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The Measurement of Credit Channel in the CEMAC Zone

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Abstract. This article measures the credit channel's parameters in monetary policy transmission in the CEMAC zone. Having highlighted the limitations of other channels with a theoretical and factual assessment, we check the effectiveness of bank credit channel through the autoregressive vectors' method, using consolidated monetary and macroeconomic data from six countries in the Zone, from 1960 to 2012. It appears that credit channel is narrow. It has a low outflow and a depth-based credit as far as the private sector is concerned, while the GDP reacts with a two-year period following a monetary policy impulse.

Keywords. Credit channel measurement, Monetary policy, Autoregressive vectors, CEMAC.

JEL. E51, E52, E58, G32.

1. Introduction

Modern nations are economically asserted because they produce more and better. The productive investment financing therefore appears as a categorical imperative, questioning both private agents and public decision-makers. The good distribution of credit for the improvement of financing conditions then appears necessary as a precondition for the establishment of a viable production sphere which is a growth bearer. This analysis highlights the significance of the monetary variable in the implementation of economic policy for the survival of African economies.

The history of economic facts reveals that financing productive activities in most developed economies is operated through a dynamic bank credit during the Industrial Revolution. In a more recent period, lessons learned from the 2007-2010 global financial crisis have generated the entry into force of unconventional¹ monetary policies. Incentive mechanisms to the supply of bank credit called quantitative easing or credit easing are then increasingly used (Artus, 2014). Presently, central banks of developed countries such as Japan, the US and to a lesser extent, the European Union (EU), resort to such an expansionary monetary policy of easy credit known as "quantitative easing." These measures constitute a

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real revolution (Stiglitz, 2013) through which developing countries can get inspired, particularly those of the CEMAC Zone. These new strategies recognize the relevance of monetary policy and its influence in the real economic sector. An intervention of the Central Bank then places credit supply in the centre of such an intervention. However, this new context reveals that instruments commonly used by central banks do not seem to give full satisfaction in monetary policy transmission to the productive sector (Artus & Broyer, 2014).

In developing countries (DCs) on the contrary, the difficulty to access financing was formally identified as the main obstacle faced by companies, especially the Small and Medium size Enterprises (SMEs) which are more vulnerable to credits' scarcity (UNO, 2005).

The concern about monetary policy transmission to the CEMAC Zone productive sector is justified for a number of observations: the CEMAC Zone post-colonial financial system superficially reformed nowadays tends to orient credits towards trade rather than productive investment. Monetary cooperation agreements signed in 1972 between the French Treasury and the CEMAC member States negatively affect the monetary sovereignty of the Bank of Central African States (BEAC) according to Guillaumont & Guillaumont (1984). Several financial institutions specialized in development financing in the BEAC zone experience bankrupt after the 1980s' economic crisis. Secondary banks that escaped bankruptcy and those created after the financial system restructuring remain very cautious in terms of credit supply. They are reinforced in this cautious attitude by a restrictive monetary policy from the BEAC. The financial liberalization of the 1990s led to the abandonment of credit direct control instruments in favour of indirect instruments. They no longer give room to the government to direct bank credit supply towards promising growth activities.

Economic growth is neither found in the BEAC status nor in the Convention governing the Monetary Union of Central Africa (UMAC), thus reflecting the negligence of production financing.

Several reports and studies² reveal, if not, the failure³ or at least, the limits of the old funding policies such as public aid to African Development (PAD), foreign direct investment (FDI), the international debt of developing countries (Ngango, 1967) and the initiative for Heavily Indebted Poor Countries (HIPC) (Sogge, 2003).

Therefore, to overcome the shortcomings observed in credit market and to favourably and sustainably influence the economic activity, public authorities generally make use of two main economic policy instruments: monetary policy and fiscal policy. In particular, monetary policy is able to act on economic financing conditions to correct credit market imbalances (Mishkin, 2010). The choice we make on monetary policy is then justified by its malleability and flexibility which demarcates it from heaviness inherent to the implementation of fiscal policy.

Most studies have often considered monetary policy transmission channels as passive and incidental mechanisms. Credit channel is therefore not seen as an endogenous mechanism for facilitating production financing, hence the significance and relevance of our study. The issue developed here on production monetary financing by credit channel under the leadership of the Central Bank then has a dual theoretical and empirical interest.

Theoretically, it contributes to both the renewal and extension of the economic thought with an application within the framework of a monetary union in developing countries. Regarding the renewal of thought, the Keynesian circuit theory and that of the post-Keynesian monetary economy of production, they are on the agenda as far as production financing is concerned. Both theories are therefore of remarkable significance to us because of the limitations and

incompleteness of financial markets revealed by financial changes experienced by developing countries in general, and those of the CEMAC Zone in particular. These are recent crises which different solutions have consecrated the "resurrection of Keynes." Regarding the monetary thought extension, credit channel which until then was considered as a passive transmission mechanism of monetary policy to real economy, is envisaged as part of this work, as an active tool stimulating productive investment at the disposal of policymakers. Similarly, we would like to make a second extension in our analysis: from the post-Keynesian "production monetary economy" to a "production monetary policy". This is a monetary policy based on the currency-credit-production triptych to focus its action towards the search for economic growth.

Empirically speaking, bank credit is still of paramount significance in corporate finance process, companies being economic engines in developing countries which often lack efficient capital markets such as stock exchanges. And even though the latter exist, most Small and Medium size Enterprises (SMEs) and Very Small Enterprises (VSEs) have no access to market financing (shares, bonds).

A credit channel study in the BEAC Zone allows highlighting the malfunctions, nature and optimal architecture of financial system, that is to say, the share which belongs to the bank and market financing respectively (Pollin & Vaubourg, 1998). The question of credit channel's effectiveness in production financing is particularly noteworthy that recent international financial crises and mutations led to reflect on the new role of central banks as well as the best types of financing to be adopted by various economies. The current debate between the Federal Reserve's (FR) strategy and that of the European Central Bank (ECB) for funding or growth is indeed edifying, giving to our study its whole present nature.

