Determinants of inflation in CEMAC: the role of money

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Abstract

The aim of this study is to investigate the causes of inflation in CEMAC, with a particular attention to the monetary dimension. Using a Panel Vector Autoregressive (PVAR) approach on CEMAC countries and data from 1990 to 2014, we show that money supply and imported inflation are the two main sources of inflation in CEMAC countries. These factors seem to explain inflation better than oil prices, budget balance and output gap. Specifically, the results show that money supply causes about 24% of inflation's variation while imported inflation explains about 6% of inflation's fluctuations. However, an important inflation's inertia is observed (64% in mean), enlightening some structural problems, in particular, the slowness of expectations adjustment of agents in CEMAC.

Keywords: Panel VAR, Inflation, Monetary Policy, Central Bank Policy

JEL Classification : C33, E30, E52, E58

Déterminants de l'inflation dans la CEMAC : le rôle de la monnaie

Résumé

L'objectif de cette étude est d'identifier les déterminants de l'inflation dans la CEMAC avec un regard particulier sur la masse monétaire. À l'aide d'un modèle VAR en panel appliqué aux pays de la CEMAC sur la période allant de 1990 à 2014, nous montrons que la masse monétaire et l'inflation importée expliquent mieux l'évolution des prix dans la CEMAC que le prix du pétrole, le solde budgétaire ou encore l'écart de production. Spécifiquement, les fluctuations de l'inflation sont dues environ à 24% à la croissance de la masse monétaire contre 6% environ pour l'inflation importée. Toutefois, nous observons une très forte inertie de l'inflation (64% en moyenne), traduisant des problèmes structurels et particulièrement le lent ajustement des anticipations des agents économiques.

Mots-clés : VAR en panel, Inflation, Politique monétaire, politiques des banques centrales.

Codes JEL : C33, E30, E52, E58

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Non-Technical Summary

Price stability is one of the main objectives of most central banks, including the Bank of Central African States (BEAC). From this perspective, a good knowledge of the potential causes (determinants) of price instability in the Central African Economic and Monetary Community (CEMAC) is therefore of paramount importance for the Central Bank.

The objective of this article is thus to identify the determinants of inflation in the CEMAC with particular emphasis on the money supply, with a view to, on the one hand, to help the Central Bank of the Community to have a better understanding of the sources of inflation in the economic space for which it is responsible, and on the other hand to guide the development of the monetary policy of the BEAC.

Controlling the sources of inflation is crucial to understanding the strategies and orientations of monetary policies as it would be futile for any central bank to seek to stabilize prices on which it has no or very little influence. This is all the more important as price shocks can take a transitory or permanent form and, depending on the situation, require or not central bank intervention.

From a theoretical point of view, inflation can result from several causes, both monetary and economic. These causes may come from the supply side or the demand side and influence inflation in the short, medium or long term.

In the case of African countries, many studies tend to show that supply shocks tend to exert more pressure on prices. Thus, shocks on the prices of raw materials, essential goods, climatic and environmental hazards can generate inflation. Socio-political conflicts are also identified as potential sources of inflation in Africa.

Using a panel VAR model estimated on the CEMAC data from 1990 to 2014, we show in this study that the money supply and imported inflation (the increase in the general price level of imported goods) are the main determinants of inflation in the CEMAC. They are much more significant than other factors such as the fiscal balance, the oil price or the output gap. Nevertheless, money supply and imported inflation account for only 30% (of which 24% for the money) of the dynamics of inflation. Almost 64% of this dynamic is determined by inflation itself. The observed inertia reflects not only structural problems, but also a slow adjustment of the economic agents' inflation expectations.

Such results call on the authorities responsible for price stability issues. In other words, it seems useful for the Central Bank to understand that much of the price dynamics is beyond its reach. It would therefore be wise to give more weight to the analyzes of "core inflation" which is generally purged from short-term fluctuations and better reflects the weight of money in explaining prices. Such a choice would allow to better control the effect of central bank actions on prices.

Introduction

The identification of inflation sources has significant importance for central banks not only because inflation has been one of their main objectives since the 1970s but also because of the role of the central bank in the regulation of inflationary pressures. The monetary tool can indeed be a good instrument for stimulating activity and fighting against inflation when the transmission mechanisms of monetary policy are functional. However, under the principle of "money neutrality" it is generally accepted in the long run that monetary policy affects only the general level of prices and not the real sector (output, unemployment). One of the consequences of this widely shared consensus in economics is that monetary policy decisions cannot effectively solve a short-run inflation problem that would rather be caused by factors other than money.

Controlling the sources of inflation is therefore essential to understanding the strategies and orientations of monetary policies, since it would be futile for any central bank to seek to stabilize prices on which it has no or very little influence. This is all the more important since price shocks may take a transitory or permanent form and may require, depending on the situation, the intervention of the central bank. This problem has led several central banks to focus on controlling core inflation, that is, inflation which is supposed to be due to central bank actions and whose calculation excludes its potential fluctuations sources in the short-term.

In theory, price movements can be the result of several causes, both monetary and economic, from the supply side as well as the demand side and which can influence inflation in the short, medium or long term.

Specifically, it is generally accepted in the long run that inflation is fundamentally a monetary phenomenon, it is caused by too much money creation (Friedman, 1956). This monetarist vision led several central banks in the 1970s, in relation to the stagflation situation observed at that time, to opt for a strategy of controlling the evolution of the money supply in order to guarantee the objective of price stability. Several empirical studies have highlighted money as the main determinant of inflation in developed countries (Gelarch and Svensson, 2003, Assenmacher-Wesche and Gelarch, 2006) compared to developing countries (Doe and Diarisso, 1997; Diouf, 2007, Diop et al, 2008, Barnichon and Peiris, 2008).

In the short term, in contrast, it is recognized that changes in the general price level would be influenced by determinants such as changes in aggregate demand and supply, changes in commodity prices, technological change, exchange rate constraints, climate shocks (Blinder 1982, Loungani and Swagel 2001, Fischer and al 2002, Catao and Toroness 2005, Diouf 2007, Barnichon and Peiris 2008, Kinda, 2011).

Sociological, institutional, natural and socio-political factors can also affect the price level both in the short and long term and especially in developing countries. Some of these factors are due to the difficulties governments face in maintaining strong and sustainable economic growth with strong institutions. As such, inflation would result from factors that are not directly link to the action of the central bank and which are harmful to growth, notably the

insufficiency of private savings, the inadequacy of developed industries, wars and political unrest, landlocked countries, the quality of infrastructure, governance and the quality of institutions. For example, it would be difficult for a central bank to stabilize inflationary pressures caused by a climate of political tensions or to the isolation of a State with no opening to the sea and where all imported goods move through another country (Central African Republic and Chad).

Factors such as subsidies from some sectors and products, the signing of contracts guaranteeing long-term low price between firms, the costs of multiplying negotiations and changing price catalogs (see the theory of menu costs) are also likely to influence prices and especially by making them more rigid. A good understanding of the factors likely to generate or limit inflationary pressures is therefore important in order to better guide economic policy decisions.

Belonging to a monetary zone governed by Community disciplines in economic policy-making, however, is beneficial to maintaining price stability. Indeed, countries that are generally unionized and have adopted a fixed exchange rate regime, such as those of CEMAC[1] or WAEMU[2], perform very well in stabilizing prices (Ghosh and al., 1995). In the CEMAC, for example, since the monetary reforms started in the 1990s, inflation is on average equal to the Community norm of 3%, but with disparities between countries. However, it is not certain that such a performance is due to the Central Bank policy. Indeed, in a context marked by a weakness in the transmission channels of monetary policy, it would be difficult to maintain a low price level due to the central bank's single action (Saxegaard, 2006; Bikai and Kenkouo, 2015).

Since one of the objectives of the BEAC is to maintain internal stability by ensuring a low inflation rate, it is important to know what is the weight of the money in explaining price fluctuations. This requires identifying the determinants of inflation in the CEMAC. Such a study could allow and judge whether or not the central bank should act on all price fluctuations.

The rest of the article will be divided into three sections. The first section will focus on the characteristics of inflation as observed in the CEMAC. The second section presents a brief literature on the determinants of inflation with particular emphasis on developing countries. The third section will be devoted to the presentation of the methodology, results and policy recommendations.

