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Real Effective Exchange Rate and Standard of Living: Case of Democratic Republic of Congo (DRC)

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Abstract

The aim of our study is to analyze the impact of the real effective exchange rate on the living standards of the Congolese population. Firstly when applied, the Dickey-Fuller test showed that all variables are stationary in first difference. The Johansen test showed that all the variables are co-integrated and that exists a long-term relationship between the variables.

The error correction model (ECM) is applied, and we have seen that the Standard of Living and the real effective exchange rate adjust very slowly, since the convergence rate the Standard of living is about 22%.

According to our analysis, the variation in the real effective exchange rate and the living standards of the Congolese population are inter-related, that is to say, in the DRC when the real effective exchange rate varies of 1%, the GDP per capita increases of 0,00068%. According to the statistical study we have treated, we can conclude that our model is generally satisfactory.

Keywords: Standard of Living, Real Effective Exchange Rate, Stationary, Co-Integration, ECM.
JEL Classification Codes: C59, E29, F33, O49.

Reel Efektif Döviz Kurları ve Hayat Standardı: Demokratik Kongo Cumhuriyeti Örneği[*]

Öz

Bu çalışmanın amacı reel efektif döviz kurlarının Kongo halkının hayat standartları üzerindeki etkisini analiz etmektir. Dickey-Füller Testi'nin ilk sonuçlarına göre bütün değişkenler sabit sonuç vermiştir. Daha sonra yapılan Johansen Testi ise bütün değişkenlerin analizle eş bütünleşme gösterdiğini ve değişkenler arasında uzun dönemli bir ilişki kurulabileceğini göstermiştir. Çalışmada ECM modeli kullanılmıştır ve hayat standardı oranının %22'yi bulmasından sonra incelenen dinamiklerin birbirine uyumu çok yavaşlamıştır. Demokratik Kongo Cumhuriyeti özelinde yapılan analizlerin sonucunda reel efektif döviz kurlarında meydana gelen %1'lik pozitif bir değişimin kişi başına düşen milli gelirde %0,00068'lik bir artış sağladığı gözlemlenmiştir. Uygulamış olduğumuz istatistiksel bilgiler bağlamında çalışma tatmin edici sonuçlara ulaşmıştır.

Anahtar Kelimeler: Hayat Standardı, Reel Efektif Döviz Kuru Oranları, Sabitlik, Eşbütünleşme, ECM.
JEL Sınıflandırma Kodları: C59, E29, F33, O49.

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Bu çalışmanın İngilizce başlık ve özeti, Yayın Kurulu tarafından Türkçe'ye çevrilmiştir.

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1. Introduction

The DRC Government recently celebrated mastery of the macroeconomic aggregates, but there is still great efforts to make in order to control the exchange rate which is seen not only as one of the prominent adjustment tool of the monetary politics, but also an outstanding competitive commercial tool on the international market. However, the DRC is neither listed among the competitive countries of the world nor among the best countries in Africa. This is due to high rate of unemployment; economy shows acute deficit, record of low exportations, and high rate of importation. The DRC currency devaluates progressively, thus the population encounters poverty and employees receive paltry salary while fluctuations of foreign currency ($ USD) is recurrent.

It is worth mentioning that a recurrent fluctuation of exchange rate is a prominent source of production instability in poor countries. The latter constantly affects negatively economic performances which have an impact on resources allocation (Ben Abdallah & Drine, 1999). As DRC is counted among the poorest countries, economically, it is understandable that frequent fluctuations of the exchange rate constitute the principal source of unstable economic growth.

In 2011, inflationist tensions on global level and tense internal political atmosphere plunged DRC into slowdown of 6.5% of the gross domestic product per capita. In 2012, the situation turned worse with 5.1% of falling, and then the situation improved of 6% in 2013. The budget deficits grow at 6.3% of gross domestic product (GDP) in 2011. Due to uncertain political context, the falling is projected at 7.8%of GDP in 2012, with inflation slide rate of 15.1%.The employment of youth and women is still a major challenge for the country. More than 70% of youth aged between 15-24 are unemployed, especially in the big cities because the government hasn't developed yet a real policy favorable for youth employment therefore this push the youth into delinquency. Due to this preoccupying situation, in 2011, the macroeconomic politics limited the net credit allocated to the DRC in order to regulate inflationist pressure and to protect monetary value. Owing to this, the inflation was adjusted from 23.5% in 2010 to 14.8% in 2011. Hence, 1$USD was exchanged at 919.4CDF by the end of 2011. Whereas, 1$USD was exchanged at 915.1 CDF by end of 2010 with depreciation of 0.5%. It is important to note that in 2011, the World Bank cancelled the remaining debt thanks to the DRC efforts of reducing considerably its due in 2010. However, the public finances showed deficit 6.3% of GDP by the end of 2011 due to weak mobilization of income and overlap of expenses because of the electoral process. Because of the projections related to weak growth and fragile political context, the budget deficit would represent 7.8% of GDP in 2012. This may cause inflation slide of 15.15 and occasion exchange rate of 1$ USD at 942.5%. The DRC commercial balance is negative due to excessive importations than exportations. This is one of the motives that justify ascendance of foreign

currency on the local ones. For instance, the DRC currency (CDF) has constantly lost its value for decades. In 1997, 1$ USD was equivalent to 0.5 CDF and in February 2014, 1$ USD was equivalent to 931CDF. In a fork of 17 years, the CDF devaluated of 1861% in comparison to $USD. Due to this devaluation, and monetary instability, most of DRC economists decided to import products in USD or its equivalent.

This article aims at studying the impact of American dollar exchange rate variation on the CDF in relation to growth of DRC economy.

As far as international competition is concerned, the recent improvement of macroeconomic stability and the budget situation has positive effects on the climate of affairs, though some factors impede economic development process. Other Factors than real effective exchange rate play a preponderant role. As far as international classification of competitive countries is redundant, the DRC is on the bottom list because of corruption, administrative complexity and good governance anxiety which lead to fake fiscal politics characterized by inefficiency, lack of energetic supply friability, bad conditions of transport network and social services, then weak level of human capital constitute a serious obstacle to development of exportation sector independent to natural resources (FMI , 2013).

