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UDK: 657.411.4:336.02(674)
DOI: 10.2478/jcbtp-2019-0014

Journal of Central Banking Theory and Practice, 2019, 2, pp. 65-83
Received: 13 February 2018; accepted: 30 March 2018

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Forecasting CEMAC's foreign exchange reserves in presence of unanticipated changes in oil prices: an interrupted time series modelling

Abstract: The foreign exchange reserves of the Central African Economic and Monetary Community (CEMAC) countries have decreased since the fall of world oil price that began in July 2014. In fact, five of the six of the CEMAC countries are oil producers. Based on interrupted time series modeling, the analysis shows that the unanticipated changes in oil prices immediately led to a decline in the level of their foreign exchange reserves. The trend is also decreasing. The model predicts a continued degradation of these reserves if oil prices remain low. In these conditions, the CEMAC could experience a currency crisis if economic policies implemented in this region do not lead to a return of economic growth.

Key Words: oil prices, CEMAC countries, foreign exchange reserves, interrupted time series analysis.

JEL classification: E4; E5; E6.

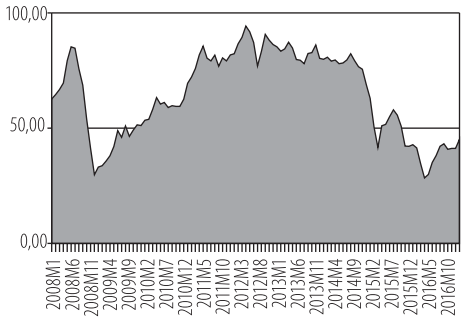
1. INTRODUCTION

Five of the six countries of the Central African Economic and Monetary Community (CEMAC)[1] are oil producers. As can be seen in Figure 1, the price of bar-

[1] Cameroon, Congo, Gabon, Equatorial Guinea, Chad and Central African Republic.

rel of oil began to decline in July 2014; leaving from € 82.2 in June to € 79.2 in July. Thereafter, the price stabilized around € 41 in 2016.

Figure 1: Evolution of world oil prices from 2008 to 2016 (monthly data).



Source: *http://prixdubaril.com* and author's calculations.

In this context, the present work aims to analyze the impact of this oil price shock on the level and the trend of the CEMAC's foreign exchange reserves. The ultimate objective is to forecast their evolution. A continued degradation signifies that the CEMAC could experience currency crisis in the future if economic policies implemented in this region do not lead to a return of economic growth. In the "first generation" crisis models, a causal link is established between the continued fall of foreign exchange reserves and the onset of a currency crisis (Krugman, 1979; Flood and Garber, 1984).

Many reasons explain why the decline in foreign exchange reserves could lead to currency crisis in this region. In fact, the CEMAC and the West African Economic and Monetary Union (UEMOA) compose the CFA Franc zone; each region having its central bank. The exchange rate of the CFA franc to the euro is fixed, but history shows that this may depend on the exposure of countries of the zone to external shocks, including unanticipated changes in oil prices. Indeed, the debt crisis of developing countries in the 1980s caused by the oil shocks in the 1970s had led to devaluation of the CFA franc and application of structural adjustment programs (SAPs). The current exposure to oil price shocks shows that the SAPs have failed to make these economies more resistant to external shocks. Despite this finding, the CEMAC countries are currently pursuing a procyclical economic policy by reducing government investment to meet structural adjustment requirements of the International Monetary Fund. In fact, Congo's public expenditure as a percentage of GDP ranges from 18% in 2015 to 15% in 2016 (a decrease of 2%), those in Gabon range from 15% in 2014 to 14% in 2015 (a decrease of 1%). In Chad, we have percentages of 6% in 2014, 5% in 2015, and 4% in 2016[2].

Thus, the analysis of the effect of the unanticipated changes in oil prices on the evolution of foreign exchange reserves leads to a debate about the economic policy adapted to the situation. The implementation of economic policies that do not

[2] *World Development Indicators* and author's calculations.

promote economic growth could lead to social and currency crisis. In fact, imports account for a large share of the CEMAC household consumption products. In Cameroon, they accounted for 44% of household consumption in 2016, while these percentages were 96% and 48% in Gabon and Chad, respectively[3]. Thus, currency crisis accompanied by procyclical economic policy would have damaging effects on their purchasing power. In addition, the CEMAC has been hit by political instability in recent years (Congo, Central African Republic and Chad). To this should be added the terrorist threat symbolized by Boko Haram and the Lord's Resistance Army (LRA). An economic crisis followed by an exchange rate crisis could exacerbate social tensions and lead to more regional instability.

To analyse the effect of oil price shock that began in July 2014 on the evolution of CEMAC's foreign exchange reserves, we use interrupted time series modelling. In the literature, there is a diversity of methods for analysing the effect of the shocks on domestic economies. These include the VAR models (Huang and Guo, 2007, Peersman and Robays, 2009, Chuku et al, 2011, Turhan et al. 2014; Haase, 2016), VECM (Lizardo and Mollick, 2010, Eo, 2016), GARCH (Narayan, et al. 2008; Wu et al. 2012; Imarhiagbe, 2015), quantile regression (Su et al. 2016), stochastic general equilibrium (Bodenstein et al. 2011), and theoretical model (Berthold and Stadtmann, 2018). We aim to enrich this range of models through the use of interrupted time series modelling. With this method, we can measure the immediate effect of oil price shock on foreign exchange reserves, and the effect on the trend. Also, this method has advantage to make possible, the comparison of the evolution of foreign exchange reserves before and after the exposure to oil price shock.