1. Inflation in CEMAC

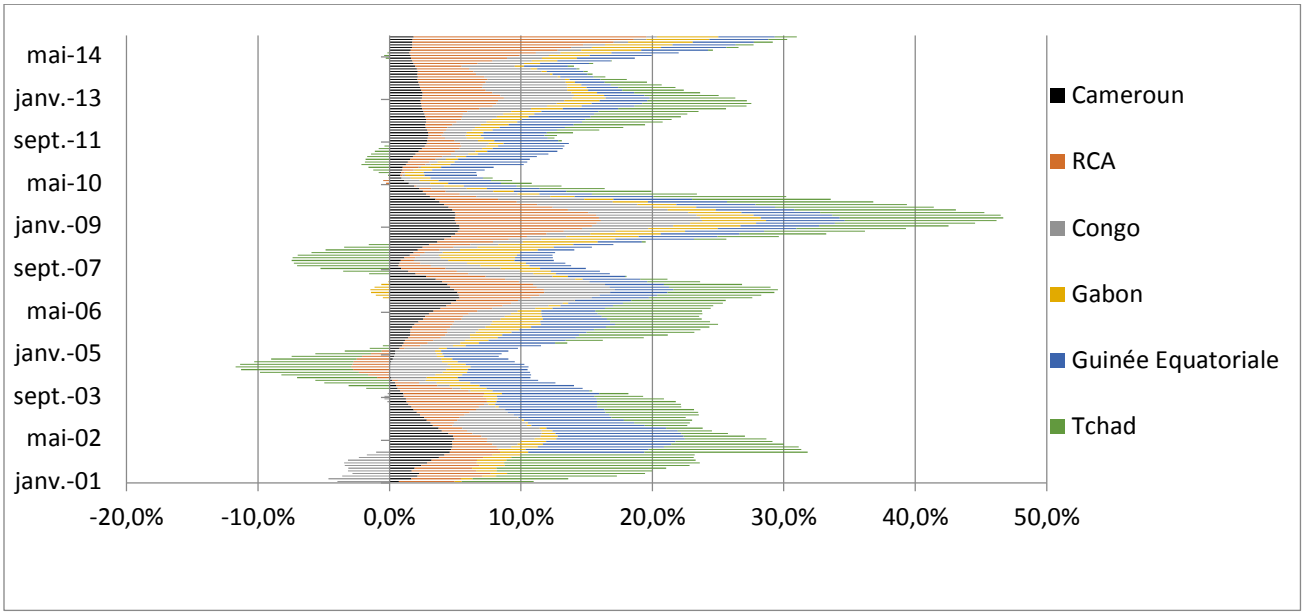
In the CEMAC, inflation is apprehended by the growth rate of the Consumer Price Index (CPI). Although, on average, the inflation rate of the CEMAC countries is close to the Central

[1] Economic and Monetary Community of Central Africa composed of six States: Cameroon, Central African Republic, Congo, Gabon, Equatorial Guinea and Chad.
[2] West African Economic and Monetary Union

Bank's 3% standard, inflation levels by country differs widely from one to another, highlighting the potential heterogeneities between these countries and the difficulty that the Central Bank can have in carrying out an effective common monetary policy.

As can be seen in Figure 1 below, some countries (Cameroon and Gabon) have had fairly well-controlled levels of inflation since the early 2000s, but other countries are characterized by relatively high levels of inflation volatility (Chad, Congo, Equatorial Guinea), which tends to stabilize over time (Chad case). For the Central African Republic, the inflation situation has deteriorated significantly over the past four years, in line with the political tensions it experienced during this period. This overall picture leads us to understand that the determinants of inflation are certainly not similar from one country to another, but the co-movements observed between the different series may suggest that there are common factors dictating the structural evolution of inflation in the CEMAC.

Figure 1 – ***Evolution of inflation in the CEMAC countries (2001 - 2014)***



Source: ***Authors using data from national administrations***

In recent years (2004-2014), the general level of prices in the CEMAC has experienced an average annual change of 2.8% for all countries, slightly below the Community norm of 3%. However, over the same period, the inflation rate exceeded the Community norm, in particular in 2005 (+ 3.4%), 2006 (+ 4.8%), 2008 (+ 6%), 2009 (+ 4.4%), 2012 (+ 3.8%) and 2014 (+ 3.2%). The countries most affected by relatively high inflation were the Central African Republic (+ 4.7%), Equatorial Guinea (+ 4.6%) and Congo (+ 3.4%). Chad, Cameroon and Gabon experienced average inflation over the ten years of 2.8%, 2.5% and 2.3%, respectively.

Table 1 – *Evolution of inflation rate in the CEMAC* (in %)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	moy 2004 2014
Cameroun	0,4	1,9	5,2	0,9	5,3	3,1	1,2	2,9	2,4	2,1	1,8	2,5
RCA	-2,1	2,9	6,6	1,0	9,3	3,5	1,5	1,2	5,9	4,0	17,7	4,7
Congo	3,3	2,9	5,0	2,6	5,0	5,6	0,4	1,8	5,0	4,7	0,8	3,4
Gabon	0,5	3,8	-1,4	5,0	5,3	1,8	1,5	1,3	2,7	0,5	4,7	2,3
Guinée Equat	4,2	5,6	4,4	3,0	6,0	6,0	5,6	4,8	3,6	3,0	4,3	4,6
Tchad	-5,4	7,8	8,1	-7,4	8,3	10,1	-2,1	2,0	7,6	0,2	1,7	2,8
CEMAC	**-0,3**	**3,4**	**4,8**	**0,3**	**6,0**	**4,4**	**0,9**	**2,5**	**3,8**	**2,0**	**3,2**	**2,8**

Source: BEAC's data.

These developments highlight the heterogeneities of these countries and, presumably, the difficulty that the central bank may have in conducting an effective policy of price stabilization.

In order to better understand the determinants and factors that may influence the evolution of this index, we will follow two approaches: an approach by consumption functions and an approach by the determinants of inflation.

1.1 Analysis of inflation in CEMAC: consumption functions Approach

The analysis of inflation according to the consumption function approach makes it possible to identify the consumption pattern of agents and to analyze the functions subject to recurrent fluctuations.

The most recent situation, as can be seen in Table 2 below, allows us to provide a primary analysis of the factors that may affect inflation within CEMAC.

Table 2 - ***Evolution of the price index by consumption functions of the CEMAC (Base 100: year 2011)***

Consumption functions	2012	2013	2014	2015	Mean
Food and non-alcoholic beverages	106,3	108,4	112,9	115,7	110,8
Alcoholic beverages and tobacco	101,3	103,2	107,4	111,4	105,8
Clothing and footwear	102,3	103,6	106,5	110,3	105,7
Housing, water, gas, electricity and other fuels	102,5	105,2	107,4	109,7	106,2
Furniture, household articles and routine maintenance	102,2	104,9	108,4	109,9	106,4
Health	100,9	102	104,4	104,3	102,9
Transports	102,9	104,9	109,7	115,4	108,2
Communications	97,9	96,1	96,6	93,2	95,9
Leisure and culture	100,5	101,1	103	106,3	102,7
Teaching	101,1	104,7	107,9	112	106,4
Restaurants and hotels	103,5	105,9	111	116,1	109,1
Miscellaneous goods and services	102,8	105	106,1	108,4	105,6
General index	103,8	105,8	109,2	111,9	113,3

Source: Authors using data from national administrations.

Note: For the sake of consistency, the benchmark period was set for 2011 due to the adoption this year by all CEMAC countries of the COICOP nomenclature (Classification of Individual Consumption by Purpose) with 12 consumption functions.

If we limit ourselves to a recent analysis of inflation across the different consumption functions, we can see that the most inflationary functions are: Food and non-alcoholic beverages, Transport, Restaurants and hotels. Factors likely to influence these consumption functions could be potential determinants of inflation in CEMAC, especially in the short term. And as we can see, not all of these factors are directly link to the monetary policy of the central bank. For example, providing an efficient and low cost transport system to households depends more on a proactive policy of States to finance and maintain public infrastructures, the financing of which depends on its ability to collect revenues and to have a level of optimal and realistic expenditure. It should also be noted that much of the food and non-alcoholic beverages that have a preponderant weight in the household consumption function are imported. This situation suggests an influence of foreign prices or the exchange rate in the explanation of inflation in the CEMAC but also a rather limited importance of the money in the explanation of price fluctuations.

1.2 Analysis of the determinants of inflation in CEMAC

Theoretically, the explanation of price movements can be the result of several causes, both monetary and economic, from the supply side as well as the demand side and which can influence inflation in the short, medium or long term. Socio-political and environmental causes can also play a major role in explaining price fluctuations and the weight of all these factors may vary from country to country and even over time.

