentals" that is consistent with the chosen nominal exchange rate regime), the real exchange rate is therefore at the long – run equilibrium level :

$$RER = G\left(F^*\right) \quad (1),$$

where RER^* is the equilibrium real exchange rate, F^* is the *sustainable* level of "fundamentals".

Sustained deviations of the actual real exchange rate from its long – run equilibruim level represents real exchange rate misalignment :

$$RER(t) - RER^* = G\left(F(t) - F^*\right) \quad (2)$$

This study will be organized following Baffes, Elbadawi and O'Connel (1999)'s steps for estimating the degree of real exchange rate misalignment : in a first step, we will present an analytical model designed to identify the "fundamentals" of the real exchange rate in a representative emerging economy (section 2), in a second step, we will estimate, the elasticity coefficient, called long – run parameters, between the real exchange rate and its "fundamentals" (section 3), thus, the third step estimate the real exchange rate misalignment by combining these long – run parameters with a set of *sustainable* values for the "fundamentals" (section 4), finally, in conclusion, we will present a summary of the main results (section 5).

Box 2 : real exchange rate and international competitiveness

Formally in order to draw inferences about a country's international degree of competitiveness, it is usual to use the concept of real exchange rate.

In the economic literature the real exchange rate is generally defined in two principal ways and each of them provides a good index of a country's international degree of competitiveness.

In most modern theoretical works, the real exchange rate is generally defines in *internal* terms as, the domestic relative price of nontradable goods to tradable goods :

$$IRER = P_N / P_T$$

where P_N is the price of nontradable goods, P_T the price of tradable goods.

This definition captures incentives in a particular economy to produce or consume tradables relatively to nontradables. An increase in $IRER$ will make the production of nontradables relatively more profitable, inducing resources to move out of the tradables sector and into the nontradables sector. If there are no changes in relative prices in the rest of the world, this increase in $IRER$ represents a deterioration of the country's degree of international competitiveness – the country now produces tradable goods in a relatively (that is relative to the rest of the world) less efficient way than before –. The interpretation of a decline in $IRER$ is perfectly symmetrical and represents an improvement in the degree of international competitiveness.

A more traditional approach relies on the Purchasing Power Parity (PPP) and defines the *external* real exchange rate as the relative price of domestic to foreign consumption or production baskets :

$$ERER = \prod_{j=1}^{n} \left(E^j P / P^j \right)^{\theta_j}$$

where E^j is bilateral nominal exchange rate between the home country and the foreign partner j, P the domestic price index, P^j the foreign price index in the foreing contry j, θ_j is the weight of foreign partner j in the total trade of the home country.

If total factor productivity do not change, an increase or real appreciation (respectively a decline or real depreciation) in $ERER$ represents a deterioration (an improvment) of the country's international degree of competitiveness.

2. The "fundamentals" of the real exchange rate : Montiel (1999)

We consider a small open economy in which the domestic production structure consists of traded and nontraded goods sectors. The unique factor of production in each sector is a perfectly mobile labor. In this framework the real exchange rate is defined in *internal* term as the domestic relative price of nontradable goods to tradable goods :

$$e = IRER = P_N / P_T \qquad (3)$$

where P_N is the price of nontradable goods, P_T the price of tradable goods.

In order to identify the "fundamentals" of the real exchange rate, Montiel (1999) follows an approach now standard in the economic litterature. The idea is to define the equilibrium real exchange rate like Nurkse (1945), as the value of the real exchange rate that is consistent with the two objectives of internal and external balance, for specified *sustainable* values of variables that may influence these objectives.

Internal balance holds when the markets of labor and nontraded goods clear :

$$y_N(e,\xi) = c_N + g_N = \theta c + g_N \,,\ \partial y_N / \partial e > 0 \,,\ \partial y_N / \partial \xi < 0 \,, \qquad (4),$$

where y_N represents the supply of nontraded goods under full employment, c is total private spending measured in nontraded goods, θ is the share of spending devoted to nontraded goods, g_N is government spending on nontraded goods, ξ is a differential productivity shock.