The private capital flux from foreign countries increased in 2011 differently from 2010. Consecutively to efforts related to restoration of global economy on the course of raw materials, direct foreign investments (DFI) increased from 1.501 to 1.649 million of $USD from 2010 to 2011. But it would decrease in 2012 because of the troubled interior political context. Development Assistance also decreased from 2010 to 2011 shifting from 14.1% to 8.9% of GDP, and would fall at 6.6% of GDP in 2012[1].

Owing to this, the following question raised: *What is the impact of Congolese currency devaluation on DRC population?*

Hypothetically, we can say that the CDF is evaluated of one point according to American dollar, the gross domestic product per capita increases of slight proportion than CDF. When the DRC currency devaluates of 1% according to American dollar, the real gross domestic product per capita decreases of a given point.

This article aims at proposing some response in order to stabilize the exchange rate. To reach this objective, three essential points will be tacked. Apart from the introduction and conclusion, the first section of the article will deal with the relationship between exchange rate and gross domestic product per capita.

The second section will present variables and model, and then the third section will deal with the econometric study and presentation of results.

2. Review of Literature

Many empiric studies have been made on relationship between exchange rate and real gross domestic product per capita. There are several empirical studies on the same subject but in different country contexts. Many of these studies raise negative relation between variability of exchange rate and economic growth (Bosworth et al., 1995). There may be long-term consequences that go beyond the impact commonly practiced the short-term at competitiveness of companies in the considered country. Very sensible overvaluation may slow down economic growth while undervaluation, without being excessive, would speed up (Razin & Collins, 1997).

Large movement related to real effective exchange rate is associated to a considerable uncertainty as far as prices are concerned. Hence this situation leads to big risks and to very short term investments. As a matter of fact, this situation leads to very high adjustment costs: A backing in production, a movement of exchangeable sector towards non-exchangeable one with growing volatility of interest rate conveys to financial instability. This exchange rate adjustment being often an unfavorable overvaluation of exchangeable activities is largely sited in economic performance study as ill-fated (Edwards, 1988; Cottani et al., 1990; Ghura & Grennes, 1993; Sekkat & Varoudakis, 1998). This may reduce economic efficiency, bad allocation of resources, weak profitability in industries where relative prices are reduced. This phenomenon captures our attention as important resource of macroeconomic imbalance whose correction is one of crucial condition to improve economic performance and to insure macroeconomic stability (Domac & Shabsigh, 1999). Politics aimed at stabilizing the real effective exchange rate to requisite realistic level, through this mechanism, it encourages economic growth. It is worth sustaining that the more ill-fated the instability of real exchange rate was on exportation growth of South American countries, the worse their stability was centered to promote expansion of East-Asian countries, in Maghreb, studies reveal different economic growth's profile expanded on the period 1966-2003. Though siding with production extravert strategies, the real effective variation does not affect economic growth in Morocco and in Tunisia (Ziadi & Abdallah, 2007). Ontario economic is very sensible to variations of real exchange rate. Provinces of Atlantic and British-Columbia show very weak and insignificant sensibility. The impact in Quebec and in the Prairies is significant and is generally located between the two (Bourque & Gaudreault, 2004). Thanks to econometric techniques, studies achieved on a panel of developing countries reveal, on one hand, a relation of causality of the nominal exchange rate through the product and its different components; and on the other hand, a secessionist effect of nominal exchange rate depreciation (Drine & Rault, 2007)

We can also cite a large body of literature on the impact of exchange rate on standard of living see Balassa (1964), Samuelson (1964), Freedman (1977) and Stuber (1983). For a recent literature review, see Asea & Corden (1994), Froot & Rogoff (1995), Gullickson (1995), Amano & Van Norden (1995), Djoudad & Tessier (1999), Murray & Antia (1999), Dupuis & Tessier (1999), Diewert & Nakamura (2000) and Coudert (2004).

3. Empirical Study

3.1. Specification of Model

The choice of our variables was inspired by the gross domestic product per capita (GDP) which distinctly depicts evolution of the population living condition level at a given moment. As far as our study is concerned, the variable depending upon Congolese GDP per capita from 1980 to 2012. Our independent variables are REER, EGR, ER and IR. The latter have been chosen because we aim at analyzing the behavior of GDP per capita as far as the real effective exchange rate' variation is concerned. In other words, we would like to learn more about GDP reaction when the CDF is appreciated or disappreciated according to American dollar. Being aware that the DRC economy is extravert, we have chosen the importation and exportation rate variables according to GDP. Our theoretical model as follows:

$$GDP = f\ (REER^{(+)}, EGR^{(+)}, ER^{(-)}, IR^{(+)}) \quad (1)$$

In other words, the GDP per capita is growing according to economy's growth and importation of goods and services grows according to GDP. But GDP per capita decreases according to the exportation rate of goods and services in relation to GDP and real effective exchange rate. Theoretically, exchange instability can also well produce positive or negative effects. It is worth dealing with deep econometric techniques to prove it when making empiric analysis.

Assuming that a linear relation between variables, our model will be transcribed as follows, according to GLS approach:

$$\log(\mathrm{GDP}_t) = c_1 + c_2 REER_{t-1} + c_3 \mathrm{EGR}_t + c_4 \log(\mathrm{ER}_t) + c_5 \log(\mathrm{IR}_t) + \varepsilon_t \quad (2)$$

With:

GDP_t : Gross domestic product per capita
EGR_t : Economic Growth Rate
$REER_{t-1}$: DRC real effective exchange rate delayer of 1 year
ER_t : Exportation rate related to GDP

IR_t : Importation rate related to GDP

log : Natural Logarithm

According to the shape of our real effective exchange rate, increase of variation means appreciation of CDF according to foreign currency (American dollar), while opposite indication shows depreciation. Consequently, if the coefficients associated to real effective exchange rate are negative, appreciation of CDF would increase the GDP and would increase possibilities of importing goods and services. Our expectations from the DRC economic growth associated to the increase of Congolese GDP. Finally, we anticipate that if the coefficient associated to variables of goods and service expectation, the Congolese GDP will be negative.