Finally, lessons learned from the 2007-2010 global financial crisis drew particular attention on monetary policy transmission. The blocking of transmission channels has revived the debate on the economic activity financing with particular emphasis on credit channel (Artus, 2014). Central banks therefore seek to "fix" these faulty transmission mechanisms (Marchal, 2013). Regarding Developing Countries and particularly those of the CEMAC Zone, after observed the mitigated results of the Structural Adjustment Programmes (SAPs) and an unsustainable external debt, they are engaged in a search logic of very high growth rates for economic emergence and poverty reduction. It is therefore appropriate for them to make use of all economic policy instruments at their disposal (including monetary policy) to achieve these legitimate long or short-term goals.

Moreover, the mastering of policy transmission allows ensuring that it actually reaches the real economy. This transmission issue is still particularly very acute in the implementation of monetary policies in Africa (IMF, 2014). Finally, a good command of credit channel by the CEMAC countries may not only contribute to high growth rates achievement, but also, to the consolidation of productive sphere and the diversification of their economies. These are few prerequisites for these countries to ensure their economic emergence as well as their inclusion in the very competitive globalization process.

Thus, the main objective of this work is to assess the CEMAC Zone monetary policy transmission through credit channel. To achieve this goal, we will first highlight the various monetary policy transmission channels usually presented in economic literature, while discussing their relevance within the framework of the CEMAC monetary policy. This discussion will allow us to assess the most appropriate channel of the BEAC monetary policy transmission. Thereafter, we will proceed with the evaluation of the selected channel by measuring its parameters (width, depth, speed and time), using causality tests and autoregressive vectors (VAR). Economic policy recommendations will be formulated based on

results obtained to improve the transmission efficiency of monetary policy in the zone.

2. Monetary Policy Transmission Channels: A Brief Literature Review

Economic literature distinguishes a multitude of transmission channels of monetary policy that can broadly be reduced to three (3): the interest rate channel, the channel for other assets' prices (stocks, bonds, and currencies) and credit channel (Mishkin, 1996). Furthermore, the financial system's architecture of Central Africa (most predominantly of bank financing at the expense of market funding) led to be interested in credit channel. The mastery of this transmission mechanism would allow the monetary authority of this zone to ensure effective allocation of financial resources to the real economic sector.

In an economy without an efficient financial market, this approach led to be interested in the ability of monetary policy to affect (decisions) bank credit supply so as to give significant impetus to the financing of the real growth generating activity.

Good monetary policy transmission contributes to "... ensure a long-term growth of money and credit aggregates consistent with output potential growth in order to promote a maximum employment level, stable prices and moderate long-term interest rates" (Mishkin *et al.*, 2010, p. 602).

Now in-between "Science and the Central Bank's art", it implies a sound decision-making allowing secondary banks to provide sufficient liquidity for optimal allocation of credit financial resources in economy (Bordes, 2007).

Currency is required not only for transaction, precaution and speculation purposes. It is also much needed for "financing motive"⁴. This refers to the need for a forward advance of required currency to concretize current investment decisions.

The existence of information asymmetries, nominal rigidities and hysteresis's⁵ effect determine the incompleteness, or even the failure of the financial market. These patterns provide a full effectiveness to monetary policy and thus its transmission to real economy (Pollin, 1999). Recent analyzes, while questioning the monetarist doctrine, placed production financing at the centre of their concerns (Artus, 2014; Kaldor, 1985; Taylor, 1995; Blanchard & Gali, 2007). Ireland (2004) also shows that through a judicious credit supply, currency can be introduced in the real cycle analysis because of its crucial role in the financing of real activity.

In this perspective, banks are seen as key institutions for their money creative and distributive liquidity function in economic financing process (Kashyap *et al.*, 2002). They create money in exchange of loans granted to companies based on profitable projects. Companies invest to produce. This production will justify ex-post the creation of the ex-ante currency. Money created is thus an anticipation of future production; this is credit money. The interest we then have on credit channel comes from the fact that other transmission channels do not cope with the operating efficiency conditions in the CEMAC zone. This goes with the interest rates channel and other assets' prices channels (stocks, exchange rates, housing price and land price).

2.1. Limits to other monetary policy transmission channels' effectiveness in the CEMAC Zone

The relevance of credit channel study for the CEMAC Zone highlights the applicability limits of other transmission mechanisms namely the interest rates' channels and those of other assets' prices.

2.1.1. The interest rates channels' limited scope

The Keynesian channel of interest rate which the IS-LM model is a reference implies that an expansionary monetary policy marked by an increase in money

supply ($M \uparrow$) induces a decrease of real interest rates ($i_r \downarrow$). This reduction in capital cost increases investment expenditures ($I \uparrow$) which generate (through a multiplier effect) an overall increase in production ($Y \uparrow$).

Considering the Fisher's relation in which the nominal interest rate is equal to the sum of the real interest rate i and the inflation rate π^e , a growth in money supply ($M \uparrow$) is likely to raise the level of expected price ($P^e \uparrow$) and thus the anticipated inflation ($\pi^e \uparrow$), consequently causing a reduction in real interest rates ($i_r \downarrow$) and stimulating investment through the interest rate channel. The interest rate's channels as described imply a significant and automatic effect of money supply's increase on interest rate. However, this reaction is not always verified in the CEMAC zone. Indeed, interest rates formerly administered until their liberalization in 1990, lending rates since then freely negotiated between banks and borrowers are no longer an indicative variable for monetary policy. Changes in market's interest rates are less the result of monetary policy than banks' discretionary decisions rely on the borrowers' quality as well as their negotiating power.

Artus (2014) also shows, inspired by EU data that monetary policy based on interest rates are no longer effective⁶. In addition, numerous studies, including that of Bernanke & Gertler (1995) showed that empirical studies found it very difficult to detect a significant incidence of interest rates through capital cost. They consider that the failure of interest rates in impulses' transmission from the Central Bank encouraged the search for other mechanisms, notably credit channel (Mishkin, 1996). Moreover, in the relationship between interest rate i and investment I , investment elasticity with respect to interest rate is not guaranteed, hence the need to resort to credit channel.

2.1.2. The structural blockage of other assets prices' channels: exchange rate and Tobin's q

Meltzer (1995) after Modigliani (1971) considers other assets' prices (exchange rates and share prices) as fundamental in monetary policy transmission.