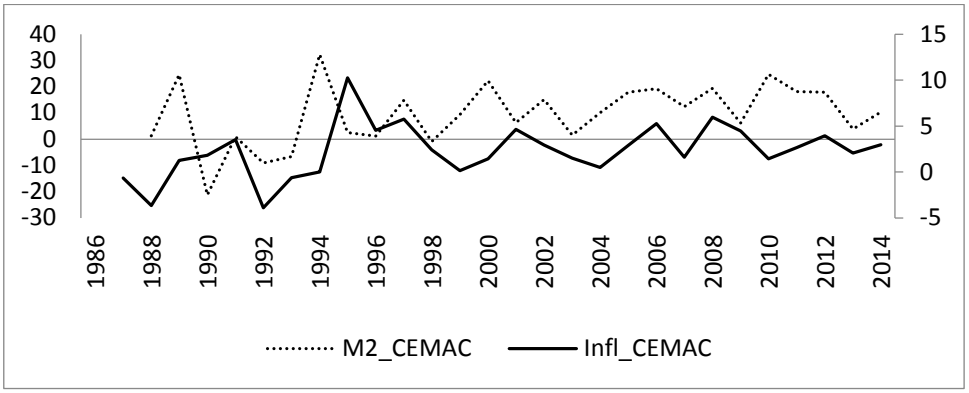
As for the Central African Republic, the security situation of the country during the last ten years, marked by political tensions and the country's isolation, certainly played a role in explaining prices. For Equatorial Guinea and the Congo, in contrast, the inflation level may reflect fluctuations in the prices of raw materials, particularly oil, of which they are highly dependent. It should be noted that the weight of oil in the total exports of these countries is 90% and 92% respectively. Factors such as money and government budget expenditures may also be the source of such price fluctuations. However, countries in the sub region with a structural deficit in balances of payment, and with consumption mainly oriented towards imported products, would also expect imported inflation to play a role in explaining prices.

Among the factors that can influence prices in CEMAC, we shall limit ourselves in our analysis to endogenous factors, which can be influenced by the monetary and fiscal authorities (money supply and fiscal indicators) and exogenous factors such as changes in oil prices and imported inflation that are beyond the control of the economic policy authorities.

As regards money, it may represent a source of fluctuation in prices in the CEMAC. As monetarist analyzes point out, too much money creation creates long-term inflationary pressures. Despite the weakness of the monetary policy transmission channels in the CEMAC (Saxegaard, 2006; Bikai and Kenkouo, 2015), the hypothesis of correlation between money supply and prices in the CEMAC cannot be rejected. Keungne and Ousman (2015) show that monetary growth in CEMAC is positively and strongly correlated with inflation from 1973 to 2002, and after that date, the correlation between these two variables has decreased significantly. Such an evolution may be justified, among other things, by excess liquidity combined with credit rationing observed since the early 2000s. This result also implies that

factors other than money contributed to explain inflation during the 15 last years. However, from Figure 2 below, it would be difficult to conclude that changes in the money supply are unrelated to fluctuations in CEMAC inflation.

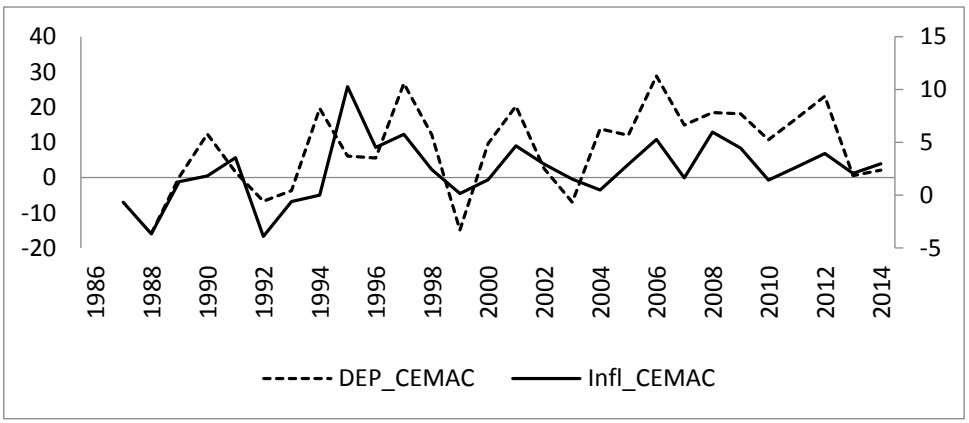
Figure 2 – ***Inflation and the growth of money supply in CEMAC (in %)***



Source: Authors based on BEAC data.

Another factor likely to influence inflation in the CEMAC could come from the ***fiscal policy***. Indeed, the large share of government expenditure in the economies of the subregion is likely to affect many consumption items taken into account in the calculation of the consumer price index, such as housing, transport, water and electricity consumption. As the State is one of the biggest job-supplier and one of the biggest investors in the CEMAC countries, its action can therefore impact aggregate demand and affect activity and prices. The analysis in Figure 3 below thus allows us to see that the movements of rise and fall in public expenditure in the CEMAC are sometimes accompanied by similar movements in inflation. But on the whole, this variable does not seem relevant in the explanation of price fluctuations.

.**Figure 3 –** ***Change in public expenditure and inflation in CEMAC (in %)***

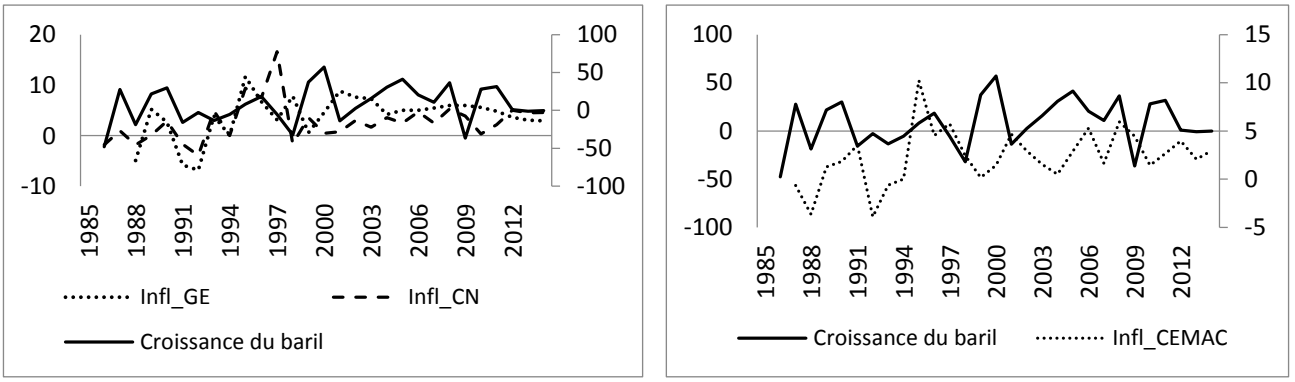


Source: Authors based on BEAC and national administrations data.

Regarding oil, given its high weight in total CEMAC exports, changes in oil prices may represent a source of price fluctuations. Kenkouo (2015) shows that an increase in oil prices by 10% would be responsible for the increase in long-term inflation in the CEMAC in the range of 1.5 to 4 percentage points depending on the country. But in the short term, the existence of hydrocarbon stabilization funds in some countries would prevent excessive

fluctuations in inflation, these prices are generally adjusted only in the medium term to take account of real developments.

Figure 4 – ***Inflation and oil price in CEMAC***

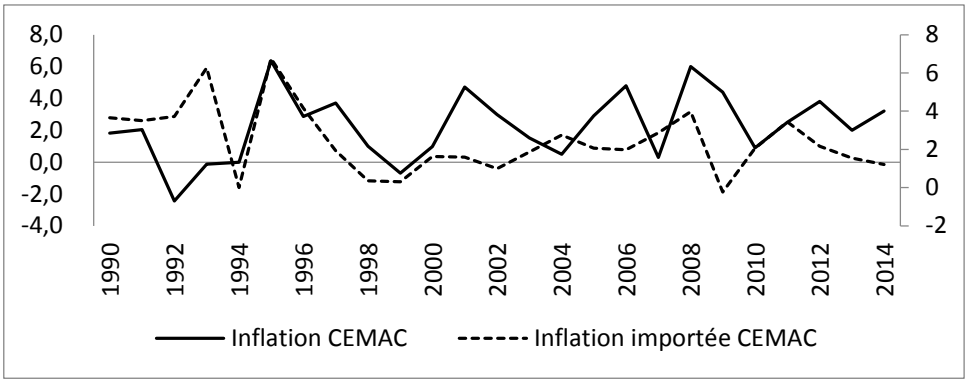


Source: Authors based on BEAC data.