To do this, we firstly identify the structural breaks on foreign exchange reserves caused by the oil price shock using Dickey-Fuller test and the intercept break statistics. The results show that the oil price shock has resulted in a structural break down CEMAC's foreign exchange reserves on different dates, because these countries have not the same degree of dependence on oil revenues. These preliminary results are confirmed by the estimates using the interrupted time series modelling of Tables 1 and 2, and Figure 4. Indeed, the oil price shock leads to an immediate decline in the level of foreign exchange reserves, and a decline of the trend. Finally, forecasting foreign exchange reserves shows their continuous decrease.

The rest of the paper is organized as follows: Section 2 shows the value added by the use of interrupted time series modelling compared to the methods usually used to analyse the effects of oil price shocks on the domestic economy. Section 3 identifies structural breaks. Section 4 presents the empirical model. Finally, the results and economic policy recommendations are presented in section 5.

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[3] *World Development Indicators* and author's calculations.

2. A BRIEF REVIEW OF METHODS: THE VALUE ADDED OF USING INTERRUPTED TIME SERIES MODELING

This section provides a brief summary of the methods often used in recent work to analyse the effect of international oil price shocks on domestic economies. The objective is to show the need for complementing this range of methods by the interrupted time series modelling.

VAR is the first method identified (Huang and Guo 2007, Peersman and Robays 2009, Chuku et al 2011, Turhan et al 2014). The second method used is VECM (Lizardo and Mollick, 2010, Eo, 2016). The third method is GARCH (Narayan, et al. 2008; Wu et al. 2012; Imarhiagbe, 2015). Finally, the fourth and fifth methods are quantile regression (Su et al. 2016) and stochastic general equilibrium (Bodenstein et al. 2011). These methods permit to evaluate immediate effect of oil shock on the exchange rate and foreign exchange reserves. They do not allow evaluating, at the same time, the impact of the shock on the level and the trend. They also do not make it possible to compare the evolution of the variable before and after its exposure to shock. The interrupted time series modelling makes it possible to bridge these limits.

For Penfold and Zhang (2013), the analysis of interrupted time series is probably the strongest quasi-experimental research design. The approach consists of constructing a time series of the population studied, and to statistically test whether there has been a change in its trend the time periods before and the periods after implementation of a policy or a new program. Jandoc et al. (2015) identify 220 empirical applications since 1984 that use this method in research that study the effect of using a new drug on sample evolution. For Taljaard et al. (2014), interrupted time series analysis is powerful approach to evaluate the effects of interventions introduced at a specific point in time. The change in the level and / or slope of the explained variable before and after the intervention is estimated and used for testing the causal hypotheses of the intervention.

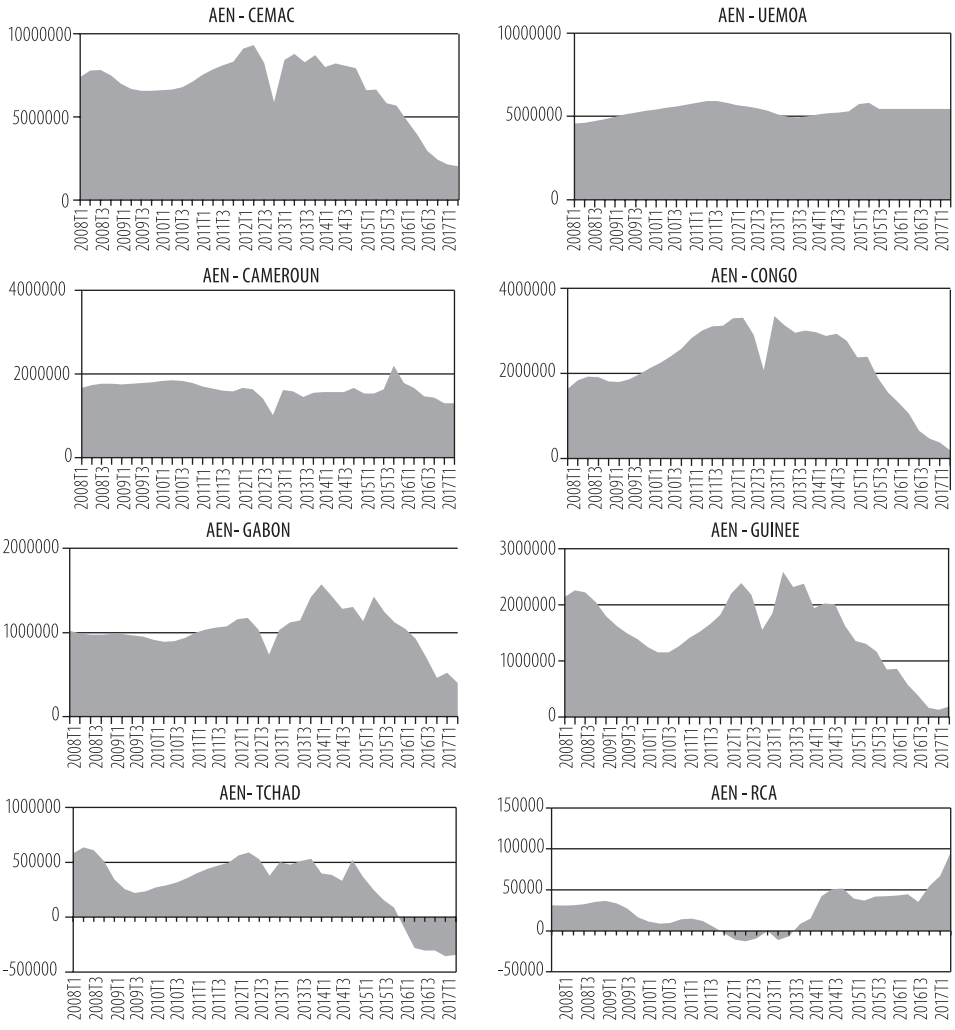
In this study, unanticipated change in oil price is analysed like new policy or new program (Penfold and Zhang, 2013), new drug (Jandoc et al. 2015) or intervention (Taljaard et al. 2014). Thus, we can estimate the change in the level and the slope of the foreign exchange reserves before and after the oil price shock using interrupted time series modelling.