2.1.2.1. Exchange rate channel's efficiency

Theoretically, exchange rate channel implies that a decrease in domestic real interest rates reduces attractiveness of domestic deposits in national currency, compared to deposits denominated in foreign currencies, and this results in a fall of deposits in national currency's value compared to foreign currency deposits. What follows is a depreciation of national currency ($E \downarrow$) which induces a decrease of domestic goods' prices in foreign currency, resulting in an increase in net exports ($NX \uparrow$) and consequently, an increase in the overall production ($Y \uparrow$).

However, in the CEMAC Zone, this channel is experiencing a fatal hindrance due to the practice of fixed exchange rate set by monetary cooperation agreements between the CEMAC States and France, the former colonial power. Unlike the generalization of floating exchange regimes in the 1980s, the CEMAC countries have remained in fixed exchange towards specific monetary relationships they have with the French Treasury, and which had not work without causing monetary sovereignty problems to these countries. This transmission mechanism thus undergoes a structural institutional blockage, and can no more regularly acts enough to allow a stimulation of economic financing. At the same time, it raises the issue of monetary sovereignty found in the "inconsistency triangle"⁷. In virtue of this, openness to foreign market is such a way that countries not controlling capital's movement cannot effectively conduct autonomous monetary policies. In this case, an economy cannot simultaneously have a fixed exchange regime, an autonomous monetary policy and freely release capital (financial integration).

2.1.2.2. The limited game of stocks' price channel: the Tobin's q

Monetary policy acting through the stocks' price channel is transmitted on investment thanks to its effects on "Tobin's q" coefficient on the one hand, and on consumer's wealth on the other.

As concerns the Tobin's q coefficient (1969), it is defined as the ratio between companies' market value and capital renewal cost. Thus, there is a positive linear relationship between the Tobin's q and corporate investment. An expansive monetary policy raises the stocks' price (P_a) which in turn increases the Tobin's q coefficient, thus provoking an increase in companies' investment expenditure (I), and consequently an increase in output (Y). Unfortunately, the relevance of this mechanism is not established within the CEMAC zone where financial markets remain underdeveloped. At least, it could be very low, as only three companies are listed in Douala⁸ Stock Exchange; the Central Africa Stock Exchange (BVMAC) located in Libreville, Gabon, being not much advanced⁹. Furthermore, the relationship between the Tobin's q and investment expenditure I is insignificant. In the absence of an efficient stock exchange, this channel appears ineffective. Therefore, monetary policy cannot pass through stocks' price to effectively convey its effects in the productive sector.

The stocks' price channel acts on consumption through wealth's effects. This channel has been highlighted by Modigliani (1971) in his life cycle model. He shows that consumption expenditures are determined by consumers' resources throughout their lives. These resources consist of human capital, physical capital and financial wealth - or heritage. The shares are thus considered as a major component of financial wealth. Also, when the stocks' price increases, the value of this financial wealth rises, the overall consumers' resources during their lifetime also increase and consequently their consumption. However, given the households' low income, the embryonic state of the CEMAC zone financial markets as well as the very low participation of SMEs in the sub-regional stock exchange, this mechanism also remains limited, and cannot be an effective transmission tool of the BEAC monetary policy to the real sector.

These channels being ineffective to optimally transmit the CEMAC zone monetary policy, it is appropriate to focus on credit channel which parameters will therefore be measured.

2.2. Theoretical Justification of Credit Channel

Based on microeconomic arguments such as information asymmetry, nominal rigidities and market incompleteness¹⁰, the New Keynesian Economy notes the market failure, hence the need and monetary policy effectiveness in financial contracts conclusion. Its main proponents, Akerlof (1970), Stiglitz & Weiss (1981), Mankiw (1986), Greewald (1995), Yellen & Romer (1990) agree on two fundamental points: currency is not neutral; market imperfections lead to non-optimal financial contracts, the need for public intervention to correct bank credit market failures. Theoretically speaking, credit channel is based on the idea that monetary policy leads to bank portfolio shifts which lead to bank credit possible change. Credit channel acts as follows: an expansionary monetary policy (for example) which helps to increase reserves and bank deposits, increases the volume of available bank loans. This increase in loans leads to a rise in investment spending (and eventually of consumption), resulting in an increase in economic activity (Mishkin *et al.*, 2010).

Credit channel can be in two forms: broad credit channel or financial accelerator, and narrow credit channel also called bank credit channel. Broad credit channel implies that there are borrowers who, due to their rather large financial sphere, can access other financing forms than bank credit. The debate on monetary policy transmission to real economy has recently been revived in the early 2010s by Artus & Broyer (2014) who find that after the 2007-2010 financial crisis, no

transmission channel no longer works in the Euro zone. This issue had already brought some interest ten years ago in United States, Europe (McCallum, 2004, Mishkin, 1994) and in developing countries (DCs). Monetary policy may affect real economy through the availability and terms of granting loans by banks (Villieu & Lavigne, 1996). The influence of credit dynamics on growth and economic development had already given rise to numerous studies. Thus, Schumpeter (1911, 1923) considers financial institutions as a prerequisite for technological innovation underlying growth. Financial intermediaries thus form the cornerstone of new questions about the monetary policy transmission mechanisms (Villieu & Lavigne, 1996). It should be noted that credit analysis as monetary policy transmission mechanism makes its way from Tobin & Brainard (1963) investigations. In this same approach, Romer & Romer (1989) establish that a restrictive monetary policy reduces the money supply (M2), and leads to a contraction of bank credit. What follows is a fall in investment which depresses the economic activity.

Bernanke¹¹ & Blinder (1992) on the one hand, Kashyap & Stein (1993), on the other examine, in the American context, the influence of monetary policy on bank credit supply, and show the existence of a bank lending channel. Lavigne & Villieu (1996) make the distinction between broad and narrow lending channels. They also present an evaluation process of the lending channel through the autoregressive vectors' method (VAR). Guille (1996) presents an analysis on the influence of information asymmetries in monetary policy transmission through the lending channel. Goux (1996) conducts an empirical verification test on credit narrow channel in France, and shows that it is possible to measure the width, depth and flow rate of bank lending channel. Joseph (1996) observed in the case of Cameroon, the extent of bank credit rationing, and presents the criteria - however disincentive- of banks' credit supply.