Note: GE-Equatorial Guinea; CN-Congo.

Due to the strong extraversion of the CEMAC economies and the structural deficit in country balance of payments, ***imported inflation*** could also play a significant role in explaining price fluctuations in the sub region. In order to capture imported inflation, we constructed an indicator based on the inflation levels of the main partners in each country, weighted by the weight of trade with these partners in the overall external trade. As can be seen in Figure 5 below, imported inflation into the CEMAC may explain some price movements in the CEMAC.

Figure 5 – ***Imported inflation and inflation in the CEMAC (en %)***



Source: BEAC and national administrations data.

The existence of several determinants of inflation often leads central banks to choose a more useful indicator: core inflation, which is somehow purged from the main sources of short-term fluctuations.

2. Determinants of inflation in developing countries: a brief review of the literature

Several empirical studies have been conducted to identify the causes of inflation, which may be monetary, economic, sociological, socio-political or even environmental.

As for money, one cannot analyze the theory about the determinants of inflation, without recalling the famous and well-known affirmation of Milton Friedman (1970), *"Inflation is always and everywhere a monetary phenomenon in the sense that it is and can only be generated by an increase in the quantity of money faster than that of production."* According to the latter, any excess of the money supply in relation to the real cash balances required for the economic agents, results in a rise in prices. The relevance of money growth as a determinant of inflation has been tested in many empirical studies and especially in developed countries. For example, Assenmacher-Wesche and Gerlach (2006) find that money supply growth is a determinant of inflation in Japan, the United Kingdom, the United States and the Eurozone.

However, in developing countries, Loungani and Swagel (2001) use a VAR approach to demonstrate with a sample of 53 developing countries that monetary growth and exchange rate fluctuations explain a large part of inflation movement more in countries with flexible exchange rate regimes than in countries with a fixed exchange rate regime. Moreover, Barnichon and Peiris (2007) use an error-correction model on a panel of 16 African countries and conclude that the gap between the quantities of money offered and demanded is a more determining factor of inflation than the production gap. Monetary variables would therefore be key long-term determinants of inflation. Doe and Diarisso (1997), Diouf (2007), Diop et al (2008) also reached the same conclusion for WAEMU countries.

According to the economic approach, inflation is the result of an imbalance between supply and demand for goods and services. When aggregate demand grows faster than supply, it leads to an upward adjustment in prices to restore equilibrium.

The Aggregate Supply-Aggregate demand approach emphasizes the influence of supply and demand shocks. Work on the determinants of inflation in some African countries highlights the preponderance of supply shocks in the activation of inflationary pressures such as shocks on commodity prices, production shortages due to unpredictable factors (climate problems, floods, wars?) or austerity policies. Thus, the economic approach to the determinants of inflation cannot be dissociated from some environmental factors that have a significant impact on supply shocks.

As such, in West Africa, Zonon (2003) examines the determinants of inflation in Burkina Faso through an error-correction model that includes the money supply, external prices, exchange rate, production gap and per capita income. In addition to the monetary explanation of inflation, he also identifies fluctuations due to climatic conditions as significant determinants of inflation. Diouf (2007) also shows for Mali that climatic conditions influence the production of cereals and consequently the price level.

In the same vein, Ndiaye (2008), using a consumption-based approach related to an error-correction model on quarterly data from 2000-2007, shows that the functions "feed", "housing", and "clothing" would be the ones that most influence the evolution of inflation in Senegal. In addition, insufficient supply of foodstuffs would be an important factor explaining pressure on cereal prices, which is reflected in the general level of prices.

To go further, Nsengiyumva (2011) using a VAR model with five variables estimated from annual data over the period 1975 to 2008, shows that the general level of prices depends, in Burundi, on the evolution of the price of oil, the real exchange rate, GDP, the short-term interest rate, but also, and above all, on direct price increases.

Simpasa and Gurara (2011), analyzing the causes of inflation in Ethiopia, Kenya, Tanzania and Uganda, highlight world prices for food and oil, domestic production, monetary, fiscal and interest rate policies as the main determinants of inflation in these countries of East Africa. Loening and Birru (2013) also highlighted, in the case of Ethiopia, the importance of international commodity prices in explaining inflation.

Regarding work in Central Africa, Caceres and al (2011) use a panel VAR to show that food and oil prices affect the dynamics of non-monetary inflation for four or five quarters and their impact decreases substantially over time. Indeed, for these authors, past inflation influences current inflation due to the slow adjustment of the expectations of economic agents. In addition, fluctuations in the prices of food products such as wheat, maize, rice, palm oil and sugar would contribute between 10 and 15% to the explanation of price increase in Central Africa. Using the example of Chad, Kinda (2011) highlights as the determinants of inflation: rainfall and foreign price fluctuations, the combined effects of which would persist for six quarters.

Nguyen and al (2015) also identify as predominant determinants of CEMAC inflation: domestic supply shocks, exchange rate and monetary shocks.

In addition to economic and monetary factors, studies have also highlighted the inertial nature of inflation, especially for countries with a fixed exchange rate regime. This phenomenon would account not only for the lack of flexibility in price adjustment but also for structural rigidities (Loungani and Swagel, 2001).

Since the determinants of inflation are constantly changing according to the structural evolution of economies, it is of great importance to examine them again through more recent methods.

3. Determinants of inflation in CEMAC in a panel VAR

3.1 Model and data

Most studies that analyze the determinants of inflation typically use error correction models or VAR models based on the information provided by the data. In this study, we use a panel VAR model with the advantage of addressing the determinants of inflation through a VAR approach applied simultaneously to the six countries in the zone. Such an approach makes it possible to analyze the overall situation of the determinants of inflation in the CEMAC without necessarily worrying about individual disparities. This is also due to the fact that the overall situation of the sub-region is sometimes preponderant in the decision-making of the Central Bank.

The model used have the following form :

$$Y_{it} = \gamma + \emptyset(L)Y_{it} + u_i + \varepsilon_{it} \qquad (1)$$

In this representation, Y_{it} is a vector of stationary variables and $\emptyset(L)$ is a polynomial matrix of the lag operator L. u_i represents the country-specific effect and ε_{it} represents the error.

Let's recall that:

$$\emptyset(L) = \emptyset_1 L^1 + \emptyset_2 L^2 + \cdots + \emptyset_p L^p \qquad (2)$$

$\emptyset_j$ are matrices of coefficients specific to countries and periods.

The variables we use for each country are, the output gap[3] (gap), the growth rate of the money supply (gm2), the budget balance (sob), the price of oil (pp), inflation imported (inf_imp) and inflation (inflation).

Due to the presence of country-specific effects, the variables will be subtracted from the mean (Arellano and Bover, 1995). The final model is therefore of the form:

$$\tilde{Y}_{it} = \emptyset(L)\tilde{Y}_{it} + \tilde{\varepsilon}_{it} \qquad (3)$$

Where $\tilde{Y}_{it}$, and $\tilde{\varepsilon}_{it}$ are vectors of variables differentiated at their mean following the Helmert approach, which eliminates the unobservable individual effects. Indeed, for K variables and T periods, we will have:

$$\tilde{Y}_{it} = \left(\tilde{Y}_{it}^1, \tilde{Y}_{it}^2, \ldots, \tilde{Y}_{it}^K\right) \ et \ \tilde{\varepsilon}_{it} = (\tilde{\varepsilon}_{it}^1, \tilde{\varepsilon}_{it}^2, \ldots, \tilde{\varepsilon}_{it}^K)$$

With :

$$\tilde{Y}_{it}^k = \delta_t\left(Y_{it}^k - \bar{Y}_{it}^k\right) \ , \ \tilde{\varepsilon}_{it}^k = \delta_t\left(\varepsilon_{it}^k - \bar{\varepsilon}_{it}^k\right) , \ \bar{Y}_{it}^k = \frac{1}{T}\sum_{t=1}^{T} Y_{it}^k \ , \ \bar{\varepsilon}_{it}^k = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_{it}^k \ et \ \delta_t = \sqrt{\frac{T-t}{T-t+1}}$$

After estimating the parameters of the panel VAR, we will identify the impulse response functions as well as the variance decomposition using a Cholesky decomposition. We also make a structural decomposition of the errors in order to test the robustness of our results. Regarding the Cholesky transformation, the results generally depend on the order of introduction of the variables, which must be from the most exogenous to the most endogenous. Following this approach, we make the following assumptions:

(i) *the price of oil* is the most exogenous variable, and therefor is not influenced by the other variables of the model. Indeed, given their dependence on oil production and their position as a price taker, the main exogenous shock that can significantly affect the CEMAC countries concerns the fluctuations in the price of a barrel of oil;

(ii) follow *the imported inflation*, which may be influenced by the price of oil but not necessarily by the other variables of the model instantaneously. As CEMAC countries globally face a trade deficit, in the absence of structural transformation and diversification of productive structures, imported inflation appears as an

[3] Calculated as the difference between real GDP and potential GDP normalized by real GDP. Potential GDP is calculated using the Hodrick and Prescott filter.

exogenous factor that can also be affected by oil prices that have an impact on the production costs of international partners;

(iii) *the money supply* which is generally assumed to be exogenous may come in third position, implying that it can be influenced by the two preceding variables. Indeed, the central bank generally controls the supply of money in relation to two key indicators: the situation of foreign exchange reserves (heavily dependent on oil prices), and local inflation, which is also affected by imported inflation ;

(iv) *the budget balance* comes in fourth position, implying that it is influenced by the previous variables instantaneously. However, given the high dependence of CEMAC countries on oil, we are particularly looking forward to a significant response from the budgetary balance to changes in the price of oil. Moreover, the fiscal policies of the states can also affect the money supply, and in order to take account of this possible double causality, we will in another estimate modify the order of the budget balance by swapping it with the money supply ;

(v) *the output gap* comes in fifth position, implying that it can be influenced by the four previous variables. Indeed, this indicator measures the position of the cycle of an economy and can therefore be affected by exogenous and endogenous shocks. The output gap generally gives an idea of the inflationary pressures affecting the economy, and the Phillips curve accounts for this phenomenon and generally describes inflation as a phenomenon affected by the output gap ;

(vi) *inflation* comes last, implying that it can be influenced by all other variables.

Our vector of variables will therefore have the following form:

$$Y_{it} = (gpp, infimp, gm2, sob, gap, inflation)'$$

The study is carried out on a panel made up of all six (06) countries of the CEMAC and concerns the annual data from 1990 to 2014.

3.2 Results and recommendations

i. Results

As it is usual for such an exercise, we first tested the stationarity of the variables used in our VAR in order to detect possible cointegration relationships before estimating the VAR model on panel data (PVAR).

Stationarity tests of the variables and VAR stability

We performed two types of stationarity tests in panel data:

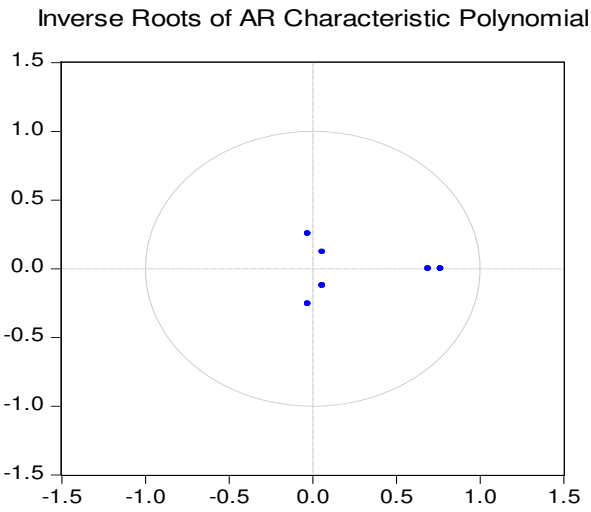
- Tests assuming a common unit root for each individual: Levin, Lin and Chu (LLC), and Breitung;
- Tests assuming an individual unit root in the series: Im, Pesaran et Shin (IPS), ADF[4]-Fisher, PP[5]-Fisher.

The results of the stationarity tests (in appendices) indicate that the variables used are stationary. In other words, we can estimate a VAR at level without worrying about possible cointegration relationships since the variables are not integrated.

In addition, according to the Schwartz and Hannan-Quin tests (see appendices), the maximum lag to be taken into consideration is one.

Moreover, as shown in figure 6, the estimated VAR is stationary in level, in other words, the interpretation of the impulse response functions is not problematic, since all the inverse roots of the characteristic polynomial of the lag operator are inside the unit circle, which validates Wold's theorem thus guaranteeing the transformation of a VAR into a VMA[6](∞).

Figure 6 – *Inversibility of the characteristic polynomial*



Results of the PVAR on the determinants of inflation

Our results indicate that, of the variables used to explain inflation in the CEMAC, money supply and imported inflation are the most significant. As can be seen from the last line of Figure 7 below, when countries are taken together:

- inflation in the CEMAC does not react to fluctuations in the price of oil. This can be justified by the existence of stabilization funds for hydrocarbon prices in some countries which would prevent excessive fluctuation in inflation. This result was also obtained by Kenkouo (2015);

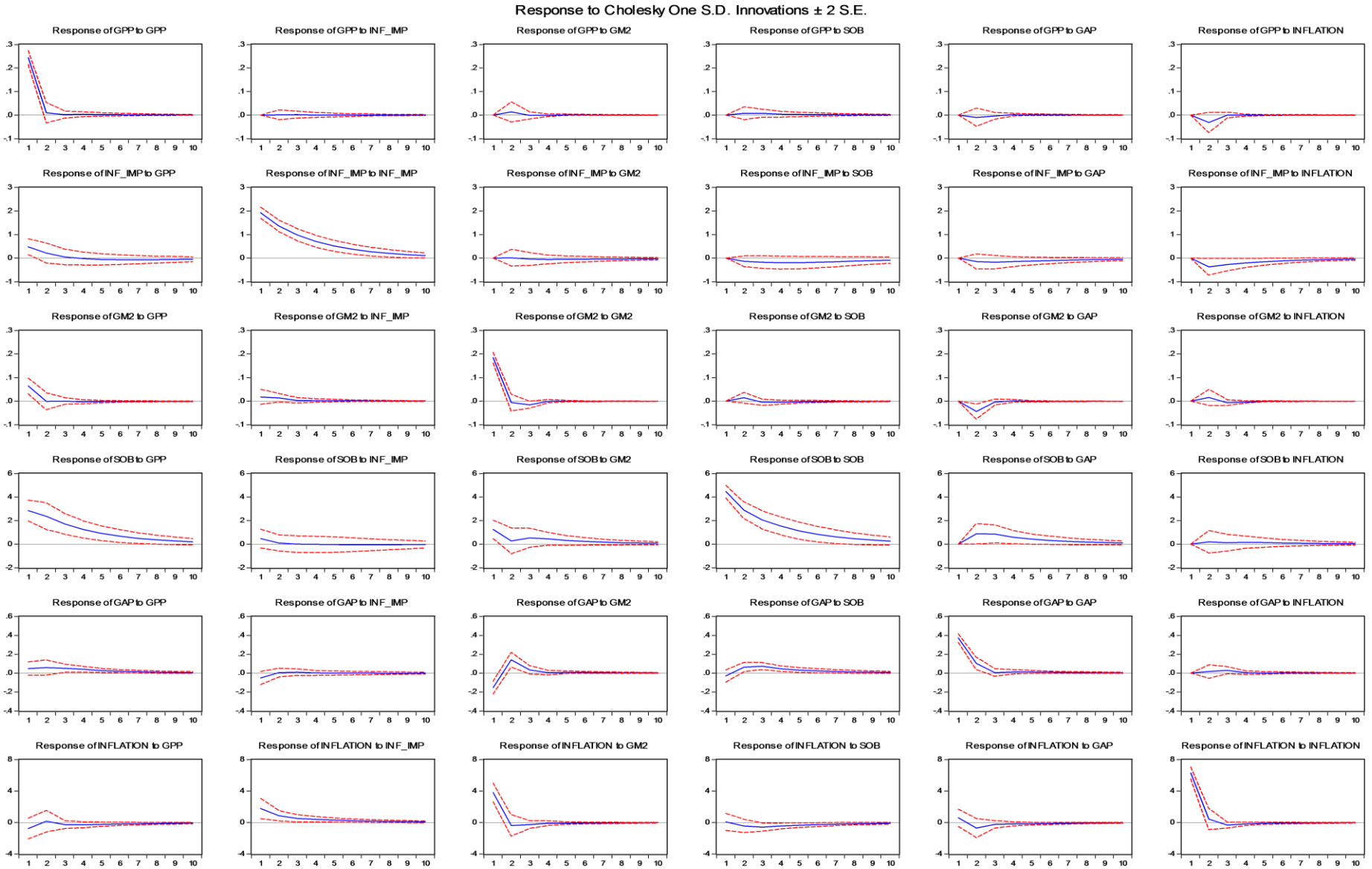
[4] Augmented Dickey Fuller
[5] Phillips Perron
[6] Vector Moving Average

- inflation in CEMAC responds positively to positive external price shocks for at least four years. In other words, an increase in imported inflation leads to an increase in prices in the CEMAC. Imported inflation is therefore a significant determinant of short-term inflation. This result is very plausible in the CEMAC as countries are net importers and the daily consumption of households is composed of a large quantity of imported products;

- the growth of the money supply leads to an increase in inflation. Money can thus be counted among the determinants of inflation in the CEMAC. Direct funding from the Central Bank to the States facilitate this process ;

- the fiscal balance and the output gap would not be good indicators of inflation in the CEMAC. This result may seem ambiguous for African countries because the state is the main investor and provider of jobs, but in the short term such a result is possible because our estimates show that the output gap reacts to a budgetary balance only after about two years. The magnitude of this effect is low, this suggests a weakness of the fiscal multiplier. However, this result may hide disparities between countries.