3. IDENTIFICATION OF STRUCTURAL BREAKS

3.1. DESCRIPTIVE ANALYSIS OF THE DATA

In this subsection, we present the descriptive statistics to see the evolution of the foreign exchange reserves from the first quarter of 2008 to the first quarter of 2017. The objective is to see if these reserves decrease from July 2014. On the axis of abscissa, we have time and the y-axis represents foreign exchange reserves.

Figure 2: Evolution of foreign exchange reserves (AEN) from 2008 to 2017



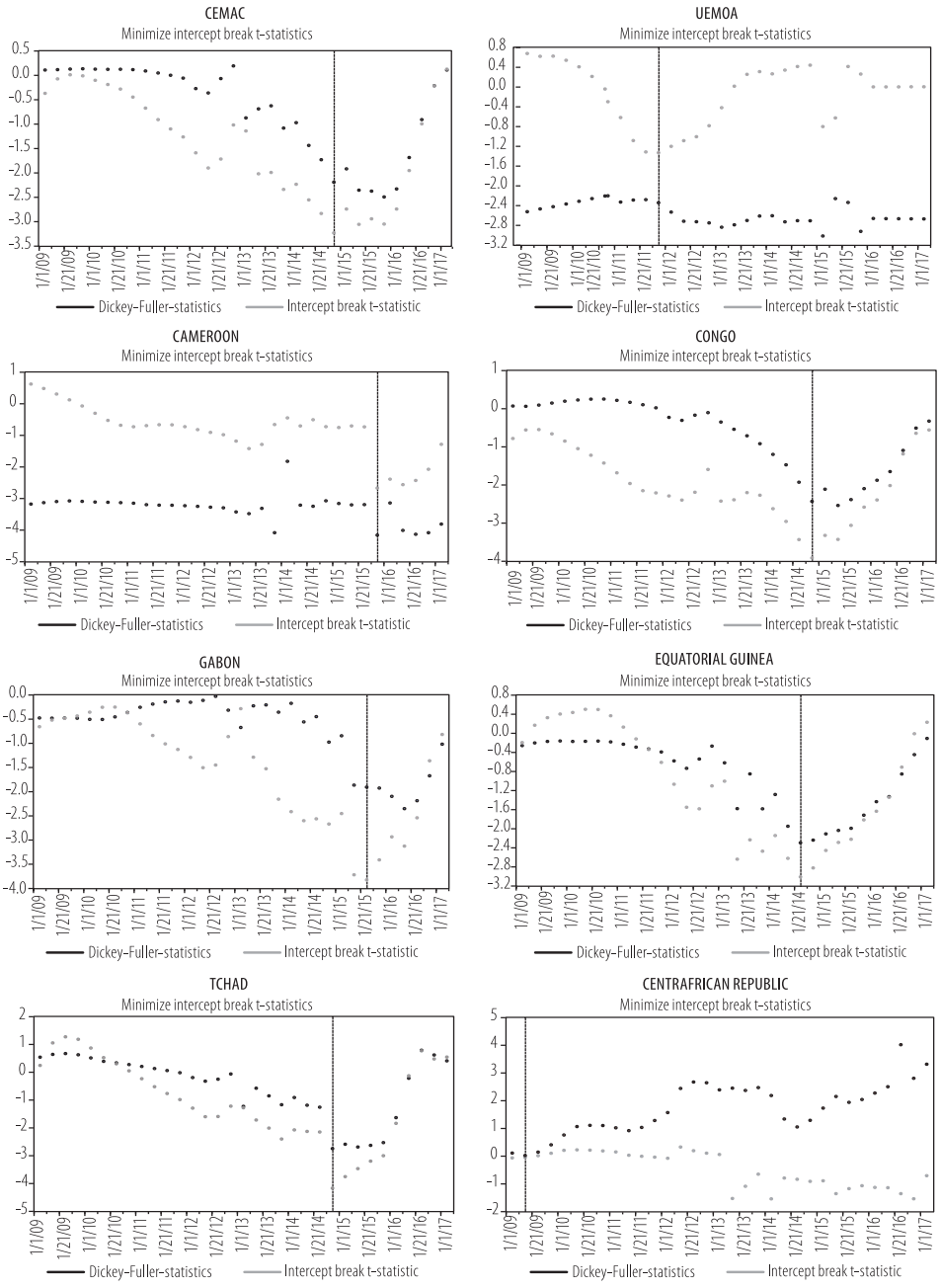
Source: The Bank of Central African States (BEAC) and the Central Bank of West African States (BCEAO) data, and author's calculations

According to Figure 2, the decline of foreign exchange reserves is visible as of the last half of 2014 throughout the CEMAC zone, in the Congo and in Equatorial Guinea. However, this decline becomes much strong from the first quarter of 2015. The reserves of Gabon and Chad are impacted as of 2015; in the first quarter for Chad and in the third quarter for Gabon. Finally, Cameroon is the country whose reserves were impacted last; from the first quarter of 2016. There is no decline in foreign exchange reserves of UEMOA. The Central African Republic, the only non-oil producing country in the CEMAC, has fluctuating reserves that do not seem to depend on the fall in world oil prices. Figure 3 shows it perfectly, because the structural break is located in 2009 in this country. In summary, CEMAC's foreign exchange reserves appear to have been impacted by the drop in international oil prices that began in July 2014, compared to UEMOA. However, not all CEMAC oil producing countries were impacted at the same time because their dependence on oil exports is not the same. We complete the above analysis by looking for structural breaks. The objective is to see if the declines in oil price noted in Figure 1 have changed the structure of foreign exchange reserves of CEMAC.

3.2. STRUCTURAL BREAKS TEST

In this subsection, we present Dickey-Fuller and break tests on foreign exchange reserves. The objective is to see if the declines in oil price have changed their structure.

