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Macroeconomic and Financial Shocks in African Franc Zone: Exploring the nexus with Vector Autoregression

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Abstract

This paper analyzes the impulse response functions due to macroeconomic and financial shocks in the African franc zone. To this end, we rely on the estimation of a vector autoregression (VAR) model for a sample of 14 African countries of the franc zone over the 1994-2014 times. Our results show that the evolution of the combined impulse response functions that a shock of the interest rate has a positive impact on snapshot itself, but negative on the other variables. A shock of the consumer price index has a positive impact on the instantaneous interest rate and the change in GDP per capita. But has a negative impact on the global balance as well as itself. A shock of the global balance has a negative higher instantaneous impact on itself but positive on the other variables. Although the variations observed following this shock on the other variables are quite low. A supply shock in the level of GDP per capita has a negative instantaneous impact on the global balance and itself, but positive on the other variables. Moreover, while this shock causes a slight increase in interest rates over the time, the stationary trend evolutions of the price index and decreasing of the global balance is observed. In terms of recommendations, it appears that the interest rate and the global balance are the two central variables that have captured the attention of the economic policymakers in these countries to improve country's performance on the pathway of progress.

Keywords: gross domestic product per capita, consumer price index, global balance, interest rate, franc zone, impulsive response functions, vector autoregression

1. Introduction

Macroeconomy deals with the implementation, the configuration, the performance, the managerial and the decision-making of the whole economy, which can be a nationwide, regional, or the worldwide economy. Since the macroeconomic includes many complex interactions, only one variable is durable to characterize how the entire financial system moves. International macroeconomic repercussions of the recent financial and economic crisis have revealed a mitigated economic growth in many countries in the world. Potential growth in many advanced and developing economies is very low. This is bad on its own, but it also makes fiscal adjustment more difficult.

In this context, measures applied in order to increase possible growth are becoming more important. Although the evidence is not yet clear, potential growth in many emerging market economies also appears to have decreased (IMF, 2014). The implementation of strong fixed exchange rates in developing countries as a potential road of building a credible promise to a low internal inflation rate (Edwards, 1993) is still interesting nowadays. An irreversible commitment to a fixed exchange rate may help to solve the time inconsistency problems of rules rather than discretion (Barro & Gordon, 1983; Kydland & Prescott, 1977). Current study indicates that countries that have made a reasonable promise to a fixed exchange rate policy do have poorer average inflation rates (Anyadike-Danes, 1995; Ghosh et al., 1995). The practicality of the commitment depends on the institutional context within which the exchange rate is fixed (Fielding & Shields, 2001).

The macroeconomic shocks include the gross domestic product (GDP) per capita, the consumer price index (CPI inflation) and the global balance shocks, and the financial shock as approximated by the interest rate shock. The GDP per capita and the global balance are the budgetary policy tools. The consumer price index and the interest rate are the monetary policy instruments. The theoretical framework of this research is based on the reasoning in line with the current thinking on the *policy-mix* of the monetary union. The literature emphasizes, indeed, the

difficulty but also the need to promotes efficiency in these unions through a combination of good policies monetary and fiscal (Devarajan & Walton, 1994; Semedo & Villieu, 1997). In an integrated optimal economic zone (Mundell, 1961; McKinnon, 1963; and Kenen, 1969) and the monetary union by combining the two policies, the so call *policy-mix* ideally, should intend at maximizing economic growth and minimizing unemployment. The subsequent debate between monetarists and Keynesian on the appropriate allocation results from the assumptions underlying the calculation of monetary and fiscal multipliers: openness of the economy, capital mobility, nature of expectations, price flexibility, differences horizon among others. A critical review of the theories related on the *policy-mix* has been done by Desquilbet and Villieu (1998). The *policy-mix* concept is continuing to enrich nowadays debates among researchers, policymakers and the Central Banks in the franc zone.

Three key questions can be addressed: Are these macroeconomic and financial shocks nexus? Do macroeconomic and financial shocks exert positive or negative effects on the economic performances of the African franc zone? Does any variable influence positively or negatively the three others? This paper aims at investigating the interactions between four key macroeconomic and financial shocks. Specifically, this paper analyzes the impulse response functions due to macroeconomic and financial shocks in the African franc zone composed by two integrated economic and monetary unions. The two African Financial Community and African Financial Cooperation- CFA monetary unions are the West African Economic and Monetary Union (WAEMU) and the CEMAC (Economic and Monetary Community of Central Africa).

To this end, we use vector autoregression (VAR) model. Vector autoregression is an econometric representation used to capture the progression and the interdependencies between numerous time series, generalizing the univariate autoregression models. All the variables in a VAR are treated symmetrically by including for each variable an equation clearing up its evolution based on its own lags and the lags of all the other variables in the model. Established on this feature, Sims (1980) advocates the use of VAR models as a theory-free approach to estimate macroeconomic and financial relationships. Macroeconomic and financial data from the Word Development Indicator (2015), the central banks of CEMAC and WAEMU for a sample of 14 African countries of the franc zone over the period 1994-2014 are used.

The rest of the paper is structured as follows. Section two reviews the literature. Section three describes the methodology, the applied VAR model and the procedure, defines the variables and the data sources. Section four presents and discusses the estimation results. And, the last section concludes.

2. Review of the Literature

In the early Keynesian models, captured with the symbols IS-LM, the choice between debt and tax requires no special treatment. Indeed, only the recessionary effect of the total sample is considered. Although Lerner (1943) notes that the reference to the future of the "deadweight loss" due to tax can cause second-order effects on the intergenerational welfare. Researchers have to wait the Keynesian synthesis, including Ando and Modigliani (1963), to highlight the tradeoff between tax and debt that can have major implications on economic growth, through a wealth effect on consumption function.

Nevertheless, the Ricardian equivalence theorem proposed by Barro (1974) takes the obverse this argument. Since the current debt is a future tax. The breaks duties are only adjournments taxes.

The first application area of comparative advantage for economic policies is provided by Mundell (1962), as a direct extension of its principle of open economy. Mundell considers an IS-LM model with fixed prices in exchange regime with sterilization of capital flows. The objectives are the internal equilibrium and external stability; and the instruments are the monetary policy and the budgetary policy.

A fundamental subject in most of the empirical literature on financial integration is whether the cost of integration outweighs the benefits. The origins of this debate can be traced back to Mundell's (1961), McKinnon (1963) and Kenen (1969) seminal papers on optimum currency areas. Mundell writes that the benefits of financial integration are realized more amongst countries with similar terms of trade shocks than amongst those with asymmetric shocks. The presence of asymmetric shocks, he argues, makes financial integration harder and more costly to manage because the respective countries may need different monetary policies to respond effectively to their individual shocks (Etta-Nkwelle et al., 2012; Houssa, 2008).

Many existing literatures on the identification and cross-country comparison of macroeconomic shocks follow the method of Blanchard and Quah (1989). It is for instance works of Fielding and Shields (2001), Bayoumi and Eichengreen (1996), and Funke (1995). This involves estimating a reduced form vector autoregression for inflation and output growth, and identifying structural shocks to each variable by imposing a set of restrictions

that includes the theory-based assumption that in the long run output shocks can affect inflation but not *vice versa*.