Figure 7 – ***Response of inflation to various shocks***



Source : Authors estimation

Other results

In addition to the results on the determinants of inflation, we obtain other results that give credit to previous results. Indeed, as can be seen in figure 7 above:

- imported inflation reacts positively to a rise in oil prices (second figure in the first column). As the key CEMAC partners are for the most part net importers of oil, an increase in oil prices necessarily affects the production costs of the latter and at the same time affects their selling prices;
- an increase in oil prices affects the money supply of the CEMAC countries. As the CEMAC countries are net oil exporters, an increase in oil prices leads to an increase in the foreign exchange reserves and therefore to the resources of the States, which increases the money supply;
- the fiscal balance improves as a result of a positive price shock for at least five years. This result, which is strongly correlated with the previous one, highlights the high dependence of state budgets on oil price fluctuations;
- changes in the oil price do not significantly affect demand in the CEMAC. This result may be justified by the existence of a number of rigidities such as the slow adjustment of agents' expectations, the existence of hydrocarbon stabilization funds and the control of prices in some States. This result is completely consistent with that obtained previously with regard to the effect of oil prices on inflation;
- a positive shock on the fiscal balance due to, for example, a change in oil prices only positively affects activity one year later, and this effect lasts at least two years.

These results, which are consistent and in line with economic theory and practice in the sub region, reinforce our main results discussed above.

Robustness check

In order to test the robustness of our results, we first modified the order of the variables in the VAR by swapping the budget balance and the money supply, and then we carried out the estimates within the framework of a Panel VAR taking into account the structural decomposition of errors with short term constraints. According to this approach, the order of the variables is of little importance in the determination of the impulse response functions. The results (presented in the appendix) are close to those presented in the case of a Cholesky decomposition.

Decomposition of the variance of the forecast error

In order to better estimate the shares of the different variables in the explanation of inflation in the CEMAC, which can be used for the economic policy orientations, we have decomposed the variance of the forecast error whose results are contained in Table 3 below. This table shows that changes in inflation in the CEMAC are due in order of priority at:

- 68% by its own innovations in the first year. This value decreases over time to reach 64% ten years later, thus marking the inertia of inflation in the CEMAC. In

other words, the inertia of inflation reflects the slow adjustment of the expectations of economic agents. This result also highlights structural rigidities in the CEMAC countries, which at the same time limit the growth potential of these economies. This includes, for example, the absence of an efficient system for the optimal functioning of the labor market (for example, a lack of adjustment of nominal wages to inflation)

- 25% by the growth of the money supply during the first year. This value decreases slowly over time to 24% ten years later. In other words, through their actions on the money supply, the monetary authorities can affect only about 24% of the CEMAC inflation, the remaining 76% being due to factors other than the money;
- 5% from imported inflation, 1% from oil prices, 1% from the output gap, and 0% from the fiscal balance in the first year. Unlike the other variables, the weight of imported inflation, oil price, output gap and fiscal balance in explaining changes in inflation is increasing over time to 7%, 1, 5%, 1.7% and 1.8% ten years later. With particular reference to the fiscal balance, its effect on inflation appears after the second year and is estimated at around 0.4%.

Table 3 – *Decomposition of the inflation variance*

Period	S.E.	GPP	INF_IMP	GM2	SOB	GAP	INFLATION
1	0.244126	1.029183	5.359750	25.02385	0.007885	0.596227	67.98310
2	0.247062	1.038622	6.400201	24.52086	0.367487	1.434799	66.23804
3	0.247228	1.144291	6.739910	24.25854	0.952134	1.517474	65.38765
4	0.247288	1.281106	6.938591	24.06366	1.283641	1.564955	64.86805
5	0.247320	1.364538	7.047802	23.95365	1.479333	1.601812	64.55286
6	0.247338	1.416412	7.104898	23.88903	1.602688	1.623336	64.36364
7	0.247347	1.449595	7.135225	23.85009	1.679232	1.636079	64.24978
8	0.247352	1.470526	7.151484	23.82676	1.726188	1.643835	64.18121
9	0.247355	1.483578	7.160214	23.81282	1.754893	1.648520	64.13998
10	0.247356	1.491661	7.164914	23.80449	1.772369	1.651333	64.11524
			Cholesky Ordering: GPP INF_IMP GM2 SOB GAP INFLATION				

Source: Author's estimates.

Conclusion

The main objective of this study was to identify the determinants of inflation in the CEMAC with a particular emphasis on money supply. The use of a panel VAR model allowed us to highlight a number of results, the main ones of which indicate that the money supply and the imported inflation explain better the price evolution in the CEMAC than the price of the oil, the fiscal balance or the output gap. Fluctuations in inflation are due to about 24% to the growth of the money supply. However, there is a very high inertia of inflation, reflecting structural problems and a slow adjustment of the expectations of economic agents.
Such results call on the authorities responsible for price stability issues. In other words, it seems useful for the central bank to give particular weight in its analyzes to the core inflation which is generally purged from short-term fluctuations and better accounts for the weight of money in the explanation of prices. Such a choice would better control the effect of central bank actions on prices.

Our results also suggest a weakness of the fiscal multiplier in CEMAC, a more in-depth study on this subject will undoubtedly make it possible to clearly quantify the weight of the action of the States on the activity.

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Appendices

A. Methodology for calculating the imported inflation indicator

The calculation of the imported inflation indicator by country was a multi-step process:

- Identification of main import partners by reference to the average imports over the last 10 years (2004-2014);
- Collection of inflation data from the country's three main import partners;
- Calculation of the countries imported inflation indicator by averaging the inflations of the three main import partners weighted by the average imports over the past 10 years.

The same procedure was used for the calculation of the imported inflation indicator at the sub regional level. Over the period, China, France and the United States are the main import partners in CEMAC.

B. Stationarity tests of variables

Méthods	GAP		GM2		GPP		INF_IMP		SOB		INFLATION	
	statistic	prob*	statistic	prob	statistic	prob	statistic	prob	statistic	prob	statistic	prob
Null: Unit root (assumes common unit root process)												
Levin, Lin & Chu	-3.944	0.000	-5.631	0.000	-5.818	0.000	-2.018	0.021	-2.212	0.013	-5.894	0.000
Breitung	-1.998	0.023	-3.615	0.000	-3.956	0.000	-4.339	0.000	0.978	0.836	-4.809	0.000
Null: Unit root (assumes individual unit root process)												
Im, Pesaran and Shin	-5.274	0.000	-4.723	0.000	-5.406	0.000	-2.909	0.002	-1.552	0.060	-4.998	0.000
ADF - Fisher	48.042	0.000	42.582	0.000	48.469	0.000	28.062	0.005	18.270	0.108	45.214	0.000
PP - Fisher	47.830	0.000	74.194	0.000	58.834	0.000	18.510	0.101	20.798	0.053	57.497	0.000
*Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.												