Figure 3: Dickey-Fuller and break tests on foreign exchange reserves



Source: Bank of Central African States (BEAC) and Central Bank of West African States (BCEAO) data, and author's calculations

Figure 3 shows that there is a structural break between late 2014 and early 2015 in Congo, Chad and throughout CEMAC. Equatorial Guinea is the country whose foreign exchange reserves were first impacted; the structural break is visible between the third and fourth quarters of 2014 in this country. The structural breaks in Cameroon and Gabon are, for their part, in 2015, respectively in the third quarter for Gabon and between the last quarter of 2015 and the first quarter of 2016 for Cameroon. As for the UEMOA and the Central Africa Republic, their structural breaks appear before the oil shock of July 2014; in 2011 for WAEMU and in 2009 for Central African Republic following political instabilities in Côte d'Ivoire and Central African Republic. In sum, Figures 2 and 3 show that the decline in oil prices that began in July 2014 had a negative structural impact on the level of CEMAC's foreign exchange reserves. However, structural breaks do not appear at the same time in all countries because their dependence on oil exports is not the same.

4. INTERRUPTED TIME SERIES MODELING

4.1. THEORETICAL FRAMEWORK

The CEMAC oil-producing countries are price takers and not price makers. As a result, they remain small economies open and exposed to fluctuations in international prices. The decline in oil prices that began in July 2014 led to deficits of their balance of payments and the erosion of foreign exchange reserves. This situation raises questions about the stability of the exchange rate. Thus, the theoretical frame of reference is the modelling of first-generation crises (Krugman, 1979, Flood and Garber, 1984).

4.2. EMPIRICAL MODEL

The interrupted time series modelling makes possible to compare the evolution of a variable before and after its exposure to an innovation. As a result, the assumption is that the level and the trend of the series before and after the arrival of the innovation would not have changed if innovation had not occurred. In this paper, we propose to use it to measure the effect of the decline in world oil prices that began in July 2014 on the evolution of foreign exchange reserves in the CEMAC. The objective is to compare evolution of foreign exchange reserves before and after the oil price shock. Indeed, Figures 2 and 3 show that CEMAC's foreign exchange reserves have been declining since the last half of 2014; which coincides with the beginning of the decline in international oil prices. Thus, the

oil shock can be likened to an innovation that affects export earnings and, consequently, foreign exchange reserves. Based on figure 3, the oil price shock is taken into account in the equations (1) and (2) assuming that the innovation occurred in the quarter where the decline in oil price led to a structural break in foreign exchange reserves. For this purpose, we estimate the models below:

$$reserves_{jt} = \beta_0 + \beta_1 time_t + \beta_2 level_j + \beta_3 trend_{jt} + \varepsilon_{jt} \quad (1)$$

The explained variable, *reserves*, represents the evolution of foreign exchange reserves. *j* is the index representing the oil price shock and *t* the time index. The coefficient β_0 is an interception term that refers to the level of the foreign exchange reserves existing at the beginning of the study period. The coefficient β_1 is associated with the modeling time and gives an idea of the upward or downward trajectories of the foreign exchange reserves before the oil price shock; *level* is the first variable of interest that measures the impact of the oil price shock. It is an indicator variable that takes the value 0 the quarters before the date of the oil price shock, and the value 1 the quarters from the date of the oil price shock to the end of the study period. The coefficient β_2 associated with it permits to characterize the immediate change in the level of foreign exchange reserves following the oil price shock. *trend* is the second variable of interest. It takes the value 1 in the quarter in which the oil price shock occurred, and increases of one unit each quarter thereafter. If, for example, the oil price shock had occurred six quarters before the end of the study period, it will take the following values: 1, 2, 3, 4, 5, 6. Respectively 1 for the quarter of the introduction of the oil price shock, 2 for the next quarter, and so on. Its coefficient, β_3, makes it possible to see if there is a decline (rise) in the trend of the foreign exchange reserves after the oil price shock compared to that which the foreign exchange reserves would have if the shock had not taken place. Finally, ε_{jt} is an error term that allows reserves to vary around their linear predictions.

The data come from the statistics of the Bank of Central African States (BEAC) and the Central Bank of West African States (BCEAO) and these are quarterly data. The study period is from the first quarter of 2008 to the second quarter of 2017.

Equation (1) does not take into account the control variable, which in this study will be the change in the foreign exchange reserves of a country or group of CFA franc zone countries with no or low exposure to the oil price shock. In the case of the estimation of foreign exchange reserves of all CEMAC zone, we use as a control, the foreign exchange reserves of the West African Economic and Monetary Union (UEMOA). Indeed, according to figures 2 and 3, the reserves of the CFA

Franc zone of West Africa did not suffer from the decline in oil prices that began in July 2014, compared to those of the CFA franc zone of Central Africa. Tables 1 and 2 confirm this analysis. In the case of estimating the foreign exchange reserves of each CEMAC country producing oil, we use as control, the reserves of the Central African Republic which is the only non-oil producing country of the Community. Tables 1 and 2 also confirm the non-exposure of this country's net foreign exchange reserves to the oil price shock; which makes it a good control variable. As a result, we have equation (2) below:

$$\text{reserves}_{jkt} = \beta_0 + \beta_1 * \text{time}_t + \beta_2 * \text{level}_{jt} + \beta_3 * \text{trend}_{jt} + \beta_4 * \text{uemoa}_t + \beta_5 * \text{control}_k * \text{time}_t + \beta_6 * \text{level}_{jt} * \text{control}_k + \beta_7 * \text{trend}_{jt} * \text{control}_k + \varepsilon_{jt} \quad (2)$$