Fielding and Shields (2001) have modified the method of Blanchard and Quah (1989) in order to estimate a structural vector autoregression model appropriate for a small open economy. In this way these authors have detected shocks to output and prices in the members of the two monetary unions that make up the African CFA Franc Zone. In general, asset prices are known to affect the real economy. In addition to house prices, stock prices and loans also sometimes trigger adverse macroeconomic developments. Recently, attention has focused on risk, uncertainty and bank leverage when considering the real effects of financial shocks (European Central Bank, 2013). Prominent contributions to this literature include Borio and Lowe (2004, 2002), Claessens et al. (2011a, 2011b, 2009) and Gilchrist, Yankow and Zakrajsek (2009), among others studies.

Empirical studies exploring the nexus between the key macroeconomic variables (gross domestic product per capita, consumer price index, global balance, interest rate) are not many. Some authors like Bart, Beaver and Stinson (1991) and, Correia-Nunes and Stemitsiotis (1995) have analyzed the possibility of linking the global deficit and the interest rates. These authors have classified empirical studies on the links between interest rates and global deficits depending on whether the measurement of the impact is on the short rate or a long rate. They note that studies on short rates generally not indicate the effect of global deficit. Clarida, Gali, and Gertler (1998) in analyzing the monetary policy rules based on the interest rate and the macroeconomic stability based on global deficit have captured some evidence and theory. Clarida, Gali, and Gertler (1998) do not test the possible impact of the global deficit on the interest rate.

Havránek et al. (2010) examine the interactions of financial variables and the macroeconomy within the block-restriction vector autoregression model and evaluate to what extent the financial variables improve the forecasts of gross domestic product growth and inflation. For this reason, a combination of financial variables are examined, including those unexplored in previous literature, such as the share of liquid assets in the banking industry and the loan loss provision rate.

Institutionally and historically, the franc zone has been constructed and the dynamic of the economic and monetary integration analyzed by Gérardin (1994, 1989). In Africa, the CFA franc zone consists of two monetary unions between different African states (Hugon, 1999; Fielding & Shields, 2000). The two CFA currencies have been pegged to the French Franc (and now the Euro) since 1948, with the French treasury guaranteeing to exchange French currency for CFA currency at a fixed rate (Vizy, 1989). The fixed exchange rate is a budgetary agreement between France and its former colonies. The countries that will appear in this paper are (except Comores Republic) composed of the monetary union in Western and Central Africa (Ghosh et al., 2008). They are 14 countries: Benin, Bissau Guinea, Burkina Faso, Cote d'Ivoire, Senegal, Togo, Mali and Niger - all WAEMU members - plus Cameroon, Equatorial Guinea, Congo Republic, Gabon, Central Africa Republic and Chad - all CEMAC members.

The franc zone arrangement has been beneficial or detrimental over the past is debated (Masson & Pattillo, 2001; Dordundo, 2000; Fouda & Stasavage, 2000; Honohan & O'Connell, 1997; Elbadawi & Madj, 1996; Guillaumont & Guillaumont-Jeanneney, 1995; Devarajan & Rodrik, 1991). It is generally concluded that the arrangement was successful from the early 1950s to the mid-1980s, in terms of lower inflation and higher GDP growth, compared with other sub-Saharan countries (Bénassy-Quéré & Coupet, 2011). Conversely, during the 1986-1993 periods, the zone suffered from a cumulative deterioration of the terms of trade combined with growing external debt in line with fiscal indiscipline, and a bank crisis stemming from generous lending to public enterprises, although the franc zone still displayed lower inflation than non-CFA countries. The devaluation of the CFA franc by 50% in January 1994 seems to have been successful. It has been supported by bank restructuring and debt relief. On the whole, it is often pointed out that WAEMU has been more successful than CEMAC; but that, if any, the success of the CFA essentially comes from higher credibility related to the specific arrangement with the French Treasury (Collier, 1991; Guillaumont & Guillaumont-Jeanneney, 1989).

3. Methodology: VAR Model and Procedure, Variable Descriptions and Data Sources

3.1 VAR Model

VAR model is a method in which each variable is modeled as an endogenous variable. The function is its own lag values and those of all the endogenous variables used in the system. VAR (p) model can be presented as:

$$Y_{it} = c + \Phi_1 Y_{it-1} + ... + \Phi_p Y_{it-p} + \zeta_{it} \quad (1)$$

Y_{it} represents the vector of variables $(nt \times 1)$ including the n endogenous variables for the i countries, t represents a time index, p represents the number of lag (s) concerned, the vector c is a constant vector (with

$(nt \text{ x } 1)$ dimension), and $\Phi_1,...,\Phi_p$ represent the matrices with $(nt \text{ x } n)$ dimension comprising coefficients to estimate. The sign ζ_{it} represents a vector of innovations with $(nt \text{ x } 1)$ dimension. The series of innovations contained in ζ_{it} represent the unexplained parts of Y_{it}. These innovations can be correlated between them to contemporary values. But they do not show more temporal correlations (serial), with their own past values (autocorrelation) or past values of the other variables.

In more formal terms, we have $E(\zeta_{it}) = 0$, $E(\zeta_{it}\zeta_{it}') = \Omega$, where Ω is a symmetric matrix positive defined, with $(nt \text{ x } n)$ dimension of variances-co variances, which may have non-zero values other than on the main diagonal, and $E(\zeta_{it}\zeta_{is}') = 0$ for $t \neq s$. The various parameters in the matrices $\Phi_1,...,\Phi_p$ can be estimated using several methods, including using ordinary least squares. These matrices provide information about the link, the causal relationships between the *n* variables contained in the vector Y_{it}.

By analogy to the modeling of univariate autoregressive processes, we also found in the literature the following expression for the VAR (p) model:

$$\Phi(L)Y_{it} = c + \zeta_{it} \tag{2}$$

where L represents the lag operator with function:

$$L^n Y_{it} = Y_{it-n} \tag{3}$$

and Φ the lag (s) polynomial matrix, defined as:

$$\Phi(L) = I_n - \Phi_1 L - \Phi_2 L^2 - ... - \Phi_p L^p \tag{4}$$

where I_n represents the identity matrix with $(nt \text{ x } nt)$ dimension.

If we are interested in making a forecast from the period t (origin of the prediction) for a horizon of forecast period of h, by having available only the information existing at the time t. Formally, we have for the VAR model (p):

$$E(Y_{it+h}) = c + \Phi_1 E(Y_{it+h-1}) + ... + \Phi_p E(Y_{it+h-p}) \tag{5}$$

3.2 VAR Procedure

Sims (1980) has spawned a riche literature applying the VAR procedure. Before estimating our VAR model we perform the usual tests of stationarity: Levin, Lin and Chu test; Im, Pesaran and Shin test; Augmented Dickey-Fuller (ADF) test and Phillips Perron (PP) test. Given the importance of the model specification of the stationary character (stochastic) and the possible presence of a deterministic trend in the series, we conducted previous tests usual unit root on annual.

Then we will try to determine the optimal number of lag VAR model to be estimated. To this end, we will choose the model that minimizes the information criteria. Then, we will perform the Granger causality test to determine the order of variables in the model (from more endogenous to more exogenous). Once the estimate made, we will proceed to a set of post-assessment test to judge the quality of the estimates. Thus, we will first check the stationarity of the estimated VAR model, and then proceeded to test Figure correlograms, and finally the test of autocorrelation of residuals, which is a prerequisite to the implementation of the VAR model.

Once the quality of the estimated VAR model proved, we will proceed to stimulation of changes in certain variables suites to shocks from the real sector as well as nominal up to 10 years after the shock, through the study of the impulse response functions and the variance decomposition of the four variables.