Investigations within the CEMAC framework show that banks in the BEAC zone, though restructured and because of their atomicity, seem unprepared for development financing and globalization challenge (Bekolo-Ebe 1998, Okah-Atenga 1998). Similarly, more recent studies show that the CEMAC financial sector has been remediated, and that banks have become profitable and have more excess to liquidity (Avom, 2006). But the financial system highly segmented is still unable to finance development (Hugon, 2007).

Finally, it appears that "a significant consequence of bank lending channel is that monetary policy has a strong impact on Small Enterprises' expenditure. They are more dependent on bank loans than large companies. The latter have direct access to capital markets without any solicitation from banks" (Mishkin et al., 2010, p. 836). To study and make use of this channel may prove itself beneficial for developing countries, especially those of the CEMAC zone which productive sphere consists mainly of Small and Medium Enterprises.

3. Credit channel assessment in the CEMAC zone methodological approach

To assess credit channel in this context is to quantify the width, speed, depth, and time limit, using statistical and econometric techniques applied to monetary policy transmission variables. This requires two types of tests: those which are prerequisites for the VAR usage (stationary test and cointegration test) and those which assess credit channel's depth, speed, width and time limit (causality test and VAR test). The VAR model predictive power used in our analysis helps to measure the direction, magnitude and duration with which a monetary impulse affects macroeconomic variables (Friedman, & Schwartz 1963; Sims 1980; Lavigne, Villieu 1996). This method therefore facilitates the forecasts as far as monetary

policy decision-makings are concerned. The auto-regressive vector's estimate will therefore be done from consolidated data from six countries of the Monetary Union of Central Africa (UMAC).

There is abundant literature on how to assess monetary policy transmission acting through financial variables. It can be mentioned for this purpose, the Bernanke & Blinder (1992) investigations, those of Friedman & Kuttner (1992). Moreover, empirical works on monetary policy implementation oriented towards the financing of nominal Gross Domestic Product were done by Taylor (1985, 1993); McCallum (2004, 1988, 1990); Motley & Judd (1991); Hess & Brayton (1992) and Feldstein & Stock (1994). Though based on the evolution of financial variables' analysis which is part of credit channel constitution, the monetary policy transmission model we are trying to build heavily relies on economic theory developed up to date on the financial sector integration to real economy.

This model which targets production through credit channel is built from two economic principles: the first refers to the theory targeting production (which impact variable here is the GDP's aggregate) from an action on money supply. Broadly speaking, this is M2 retained as instrumental variable. In fact, there is a stable explanatory link between money supply M2 and nominal GDP (Feldstein & Stock, 1994) such that we have: $GDP = f(M2)$.

The second principle on which we rely in the construction of our model addresses the Keynesian transmission mechanism as concerns monetary policy through credit channel in situation of information asymmetries (Lavigne, & Villieu 1996; Mishkin, 1994) or under the use of the IS-LM model by introducing credit therein (Bernanke, & Blinder, 1988). These various studies have shown that an increase in money supply due to an expansive monetary policy increases bank deposits. What follows is an increase in credit supply which induces investment growth, thus resulting in production's expansion.

To estimate the monetary policy real effects, the empirical research often borrowed three methodological directions (Lavigne & Villieu, 1996). These include the structural models, the auto-regressive Vectors' models (VAR) (Friedman & Schwartz 1963; Sims, 1980) and qualitative information (Romer & Romer, 1990). The approach used in this work extensively uses qualitative information. But, it is completed with autoregressive vectors' analysis. This refers to time series econometrics which consists of observing the historical evolution of statistical variables' series, and identifies the causal link they may have each other. By so doing, it is possible to identify explanatory closed and stable relationships between these various economic and financial variables involved. The VAR method helps to detect these types of relationships among which those expressing plausible economic behaviours are chosen, based on economic theory.

Our approach is therefore not a priori based on an existing economic model, but rather on observation of facts revealed by statistical data on macroeconomic aggregates that make up the credit channel. However, we have presumptions on a possible configuration of relationships between monetary policy instruments and objectives from economic theory as reflected in Bernanke & Blinder (1988) model. These relationships involve the sequential succession from cause to effect, variables' response in monetary policy transmission process by credit channel towards production's target. Based on statistical tests' results, we seek to measure credit channel's parameters, which is a transmission privileged mechanism of the BEAC Zone monetary policy.

Any monetary policy instruments' manipulation leads to a rapid change in money supply (Ramey, 1993). The latter thus appears as a key indicator both in monetary policy management than in its transmission in real economy (Mc Callum, 2008, 2005; Brunner, 1968). That's why we chose M2 as a monetary policy

indicator variable for the BEAC. The choice of this monetary aggregate holds moreover, to the adoption by the BEAC, of money supply increasing standards policy, which consists in acting in fixed rule to determine ex ante the growth rate of the amount of money in economy. This mechanism is fundamentally based on banks' money creation function, following a credit multiplier process. With money supply (M2); Investment (INV) and Gross Domestic Product (GDP), we can diagram credit channel as follows¹²:

$$M2 \uparrow \Rightarrow \text{Credits} \uparrow \Rightarrow INV \uparrow \Rightarrow GDP \uparrow$$

Using the VAR method, the existence of direct or indirect links between specified variables in this monetary policy transmission channel (bank lending channel) can then be verified. And using the time series econometric method, we can also observe the historical evolution of these variables, taking into account the causal relationships relative to each other. Meaning and intensity of each causal link are revealed between two variables by Granger's test (1969). This analysis helps to induce an explanatory relationship between credit channel variables, using autoregressive vector's tests which enable to induce the overall production's (GDP) regression. We then express the global output according to other aggregates and their own past values, following different correlations selected from the VAR test. The latter effectively allows obtaining these correlations while indicating their respective meanings and intensity.

GDP appears in this context as the main target to be reached by monetary policy. We don't ignore other models which target output's inflation and growth (Taylor, 1993). However, we would like to lay emphasis on credit role in monetary policy transmission mechanism in developing economies such as those of the CEMAC Zone, using the VAR tool. Tests made directly relate to aggregates from monetary statistics; here, we use the BEAC annual data and those of the African Development Indicator (ADI) of the World Bank. This clarification being given, we can carry out the mathematical formulation of the VAR process.