k is the index of the control variable. The coefficient β_0 is an intercept term that refers to the level of the control variable that exists at the beginning of the study period. The coefficient β_1 indicates the current trend of the control variable. The coefficient β_2 characterizes the immediate change of level of the control variable following the arrival of the oil price shock. The coefficient β_3, for its part, characterizes the change of trend of the control variable. The coefficient β_4 indicates the existing level difference at the beginning of the study period between the explained and the control variables. The coefficient β_5 associated with the interaction between the control variable and the time indicates the difference in trend between the explained variable and the control variable before the oil price shock. The coefficient β_6 characterizes the difference in immediate change of level between the explained variable and the control variable following the oil price shock. Finally, β_7 characterizes the difference of change in the trend between the explained variable and the control variable inherent to the oil price shock. The coefficients β_6 and β_7 are the variables of interest. Equations (1) and (2) formalize the general case of CEMAC where the control variable is UEMOA foreign exchange reserves. Equations representing the specific cases of each CEMAC oil-producer country could also be presented by changing *uemo* by *rca*. In addition, since the foreign exchange reserves of the CEMAC oil-producer countries are not structurally impacted at the same date (see Figure 3), we consider that oil price shock is introduced as soon as the structural break appears. As a result, the following dates are used in the modelling: the third quarter of 2014 in Equatorial Guinea and the fourth quarter of 2014 in the entire CEMAC zone, in the Congo and in Chad. Finally, oil price shock is introduced in the third quarter of 2015 in Gabon and in the first quarter of 2016 in Cameroon.

The estimate is made in several steps. We first perform a standard linear regression, with a time series specification. Next, we verify the independence of the data points by performing the autocorrelation test to ensure that the estimates

conform to the assumptions of the linear regression. As a result, we use three methods. The first is to do a Durbin-Watson test. The second is a visual examination of the residues. The third is to look at autocorrelation function (ACF) and partial autocorrelation function (PACF). After identifying the autocorrelation of the MCO estimate, we proceed to the final generalized least squares (GCM) estimation that allows for inclusion of an autoregressive and / or moving average process in the model (AR (p), MA (q) or ARMA (p, q)). The autocorrelation of GCM residuals is done using the likelihood ratio (LR) test. The final results (see Tables 1 and 2) are subsequently represented graphically (see Figure 4). Finally, we forecast the relative and absolute changes in foreign exchange reserves following the oil price shock (see Table 3).

5. RESULTS AND RECOMMENDATIONS OF ECONOMIC POLICIES

5.1. RESULTS

Table 1: Results without correction of the seasonal effect

	Reserves CEMAC		Reserves Cameroon		Reserves Congo		Reserves Gabon		Reserves Equatorial Guinea		Reserves Chad	
	Without control	With control	Without control	With control	Without control	With control	Without control	With control	Without control	With control	Without control	With control
Intercept	6487490*** (0.000)	5180536*** (0.000)	1689772.3*** (0.000)	19355.7 (0.827)	1812541.3*** (0.000)	28542.5 (0.163)	847141.3*** (0.000)	23149.2 (0.674)	1625277.4*** (0.000)	24582.1 (0.84)	343996.5*** (0000)	23580.34 (0.122)
Time	83252*** (0.000)	12047 (0.363)	-479.7 (0.939)	153.9 (0.972)	56557.7*** (0.000)	-1226.6 (0.388)	17145.9*** (0.000)	-241.4 (0.934)	14251.5 (0.288)	-759 (0.921)	5802.4*** (0.003)	-717.94 (0.442)
Level	-1012563** (0.046)	-273163 (0.57)	-15666.2 (0.926)	-10073.4 (0.935)	-225671.9 (0.332)	36595.3 (0.672)	-204252.9* (0.065)	8301.8 (0.914)	-54012.1 (0.806)	-16476.3 (0.872)	-190176.4*** (0.008)	-275.15 (0.995)
Trend	-611719*** (0.000)	15132 (0.826)	-81726.6* (0.076)	11034.8 (0.732)	-360546.2*** (0.000	6121.1 (0.59)	-108071.4*** (0.000)	6980.9 (0.676)	-166635.4*** (0.000)	10614.7 (0.705)	-79175.9*** (0.000)	11893.4 (0.132)
UEMOA		1539987*** (0.000)		1673535.1***		1740822.3*** (0.000)		824443.9*** (0.000)		1516607.4*** (0.000)		308736.44*** (0.000)
Control*time		55249*** (0.004)		-650.1 (0.918)		63600.4***		17385.9*** (0.000)		21403.1** (0.053)		7275.56*** (0.000)
Level*control		-124746 (0.854)		-23711.7 (0.892)		-793252.4*** (0.000)		-213536.5** (0.052)		-288685.2** (0.05)		-193776.65*** (0.002)
Trend*control		-668593*** (0.000)		-80067.5* (0.082)		-329561.9*** (0.000)		-115042.6*** (0.000)		-162161.5*** (0.000)		-94721.53*** (0.000)
LR test	0.164	0.792	0.137	0.278	0.421	0.132	0.651	0. 0.569	0.305	0.954	0.573	0.126

With regard to Figure 4, it can be seen that the foreign exchange reserves of the entire CEMAC zone and of each CEMAC country producing oil followed a seasonal pattern before the oil price shock. In this context, we make a second estimate (equation (3)) to account for this seasonality:

$$reserves_{jkt} = \beta_0 + \beta_1 * time_t + \beta_2 * level_{jt} + \beta_3 * trend_{jt} + \beta_4 * uemoa_t + \beta_5 * control_k * time_t + \beta_6 * level_{jt} * control_k + \beta_7 * trend_{jt} * control_k + \beta_8 * saison_t + \varepsilon_{jt} \quad (3)$$

To model the seasonality, we add in equation (2), a variable named season which takes the value 1 the quarters where we see a seasonal effect in Figure 4 and the value 0 otherwise.