3.3 Variable Descriptions and Data Sources

Levels of GDP per capita are obtained by dividing GDP at current market prices by the population. A variation of the indicator could be the growth in real GDP per capita, which is derived as the percentage change in real GDP divided by the population. This marker is a key macroeconomic indicator and deals with the level of whole economic output related to the population of a country. Global balance is the sum of the current account balance,

the balance of financial operations and the net errors and omissions balance. When the global balance is positive the national economy receives more payments from the rest of the world that are done spending. When it is negative, we speak of positive or negative contribution to growth outside of the national currency in circulation. The current account balance is the sum of the balance of goods and services (trade balance and services), the income balance, the balance of transfers and balance of the capital account. The balance of financial operations (excluding reserve assets) is the sum of the balance of direct investment plus the balance of portfolio investments and the balance of other investments.

A consumer price index (CPI) measures changes in the price level of a market basket of consumer goods and services purchased by households. The CPI is a statistical approximate constructed using the prices of an example of representative subjects whose prices are collected at regular intervals. The yearly proportion of change in a CPI is used to quantify inflation. Inflation affects an economy in a number of ways, both positive and negative. Negative impacts of inflation consist of an augment in the opportunity cost of sharing money, doubt over future may put of investment and savings. In addition, inflation has positive impacts. Basically, inflation gives every actor a reason to expend and invest. Since if they don't, their money will be value less in the forthcoming. This raise in expending and investment can helpful to the whole economy. The CPI-Inflation keeps nominal interest rates above zero, so that central banks can bring down interest rates, when needed, to stimulate the economy.

An interest rate is the percentage at which interest is remunerated by debtors for the use of money that they borrow from creditors. Specifically, the interest rate is a proportion of principal paid a certain number of times per period for all periods during the total term of the loan or credit. Different interest rates exist parallelly for the same or comparable time periods, depending on the default probability of the borrower, the residual term, the payback currency, and many more determinants of a loan or credit. Interest rate targets are a very important instrument of monetary policy and are taken into account while dealing with variables like investment, inflation, and unemployment. The central banks of countries generally have a tendency to reduce interest rates when they want to increase investment and consumption in the country's economy. Nevertheless, a low interest rate as a macroeconomic policy can be uncertain and possibly will go ahead to the establishment of an economic bubble, in which large amounts of investments are poured into the real-estate market and stock market.

To conduct our research, we have used data from the Word Development Indicator (2015) of the World Bank, statistical databases of central banks of CEMAC and WAEMU to describe the four variables above. A sample of 14 African countries of the franc zone over the 1994-2014 times is used to present, to interpret and to discuss the empirical results.

4. Empirical Results: Presentations and Discussions

4.1 Descriptive Statistics

Table 1. Results of the descriptive statistics

Variables	CPI	GDP pc in USD	Global balance	Interest rate
Codes	CPI	GDP_PC	GLOBAL_BAL	INT_RATE
Average	4,957	1687,820	-33,864	505,834
Median	2,892	539,623	-32,100	495,277
Maximum	50,734	15095,640	1104,747	733,039
Minimum	-27,983	231,009	-731,598	198,341
Standard deviation	8,845	2930,088	226,641	97,628
Skewness	2,671	2,788	1,140	0,428
Kurtosis	13,029	10,148	8,071	3,020
Jarque-Bera	1581,858	1006,760	378,733	8,986
Probability	0,0000	0,0000	0,0000	0,0112
Sum	1457,28	496219,20	-9956,03	148715,10
Sum Sq. Dev.	22920,12	2520000000,00	15050334,00	2792641,00
Observations	294	294	294	294

Source: Authors' calculations.

The results presented in the Table 1 before indicate that the consumer prices index, the gross domestic product per capita in United State Dollar (USD), the global balance and interest rates are at a respective annual average

level of 4.957; 1687.820; 505.834 -33.864 and within the 14 countries of the Franc zone with a respective average dispersion around the mean of 8.845; 2930.088, 226.641 and 97.628. The average of the first three values are below their standard deviation implies a great dispersion around these average values. In addition, the medium in each case being to the right of median let appear that the majority of values located in the left of the median or have low values.

Most countries with low values over the study period leaves appear mixed results in terms of economic performance in the franc zone. While if for the consumer prices index and he interest rate, these figures seem to be favorable, the fact is not the same for the other two variables (GDP per capita and global balance) for which the figures refer to a data essentially composed by developing countries.

4.2 Figures

In the Figure 1, Figure 2, Figure 3 and Figure 4 presented below, we have captured the evolution of the four variables for the 14 franc zone countries by some figures. Benin: 1; Burkina-Faso: 2; Cameroon: 3; Central African Republic: 4; Chad: 5; Congo Republic: 6; Côte d'Ivoire: 7; Equatorial Guinea: 8; Gabon: 9; Bissau Guinea: 10; Mali: 11; Niger: 12; Senegal : 13; Togo: 14.