3.1. Mathematical Formulation of the VAR

Given a vector Y_t consisting of k endogenous variables representing the studied economy, the VAR model with k variables and p shifts also called autoregressive model of order p [Ar (p)] can be written:

$$Y_t = a_1 Y_{t-1} + \dots + a_p Y_{t-p} + \mu + \varepsilon_t \quad (1)$$

Taking into account the influence of other explanatory variables on Y_t , then we find ourselves in the general case with an equation:

$$Y_t = a_1 Y_{t-1} + \dots + a_p Y_{t-p} + b_1 X_{1t-1} + \dots + b_2 X_{mt} + \mu + \varepsilon_t \quad (2)$$

Where X_i are exogenous variables which can be delayed. The structural VAR helps to obtain the reduced VAR:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + \eta_t \quad (3)$$

Where $\eta_t = B_o^{-1} \varepsilon_t$ is a linear combination of structural shocks following a normal distribution $N(0, B_o^{-1} B_o^{-1})$.

The use of the VAR model will then help to estimate a transmission function reflecting credit channel's measurement in the form of the multiple regression model below:

$$GDP_t = \beta_0 + \beta_1.M2 + \beta_2.CRI_{t-i} + \beta_3.CRP_{t-i} + \beta_4.INV_{t-i} + \beta_5.GDP_{t-i} + \varepsilon_t$$

with i the number of years shifted to be determined for each variable as a result of causality tests and β_i the regression coefficients to estimate. Monetary policy transmission variables through credit channel are: broadly speaking the money supply (M2); the domestic credit (CRI); the private sector's credit (CRP); total investment (INV); the nominal Gross Domestic Product (GDP). Causality tests' interpretation and VAR thus presented will help to measure the different credit channel's parameters.

4. Findings and Discussion

The tables below present cointegration and stationary tests' results of the studied variables:

Table 1. Stationary test's results on credit channel's variables in the CEMAC Zone

Variable	M2	CRI	CRP	INV	GDP
Order d'intégration	I(1)	I(1)	I(1)	I(1)	I(1)

Source: Authors' estimates from the BEAC annual data and those of the African Development Indicator (ADI).

It shows that all community variables' series used are stationary and integrated of order 1. In other words, the level of the studied variables in current year depends on their previous year level. It can therefore be envisaged a stable long-term or cointegration relationship between the CEMAC zone credit channel's variables. The table below which presents different Johansen's cointegration tests shows that M2, CRI, CRP, INV and GDP series are all cointegrated of order 1, this at 95% confidence level (see cointegration test table in appendix), thus confirming the specification of long-term and stable relationships between the studied variables.

Table 2. Johansen's cointegration test results

Eigenvalue	Likelihood ratio (LR)	Critical Value (CV) at 5%	Critical Value (CV) at 1%	Number of supposed CE
0.805356	136.4105	87.31	96.58	None **
0.464438	70.94709	62.99	70.05	At most one **
0.418618	45.96958	42.44	48.45	At most two *
0.286021	24.27567	25.32	30.45	At most three
0.236613	10.79961	12.25	16.26	At most four

Note: The stars * (**) designate the non-cointegration hypothesis's rejection and therefore the acceptance of cointegration at 5% (1%) and CE the number of supposed cointegration equations.

The possible causal link between variables was performed using the Granger's (1988) test. Indeed, according to him, X "Granger cause" Y, if Y can better be predicted from the past of Y and X rather than from the past of Y only. The test results are shown in table 3:

Table 3. *Granger's bivariate causality test: null hypothesis, H_0 : X does not ("Granger cause" not Y.)*

X/Y	P (1 delay)	P (2 delays)
M2 / CRI	0.05982	0.12558
CRI / M2	0.05823	0.57459
CRI / INV *	0.61661	0.02105 *
INV / CRI	0.01268	0.00278
INV / GDP	0.47304	0.97928
GDP/INV	0.09469	6.0E-06
M2/INV	0.46548	0.98577
INV/M2	0.00057	0.00841
CRI/GDP	0.13981	0.82695
GDP/CRI	0.01412	0.00714
M2/GDP*	0.00419*	0.00235*
GDP/M2	5.4E-08	1.4E-06
M2/CRP	0.40262	0.24444
CRP/M2	0.47402	0.47591
INV/CRP	0.13814	0.62746
CRP/INV*	0.03529*	0.07843
CRP/GDP	0.05997	0.20186
GDP/CRP	0.19056	0.03334

Source: By ourselves, based on BEAC data.

Note: The table's values indicate the probability P associated with Fisher's F testing coefficients' nullity hypothesis of Y regression in X. A low figure (below 5%) identified in bold, indicates that the risk to wrongly reject the null hypothesis is low and therefore, causality can be accepted. We selected the 1 and 2 delays for convenience reasons, with the VAR used next and because variables' series are annual. The star * designates the interesting causalities for monetary policy transmission.

It appears that domestic credit (*CRI*) causes investment (*INV*) according to Granger's view with a delay of two years and an error risk of 2.1% only (*CRI* $\uparrow \Rightarrow$ *INV* \uparrow). The private sector's credit (*CRP*) causes investment (*INV*) according to Granger's view with a delay of one year and a negligible error risk of 3.5% (*CRP* $\uparrow \Rightarrow$ *INV* \uparrow). This result confirms the choice of the private sector's credit (*CRP*) as credit channel transmission variable because it acts quickly and positively (one year) on investment than domestic credit. The different causal relationships detected can then be analyzed and interpreted in terms of credit channel's measurement according to Mishkin's (1996) perspective.

Money supply M2 causes nominal GDP according to Granger's view with a delay of one year or two (M2 $\uparrow \Rightarrow$ GDP \uparrow). Though these results are all interesting, we will retain the most significant, namely money supply's direct influence on GDP with a delay of one year. This result is an empirical confirmation of economic theory as reflected in Brunner's (1968), McCallum's (2008) and Taylor's (1985) works, and especially those of Feldstein & Stock (1994) which establish the existence of a strong and stable relationship between money supply M2 and nominal GDP. They conclude that money supply M2 can validly be used as indicator variable for monetary policy because it has a significant explanatory power on real economic activity represented by the GDP's ultimate objective. That's why we chose M2 as monetary policy indicator variable.