C. Maximum lag test

VAR Lag Order Selection Criteria
Endogenous variables: GPP INF_IMP GM2 SOB GAP INFLATION
Exogenous variables: C

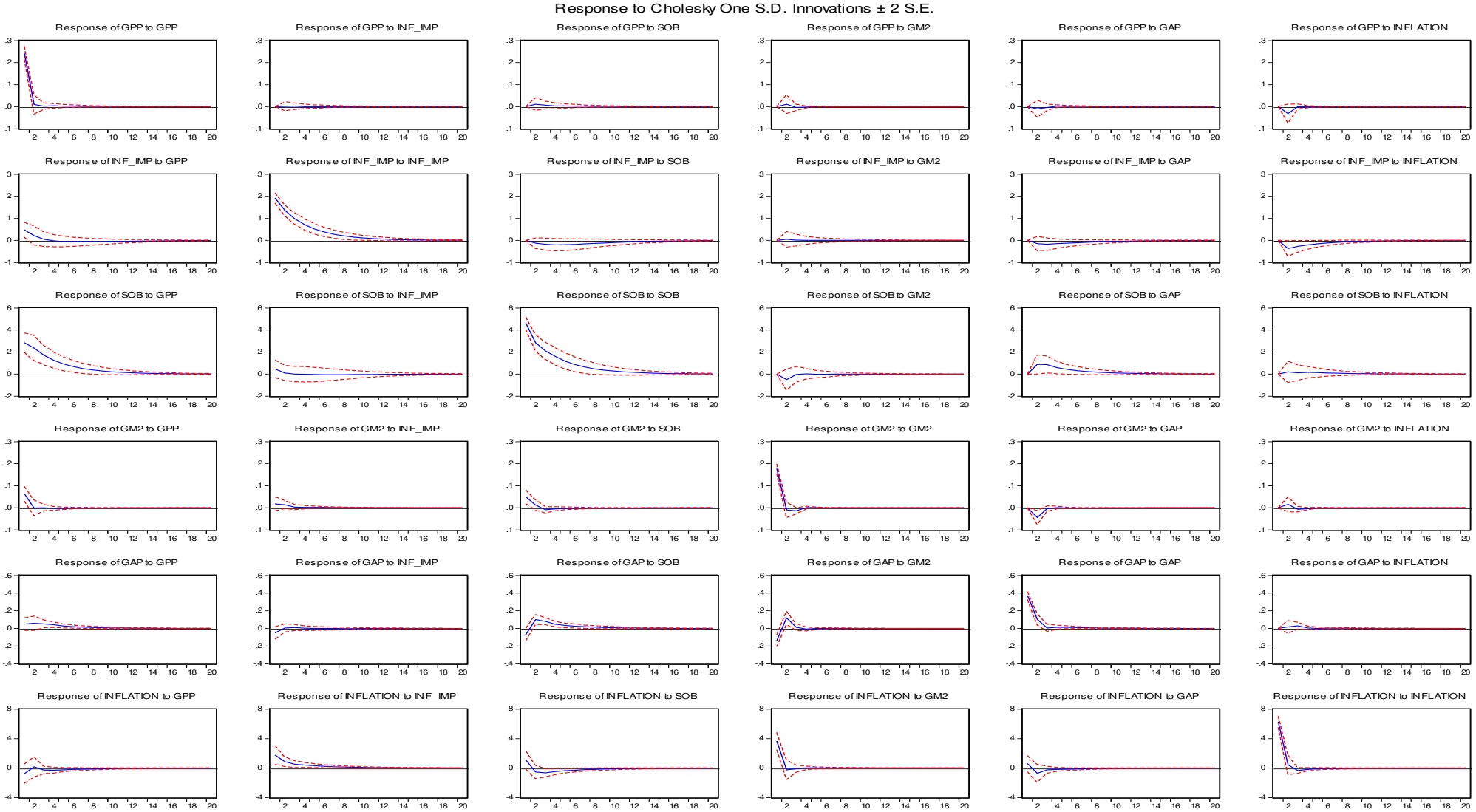
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-666.6882	NA	0.032142	13.58966	13.74694	13.65330
1	-513.9772	283.8264	0.003046*	11.23186	12.33282*	11.67731*
2	-490.4848	40.81519	0.003952	11.48454	13.52918	12.31181
3	-449.2319	66.67121	0.003625	11.37842	14.36674	12.58750
4	-418.7084	45.63109	0.004206	11.48906	15.42106	13.07995
5	-380.2219	52.87038	0.004263	11.43883	16.31451	13.41153
6	-326.5803	67.18748*	0.003291	11.08243*	16.90179	13.43695
7	-297.0879	33.36515	0.004328	11.21390	17.97694	13.95023

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Decomposition of inflation variance in a PVAR with two variables (money supply and inflation)

Period	S.E.	GM2	INFLATION
1	0.200284	21.45811	78.54189
2	0.201072	21.09129	78.90871
3	0.201079	21.08756	78.91244
4	0.201079	21.08752	78.91248
5	0.201079	21.08751	78.91249
6	0.201079	21.08751	78.91249
7	0.201079	21.08751	78.91249
8	0.201079	21.08751	78.91249
9	0.201079	21.08751	78.91249
10	0.201079	21.08751	78.91249
Cholesky Ordering: GM2 INFLATION			