3.2. Statistics Data

In this analysis, we are going to use temporary variables coming from World Bank data base. For DRC, we have used data related to the GDP, rate of economic growth (EGR), real effective exchange rate (REER), importation rate(IR) according to GDP, exportation rate (ER) related to GDP. Our study covered on a sample of annual data covering the period 1980-2012. This temporary choice was motivated by availability of DRC and USA data fetched from World Bank data base. Our variables will be presented in graphics.

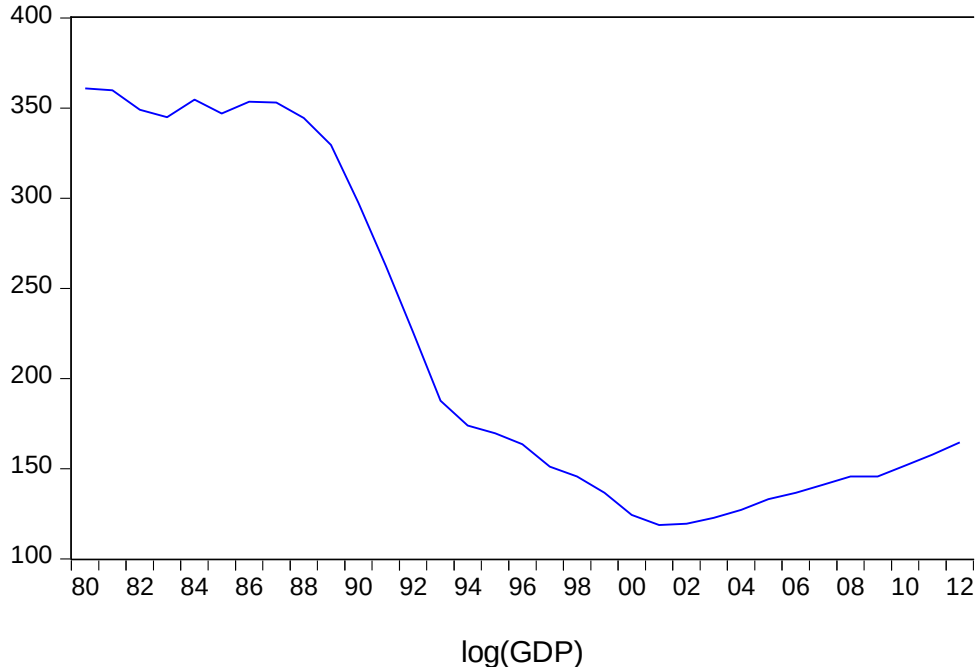


Figure 1: Gross Domestic Product per Capita (GDP)

According to the graphic, the DRC population living condition is characterized by the gross domestic product (GDP). This curve describes the level of DRC population living condition's variation between 1980 and 2012. Statements show that the DRC population' living condition collapsed from 1980 to 2001 before starting improving in 2012. Between 1980 and 2001, the GDP decreased of 67.12% while the living condition of DRC of 1980 was estimated at 67.12 times excellent than in 2001. Comparing the living condition level of DRC in habitants of 1980 to that of 2012, we remark that the GDP of 1980 was at 54.41 times superior to that of 2012. In other words, the DRC population faced misery in 2012 comparatively to the one of 1980.

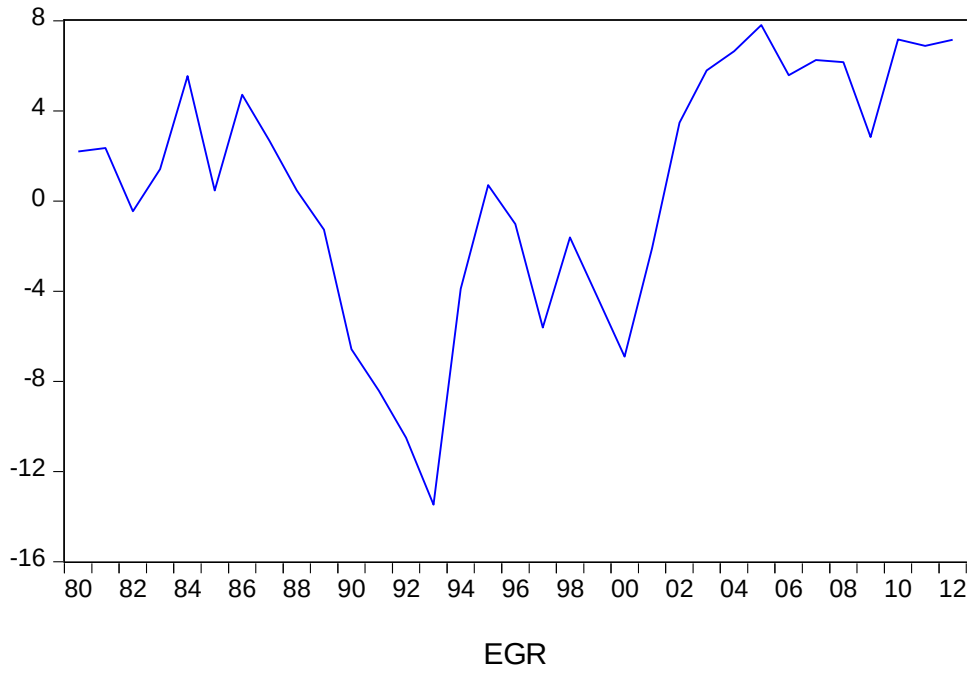


Figure 2: Economic Growth Rate (EGR)

This graphic presents evolution of DRC economic growth rate from 1980 to 2012.

The rate of economic growth was 2.19% in 1980 before reaching 2.35% in 1981. Shortly after this period, the growth reached -0.46% before up to peak of 5.54% in 1984. Then, it collapsed at 0.47% in 1985 before reaching peak of 4.72% in 1986. Since then, the DRC economy collapsed down to -13.47% in 1993. This is the worse situation the DRC economy has never reached since 1980. From 1994 to 2012, the DRC economic growth curve is sinusoidal. This means that it faced peaks and bottom level in 2005.