External balance : The *external* balance has been defined in various ways in the literature. Montiel (1999) focuses on *stock* rather than *flow* equilibruim approach in wchich, the *external* balance holds when the country's net external assets in world's financial markets have reached a steady – state equilibrium in other words when the country's external liabilities or claims remain the same at each period of time. Since the current account balance helps to appreciate the evolution of the international investment position (equation (1)), the external balance then holds when the current account balance at each period of time is nul :

$$tb + rf^* = y_T(e,\xi) - g_T - (1-\theta)ec + rf^* = 0 \qquad (5),$$

where tb is the trade balance defined as the difference between domestic production of traded goods y_T and the sum of government g_T and private spending c on these goods, f^* is steady state value of total net external asset.

(3) and (4) give the following expression for the long – run real exchange rate :

$$e = (\theta/1-\theta)\left\{\frac{y_T(e,\xi) - g_T + rf^*}{y_N(e,\xi) - g_N}\right\} \qquad (6)$$

Partial derivatives with respect to the various exogenous variables included in the model give the following expression :

$$e = G\left(\underset{+}{g_N}, \underset{-}{g_T}, \underset{-}{tb}, \underset{+}{\xi}\right) \text{ with } tb = -rF^* \qquad (7)$$

where the sign + (respectively –) expresses real exchange rate appreciation (respectively real exchange rate depreciation), G a specific functional form.

We can split up total traded goods output into output of exportables y_X and importables y_M . However in this case external balance condition has to be modified as follows :

$$toty_X(e,tot)+y_M(e,tot)-g_M-(1-\theta)ec+rf^*=0 \text{ with } tot=P_X^W/P_M^W \text{ and } e=P_N/P_M^W \quad (8),$$

where g_M is government spending on importable goods, tot the external terms of trade, P_M^W is the world price of importable goods, P_X^W is the world price of exportable goods.

With this specification on hand, the external term of trade therefore collapse within the list of "fundamentals". Indeed variations in external term of trade affect both internal and external balance. An improvement in the terms of trade causes labor to be transferred from the importables and nontraded sectors to the expanding exportables sector. Thus, it induces a demand excess in the nontraded goods market ($\partial y_N/\partial tot<0$) and a supply excess in the traded good sector ($\partial(toty_X+y_M)/\partial tot>0$).

Since the equilibrium real exchange rate was defined as the rate that prevails when the economy is in internal and external balance, an improvement in the terms of trade requires a real appreciation in order to maintain both internal and external balance.

Nevertheless on the grounds of trade policy, the domestic price of exportable goods (P_X) and that of importable goods (P_M) may differ from world prices. This can be the case if we assume that the government applies taxes on imported products at a rate t_m and subsidizes exports to the rate t_x. Under this assumption we can express internal terms of trade (P_X/P_M) as a combination of external terms of trade (tot) and tariff measures ($\eta=1+t_m/1-t_x$) :

$$P_X/P_M=tot/\eta$$

Since the stance of trade policy affects the internal terms of trade, he collapses within the set of "fundamentals". In order to illustrate our purpose we can for example consider a tightening trade policy modelled as an increase in export subsidies. This measure causes labor to be transferred from the importables and nontraded sectors to the expanding exportables sector. So the previous analysis about the effects of the external terms of trade on the equilibrium real exchange rate can be repeated. Therefore a tightening trade policy appreciates the real exchange rate.

The long – run relationship between the real exchange rate and its "fundamentals" (equation (8)) then becomes :

$$e = G\left(\underset{+}{g_N}, \underset{-}{g_T}, \underset{-}{tb}, \underset{+}{\xi}, \underset{+}{\eta}, \underset{+}{tot}\right) \tag{9}$$

It is common in the literature to assume that G is linear in logarithm :

$$\ln e_t = \beta' \ln F_t \tag{10}$$

where β is the vector of long – run parameters, F the vector of "fundamentals" or the right – hand side variables in (10).

We have defined the equilibrium real exchange rate as the value of the real exchange rate conditional on a vector of *sustainable* values for the fundamentals (equation (1)) :

$$\ln e_t^* = \beta' \ln F^* \tag{11}$$

where F^* is the sustainable level of "fundamentals".

Therefore our first task is now to estimate the long – run parameters in (10) – explicitly showed in (11) – and the second to calculate the equilibrium real exchange rate, thus the real exchange rate misalignment (equation (2)), by combining these long – run parameters with a set of *sustainable* values for the "fundamentals" (equation (12)).