Table 2: Results with correction of the seasonal effect

	Reserves CEMAC		Reserves Cameroon		Reserves Congo		Reserves Gabon		Reserves Equatorial Guinea		Reserves Chad	
	Without control	With control	Without control	With control	Without control	With control	Without control	With control	Without control	With control	Without control	With control
Intercept	6440795*** (0.000)	5261369*** (0.000)	1768787.6*** (0.000)	14378.6 (0.67)	1794174.8*** (0.000)	24678.4 (0.828)	921500.3*** (0.000)	22187.7 (0.641)	1626746.7*** (0.000)	26104.9 (0.818)	368760.9*** (0.000)	23461.1 (0.219)
Time	92057*** (0.000)	9814 (0.218)	-2496.6 (0.571)	62.5 (0.975)	57867.3*** (0.000)	-657.3 (0.926)	15132.2** (0.004)	-393.7 (0.885)	16773.3*** (0.000)	-831 (0.907)	5466.1*** (0.012)	-677.6 (0.557)
Level	-825867*** (0.016)	-445329 (0.182)	121291.4 (0.39)	-19664.6 (0.839)	20162.3 (0.937)	2799.1 (0.986)	-83040.3 (0.501)	1136.6 (0.985)	-83492.8 (0.164)	-24324 (0.548)	-121010.7** (0.051)	-7612.6 (0.852)
Trend	-638803*** (0.000)	29476 (0.558)	-93428.6*** (0.013)	16497.1 (0.48)	-340475.9*** (0.000)	7465.2 (0.787)	-123794.6*** (0.000)	10632.3 (0.505)	-215166.5*** (0.000)	12102.5 (0.634)	-80345.9*** (0.000)	12657.7 (0.129)
CEMAC		1438020*** (0.000)		1747160.8*** (0.000)		1781992.2*** (0.000)		872759.9*** (0.000)		1659603.2*** (0.000)		337296.2*** (0.000)
Control*time		76887*** (0.000)		-3226 (0.255)		58799.8*** (0.000)		14824*** (0.000)		14976.3 (0.143)		6547.3*** (0.000)
Level*control		-37537 (0.938)		163692 (0.238)		48685.8 (0.842)		-93753.7 (0.307)		-403835.8*** (0.000)		-97192.5* (0.099)
Trend*control		-640590*** (0.000)		-111025.3*** (0.001)		-357405.4*** (0.000)		-116139.4*** (0.000)		-217773.5*** (0.000)		-98412.3*** (0.000)
saison	-341992** (0.027)	-889776*** (0.000)	-142013.3*** (0.008)	-128900.6*** (0.001)	-256823.6*** (0.008)	-258241.1*** (0.000)	-73184.7** (0.055)	-57794.7*** (0.001)	-222964.2*** (0.000)	-201377.1*** (0.000)	-60893.8*** (0.002)	-57795.2*** (0.000)
LR test	0.18	0.46	0.351	0.169	0.749	0.918	0.785	0.21	0.995	0.523	0.119	0.505

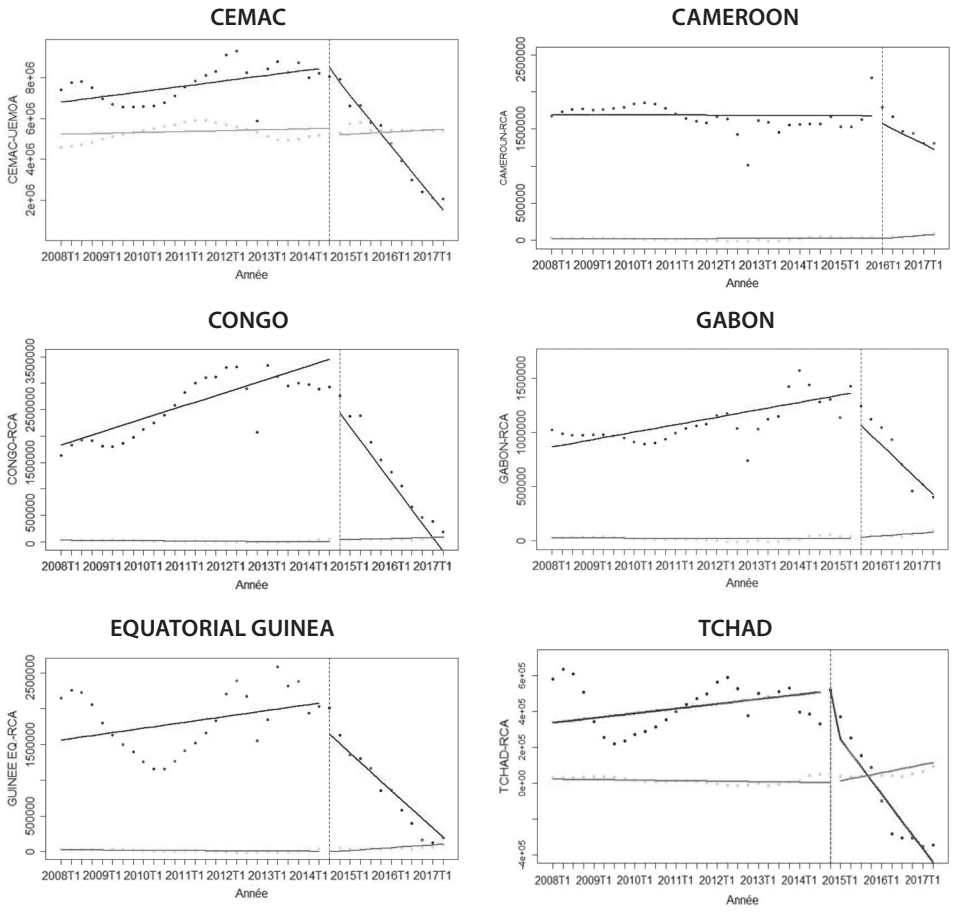
There is no significant difference in the results of Tables 1 and 2. This can be explained by the fact that seasonality is only observed before the oil price shock. The likelihood ratio test in Tables 1 and 2 leads to the rejection of the null hypothesis of the equality between the estimated models and those with the addition of an additional autoregressive term. As a result, we deduce that autocorrelation has been corrected. First, we interpret the results of the entire CEMAC zone. Subsequently, we analyse the situation of each oil producer country. The level of foreign exchange reserves existing at the beginning of the period is respectively 6440795 and 5261369 in CEMAC and UEMOA. Pre-shock trends are 92057 in CEMAC and 9814 in UEMOA. Thus, foreign exchange reserves increased before the oil price shock on average by 92057 and 9814 per quarter in CEMAC and UEMOA, respectively. However, this value is not significant in UEMOA. The immediate