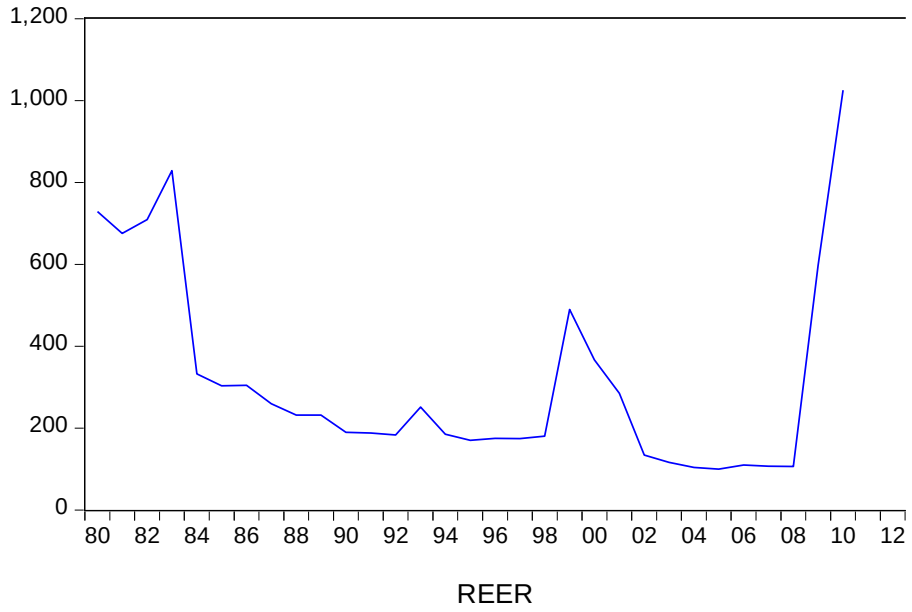


Figure 3: Real Effective Exchange Rate (REER)

This graphic presents evolution of real effective exchange rate (REER) indexed (2005=100) between 1980 and 2012. The real effective exchange rate curve above mentioned describes continued fluctuation of the variable. Taking into account 2005 as the reference point of the variable. The latter passed from 728.65 CDF in 1980 to 1025.26 CDF in 2010 according to American dollar exchange rate of 2005. Note that our analysis is spread from 1980 to 2012 through 2011 and 2012 data are not available in the World Bank data base.

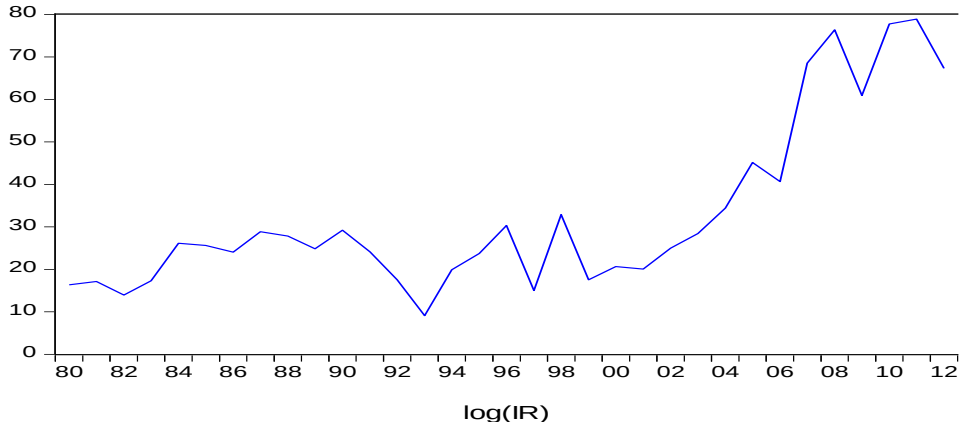


Figure 4: Importation Rate Related to Gross Domestic Product (IR)

The curve shows that in 1980, importations presented 16.36% of GDP in the DRC.

7 years later (1987), importations swung to 28.86% of GDP in the DRC. In 1996, the DRC importations represented 30.31% of GDP with increase of 13.96% in 16 years (1980-1996). In 2005, 2008, 2011 and 2012, the DRC importations swung respectively to 45.15%; 76.39%; 78.91% and 67.33% according to GDP. Importations increase of 50.98% of GDP between 1980 and 2012. Evolution of this curve proves that DRC economy is largely open to foreign countries.

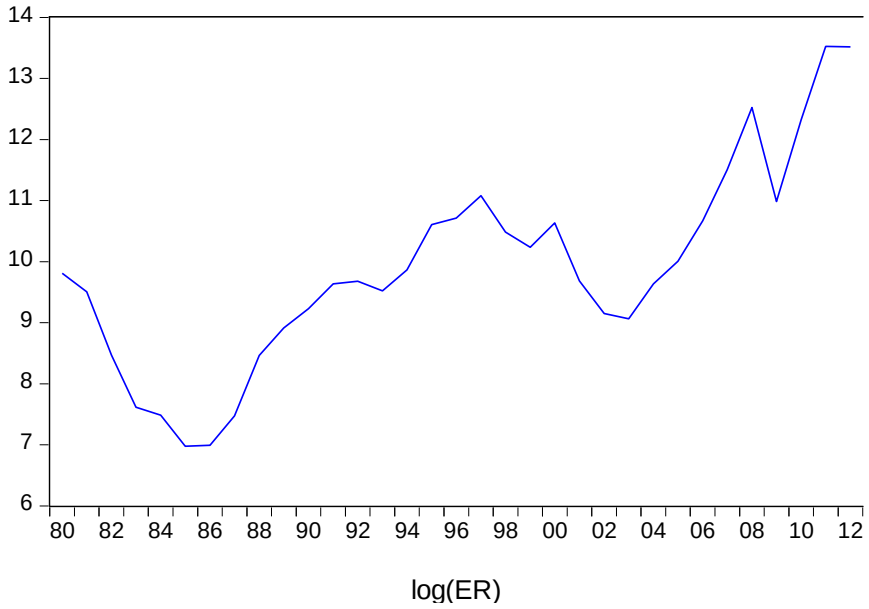


Figure 5: Exportation Rate Related to Gross Domestic Product (ER)

3.3. Unit Root Tests

There are many unit root tests. The pioneering work in this area are those of Fuller (1976) and Dickey & Fuller (1979.1981). The Dickey-Fuller tests are parametric, this tests highlight the character of a stationary or not of a chronic with identifying, a deterministic trend or stochastic. These tests are based on an estimate of an autoregressive process.