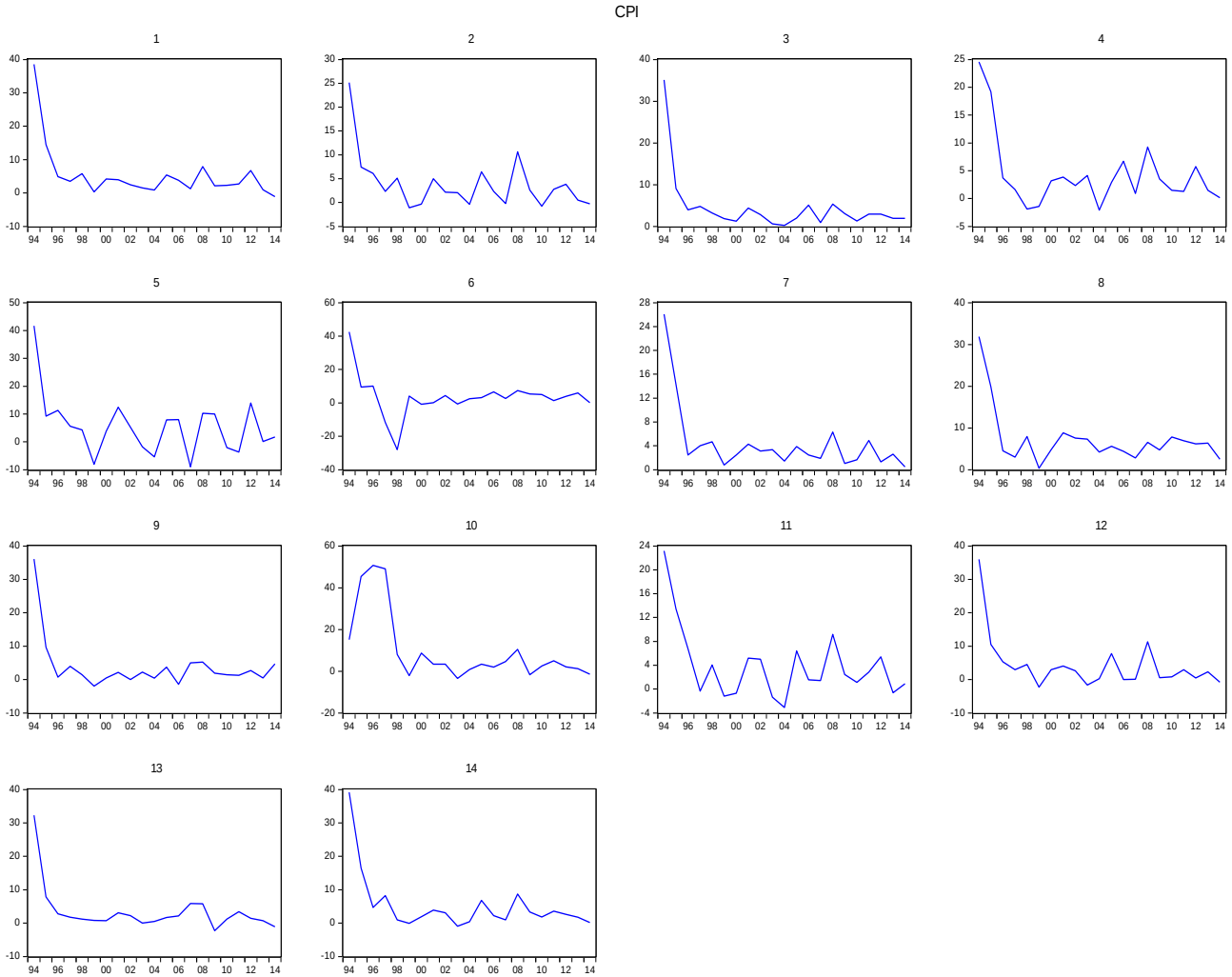

Figure 1. Evolution of the consumer price index for the 14 Franc zone members

Source: Authors' calculations.

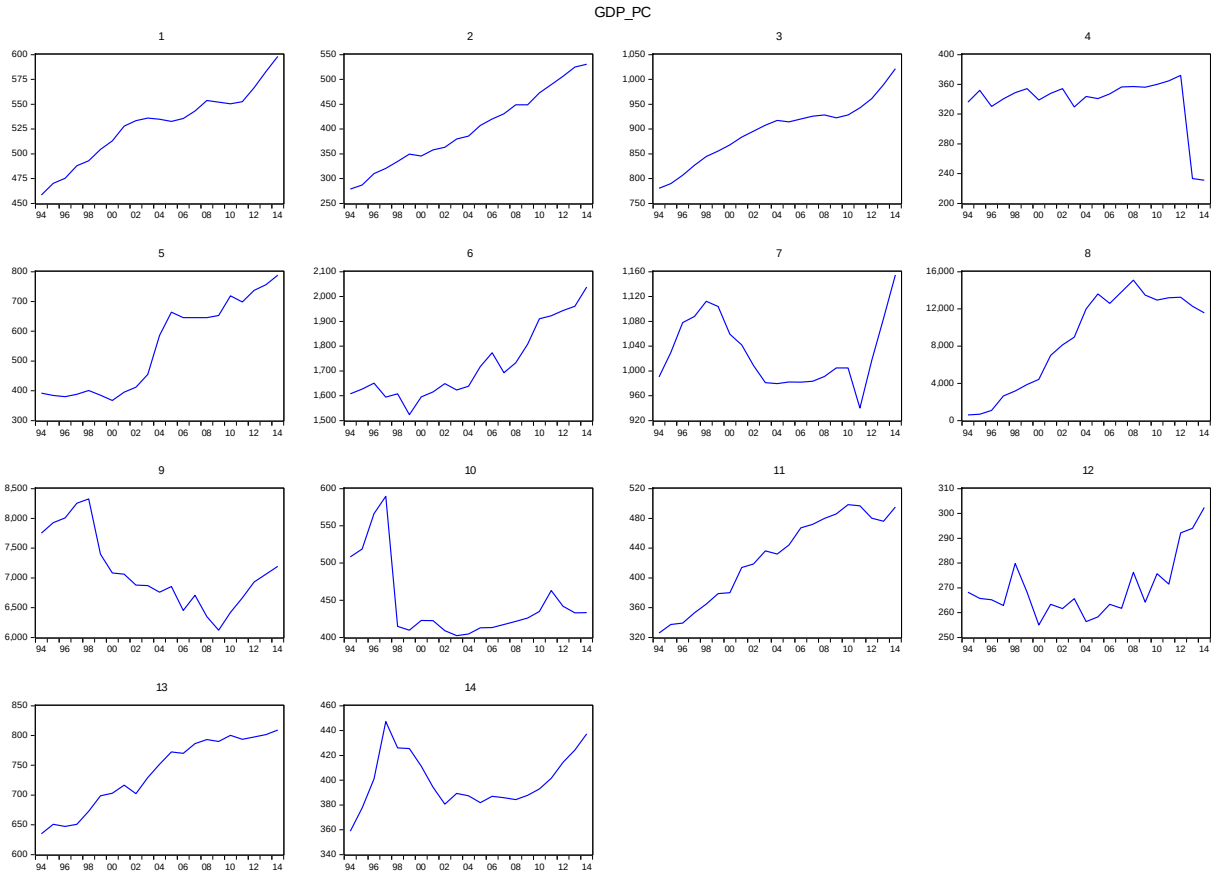

Figure 2. Evolution of the GDP per capita for the 14 Franc Zone members

Source: Authors' calculations.

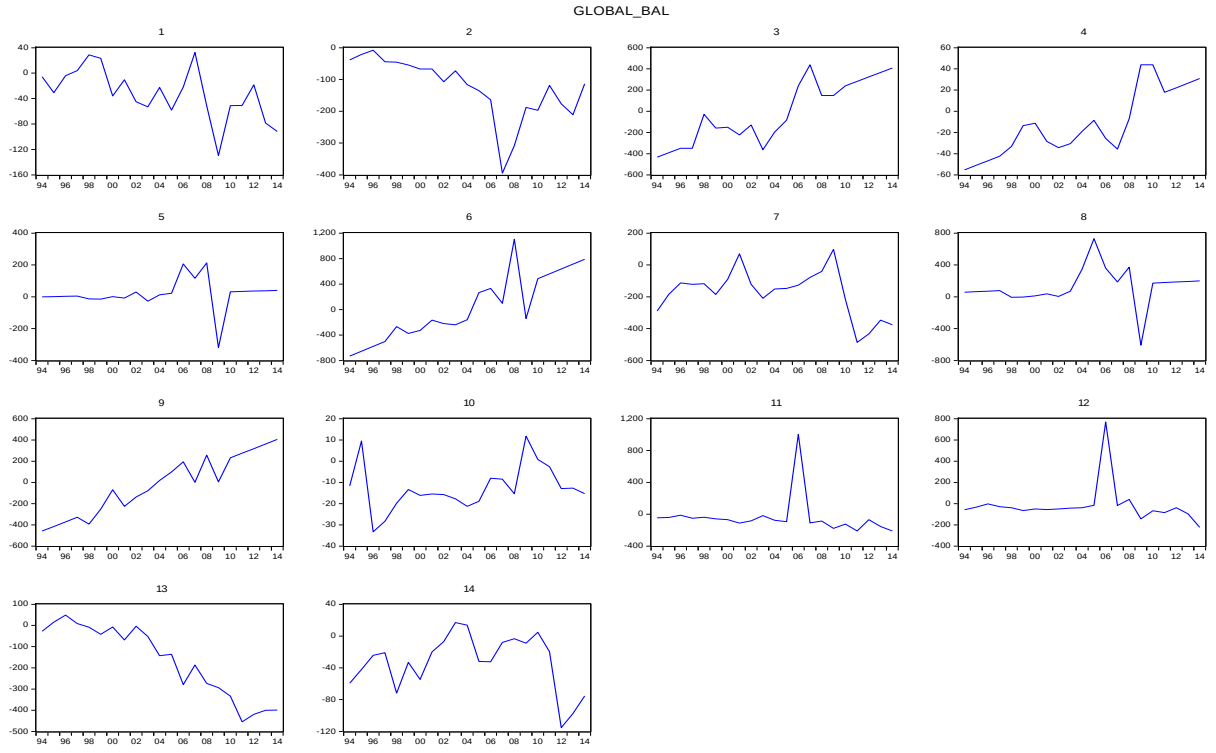

Figure 3. Evolution of the global balance for the 14 Franc Zone members

Source: Authors' calculations.