4.1. Credit Channel Parameters' Analysis in the CEMAC Zone

4.1.1. Credit channel's width in the CEMAC Zone

Credit channel is said to be wide when the financial system offers borrowers the double opportunity to get funding they need, either from banks as loans or from financial market through the issuing of shares or bonds. This situation implies a perfect substitutability between bank loans and bond debt. Concretely speaking, bank credit supply should be compared to market financing (channel width). Credit

channel remains narrow in the CEMAC zone. The Monetary Union of Central Africa (UMAC) financial system's architecture reveals that more than 91% of funding as far as the region's economies are concerned still comes from bank loans, and less than 9% from financial markets only (Central Africa Stock Exchange in Libreville, and Douala Stock Exchange in Cameroon). Indeed, in October 2014, domestic credit supply amounted to 6,001 billion CFA francs, while market capitalization of the zone is 626 billion CFA francs¹³. This situation forced companies to almost exclusively rely on bank credit for their external funding. Taking advantage of this privileged position, banks require a significant premium which value is a decreasing function of the ratio: amount of pledgeable wealth / amount of external funding (Bernanke & Gertler, 1989). Richest companies remain privileged in this financing system. Most SMEs are therefore evicted from credit market, even though they make up the CEMAC's essential productive tools. Face to such financial architecture, monetary shocks are propagated through external financing cost insofar as external financing premium borne by borrowers depends on their financial situation.

4.1.2. Credit Channel's outflow in the CEMAC Zone

Credit channel's outflow is the Central Bank's own ability to influence bank credit supply. It is revealed by credit aggregates' reaction degree to the Central Bank's impulses. It is established through causality test between monetary policy's (M2) indicator variable and bank credit supply represented by credit aggregates (CRI and CRP). The strength of this causal link can be confirmed by the VAR test (Mishkin, 1996; Goux, 1996). Causality test reveals a lack of influence of money supply (M2) on bank credit supply (CRI or CRP) in the CEMAC zone. Money supply M2 does not cause domestic credit as far as Granger's view is concerned. Therefore, the Central Bank's decisions in any way do not affect banks' credit supply. Their arbitrages in favour of credit supply's increase or reduction would therefore be primarily made based on banking firms' microeconomic behaviour oriented towards maximizing their profit. It is said in this case that credit channel has a low speed. Monetary authorities do recognize this shift. "In principle, because there is a gap between the monetary authority's will and reality on the banking field". All kinds of manipulations are found in banks to override the Central Bank's¹⁴ decisions.

4.1.3. Credit Channel's Depth in the CEMAC Zone

Credit channel's depth designates the most sensitive credit aggregate in the Central Bank's monetary policy (Goux, 1996). The next step is to identify among credit aggregates present in economy, the most sensitive one to the Central Bank's impulses (channel depth). This aggregate is, in this case, the key variable for monetary policy transmission through credit channel. We have selected two credit aggregates to be tested: the domestic credit (CRI) and private sector's credit (CRP). Although causality from Granger's view between monetary aggregate M2 and credit aggregates (CRI and CRP) is not statistically established, it is noted however from the VAR's simulations that credit to the private sector (CRP) more fully reacts than domestic credit (CRI) to the Central Bank's impulses represented in this context by M2 variations. Thus, it can be logically argued that credit's depth is represented by the private sector (CRP) which is more sensitive to the BEAC monetary policy. Credit aggregate to be selected in monetary policy transmission model within the Monetary Union of Central Africa (UMAC) is the private sector's credit (CRP). Thus, this is what credit channel's depth in the Union is all about.

4.1.4. Credit channel time limits in the CEMAC Zone

Credit channel time limit is the reaction period of the GDP to the Central Bank's impulses. Causality's and VAR's tests help to determine this time in terms of the number of shifted periods based on how data used are monthly, quarterly or

yearly. Credit channel will be most effective in such a way that its effects will be quickly felt on real economic sector. In addition, Friedman (1948) distinguishes internal and external time limit. The first refers to the required time for an economic issue to be known, the choice of an instrument and its implementation. The second materializes the required time for an instrument's modification effects to be felt on the targeted economic policy final goal. Empirical studies reveal that these credit channel time limits are 9 months on average as concerns the United States (Romer & Romer, 1993), and 12 months for France (Goux, 1996). The use of causality tests only in this work, to explain the BEAC monetary policy transmission is proved insufficient. We therefore completed them with the autoregressive Vector's analysis presented in the table below, which reveals a two-year period between the shock on money supply and the GDP reaction in the UMAC case:

Table 4. V.A.R Results and UMAC test

Period 1960 - 2012					
Number of observations : 52					
Standard deviations and Student t Statistics (in parenthesis)					
	M2	CRI	CRP	INV	GDP
M2(-1)	0.686484 (0.35282) (1.94568)	0.746151 (6.04418) (0.12345)	14.93337 (33.3440) (0.44786)	-0.526342 (0.48480) (-1.08569)	0.117850 (1.10301) (0.10684)
CRI(-1)	0.001740 (0.01140) (0.15261)	0.511206 (0.19527) (2.61800)	-1.386699 (1.07723) (-1.28729)	-0.016126 (0.01566) (-1.02964)	0.033006 (0.03563) (0.92624)
CRP(-1)	0.001473 (0.00222) (0.66503)	0.013809 (0.03795) (0.36388)	0.949237 (0.20936) (4.53408)	0.002063 (0.00304) (0.67776)	0.001241 (0.00693) (0.17925)
INV(-2)	-0.105982 (0.12394) (-0.85510)	-2.469272 (2.12321) (-1.16299)	-8.295943 (11.7132) (-0.70826)	-0.227330 (0.17030) (-1.33486)	0.085126 (0.38747) (0.21970)
GDP(-1)	0.101832 (0.09763) (1.04301)	.511016 (1.67253) (0.90343)	7.295286 (9.22688) (0.79066)	0.579809 (0.13415) (4.32200)	1.429256 (0.30522) (4.68267)
C	-155.8217 (95.5518) (-1.63076)	-1806.171 (1636.88) (-1.10342)	-3702.102 (9030.22) (-0.40997)	-245.2649 (131.294) (-1.86806)	-82.30050 (298.717) (-0.27551)
R ²	0.985666	0.965932	0.964649	0.984462	0.995045
R ² adjusted	0.980724	0.954184	0.952459	0.979104	0.993336

Source: Our findings from BEAC data (2013) and those of the World Bank (WDI, 2012)

Reading the table: The various credit channel's variables are presented in columns, assuming each of them is individually explained by other variables taken as delayed endogenous submitted online. Online are explanatory variables or delayed endogenous. In bold are indicated the reaction coefficients of various variables in relation to each other. The table above only retains significant relationships between the model's variables; some lines have therefore been deleted (the complete VAR table is available from the authors).