3. Estimating the long – run parameters

The purpose of this paragraph is to outline an analytical framework suitable to retrieve for the Gabon's economy the long – run relationship between the real exchange rate and its "fundamentals".

Following Baffes, Elbadawi and O'Connel (1999) we assume that the long – run relationship between the real exchange rate and its "fundamentals" (equation (10)) is dynamically stable. In other words the actual real exchange rate converges over time towards its equilibrium path. A specification that captures broadly this notion is the Error Correction Model (ECM).

$$\Delta X(t) = \sum_{h=1}^{p} \Gamma_h \cdot \Delta X(t-h) + \alpha b' X(t-1) + \Phi D(t) + U(t)$$

where Δ is the difference operator, $X(t)$ a $(n,1)$ vector of variables consisting of the variables defined in (10), Γ_h a (n,n) vector of parameters for the short – run dynamic, α a (n,r) matrix with full column rank, b a (n,r) matrix whose (the r) columns represents the number of long – run relationship (say *cointegrating vectors*) between the variables defines in (10), linear independant cointegrating vectors, Φ a (n,n) diagonal matrix of parameters, $D(t)$ a $(n,1)$ vector of deterministic terms (such as constant, time trend, seasonal dummy variables), $U(t)$ a $(n,1)$ vector of white noise.

There are a number of potential approaches to estimating the cointegrating parameters. The simplest approach and the oldest being the one suggested by Engle and Granger (1987). This method implicitly assumes the uniqueness of the cointegrating vector. It then chooses one of the variables of the system as dependent and applies OLS regression on the static variables taken in level.

Deterministic cointegration : $y_1(t) = \alpha + b y_2(t) + e(t)$, $t = 1,2,\ldots,T$

Stochastic cointegration : $y_1(t) = \alpha + \delta t + b y_2(t) + e(t)$, $t = 1,2,\ldots,T$

where y_1 is an $(T,1)$ vector, y_2 an vector of m variables, β an vector of m parameters, δ a parameter, e a $(T,1)$ vector of white noise.

Cointegration implies that the residuals e from this regression are stationary.

Nevertheless the tool become standard today in macroeconometry for the analysis of the long – run relationships that may arise between a set of variables is the very popular approach of Johansen (1988) and Johansen and Juselius (1990). This approach is based on an estimate through the method of the Maximum Likelihood, under the assumption that errors are independently and identically distributed as a normal distribution. However with the major drawback of being very sensitive to the sample size, in this study we will limit the use of this method to determine the rank of cointegration.

Before proceeding to estimate the long – run parameters, we recall the definition of the real exchange rate and its "fundamentals".

3.1. Definition of the real exchange rate and fundamentals

Constructing the series of the real exchange rate is quite problematic. Indeed, in practice the price indices of tradable and non – tradable goods are not readily available. If the price index of non – tradable goods is generally approached by the domestic consumer price, debates however are more intense for the prices of tradable goods. As part of this study we propose to use the consumer price index of foreign countries and to approach the series of internal real exchange rate by the external real exchange rate. The relevance of this approach is developed quite easily (see box 4 below).

Box 4 : external real exchange rate and internal real exchange rate

Let $BERER$ be the bilateral external real exchange rate between the home country and the foreign partner j :

$$BERER = E^j P / P^j \qquad (11),$$

where E^j represents the bilateral nominal exchange rate between the home country and the foreign partner j, P the domestic price level, P^j the foreign partner j's price level.

We can break down consumer prices as a weighted average of traded and non – traded goods prices :

$$P = (P_N)^{\alpha} \cdot (P_T)^{1-\alpha} \text{ and } P^j = (P_N^j)^{\alpha} \cdot (P_T^j)^{1-\alpha} \text{ with } 0 < \alpha < 1 \qquad (12),$$

where P_N represents the price of non – traded goods, P_T the price of traded goods, α the share of non – tradables goods (assumed to be the same for the home and the foreign country).