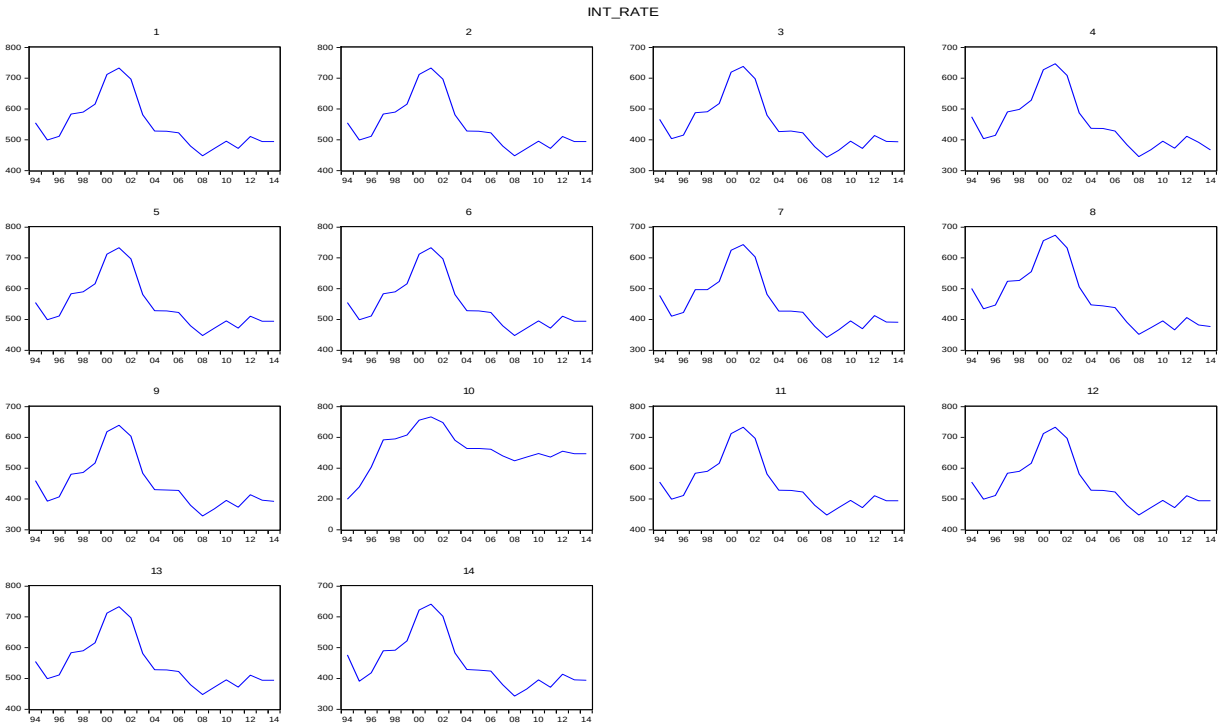

Figure 4. Evolution of the interest rate for the 14 Franc Zone members

Source: Authors' calculations.

4.2.1 Consumer Price Index

The Figure 1 presented before showing the evolution of the CPI inflation indicate that there is an overall decline in the consumer price index (inflation) level in the countries of the franc zone. This confirms the convergence towards thresholds in the two monetary unions: CEMAC (Economic and Monetary Community of Central Africa) and WAEMU (West African Economic and Monetary Union).

4.2.2 Gross Domestic Product per capita in US Dollar

From the Figure 2 before, we have observed the increase in the level of GDP per capita in US Dollar within countries of the franc zone. While growing, it is important to note that the GDP per capita level is still low and insufficient, so that these countries are essentially classified as developing countries.

4.2.3 Global Balance

The evolution of the level of global balance (see Figure 3 before) is climbing, sliding and stationary within countries of the franc zone. Apart from the four countries (Cameroon, Central African Republic, Congo Republic, Gabon) where the global balance is significantly increasing (there is an improvement), in other countries it reflects at best a deterioration of external trade for that country.

4.2.4 Interest Rate

The evolution of interest rates, presented in the Figure 4 before, shows that, after having recorded a very short period of regression, experienced thereafter a longer period of very strong growth before the reversal. This evolution knows after a period of sharp turn down. This is following with the stabilization of the interest rate. The observed stationary throughout the past and recent phases reflects the coherence in the management of banking and financial activities in the countries of the franc zone and thus a better management of risk.

The estimate of a vector autoregressive model is done on stationary data. We now check whether data of our four variables are stationary.

4.3 Unit Racine Test

We will check the stationarity of these four series using the following tests: Levin, Lin and Chu (Levin, Lin, & Chu (2002); Im, Pesaran and Shin (Im, Pesaran, & Shin, 2003); Augmented Dickey -Fuller (ADF) and Phillips Perron (PP).

From the implementation of these tests, the result presented in the Table 2 below, shows that, it appears that except for the GDP per capita in US Dollar which is integrated in order one [I(1)], the consumer prices index, the global balance and the interest rate are integrated in [I(0)], with the trend and the constant.

Table 2. Result of the stationarity tests

Variables	Tests of stationarity	Levin, Lin & Chu t*		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Order	Statistic	Probability	Statistic	Probability	Statistic	Probability	Statistic	Probability
Consumer price index	I(0) + Trend + Constant	-3,81459	0,00010	-11,73910	0,00000	157,20400	0,00000	1993,08000	0,00000
GDP per capita in USD	I(1) + Constant	-2,19212	0,01420	-3,88527	0,00010	61,56670	0,00030	136,76200	0,00000
Global balance	I(0) + Trend + Constant	-4,69974	0,00000	-3,56549	0,00020	58,20790	0,00070	99,58740	0,00000
Interest rate	I(0) + Trend + Constant	-5,10711	0,00000	-3,52714	0,00020	54,20760	0,00210	10,14180	0,99920

Source: Authors' calculations.

4.4 Determination of the Number of Optimal Lags

An essential step construction of the VAR model is the selection of the optimal number of lag. If there is no criterion adopted to determine the number of lags, econometricians agree on the fact that, theoretically, this number should be large enough that residues of various equations of the model are white noise.

Based on the notion of entropy (a measure of the information content of a set), the different existing criteria contained in table 3 help us to choose the model that minimizes the criteria information (SC: Schwarz (1978); HQ: Hannan-Quinn (1980, 1988); AIC: Akaike (1973) Information Criterion, LR: Likelihood Ratio and FPE: Final Prediction Error). These criteria are based on maximizing the logarithm of the function of 'log-likelihood'. We retain the model associated with the minimum value of the criteria. The results contained in table 3 below help us to choose the model that minimizes the criteria information.

Table 3. Result of the VAR lag order selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: CPI, GDP_PC, Global_Bal, Int_Rate
Exogenous variables: C

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-5110,074	NA	7,95E+14	45,66138	45,7223	45,68597
1	-4868,725	471,925	1,06E+14	43,64933	43,95394	43,77228
2	-4806,869	118,7412	7,06E+13	43,2399	43,7882	43,46122
3	-4729,331	146,0754	4,08E+13	42,69046	43,48244*	43,01014
4	-4693,076	67,00665*	3,41e+13*	42,50961*	43,54529	42,92766*

Source: Authors' Calculations.