The different coefficients obtained from the VAR test are used to construct the following model¹⁵:

$$GDP_t = 0.118M2_{t-1} + 0.033CRI_{t-1} + 0.001241CRP_{t-1} + 0.085INV_{t-2} + 1.429GDP_{t-1} - 82.30 + \mu_t$$

$$(1.10301) \quad (0.03563) \quad (0.00693) \quad (0.38747) \quad (0.30522) \quad (298.717)$$

$$(0.10684) \quad (0.92624) \quad (0.17925) \quad (0.21970) \quad (4.68267) \quad (-0.27551)$$

$$R^2 = 0.99 \quad ; \quad F = 582.33$$

Fisher's statistics reveals the global significance of the model ($F = 582.33 > F_{5/34} = 3.71$) and coefficients obtained all have the expected signs, thus materializing a favourable reaction of the GDP to financial variables. However, the coefficients' individual significance shows that only the GDP delayed on a period (GDP_{t-1}) is

significant; in other words, to predict the overall GDP in the CEMAC zone as a whole, one can mainly only rely on its previous year level.

The Akaike's and Schwarz's tests results presented in table 5 enable to determine the maximum number of delays that can be retained on explanatory variables.

Table 5. Number of Delays Following Information Criteria (Akaike and Schwarz)

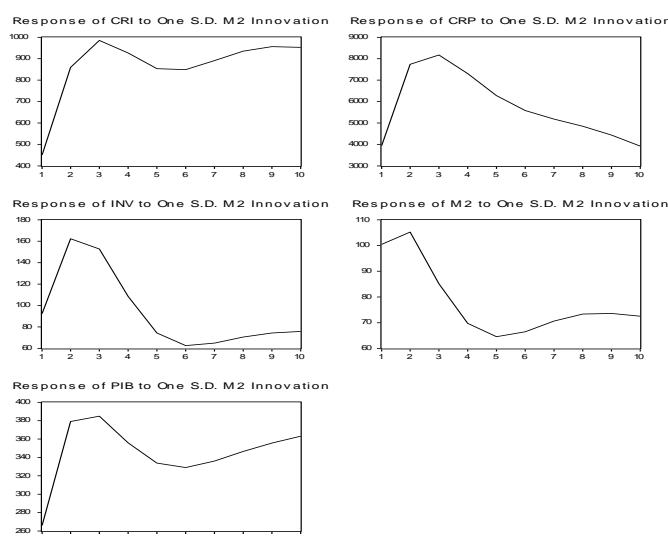
Delays	Akaike	Schwarz
1	78.48081	79.73465
2*	78.438	80.76027
3	78.09002	81.50246

Source: Our results

We chose the shift number 2 because it provides the most expected coefficients in the model. More specifically, investment reacts with two periods (INV_{t-2}) of delay, while the other GDP explanatory variables ($M2_{t-1}$, CRI_{t-1} , CRP_{t-1}) react with a shift of one year only. Investment therefore reacts slowly in the CEMAC zone, that is, two years to induce production. This is a plausible period in view of the sub-regional economy's structure which burdens can't enable a faster response. The VAR model thus estimated helps to assess macroeconomic variables' response and sensitivity to the Central Bank's impulses through impulse response functions and the forecast error variance analysis of these variables.

4.2. Macroeconomic responses' assessment to monetary impulses: impulse response functions

The following graphs show the responses to shocks on structural residues of the five (5) variables used in the model. We selected 3 monetary variables on which we simulated the shocks: money supply M2, domestic credit (CRI) and the credit to the private sector (CRP) which are the BEAC's monetary policy transmission variables.



Graph 1. Response of Credit Channel's Macroeconomic Variables to a Shock on Money Supply M2

In view of these figures, it is clear that an expansive monetary policy which results in an increase in money supply is followed by a number of effects on other economic and financial variables included in the model.

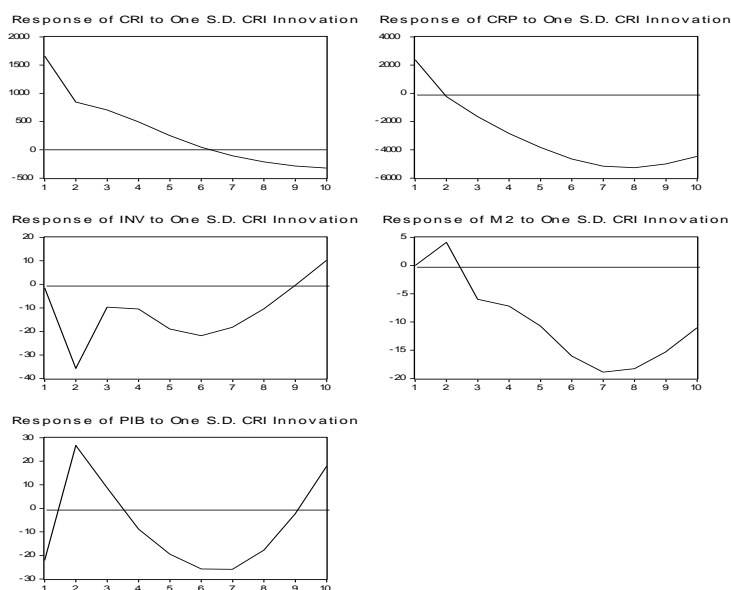
Thus, an increase in money supply leads to a rise on 3 years of the domestic credit CRI. This result means that an expansive monetary policy resulting in an

increase in money supply leads to an increase in domestic credit in the UMAC zone as a whole. And all things being equal however, this impulse is maintained for a period of three years. It strengthens the causality presumption according to Granger's view which does not clearly appear in the causality test.