Dickey and Fuller consider three basic models for the series:

- Model (1) model without constant or deterministic trend

$$X_t = \rho X_{t-1} + \varepsilon_t \quad (3)$$

- Model (2): model with constant and non-trend

$$X_t = \rho X_{t-1} + b + \varepsilon_t \quad (4)$$

- Model (3): model with constant and trend

$$X_t = \rho X_{t-1} + at + b + \varepsilon_t \quad (5)$$

In all three models, we assume that $\varepsilon_t \longrightarrow WN(0, \sigma_\varepsilon^2)$, (WN : White Noise)

The test principle is:

$H_0 : \rho = 1$: Presence of a unit root; the series is non-stationary.

$H_0 : |\rho| < 1$: Absence of unit root; the series is stationary.

If $H_0 : \rho = 1$ is accepted in one of these three models, then the process is non-stationary.

The test strategy is sequential; we start from the model (3) to the model (1). In our study we will apply the ADF test and we determined the number of lags using partial autocorrelation function. The application of this method based on the study of correllogramme for different variables in equation (2), we obtained the lags for all variables.

To identify integration order of variables, we applied the test of Dickey and Fuller (ADF). The first step of it is to determine the amount of delay that should be considered for regression. Campbelle & Perron (1991) suggested a procedure which consists of starting by maximal delay (fixed in advance) then tests it in successive regression. The meaning of coefficients associated to last delay is to maintain as superior limit, the first significant delay.

By comparing the ADF statistic (Table 1) with the critical value of ADF for a significance level of 5% and 10%. This comparison shows that the null hypothesis of no stationarity is accepted for the variables in level (Gross domestic product per capita, Economic growth rate, Real effective exchange rate, Importation rate, Exportation rate), by cons we see that the hypothesis null is rejected for the same variables in first differences (Table 1).

The series $(\Delta \log(GDP_t), \Delta REER_t, \Delta EGR_t, \Delta \log(ER_t), \Delta \log(IR_t))$ are then integrated of order 1, since the first difference of each of these variables is stationary I (0).

Note that we have accepted the stationary of the first difference of the variable GDP per capita to a significance level of 10%. We took this threshold

signification so that all variables are integrated of the same order. For this we can apply the method of co-integration of Granger.

Table 1: Augmented Dickey-Fuller Test

Variables	**Lag**	**ADF**	**Order of integration**	**Conclusion**
$\log(GDP_t)$	1	-1.42*	I(1)	NS
$\Delta\log(GDP_t)$	1	-1.64**	I(0)	S
$REER_{t-1}$	1	-0.48*	I(1)	NS
$\Delta REER_{t-1}$	1	-3,67*	I(0)	S
EGR_t	1	-1.63*	I(1)	NS
ΔEGR_t	1	-5.58*	I(0)	S
$\log(ER_t)$	1	0.94*	I(1)	NS
$\Delta\log(ER_t)$	1	-4.56*	I(0)	S
$\log(IR_t)$	1	1.11*	I(1)	NS
$\Delta\log(IR_t)$	1	-7.40*	I(0)	S

*significance level of 5%,** significance level of 10%
NS: non stationary, S: stationary, I(0): stationary in level, I(1): stationary in first difference

3.4. Co-integration Tests

In the purpose of testing the amount of co-integration in this system at five variables, we will refer to Johansen's co-integration test. The optimal amount of delay to integrate our model is determined according to Akaike's information criteria, Schwarz and Log likelihood. The likelihood test (RL) allows us to adopt three delays as described in Table 2.

In this kind of procedure, it is very complicated to introduce or to see non determinist components in the co-integration vector. In fact, bad identification of long term relation may lead to false conclusion on the nature of dynamic which characterizes movement of different variables. Hence a preliminary exercise consists of identifying the subjacent model. According to this, Johansen (1991) developed sequential procedures to identify the real model. Applying this procedure, we come to the conclusion that the co-integration relationship with 5 variables is characterized by one constant. The test allows us to reject the hypothesis of determinist trend.

Table 2: Test Log Likelihood (RL)

Data Trend: Rank or	None No Intercept	None Intercept	Linear Intercept	Linear Intercept	Quadratic Intercept
No. of CEs	No Trend	No Trend	No Trend	Trend	Trend
Log Likelihood by Model and Rank					
0	-83.33358	-83.33358	-76.46610	-76.46610	-70.88418
1	-69.83514	-63.30941	-58.58071	-55.74069	-50.40748
2	-59.89893	-50.59097	-46.65401	-41.60503	-36.53039
3	-53.51307	-40.86094	-37.32115	-30.46244	-25.49134
4	-49.85876	-36.32106	-33.45312	-21.12967	-18.36750
5	-49.07463	-33.28075	-33.28075	-17.70813	-17.70813
L.R. Test:	Rank = 2	Rank = 2	Rank = 2	Rank = 4	Rank = 3

By the applied of the Maximum Eigen value test, we can detect the number of co-integration vectors. The hypothesis of this test is:

H_0 : There are at most r co-integrations vectors

H_1 : There are at least r co-integrations vectors

When the statistical Maximum Eigen value (Max-Eigen) is below the critical values at a significance level, we accept H_0 ; otherwise we reject H_0. This test is applied sequentially from r = 0 to r = k-1.