(11) and (12) gives :

$$BERER = \frac{(P_N / P_T)^{\alpha}}{(P_N^j / P_T^j)^{\alpha}} \cdot \frac{E^j P_T}{P_T^j} \qquad (13),$$

In the long – run we can assume that the law of one price applies to tradables :

$$E^j P = P^j$$

The ratio P_N / P_T (respectively P_N^j / P_T^j) represents the internal real exchange rate for the home country (respectively for the foreign partener j) :

$$BERER = (IRERD)^{\alpha} / (IRERF)^{\alpha} \text{ with } IRERD = P_N / P_T \text{ and } IRERF = P_N^j / P_T^j \qquad (14)$$

Taking the logarithms of both sides and then differentiating equation (14) gives, for small changes :

$$\frac{\Delta BERER}{BERER} = \alpha\left(\frac{\Delta IRERD}{IRERD}\right) - \alpha\left(\frac{\Delta IRERF}{IRERF}\right) \qquad (15)$$

where Δ represents the absolute change.

In the long run we can assume that, the relative change in the foreign country's internal real exchange rate is proportional to the relative change in the home country's internal real exchange rate :

$$\frac{\Delta IRERF}{IRERF} = k\frac{\Delta IRERD}{IRERD} \text{ with } 0 < k < 1$$

So we obtain :

$$\frac{\Delta BERER}{BERER} = \alpha(1-k)\left(\frac{\Delta IRERD}{IRERD}\right)$$

Therefore, under some assumptions, the relative change in the home country's external real exchange rate is proportional to the relative change in its internal real exchange rate, and, thus, there is a link between the fundamentals and the external real exchange rate.

We use the following fundamentals, those, who, following (10), have the expected effect on the real exchange rate :

Government spending on non – traded goods : measured as the share of government consumption in GDP.

Government spending on traded goods : measured as the share of GFCF in GDP.

Stance of trade policy : like it is common in the literature (Edwards (1989), Baffes, Elbadawi and O'Connel (1999)) we assume that other things being equals, a more liberal trade regime means higher trade volumes. Therefore, we use various ratios of trade to GDP as a measure of the *stance of trade policy*. We experimented with three such proxies : the ratio of total trade (export plus import) to GDP (*open*1), the ratio of import to GDP (*open*2) and the ratio of export to GDP (*open*3). All three performed relatively well, but since the ratio of total trade (export plus import) to GDP (*open*1) gives clearly superior result to other proxies, we retain only this proxy in the analysis reported here.

Trade balance to GDP ratio.

External terms of trade : measured as the ratio of export price index to import price index.

The frequency of data is annual and covers the period 1980 – 2001. They were taken from the International Financial Statistics (IFS) and the World Development Indicator (WDI).

3.2. Determining the order of integration

Beside the use of well known unit root test – *Dickey – Fuller* (*DF*), *Augmented Dickey – Fuller* (*ADF*), *Phillips – Perron* (*PP*), *Bhargava* test (Bhargava (1986)), *KPSS* test (Kwiatkowski**,** Phillips**,** Schmidt et Shin (1992))), we supplement the analysis of the serie of the real exchange rate with the *Zivot – Andrews* test (Zivot and Andrews (1992)). Following the graphical representation of this serie the aim is to give greater flexibility on modeling its deterministic component. Indeed *Zivot – Andrews* test helps to integrate formally the possibility of a rupture trend resulting from the effect of a supposed major exogenous shock. Broadly speaking, this test belongs to the class of unit root test with break introduced by Perron (1989). Its specificity compared to Perron (1989) is to consider the date of break as a random endogenous variable.

The results of these tests were grouped in the following table :

Table 1 : unit root tests

Series	*PP*	*ADF*	*KPSS*		*Bhargava*		*Zivot – Andrews*		
			Mu	*Tau*	*R1*	*R2*	*Intercept*	*Trend*	*Both*
lreer	(1)-2.04**	-1.67	0.75*	0.12***	0.13	0.72	-4.94** (1994)	-2.96 (1987)	-4.75 (1994)
	(2) –4.82*	–4.82*	0.10	0.09	2.37**	2.04**			
lgn	-0.94	-0.63	0.14	0.10	1.32**	0.58			
	-4.63*	-4.74*	0.71	0.13	1.84**	0.97			
lgt	-0.45	-0.16	0.28	0.11	0.98	0.84			
	-7.02*	-6.64*	0.12	0.12	2.69**	2.67**			
b	-1.10	-1.23	0.28	0.12	0.77	0.85			
	-5.59*	-5.53*	0.16	0.07	2.47**	2.52**			
*lopen*1	-2.05**	-2.09**	0.28	0.11	1.15**	1.03**			
ltot	-1.03	-2.36	0.44**	0.58**	0.18	0.49			
	-3.26*	-3.19*	0.16	0.06	1.47**	1.55**			

Notes : * (**, ***) the null hypothesis is rejected at 1% (5%, 10%) level. (1) : level, (2) : First difference. $lreer$ = log real exchange rate, lg_N = log government consumption (percentage of GDP), lgt = log GFCF (percentage of GDP), b = trade balance ratio (percentage of GDP), $lopen1$ = log openness (exportation+importation in percentage of GDP), $ltot$ = log external terms of trade.