The result presented in the Table 3 before, shows that the choice must be between p = 3 (SC) and p = 4 (AIC, LR, FPE and HQ). But given that, the results of the majority of these tests are opting for a model with 4 lags, we therefore adopt a VAR for the next 4 lags. The VAR model we will estimate for the suite is VAR (4) with lag 1.4.

4.5 Granger Causality Test

From the implementation of the Granger causality test (Granger, 1969), it emerges that: there is Granger causality between the consumer price index and the global balance. There is Granger causality between the consumer price index and interest rate. There is Granger causality between the global balance and the GDP per capita US Dollar differentiated. There is Granger causality between the interest rate and the consumer price index.

Thus, the order of the variables, from the more exogenous to the least exogenous according Granger test is as follows: the interest rate > the consumer prices index > global balance > GDP per capita in US Dollar.

4.6 Study of the Stationarity of VAR

The VAR (4, 4) is stationary as the inverse root of det(Φ(L)) are inside the unit circle, as illustrated in the Figure 5 and the Table 4 presented below.

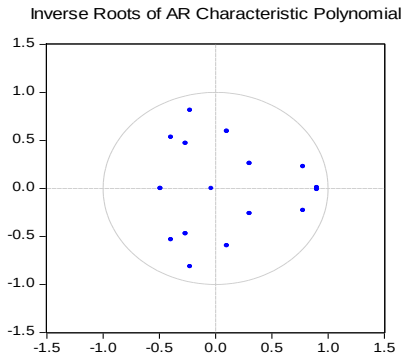

Figure 5. Autoregressive roots graph

Source: Authors' Calculations.

Table 4. Autoregressive roots table

Root	Modulus
0.901184 - 0.010053i	0.901240
0.901184 + 0.010053i	0.901240
-0.225333 - 0.813066i	0.843713
-0.225333 + 0.813066i	0.843713
0.778181 - 0.229201i	0.811233
0.778181 + 0.229201i	0.811233
-0.395116 - 0.532307i	0.662923
-0.395116 + 0.532307i	0.662923
0.100061 - 0.595427i	0.603776
0.100061 + 0.595427i	0.603776
-0.267223 - 0.470601i	0.541178
-0.267223 + 0.470601i	0.541178
-0.490518	0.490518
0.301813 - 0.261109i	0.399085
0.301813 + 0.261109i	0.399085
-0.037817	0.037817

Source: Authors' Calculations.

4.7 Residue Analysis

Residues evolution presented in the graph 6 seem to be the white noise. Then we conduct two tests (the correlograms and the VAR Residual Portmanteau Tests for Autocorrelations) to confirm.

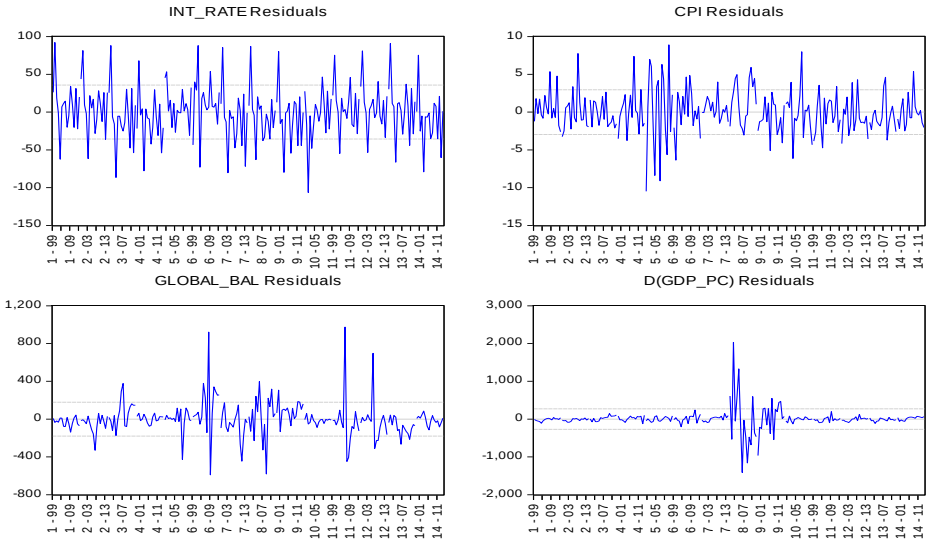

Figure 6. Evolution of the residues of the four variables

Source: Authors' calculations.

The correlograms are presented in the graph 7. These are correlograms of errors of a variable with respect to another. We observe that the error correlations are generally within the terminals.

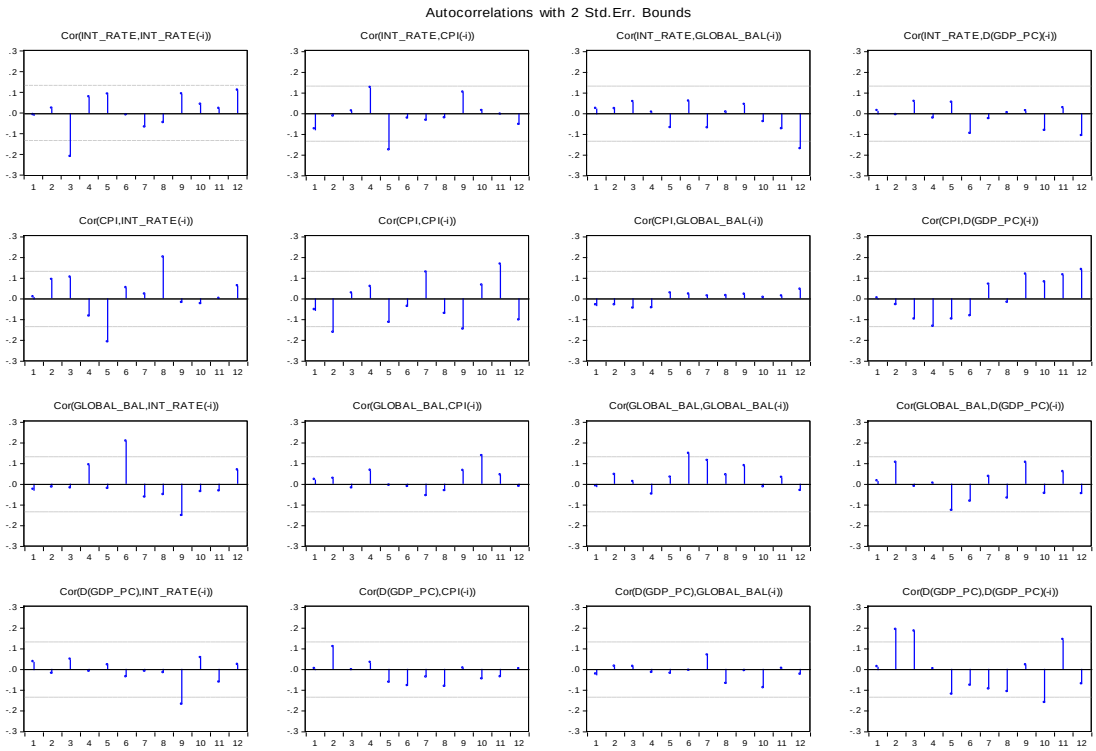

Figure 7. Result of the correlograms of errors

Source: Authors' Calculations.