Table 3 : The Johansen Test

Eigen values	Max-Eigen Statistic	Critical Value	Hypothesis on the number of EC
0,70	35,77	33,87	None
0,56	23,85	27,58	At most one
0,47	18,66	21,13	At most two
0,23	7 ,73	14,26	At most three
0 ,01	0,34	3,84	At most four

First we test the hypothesis that the number of co-integration vectors is strictly zero (r = 0) (column Max-Eigen statistic, Table 3).

We note that the statistics of the Max-Eigen for r = 0 is 35,77 which is greater than the critical value is 33,.87, which leads us to reject H_0.

We then test the hypothesis that the number of cointegration vectors is strictly equal to one (r = 1). Statistics of Max-Eigen for r = 1 is 23,85 which is lower than the critical value (27.58), which brings us therefore to accept H_0.

With The tests Maximum Eigen value of the Johansen, we conclude that there is one co-integration relationship between the five variables.

3.5. Estimation ECM Model

After we examined the stationarity of the series and co-integration among the variables, we turn to the estimation stage of the model coefficients, but prior to this step, we must verify that the single co-integration relationship is an equation of public spending and thus the other variables are weakly exogenous. For this purpose, we performed a simple test for exogeneity from the estimated VECM model using the Johansen method. This test is carried out through adjustment coefficient associated with the co-integration vectors.

From Table of VECM (Table in appendix), we find that the adjustment parameters associated with the vector co-integration (speed adjustment) are not significant except for the Economic Growth Rate, this allows us to say that the variables GDP per capita , Economic Growth Rate, Exportation rate and Importation rate are weakly exogenous

Otherwise, the Economic Growth Rate is not weakly exogenous. The weak exogeneity test, we cannot therefore say that the equation (2) above is an equation written in GDP per capita.

After the test of weak exogeneity, we address the step of estimating the parameters of the equation GDP per capita, according to Engle & Granger (1987); the simple method of estimating the long-term relationship between GDP per capita , and the variables Economic Growth Rate, Exportation rate, Importation rate and real effective exchange rate is to apply the method of ordinary least squares (OLS) regression using Eviews 8 software.:

$$\log(\mathrm{GDP}_t) = \underset{(13.52)}{9.02714} + \underset{(3.36)}{0.00068 REER_{t-1}} - \underset{(-2.41)}{0.03343 \mathrm{EGR}_t} - \underset{(2.08)}{2.25899 \log(\mathrm{ER}_t)} + \underset{(-5.89)}{0.35149 \log(\mathrm{IR}_t)} + e_t \quad (6)$$

$$R^2 = 68,24\% \qquad F-Statistic = 13,96 \qquad \mathrm{Pr}ob(F-Statistic) = 0 \qquad DW = 0,52$$

Our estimate of long term relation through method of little ordinary squares shows that at long term level. DRC population living condition is increasing according to real effective exchange rate, of importations rate of goods and services related to IPP while it is decreasing according to exportation rate of goods and services

related IPP and to DRC economic growth rate. The sign found by this model of long term are contrary to expectations of REER and EGR variables, whereas it is still the same to two variables: IR and ER. The values into parenthesis represent the t of calculated student. Both show that variables are significant at critical level of 5% adjusted determination coefficient(explicative power) at 63.35% prove that our independent variables explain significantly the behavior of long term independent variables.

It is worth mentioning that when the real effective rate increases of 1%, the GDP per capita also increases of 0.00068%.When the latter decreases of 1%, the level of living condition of DRC population decreases of 0.00068%.When the growth rate varies of 1%, the level of DRC population living condition decreases of 0.03343%.When the exportation rate of goods and services related to GDP increases of one point, the GDP of DRC population living condition decreases of 2.25899%. When the importation rate of goods and services related to GDP varies of 1%, the level of DRC population living condition increases of 0.35149%.

The study of the relationship of short-term through ECM, allows us to analyze , in one hand, the speed of convergence of real exchange rate towards its equilibrium level of long term and, in other hand, the contribution he contribution of the fundamentals to the short-term dynamics. This brings us to test the significance of the equation parameters following short-term.

$$\Delta\log(\mathrm{GDP}_t) = \phi z_{t-1} + \sum_{i=0}^{p} a_i \Delta\mathrm{REER}_{t-i} + \sum_{i=0}^{p} b_i \Delta EGR_{t-i} + \sum_{i=0}^{p} c_i \Delta\log(\mathrm{ER}_{t-i}) + \sum_{i=0}^{p} d_i \Delta\log(IR_t) + \varepsilon_t \quad (7)$$

With

$$Z_{t-1} = \log(\mathrm{GDP}_{t-1}) - (9.02714 + 0.00068\,\mathrm{REER}_{t-1} - 0.03343\,\mathrm{EGR}_t - 2.25899\log(\mathrm{ER}_t) + 0.35149\log(\mathrm{IR}_t) + e_t) \quad (8)$$

With Z_{t-1} is the residual of the co-integration relationship, and the error correction term (the adjustment term).

The ECM of the equation of our model by the approach of Granger:

$$\Delta\log GDP_t = 0{,}10 - 0{,}22Z_{t-1} + 0{,}15\Delta\log GDP_{t-1} + 0{,}24\Delta REER_{t-1} - 0{,}009\Delta\log(IR_t) + 0{,}16\Delta\log(ER_t) + 0{,}02\Delta EGR_t + e_t \quad (9)$$

We find that the coefficient associated with the restoring force is negative (0.22) and significantly different from zero at 5%. There is therefore a mechanism for error correction. This mechanism indicates the convergence of trajectories of the

series of Standard of Living towards long-term target. Thus, the impact on Standard of Living of DRC is correct to 22% by effect of feedback.

To implement the robustness tests on residuals, stability coefficients, we taken the following steps:

i) using the Chow test for testing the stability of the coefficients (equalities between the coefficients). This test can be practiced only after determining the sub-periods.

To this end, we'll take two sub-periods:

First Period: 1980-1996, which 17 observations
Second Period: 1997-2012, which 16 observations.