The *Zivot – Andrews* test gives an interesting result : in the event of a break in the constant term as well as in the trend and the constant term of the real exchange rate, the selected break point in each case corresponds to the year 1994, when the cfa franc devaluation took place. But despite the rejection of the null unit root hypothesis in the event of a break in the constant term, it seems inappropriate to consider this serie of real exchange rate in level as stationary. Indeed following Johansen, Mosconi et Nielsen (2000), p.217 "an *important finding is that a time series given by stationary fluctuations around a broken constant level is better described by a random walk than a stationary time series*".

So if $I(d)$ represents the order of integration, with these results we concluded in favor of $I(1)$ for series *lreer, lgn, lgt, b, ltot* and $I(0)$ for *lopen1*.

However conditions for the existence of cointegrating relationships are already satisfied. Indeed as noted by Johansen (1995, p.74) "*Thus one can include in the cointegration analysis the variables that are considered economically meaningful as long as they are* $I(1)$ *or* $I(0)$.[...]. *It is this possibility to have unit vectors as cointegrating vectors that force us to have a definition of* $I(1)$ *that allows both* $I(1)$ *and* $I(0)$ *components*".

3.3. Determining the cointegrating rank

Determining the cointegrating rank following the procedure developed by Johansen and Juselius (1990) appears as a generalization to the multivariate case of the Dickey – Fuller unit root test, whose specificity also is to test the null hypothesis of stationarity.

Johansen (1988) proposes two likelihood ratio tests for the cointegrating rank, the *trace* test (λ_{trace}) and the *maximum eigen value* test ($\lambda_{\max}$) :

$$\lambda_{trace} = -T \cdot \sum_{i=r+1}^{N} \log\left(1 - \hat{\lambda}_i\right) \text{ and } \lambda_{\max} = -T \cdot \log\left(1 - \hat{\lambda}_{r+1}\right)$$

where T represents the number of observations, λ_i the i^{th} largest eigen value, r the cointegrating rank, N the number of variables.

Each of these statistics tests the null hypothesis that the cointegrating rank is equal to r against the alternative hypothesis of N cointegrating vectors for the *trace* test and $r+1$ cointegrating vectors for the *maximum eigen value* test. In each case we rejected the null hypothesis when the estimated likelihood ratio statistic is greater than the asymptotic critical value. However the asymptotic distribution of these statistics non – standard under the null hypothesis is quite sensitive to the specification of the deterministic components $D(t)$ of the ECM.

In this study we have made the choice to conduct these tests without imposing linear restriction on the constant term. The Vectorial Autoregressive model (VAR) for the variables in level (respectively in first difference) have been fitted with a lag lenght of $k = 2$ (respectively $p = k - 1$). The results of these tests were grouped in the following table :

Table 2 : *trace* test and *maximum eigen – value* test

i	$\hat{\lambda}_i$	$-TLn(1-\hat{\lambda}_i)$	$\hat{\lambda}_{\max}(0.95)$	$-T\sum Ln(1-\hat{\lambda}_i)$	$\hat{\lambda}_{trace}(0.95)$	
1	0.9463	58.51	39.37	125.11	94.15	$r = 0$ **
2	0.7926	31.47	33.46	66.59	68.52	$r \leq 1$

3	0.5107	14.30	27.07	35.13	47.21	$r \leq 2$
4	0.4664	12.56	20.97	20.83	29.68	$r \leq 3$
5	0.3371	8.22	14.07	8.27	15.41	$r \leq 4$
6	0.0022	0.04	3.76	0.04	3.76	$r \leq 5$

Notes : * (**, ***) the null hypothesis is rejected at 1% (5%, 10%) level. r = cointegrating rank, λ_i = i[th] largest eigen value, λ_{trace} = trace test, $\lambda_{\max}$ = maximum eigen value test.