effect of the oil price shock on CEMAC's foreign exchange reserves is a decrease of -825867. Moreover, even if the coefficient that represents the immediate effect of the oil price shock on the reserves of UEMOA is negative (-445329), it is statistically not significant. This confirms the idea that the oil price shock would not significantly affect the foreign exchange reserves of this region. After the introduction of the oil price shock, there was a decline of trend in CEMAC reserves of -638803 per quarter on average. In UEMOA, an increase of 29476 is noted, but it is statistically insignificant; reinforcing the idea of the non-exposure of UEMOA's foreign exchange reserves to the oil price shock. In addition, the level of foreign exchange reserves of CEMAC was higher than that of UEMOA at the beginning of the period of 1438020. This value is statistically significant. Also, before the oil price shock, CEMAC's reserves increased on average by 76887, faster than those of UEMOA per quarter. After the oil price shock, the CEMAC zone recorded an immediate drop in foreign exchange reserves of -37537 compared to the UEMOA zone. Finally, after the oil price shock, there is a decline of trend in CEMAC's reserves of -640590 on average and per quarter, in comparison with the evolution of UEMOA's reserves.

Regarding the individual situations of the CEMAC oil producing countries, all were immediately negatively impacted by the oil price shock, even if the values are not significant in Cameroon, Congo and Equatorial Guinea (see Table 1). We have the impacts of -15666.2, -225671.9, -204252.9, -54012.1 and -190176.4 respectively for Cameroon, Congo, Gabon, Equatorial Guinea and Chad. In addition, each quarter, there is a decline in trend of the foreign exchange reserves following the oil price shock in all producing countries: Cameroon (-93428.6), Congo (-340475.9), Gabon (-123794.6), Equatorial Guinea (- 215166.5) and Chad (-80345.9). We also note that the level and trend of the foreign exchange reserves of the Central African Republic were not affected by the oil price shock; which makes it a good control variable. As a result, the differences in the immediate changes in the level of foreign exchange reserves after the shock between the CEMAC oil-producer countries and Central African Republic are -23711.7 in Cameroon, -793252.4 in Congo, -213536.5 in Gabon, - 288685.2 in Equatorial Guinea and -193776.65 in Chad. Finally, after the shock, trends declines on average and per quarter from -80067.5 in Cameroon, -329561.9 in Congo, -115042.6 in Gabon, -162161.5 in Equatorial Guinea and -94721.53 in Chad (see Table 1); compared with the trend of foreign exchange reserves of Central African Republic. In sum, we note that the level of the reserves of the Congo was immediately the most affected (-225671.9), followed by Gabon (-204252.9), Chad (-190176.4), Cameroon (-15666.2) and finally Equatorial Guinea (-54012.1). Regarding trends, Congo is still the most affected (-340475.9), followed this time by Equatorial Guinea ((-215166.5), Gabon (-123794.6), Cameroon ((-93428.6)) and finally Chad

(-80345.9). Figure 4 below allows to graphically evaluating the results of Tables 1 and 2.

Figure 4: Graphical representation of the results



We first have the graphical presentation of the results of all CEMAC, then of each oil-producing country of this zone. In the abscissa, we have the quarters and on the other side, the foreign exchange reserves. The dotted column represents the introduction of the oil price shock. Since the oil price shock has not structurally affected all the countries in the sample at the same time, its modelling takes into account this specificity (see Figure 3). The dots in red are a graphical representation of the estimate of the control variable; UEMOA's foreign exchange reserves and Central African Republic. The points in green are a graphical representation of the estimate of the variable of interest, in this case foreign exchange reserves

of all CEMAC and each oil-producing country in the zone. Thus, Figure 4 shows that there is a downward shift of foreign exchange reserves as soon as the oil price shock is introduced. The trend is also declining. In addition, control variables do not appear to have been impacted by the oil price shock; which reinforces the results of Figures 2 and 3, and Tables 1 and 2).

Table 3: Forecasting changes of CEMAC's foreign exchange reserves

CEMAC

Quarters	2017T3	2017T4	2018T1	2018T2	2018T3	2018T4	2019T1	2019T2	2019T3	2019T4
Absolute Change	-2854557	-2923294	-2992030	-3060767	-3129503	-3198240	-3266977	-3335713	-3404450	-3473186
Relative Change	-0.3535551	-0.3585051	-0.3633585	-0.3681183	-0.372787	-0.3773674	-0.3818618	-0.3862726	-0.3906023	-0.3948529

CAMEROON

Quarters	2017T3	2017T4	2018T1	2018T2	2018T3	2018T4	2019T1	2019T2	2019T3	2019T4
Absolute Change	-2091866	-2102250	-2112635	-2123020	-2133405	-2143789	-2154174	-2164559	-2185328	-2195713
Relative Change	-0.9907598	-0.9907331	-0.9907068	-0.9906807	-0.9906548	-0.9906292	-0.9906038	-0.9905787	-0.9905292	-0.9905048