The VAR Residual Portmanteau Tests for Autocorrelations is presented on the table 5 below. According to this test, we reject the null hypothesis of non - autocorrelation of errors because the p-value of the Q-Stat and the adjusted Q-Stat are lower to 0.05 from lag = 5.

Table 5. Results of the VAR residual portmanteau tests for autocorrelations

VAR Residual Portmanteau Tests for Autocorrelations					
Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	3.351749	NA*	3.366780	NA*	NA*
2	23.90434	NA*	24.10453	NA*	NA*
3	48.43970	NA*	48.97294	NA*	NA*
4	64.45040	NA*	65.27475	NA*	NA*
5	99.52752	0.0000	101.1527	0.0000	16
6	125.8407	0.0000	128.1901	0.0000	32
7	141.4072	0.0000	144.2588	0.0000	48
8	158.8149	0.0000	162.3112	0.0000	64
9	186.3616	0.0000	191.0110	0.0000	80
10	204.3361	0.0000	209.8254	0.0000	96
11	221.6102	0.0000	227.9916	0.0000	112
12	244.1713	0.0000	251.8298	0.0000	128

Source: Authors' Calculations.

4.8 Impulse Response Functions

The vector autoregression method presents a strong new analytical weapon: the impulse response function. Impulse response functions are used to follow the responses of a system's variables to impulse of the systems' shocks. Individual impulse response functions and combined response functions are presented. The Figure 8 below, shows the evolution of individual impulse response functions of the four variables according to shock. This evolution occurs inside the path described by the two red lines. This evolution indicates the significance of the observed effect.

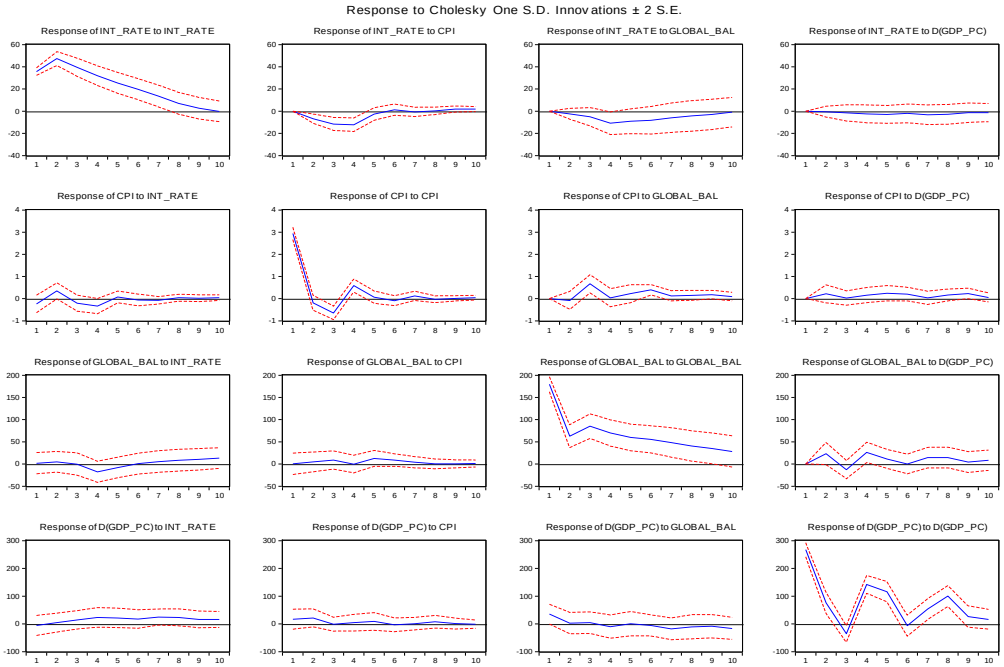

Figure 8. Result of the individual impulse response functions for Franc zone members

Source: Authors' Calculations.

The Figure 9 shows the evolution of the combined impulse response functions. A shock of official interest rate has a positive impact on snapshot itself, but negative on the other variables. Moreover, after 10 years, the effects caused by this shock on all variables including the interest rate almost are completely blurred. Since it eventually cause a slight increase in the general price level in the area after it experienced negative and positive changes which diminishes with time. This evolution is quite consistent with that predicted the economic theory in general, and the equation IS of the model IS-LM in particular (Hicks, 1937).

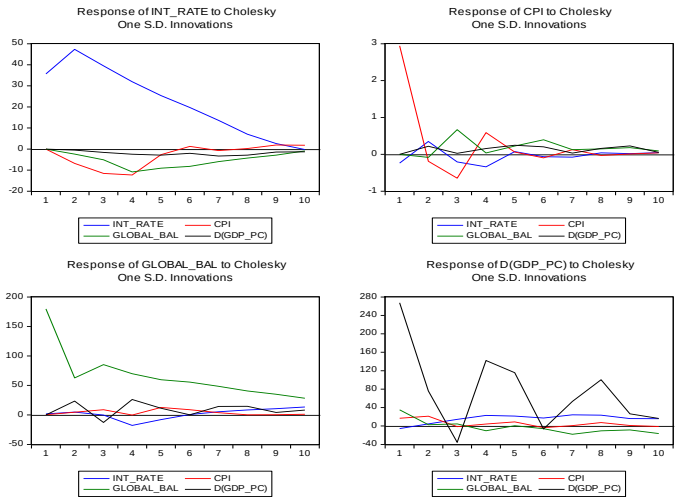

Figure 9. Result of the combined impulse response functions for franc zone members

Source: Authors' Calculations.

A shock of the consumer price index has a positive impact on the instantaneous interest rate and the change in GDP per capita. But has a negative impact on the global balance as well as itself. Subsequently, these variables are experiencing growth phases and slow down for the second, and slow down and growth and for the former. The amplitude is reduced over the time. Like the previous impact, in terms of the shock, the effects from shock almost entirely less after 10 years.

A shock of the global balance has a negative higher instantaneous impact on itself but positive on the other variables. Although the variations observed following this shock on the other variables are quite low. It is

observed that the effect of the price shock is canceled after 8 years. This effect oscillates at decreasing rate for the variation in the level of GDP per capita and increases the interest rate as of the 4th year. Growth becomes weaker from the 6th year. The abrupt reduction of the global balance that occurs due to a shock resulting from itself reverse after 2 years before returning a year later, in reducing. The effect of the budgetary deficit on the interest rate is similar to the one analyzed in Clarida, Gali and Gertler (1998) study in which this effect is no permanent. Moreover, Barth, Beaver and Stinson (1991), as well as Correia-Nunes and Stemitsiotis (1995) already covered in general the fact that government deficits had no impact on short rates.

A supply shock or changes in the level of GDP per capita has a negative instantaneous impact on the global balance and itself, but positive on the other variables. Moreover, while this shock causes a slight increase in interest rates over the time, the stationary trend evolutions of the price index and decreasing of the global balance is observed. It causes strong oscillations of the variation in the level of GDP per capita, which are reduced over the time. Also, on the 10 years following the shock is observed 3 phases of slow down, which are cut between two increasing phases during periods ranging from 3 to 4 years and 6 to 8 years.

4.9 Variance Decomposition of the Variables

Results of the variance decomposition of the four variables are presented respectively from consumer price index, GDP per capita, global balance and interest rate. The result of the variance decomposition of the consumer price index presented in the table 6 shows that in period 1, the variance of the predicted error in the consumer price index is due to 99.35% of its own innovations, 0.65% of those of the official interest rate and 0% of those the other variables. In period 10, it is due to its own innovations at 87.52%, 6.83% of those in the global balance, 3.27% from those of the interest rate and 2.38 % of those of the variation GDP per capita.