D. Response functions in the case of a PVAR with modification of the order of the variables


Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of GPP to GPP
Response of GPP to INF_IMP
Response of GPP to SOB
Response of GPP to GM2
Response of GPP to GAP
Response of GPP to INFLATION
Response of INF_IMP to GPP
Response of INF_IMP to INF_IMP
Response of INF_IMP to SOB
Response of INF_IMP to GM2
Response of INF_IMP to GAP
Response of INF_IMP to INFLATION
Response of SOB to GPP
Response of SOB to INF_IMP
Response of SOB to SOB
Response of SOB to GM2
Response of SOB to GAP
Response of SOB to INFLATION
Response of GM2 to GPP
Response of GM2 to INF_IMP
Response of GM2 to SOB
Response of GM2 to GM2
Response of GM2 to GAP
Response of GM2 to INFLATION
Response of GAP to GPP
Response of GAP to INF_IMP
Response of GAP to SOB
Response of GAP to GM2
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Response of GAP to INFLATION
Response of INFLATION to GPP
Response of INFLATION to INF_IMP
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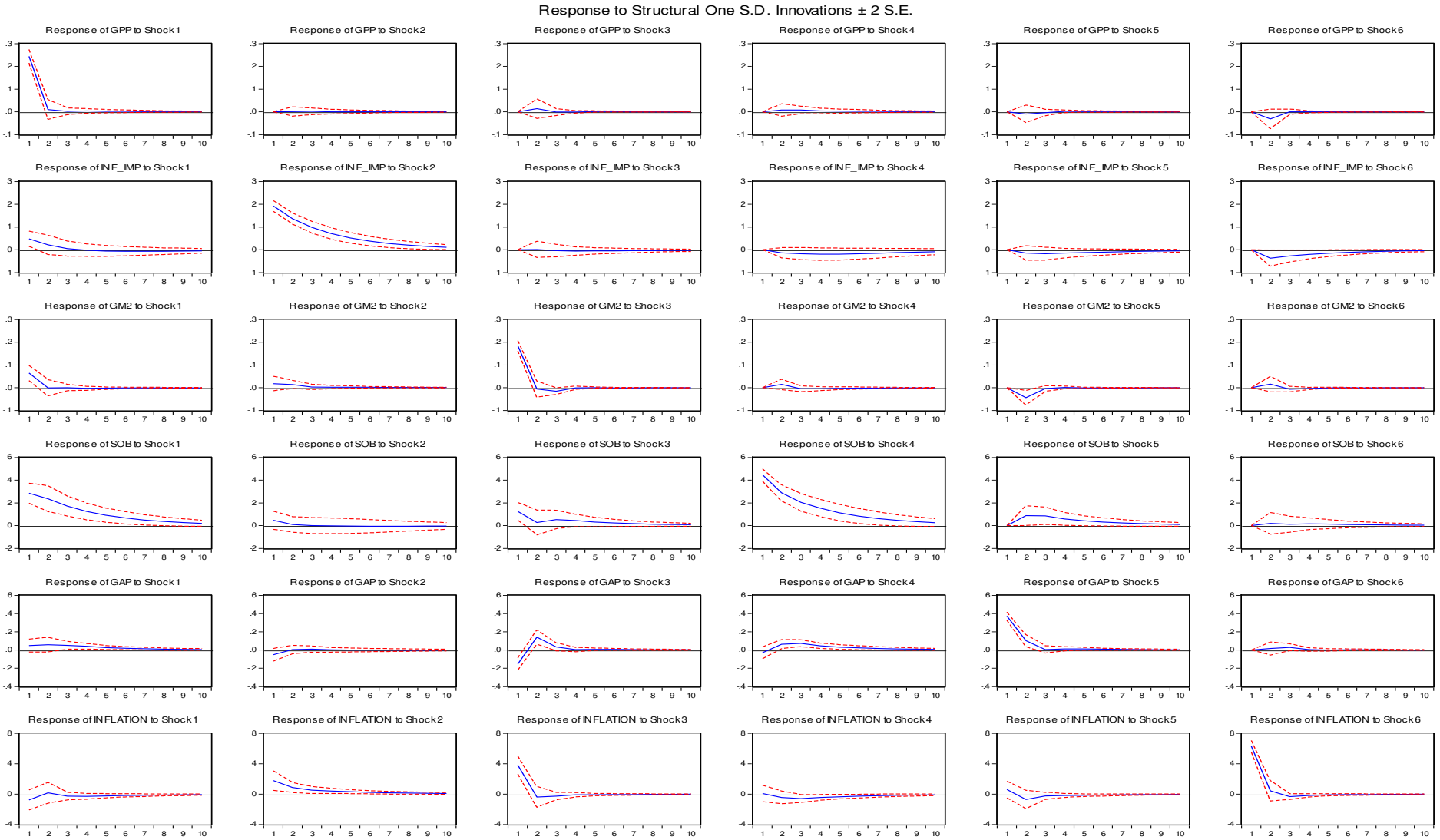
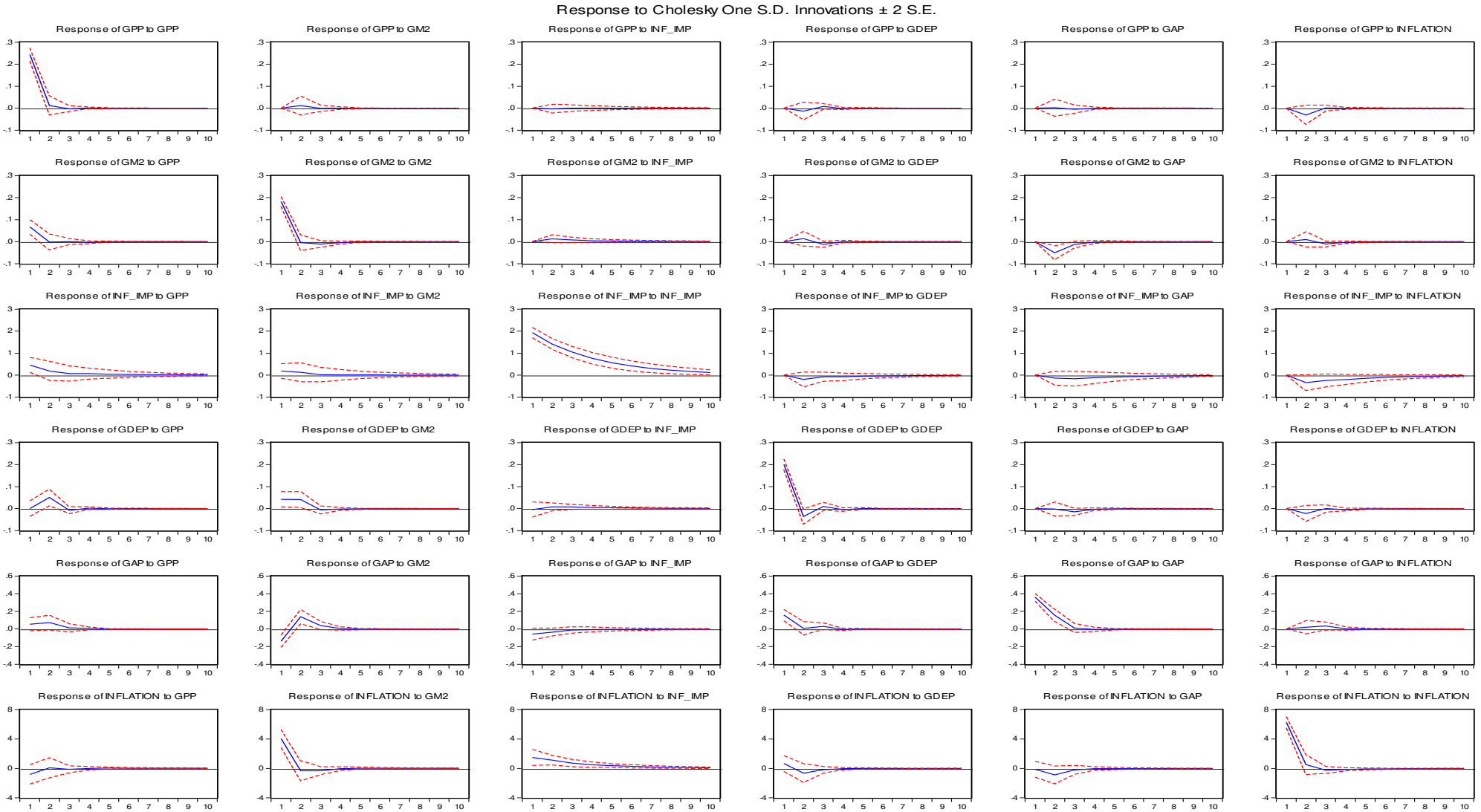
Response of INFLATION to INFLATION

E. Response functions in the case of a structural PVAR



Source : Estimations of authors. Note: Shock1 = shock on oil price, Shock2 = shocks on external prices, Shock3 = shock on money supply, Shoc4 = shock on the fiscal balance, Shock5 = shock of excess demand, Shock6 = Shock on inflationg

F. Response functions in the case of a PVAR with public expenditure



G. Inflation in the CEMAC: background, calculation methods and limits

General background on the Consumer Price Index

In general, the consumer price index measures the changes over time in the general level of prices of goods and services acquired (used or paid) by households for consumption[7]. The prices of these goods and services are weighted by their share in households' final consumption expenditure. The observation of prices is made by the price surveys on a sample of points of sale mostly carried out by the statistical institutes of the different States.

The representative basket used for the calculation of this index consists of the goods and services that the representative households consumed during a reference period. It includes (i) commodities such as food and beverages, (ii) durable goods such as clothing, footwear and (iii) services such as housing, the consumption of electricity.

Since the method of calculating this index is standard, it should be noted that the methodology for data collection for its calculation has several limitations, including (i) the emergence of new products or services not incorporated in the calculation, ii) the failure to take account of changes in the quality of a basket product, (iii) the degree of geographical coverage, which is sometimes limited to large cities in some countries. All these limitations may therefore skew the analysis that can be made of the interpretation of inflation statistics in the CEMAC.

In order to better take economic realities into account and to harmonize methodologies for the development of this indicator at the supranational level, a new harmonized indicator has been put in place: the Harmonized Index of Consumer Prices (IHPC).

The transition to the HIPC

The HIPC, used since 2011 in the CEMAC, is a consumer price index calculated according to a harmonized method for all countries. The data obtained are harmonized and thus facilitate comparison at the international level. The price index used is of Laspeyres type[8]. The HIPC covers the total monetary expenditure of the final consumption of resident households in the national territory. The prices used are the prices paid by households to acquire consumer goods and services. Weights are the aggregate expenditure that households spend on each of the categories of goods and services covered.

The nomenclature used is the Classification of Individual Consumption of households (Classification Of Individual Consumption by Purpose - COICOP) which is consistent with the requirements for calculating HICPs worldwide. It provides the necessary structure to weight and aggregate the data as well as a basis for stratifying the samples of products whose prices are collected. The classification of the COICOP nomenclature is composed of 117 classes divided into 47 groups, which provide the following 12 functions: food and non-alcoholic beverages; alcoholic beverages and tobacco; clothing and footwear; housing, water, gas, electricity and other fuels; furniture, household articles and

[7] Practical Guide to producing Consumer Price Indices, IMF.

[8] The Laspeyres price indexes weight current period expenditures by the base period expenditures (the quantities being constant between the two period.

routine household maintenance; health; transport; communications; leisure and culture; education; restaurants and hotels; other goods and services.

Since BEAC is more sensitive to an average situation in the sub region, and not particularly to the situation of each country, a CEMAC indicator is calculated to enable the assessment of the evolution of price in the zone.

The calculation of inflation in CEMAC

The CEMAC consumer price index, IPCC in abbreviated terms calculated and monitored by the BEAC, is used to estimate the average variations in the general level of prices in the sub-region. This index is the arithmetic mean of the national CPIs, rebased in 2011, and weighted by the country's final household consumption share in the total final consumption of resident households in the CEMAC. For the sake of consistency, the reference period was set to 2011 due to the adoption by all CEMAC countries of the COICOP nomenclature with 12 consumer functions.

One of the limitations of this calculation methodology relates to the final consumption expenditure of households which are not currently corrected by the Purchasing Power Parity. This can introduce a bias in the analyzes of this CEMAC index. Moreover, this limit can be considered negligible because of the single currency in the CEMAC.