CONGO

Quarters	2017T3	2017T4	2018T1	2018T2	2018T3	2018T4	2019T1	2019T2	2019T3	2019T4
Absolute Change	-2732734	-2802456	-2872177	-2941899	-3011620	-3081342	-3151064	-3220785	-3290507	-3360228
Relative Change	-0.9901031	-0.9907765	-0.991418	-0.9920298	-0.992614	-0.9931725	-0.9937068	-0.9942185	-0.994709	-0.9951796

GABON

Quarters	2017T3	2017T4	2018T1	2018T2	2018T3	2018T4	2019T1	2019T2	2019T3	2019T4
Absolute Change	-1304459	-1328826	-1353193	-1377560	-1401927	-1426293	-1450660	-1475027	-1499394	-1523761
Relative Change	-0.9827419	-0.9832286	-0.9836982	-0.9841516	-0.9845897	-0.9850132	-0.9854227	-0.9858191	-0.9862029	-0.9865747

EQUATORIAL GUINEA

Quarters	2017T3	2017T4	2018T1	2018T2	2018T3	2018T4	2019T1	2019T2	2019T3	2019T4
Absolute Change	-2484547	-2516564	-2548582	-2580600	-2612618	-2644636	-2676653	-2708671	-2740689	-2772707
Relative Change	-0.9905026	-0.9909184	-0.991324	-0.99172	-0.9921065	-0.9924839	-0.9928526	-0.9932129	-0.993565	-0.9939092

TCHAD

Quarters	2017T3	2017T4	2018T1	2018T2	2018T3	2018T4	2019T1	2019T2	2019T3	2019T4
Absolute Change	-956011	-9751799	-994348.7	-1013518	-1032686	-1051855	-1071024	-1090193	-1109362	-1128531
Relative Change	-0.9766441	-0.9777961	-0.9789062	-0.9799767	-0.9810097	-0.9820071	-0.9829707	-0.9839022	-0.9848032	-0.9856751

In Table 3, we have the relative and absolute forecasts of foreign exchange reserves until the fourth quarter of 2019. We see that the model predicts a continuous decline of the reserves over the entire period predicted in the CEMAC zone in general, in each country of the Community in particular. For example,

throughout the CEMAC, in the last quarter of 2017, the model predicts a drop of foreign exchange reserves of -2923294 compared to what it would have predicted if the oil price shock had not occurred. This represents a decrease of 35.85%. In the last quarter of 2018, the model forecasts a decrease of -3198240; that's 37.74% off. In the last quarter of 2019, we have a decrease of -3473186; that's 39.49% off. In this context, the monetary and government authorities should take appropriate measures to make this projected decline of foreign exchange reserves impracticable in order to avoid speculative attacks on the Central African CFA franc and predictions of exchange rate instability in the region that could become self-fulfilling.

5.2. ECONOMIC POLICY RECOMMENDATIONS

Exports of raw materials constitute the main financial source of the CEMAC countries. In addition, companies of the other sectors have strong economic and financial links with the government and are highly dependent on the consumption of households that work in these companies, as well as in the public and parapublic sector. In this context, a restrictive fiscal policy will have a double depressive impact on activity. It will not only lead to a drop in household consumption, but will also depress the private sector, which is highly dependent on the public sector in these countries. Pro-cyclical fiscal policy accompanied by a restrictive monetary policy would discourage investment. In short, in a context of continued downward pressure on oil prices, austerity would depress the non-oil sector and worsen the crisis. As demonstrated by Bodenstein et al. (2011), the effect of the deterioration of the oil component of the trade balance on the balance of payments could be mitigated by the improved growth rate of the non-oil sector. Under these conditions, we propose a counter-cyclical fiscal policy to increase the purchasing power of households and encourage investment, while having viable public finances. The decline in public spending should only concern the expenditure of the administrations and the political institutions. Governments should increase household purchasing power while restoring public accounts. The studies should be conducted in all household consumption sectors to determine their willingness to pay some public services. The objective is to build the infrastructure necessary for the development and the well-being of the population while allowing the State, not only to recover the funds spent, but also to diversify the sources of these revenues so to get out of export dependency. Public-private initiatives could be carried out in the most expensive sectors. Monetary policy should accompany this objective of stimulating and exiting the strong dependence on exports. As a result, it should allow banks to continue to finance the economy by keeping the reserve requirement ratio at an incentive level. The

short-term objective is to restore the growth rate of the non-export sector so that it becomes the main source of State revenue. The economic recovery should, in addition, be accompanied by the reforms of governance and improvement of the business climate necessary for the success of economic policies. Finally, we advise the CEMAC governments to set up a fiscal stabilization fund. The idea is to feed it in the event of an unexpected rise in world oil prices, in order to use it to conduct counter-cyclical policies during periods of falling prices.

CONCLUSION

In sum, based on the interrupted time series modelling, the analysis shows that the oil price shock that began in July 2014 immediately led to a decline in CEMAC's foreign exchange reserves, as well as their trend. The model predicts continued deterioration of these reserves if oil prices remain low. As a result, there is a risk of unsustainability of the CFA franc fixed exchange rate in Central Africa. This situation can also lead to currency instability if economic policies do not lead to a return to economic growth. Indeed, current activity restriction policies in CEMAC do not seem relevant. They lead not only to a decline in household consumption, but also to that of investment. In a context of keeping down oil prices, austerity would depress the non-oil sector and aggravate the crisis. Under these conditions, we propose a counter-cyclical fiscal policy to increase the purchasing power of households and encourage investment, while having viable public finances. Monetary policy should accompany this objective. The economic recovery policies should, in addition, be accompanied by the reforms of governance and improvement of the business climate necessary for their success. Finally, we advise the CEMAC governments to set up a fiscal stabilization fund. The idea is to feed it in the event of an unexpected rise in world oil prices, in order to use it to conduct counter-cyclical policies during periods of falling prices.

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