Table 6. Result of the variance decomposition of the consumer price index

Variance Decomposition of Consumer price index					
Periods	S.E	Interest rate	CPI	Global balance	GDP per capita
1	2,9511	0,6458	99,3543	0,0000	0,0000
2	2,9866	1,9851	97,4066	0,0776	0,5307
3	3,1354	2,2360	92,6515	4,6234	0,4890
4	3,2122	3,2414	91,6345	4,4188	0,7053
5	3,2310	3,2579	90,6086	4,8509	1,2825
6	3,2633	3,2324	88,9120	6,2120	1,6437
7	3,2692	3,2764	88,7387	6,3358	1,6490
8	3,2769	3,2763	88,3302	6,5086	1,8849
9	3,2900	3,2534	87,6276	6,7642	2,3548
10	3,2922	3,2675	87,5243	6,8313	2,3769

Source: Authors' Calculations.

The result of the variance decomposition of the gross domestic product presented in the table 7 shows that in period 1, the variance of the estimated error of the variation in GDP per capita is due at 97.88 % of its own innovations, 1.68 % of those in the global balance, 0.39 % of those in the consumer price index and 0.04 % from those of the official interest rate. In period 10, it is due to its own innovations at 95.24 %, 2.42 % from those of the official interest rate, 1.65 % of those in the global balance and 0.69 % of those of the variation GDP per capita.

Table 7. Result of the variance decomposition of GDP per capita

Variance Decomposition of GDP per capita					
Periods	S.E	Interest Rate	CPI	Global Balance	GDP per capita
1	270,1374	0,0430	0,3888	1,6835	97,8847
2	281,4559	0,0654	0,9308	1,5601	97,4437
3	284,0773	0,3231	0,9162	1,5552	97,2055
4	318,6863	0,7801	0,7461	1,3393	97,1345
5	339,7960	1,0869	0,7238	1,1785	97,0109
6	340,3646	1,3432	0,7321	1,2041	96,7206
7	345,8326	1,7939	0,7097	1,4367	96,0596
8	361,1405	2,0666	0,6937	1,4046	95,8351
9	362,5699	2,2459	0,6891	1,4505	95,6146
10	363,6672	2,4244	0,6861	1,6486	95,2408

Source: Authors' Calculations.

The result of the variance decomposition of the global balance presented in the table 8 shows that in period 1, the variance of the predicted error of the global balance is due to 99.99% of its own innovations, nearly at 0.00% of those in official interest rates and the consumer price index and 0.00 % of those in the change in GDP per capita. In period 10, it is due to its own innovations at 95.04%, 3.17% of those of the change in GDP per capita, 1.24% from those of the official interest rate to 0.55% from those of the global balance

Table 8. Result of the variance decomposition of the global balance

Variance Decomposition of Global balance					
Periods	S.E	Interest rate	CPI	Global balance	GDP per capita
1	179,6279	0,0096	0,0005	99,9899	0,0000
2	191,8620	0,0726	0,0595	98,3611	1,5067
3	210,5406	0,0604	0,2286	98,0889	1,6221
4	224,0505	0,6772	0,2020	96,3290	2,7919
5	232,6272	0,7426	0,4822	95,9492	2,8260
6	239,3359	0,7023	0,5896	96,0383	2,6699
7	244,7073	0,7212	0,5891	95,7862	2,9034
8	248,6310	0,8169	0,5708	95,4580	3,1544
9	251,3453	0,9749	0,5588	95,3502	3,1161
10	253,4201	1,2382	0,5515	95,0376	3,1727

Source: Authors' Calculations.

The result of the variance decomposition of the interest rate presented in the table 9 shows that in period 1, the variance of the estimated error of the interest rate due to 100.00% of its own innovations and 0.00% from those of other variables. In period 10, it is due to its own innovations at 90.72%, 4.45% of those of the global balance, 4.28% of those of the consumer price index and 0.54% from those of the change in GDP per capita.

Table 9. Result of the variance decomposition of the interest rate

Variance Decomposition of Interest rate					
Periods	S.E	Interest Rate	CPI	Global Balance	GDP per capita
1	35,7060	100,0000	0,0000	0,0000	0,0000
2	59,7455	98,5273	1,3023	0,1638	0,0065
3	72,7408	95,9362	3,4110	0,6020	0,0509
4	81,1630	92,5546	5,0417	2,2713	0,1324
5	85,6164	91,9774	4,6261	3,1633	0,2332
6	88,2704	91,5169	4,3721	3,8407	0,2703
7	89,5803	91,1802	4,2518	4,1712	0,3968
8	90,0026	90,9366	4,2129	4,3571	0,4935
9	90,1192	90,7881	4,2473	4,4483	0,5164
10	90,1519	90,7228	4,2847	4,4549	0,5376

Source: Authors' Calculations.

5. Conclusion

The purpose of this paper was to investigate the nexus between four key macroeconomic and financial shocks: shock on gross domestic product per capita, shock on global balance, shock on consumer price index and shock on interest rate. Specifically, this article has analyzed the impulse response functions due to macroeconomic and financial shocks in the African franc zone composed by two integrated economic and monetary unions.

The main results obtained are respectively: The evolution of the individual impulse response functions of the four variables according to shock occurs inside the path described by the two red lines. This evolution indicates the significance of the observed effect. The evolution of the combined impulse response functions that a shock of the interest rate has a positive impact on snapshot itself, but negative on the other variables. Moreover, after 10 years, the effects caused by this shock on all variables including the interest rate almost are completely fuzzy. Since it eventually cause a slight increase in the general price level in the franc zone after it experienced negative and positive changes which diminishes with time. This evolution is quite consistent with that predicted the economic theory.

A shock of the consumer price index has a positive impact on the instantaneous interest rate and the change in GDP per capita. But has a negative impact on the global balance as well as itself. Subsequently, these variables

are experiencing growth phases and slow down for the second, and slow down and growth and for the former. The amplitude is reduced over the time. Like the previous impact, in terms of the shock, the effects from shock almost entirely less after 10 years.

A shock of the global balance has a negative higher instantaneous impact on itself but positive on the other variables. Although the variations observed following this shock on the other variables are quite low. It is observed that the effect of the price shock is canceled after 8 years. This effect oscillates at decreasing rate for the variation in the level of GDP per capita and increases the interest rate as of the 4th year. Growth becomes weaker from the 6th year. The abrupt reduction of the global balance that occurs due to a shock resulting from itself reverse after 2 years before returning a year later, in reducing.

A supply shock or changes in the level of GDP per capita has a negative instantaneous impact on the global balance and itself, but positive on the other variables. Moreover, while this shock causes a slight increase in interest rates over the time, the stationary trend evolutions of the price index and decreasing of the global balance is observed. It causes strong oscillations of the variation in the level of GDP per capita, which are reduced over the time. Also, on the 10 years following the shock is observed 3 phases of slow down, which are cut between two increasing phases during periods ranging from 3 to 4 years and 6 to 8 years.

In terms of recommendations, it appears that the interest rate and the global balance are the two central variables that have captured the attention of the economic policymakers in these countries to improve country's performance on the pathway of progress. Thus, on the one hand, the monetary authorities (Central Bank authorities) must prevent the rise in interest rates to avoid the decline in growth, rising inflation and the worsening of the deficit of the global balance. On the other hand, the budgetary authorities (government authorities) should reduce the deficit of the global balance to a minimum to promote growth and control inflation and interest rates.

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