On the basis of this result we choose to work with the hypothesis of one cointegrating vector, which will be highlighted following the methodology suggested by Engle and Granger (1987).

3.4. The long – run parameters

Table 3 below presents OLS estimates of the static regression. We assume that the long – run relationship (equation (10)) is linear in logarithm :

Table 3 : static regression

lreer	Coefficients	t – student
lgn	0.1182	1.1364
lgt	-0.5790	-3.8548
b	-1.9675	-7.7766
*lopen*1	-0.6965	-2.8100
ltot	0.7653	11.4552
Constant	0.9061	2.3687
	Statistics	
Adjusted R^2	0.91	
DW	2.37	
ADF (BIC=0)	-5.72**	
PP	-5.69*	

Notes : * (**, ***) the null hypothesis is rejected at 1% (5%, 10%) level. $lreer$ = log real exchange rate, lg_N = log government consumption (percentage of GDP), lgt = log GFCF (percentage of GDP), b = trade balance ratio (percentage of GDP), $lopen1$ = log openness (exportation+importation in percentage of GDP), $ltot$ = log external terms of trade.

The statistics of the equation seem satisfactory. The Durbin Watson (*DW*) is most greater than 2, the null hypothesis of unit root in residual from this regression static is rejected by both the *ADF* and *PP* tests. Futhermore, table 4 below indicates that he is homoscedactic, not autocorrelated and distributed according to a Gaussian distribution. In other words according to the standard methodology of Engle and Granger (1987), we reject the null hypothesis of no cointegration.

Table 4 : tests for model adequation on residual of the static regession

Skewness	*Kurtosis*	*Jarque – Bera*	*ARCH(2)*	*Ljung – Box Q(5)*
0.31 (0.57)	0.17 (0.88)	0.39 (0.82)	3.68 (0.16)	4.13 (0.53)

(.) : significativity level.

4. Estimating the degree of misalignment

We have defined the equilibrium real exchange rate as that value of the real exchange rate conditional on a vector of *sustainable* values for the fundamentals (equation (1)). However the construction of *sustainable* values for "fundamentals" is not a trivial exercise. Since the fluctuations in such variables will contain both permanent and transitory components, in the literature it is common to identify the *sustainable* values of these variables by their permanent component. Thus identifying the relevant set of *sustainable* values for the "fundamentals" empirically involves implementing statistical techniques or time series technique. In order to investigate the empirical relevance of this assumption in this study we will consider two scenarios. In the first (*scenario* 1), permanent components were proxied by five – year moving averages. In the second (*scenario* 2), permanent components were proxied by the Hodrick – Prescott filter (Hodrick and Prescott (1997)). Finally the estimated degree of exchange rate misalignment is simply the percentage difference between the actual real exchange rate and the equilibrium real exchange rate :

$$\log e_t - \log e_t^* = \log e_t - \hat{\beta}' \ln F_t^*$$

where e is the actual real exchange rate, e^* is the equilibrium real exchange rate, F^* is the *sustainable* level of "fundamentals", β is the long – run parameter.

We use the long – run parameters reported in table 3 to compute the equilibrium real exchange rate in Gabon and the degree of real exchange rate misalignment between 1980 and 2001 and we will stand that the real exchange rate is overvalued (respectively, is undervalued) if *Misalignment* >0 (respectively, if *Misalignment* < 0)..

The figure 1 below represents the degree of exchange rate misalignment in Gabon under each scenario for the whole period considered in this study (1980 – 2001), this is a relevant measure of the Gabon's real exchange rate misalignment, indeed, while in the literature, we find that real exchange rate overvaluation reduces economic growth (Kuikeu (2011)), this measure of the Gabon's real exchange rate misalignment show that, in Gabon, the real exchange rate is negatively linked to the economic growth :

Figure 1 : Real Exchange Rate Misalignment and economic growth in Gabon

As depicted in the figure the real exchange rate in Gabon is undervalued during the first half of the 1980 decade (1980 – 1985) and rises sharply during the second until 1993. Our calculations imply that during this last period (1986 – 1993) the real exchange rate in Gabon was overvalued by 5.74% and 7.78% on average respectively following scenario 1 and 2. After the devaluation of the cfa franc implemented in 1994 the real exchange rate in Gabon fell sharply. Between 1995 and 2001, our calculations imply that the real exchange rate in Gabon was undervalued by 2.08% and 2.53% on average respectively following scenario 1 and 2.