We recall that this test is based on the following statistic:

$$\text{Chow} = \frac{RSS - RSS_1}{RSS_1} \frac{T_1 + T_2 - 2K}{2K} \rightarrow F(K,\ T_1 + T_2 - 2K) \quad (10)$$

RSS is the sum of squared residuals for all observations (33 observations), RSS_1 is the sum of squared residuals for the first sub-period and K: the number of variables.

Under H_0 : equal coefficients against H_1: instability of the coefficients,

The application of this test gives us the following result:

$$\text{Chow}^c = 11,95 > F^t(5\ ,\ 23) = 2.64$$

According to the Chow test, we can conclude that the coefficients are unstable.

ii) The residues of our empirical model meet four conditions: normality, stationary, homoscedasticity and independence between the residues.

- The residues are actually distributed as a normal distribution, the Jarque-Bera test
- Accepts the null hypothesis of normality ($JB = 0,20 < \chi^2_{0,05}(2) = 5,99$)
- The ADF test on residues confirms the stationarity of the residues using the table as critical values of Engle & Yoo (1987) (ADF = -2.89 estimated is less than the tabulated value which is equal to (-2, 67).
- The ARCH test accepts the null hypothesis and the homoscedasticity rejects the alternative hypothesis of heteroscedasticity. The result of this test is in Table 4.

Table 4: Heteroskedasticity Test (ARCH)

F- Statistic	11,48	Prob F(1,28)	0,002
Obs*R-Squared	8,72	Prob.Chi Square(1)	0,003

- The Durbin-Watson (DW) confirms the dependence of the errors ($DW = \breve{d} = 0,52$; $\breve{d} \prec d_L$)

iii) To confirm that this relationship is generally stable, several tests can be used: tests of recursive residuals, CUSUM and CUSUM squares. This last test we will apply:

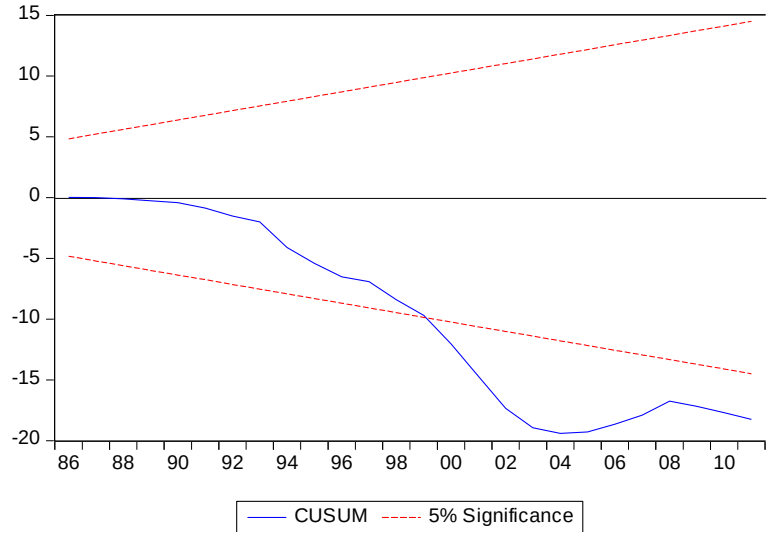


Figure 6: CUSUM Test Applied to the Model Coefficients

We observe in Figure 6 that the CUSUM leaves the interior corridor from 1999.

This test allows us to say that the relationship is unstable.

iv) The explanatory power in our model is 68%, This allows us to say that the Real effective Exchange Rate, the Economic Growth rate, the Importation rate and the Exportation rate explain GDP per capita during the study period. The probability of F-statistic (Prob(F-Statistic)) is less than 0.05, this indicates that our model is acceptable

According to the statistical study we have treated, we can conclude that our model is generally satisfactory.

3.6. Granger Causality Test

In this section, we will see if Standard of Living causes the real effective exchange rate? Where real effective exchange rate causes the Standard of Living, where there is a feedback relationship between the two? To answer this question, we will apply the test of Granger causality. The principle of causality is as follows.

We say X causes Y if the prediction based on knowledge of past joint X and Y is better than the prediction based on knowledge of the single Y

The tests are applied to non-causality which is based on statistics of maximum likelihood:

$$\xi = TC_{X \to Y} \tag{11}$$

Where T and $C_{X \to Y}$ represents respectively the number of observation and measurement of causality

Under the null hypothesis of no causal expression (11) follows a chi-square of $\tau(T-\tau)p$ degree of freedom with τ is the number of constraints imposed. The decision rule is:

- If $\xi < \chi^2_{(\tau(T-\tau)p)}$, we accept the null hypothesis of no causality
- If $\xi > \chi^2_{(\tau(T-\tau)p)}$,, we reject the null hypothesis of no causality

The result of the application of Granger causality test is summarized in the following table:

Table 5: Granger Causality Test

The Null Hypothèses	F Statistic	Prob.
The real effective exchange rate does not cause Standard of Living	2,66	0,08
the Standard of Living does not cause the real effective exchange rate	0,39	0,67

According to Table 5 of causality, we see that the probability of the F statistic "The real effective exchange rate does not cause Standard of Living" is equal to

0.08 < 0.10: we then accept H_1, The real effective exchange rate causes the Standard of Living.

The probability F is "the Standard of Living does not cause the real effective exchange rate" is equal to 0.67> 0.05: we then accept H0, the Standard of Living does not cause the real effective exchange rate. There therefore has a unidirectional causal relationship between the Standard of Living and the real effective exchange rate.

4. Conclusion

The aim of our study is to analyze the impact of the real effective exchange rate on the living standards of the Congolese population with the focus on the gross domestic product per capita.

First, the Dickey-Fuller test is applied to prove the stationarity of the variables using random walk with drift and stochastic trend, and we have found that all the variables are not-stationary. For to this reason, the Johansen test is applied to check whether the variables are cointegrated or not. it was found that all variables have a long-term equilibrium relationship. To this end, there must be an association in the short term. The error correction model (ECM) is applied, and we have seen that Standard of Living and the real effective exchange rate adjust very slowly, since the convergence rate the Standard of living is about 22%.