Because the real exchange rate converges over time towards its equilibrium path, the *Misalignment* must to be stationary variable. The table 5 below reports unit root tests on this variable. Like we can see *Misalignment* is *I*(0).

Table 5 : unit root tests on *Misalignment*

Series	*PP*	*ADF*	*KPSS*		*Bhargava*	
			Mu	*Tau*	*R1*	*R2*
*MIS*1	-3.70*	-3.71*	0.13	0.09	1.83**	1.14**
*MIS*2	-2.85*	-2.83*	0.10	0.09	1.14**	1.22**

Notes : * (**, ***) the null hypothesis is rejected at 1% (5%, 10%) level. *MIS*1 = Misalignment scenario 1, *MIS*2 = Misalignment scenario 2.

Our calculations imply that the half – life[2] is 3 months and 10 months respectively following scenario 1 and 2.

5. Conclusion

The aim of this study was to know if the January 1994 cfa franc devaluation was relevant Gabon, and in the sense that devaluation is relevant only if the real exchange rate is overvalued, we have estimate the degree of Gabon's real exchange rate misalignment. Because, following our calculations, during the whole period before the devaluation (1980 – 1993), the Gabon's real exchange rate was overvalued by 2.73% and 3.29% on average respectively following scenario 1

[2] Because *Misalignment* is stationary, we can stand that $Misalignment_t = \rho^t Misalignment_0 + \varepsilon_t$ where 0 is initial period and the half-life is $\rho^t = ½$, where $t = log(1/2)/log(\rho)$.

and 2, we conclude that the cfa franc devaluation, of January 1994, was relevant for Gabon's economy[3].

[3] For a comparative study, the annex presents the wide variety of authors who have assessed the cfa franc zone's real exchange rate misalignment.

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Annex : empirical literature review

Authors	Country	Method	Variables	Period	Conclusion
Baffes, Elbadawi, O'Connel (1999)	Côte – d'ivoire et Burkina – Faso	Cointegration, Engle and Granger.	GFCF/GDP, trade balance, openness, external term of trade, productivity choc	côte – d'ivoire : 1965 – 1993 Burkina – Faso : 1970 – 1993	Between 87-93 the real exchange rate of Côte – d'Ivoire is overvalued by about 37%, that of Burkina undervalued by about 14%
Devarajan (1996)	12 Cfa countries (Cameroon, Congo, Togo, Gabon, Mali, Côte d'Ivoire, Sénégal, Central African Republic, Niger, Burkina, Benin, Chad)	Computable General Equilibrium Model (CGEM)		1980 – 1994	The Cfa franc is overvalued in 1993 by about 31% in average. Oil producers (Cameroon, Congo, Gabon) were the most overvalued, unlike small economies whose Chad, which displays an undervaluation of its real exchange rate.
Elbadawi and Soto (1998)	8 countries of which côte – d'ivoire and Mali	Cointegration, Engle and Granger	External term of trade, openness, net inflow of capital, public expenditure, public investment, world real interest rate and country risk	côte d'ivoire : 1960 – 1993 Mali : 1968 -1993	The degree of overvaluation in Mali does not seem to be very affirmed during this period prior to the devaluation unlike the situation in Côte d'Ivoire
Kamel and Véganzones (2002)	53 LDC among which 7 Cfa countries	Dynamic umbalanced panel data analysis	External term of trade, openness, net inflow of capital, public expenditure, public investment, external debt service	1970 - 1999	The Cfa franc is overvalud by about 61 % in average between 1975 – 1999 and by about 28 % between 1985 - 1999
Ondo ossa (1992)	13 Cfa countries	PPP (base 1981)		1980 -1990	The Cfa franc is not overvalued during the decade 1980
Sekkat and Varoudakis (1998)	11 SSA countries of which 6 Cfa countries	Panel data anlysis (fixed effect and random effect)	External term of trade, openness, net inflow of capital, excess domestic credit expansion, changes in the official nominal exchange rate	1970 -1992	The Cfa franc is overvalued by an average of 20% in the early 1970. Nevertheless, the magnitude of the distortion decreases considerably during the first half of the observation period, until the early 1980. Then increases significantly between 1983 - 84 until 1993.