According to our analysis, it is worth noting that there is increasing relationship between the DRC population living condition level and the real effective exchange rate; i.e. when the real effective exchange rate varies of 1%, the GDP of DRC increases of 0.00068%. The explanatory power in our model is 68%, This allows us to say that the Real effective Exchange Rate, the Economic Growth rate, the Importation rate and the Exportation rate explain GDP per capita during the study period. The probability of F-statistic (Prob (F-Statistic)) is less than 0.05, this indicates that our model is acceptable. According to the statistical study we have treated, we can conclude that our model is generally satisfactory.

We found that there is a unidirectional causal relationship between the Standard of Living and the real effective exchange rate using the Granger causality test.

Finally, this study has helped us to predict the nature of the relationship between the exchange rate and the level of life, where economic policy should focus on the choice of exchange rate policy optimal.

Moreover, as some questions are left without any answer, it will give us the motivation to continue our research on modeling the exchange rate, and on the other estimation methods.

Appendix

Vector Error Correction Estimates
Date: 09/06/14 Time: 21:46
Sample (adjusted): 1984 2011
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
GDP(-1)	1.000000
REER(-2)	-0.001617
	(0.00025)
	[-6.50261]
EGR(-1)	-0.049138
	(0.03807)
	[-1.29077]
IR(-1)	-0.463212
	(0.09802)
	[-4.72588]
ER(-1)	2.008658
	(0.27074)
	[7.41927]
C	-7.808742

Error Correction:	D(GDP)	D(REER(-1))	D(EGR)	D(IR)	D(ER)
CointEq1	-0.099856	406.1946	-9.585605	0.169987	0.129492
	(0.05218)	(311.623)	(4.88114)	(0.59388)	(0.12505)
	[-1.91379]	[1.30348]	[-1.96380]	[0.28623]	[1.03556]
D(GDP(-1))	6.568465	8525.616	500.2611	30.02350	1.287600
	(2.12483)	(12690.3)	(198.776)	(24.1848)	(5.09226)
	[3.09129]	[0.67182]	[2.51670]	[1.24142]	[0.25285]
D(GDP(-2))	-6.243713	-3843.872	-563.9699	-24.89160	0.316842
	(2.37459)	(14182.0)	(222.141)	(27.0276)	(5.69083)
	[-2.62939]	[-0.27104]	[-2.53879]	[-0.92097]	[0.05568]
D(REER(-2))	-0.000134	0.715572	-0.013197	-0.000436	2.20E-05
	(5.6E-05)	(0.33669)	(0.00527)	(0.00064)	(0.00014)
	[-2.38064]	[2.12529]	[-2.50237]	[-0.67940]	[0.16301]
D(REER(-3))	4.39E-05	0.353770	0.004640	0.000903	2.68E-05
	(7.4E-05)	(0.44338)	(0.00694)	(0.00084)	(0.00018)
	[0.59079]	[0.79790]	[0.66816]	[1.06883]	[0.15065]
D(EGR(-1))	-0.062349	-43.60764	-5.655044	-0.219805	0.003702
	(0.02493)	(148.881)	(2.33201)	(0.28373)	(0.05974)
	[-2.50115]	[-0.29290]	[-2.42496]	[-0.77469]	[0.06196]
D(EGR(-2))	0.000182	0.246917	-0.011455	0.010596	0.005951
	(0.00231)	(13.8042)	(0.21622)	(0.02631)	(0.00554)
	[0.07875]	[0.01789]	[-0.05298]	[0.40279]	[1.07442]
D(IR(-1))	-0.114303	-225.5666	-10.75453	-1.266599	-0.060788
	(0.03160)	(188.739)	(2.95633)	(0.35969)	(0.07574)
	[-3.61699]	[-1.19513]	[-3.63780]	[-3.52135]	[-0.80264]
D(IR(-2))	-0.086361	-108.4043	-8.207751	-0.706231	-0.127078
	(0.03451)	(206.110)	(3.22842)	(0.39280)	(0.08271)
	[-2.50248]	[-0.52595]	[-2.54234]	[-1.79795]	[-1.53650]

D(ER(-1))	0.163626	-1434.674	14.14755	0.910385	-0.027756
	(0.13451)	(803.341)	(12.5832)	(1.53098)	(0.32236)
	[1.21647]	[-1.78588]	[1.12432]	[0.59464]	[-0.08610]
D(ER(-2))	-0.000670	-380.0452	-0.454649	-1.759214	-0.127524
	(0.15204)	(908.022)	(14.2229)	(1.73048)	(0.36436)
	[-0.00441]	[-0.41854]	[-0.03197]	[-1.01661]	[-0.34999]
C	-0.007983	202.3484	-0.695515	0.328112	0.079118
	(0.01870)	(111.654)	(1.74891)	(0.21279)	(0.04480)
	[-0.42701]	[1.81227]	[-0.39769]	[1.54198]	[1.76588]
R-squared	0.877576	0.446366	0.701220	0.526123	0.293481
Adj. R-squared	0.793409	0.065743	0.495809	0.200333	-0.192251
Sum sq. resids	0.012986	463200.2	113.6455	1.682315	0.074584
S.E. equation	0.028489	170.1470	2.665116	0.324260	0.068275
F-statistic	10.42662	1.172724	3.413738	1.614914	0.604204
Log likelihood	67.73513	-175.7222	-59.34259	-0.361810	43.26226
Akaike AIC	-3.981081	13.40873	5.095899	0.882986	-2.233018
Schwarz SC	-3.410136	13.97967	5.666844	1.453931	-1.662073
Mean dependent	-0.027934	11.27929	0.195357	0.054221	0.020523
S.D. dependent	0.062679	176.0318	3.753345	0.362609	0.062529

Determinant resid covariance (dof adj.)	0.000104
Determinant resid covariance	6.32E-06
Log likelihood	-31.05377
Akaike information criterion	6.860984
Schwarz criterion	9.953601

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Notes

Not 1. http://www.africaeconomicoutlook.org