The effect of private sector's credit to increase money supply is positive. This effect is higher than that recorded in domestic credit. This amplifying impulse is maintained over three years before steadily decreasing up to the 10th year. Innovation impact on money supply M2 is very important insofar as it leads to a positive result on private sector's credit which is often a growth-bearer. This result which had not been revealed by Granger's causality remains important in the BEAC monetary policy decision-making.

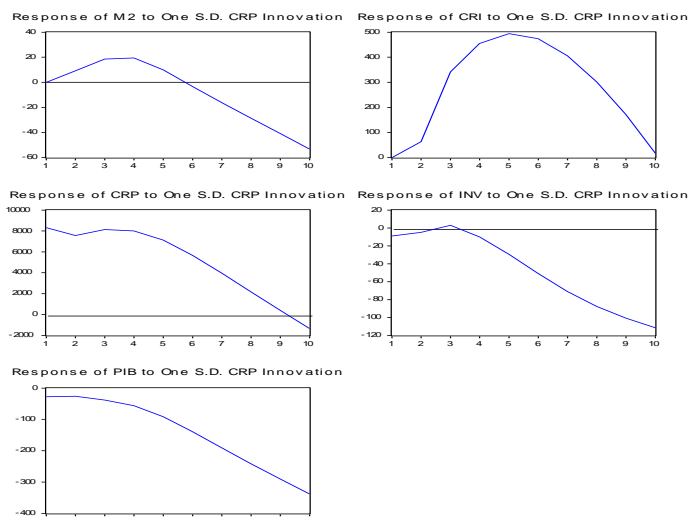
Investment positively responds to an impulse on money supply during a short period of one year. However, the effect remains positive. Then, it is amortized before being cancelled at the 6th year. This is a wealth effect which is more oriented on investment than consumption. Ensuring that there is sufficient liquidity in economy, the sub-regional States can give impetus to invest in SMEs and agricultural or industrial family firms to induce economic growth.

Finally, the nominal GDP widely and positively reacts to an impulse on money supply for a period of three years. This effect is reduced thereafter. This is the confirmation of Granger's causality test. These empirical results confirm the economic theory that monetary impulses are decisive in output changes, and that money supply is the surest index to measure these impulses provided they are properly controlled by the authorities (Brunner, 1968; Feldstein & Stock, 1994).



Graph 2: Reaction of CEMAC economic aggregates to an impulse on domestic credit.

Graph 2 above shows the magnitude, direction, and reaction period of economic aggregates to a pulse on domestic credit. Thus, a shock effect on domestic credit is felt on investment from the 2nd year, and though remaining negative, it is accelerated from the 6th year before experiencing a steady and sustained growth. A shock on domestic credit (CRI) acts positively on GDP over a year and a half. This effect regularly fades and is cancelled after 3 years.



Graph 3. Reaction of CEMAC economic aggregates to a pulse on private sector's credit.

Finally, graph 3 outlines the CEMAC macroeconomic aggregates' response to a monetary policy impulse on private sector's credit: a pulse on private sector's credit increases investment for 3 years before the effect begins to fall. This effect is however not very wide in the CEMAC zone as a whole. Furthermore, a shock on private sector's credit is very low on nominal GDP for 4 years before it steadily declines.

4.3. Measuring the UMAC real sector's sensitivity to BEAC monetary innovations: forecast error variance decomposition

When innovation explains a large part of the forecast error variance of a series, we deduce that economy is considered very sensitive to shocks affecting this series (Sims, 1980; Doan, 1992; Judge *et al.*, 1987; Goux, 1996). CEMAC economies' sensitivity to BEAC innovations can be analyzed by decomposing the forecast error variance of each of the variables used in the VAR model (M2, CRI, CRP, INV and GDP). This sensitivity aims at calculating, for each of the simulated innovations, its contribution to the forecast error variance of the variable considered. From this analysis's¹⁶ results, it appears that: domestic credit (CRI) is sensitive enough (21%) to innovations on money supply. Its variability is due at 77% to its own innovations and at 1.3% to innovations on nominal GDP. The credit private to the private sector (CRP) is sensitive at 36% to innovations on money supply M2. It reacts at 60% to its own innovations. The private sector's credit shows a high sensitivity to an expansive policy. Investment (INV) is very sensitive to money supply's (M2) innovations which explain at 60% the changes affecting it against 22% in respect to its own innovations. Finally, the GDP is highly sensitive (70%) to innovations on money supply M2. Production (GDP) very widely reacts to impulses on money supply. This result suggests that currency positively influences the productive sector.

4.4. A confirmation of the BEAC Weak Influence on Bank Credit Supply

The influence of money supply M2 is negligible on credit supply. This result confirms that of the causality test: money supply does not cause credit. BEAC monetary policy decisions are not therefore relayed (or very weakly) by secondary banks as far as their credit supply is concerned. Monetary policy transmission by bank credit channel thus appears defective in CEMAC zone as a whole. The bottleneck could be in the relationship Central Bank-secondary banks. CEMAC Zone banks do not increase their credits even in case of expansionary monetary policy. The existing condition of bank lending channel above mentioned (effective

capacity of the Central Bank to induce bank credit supply) is therefore not met. The BEAC zone monetary policy simply creates temporary disruption of banks' assets portfolio without changing their credit supply. A liquidity surplus, following an expansionary monetary policy, is rapidly placed in reserve in the Central Bank through an asset-liability management technique rather than to be used in credit supply (Payelle, 1996). The CEMAC zone banks' behaviour is rather disturbing the monetary policy transmission through credit channel.

5. Conclusion

Credit channel's measurement analysis in the CEMAC Zone on which our investigation is carried out helps assessing the monetary policy transmission otherwise than through a simple check on a causal interaction between financial and macroeconomic variables, representatives of real economy. This second procedure is often used in similar studies. But the measurement of credit channel's width, depth, speed and time limits of a debt economy like the one we have just studied seems more in line with the quantification of monetary policy decisions to guide the Central Bank's action. This led us to detect the CEMAC Zone credit channel's narrowness, the weak flow of the channel (that is to say, the weak influence of the BEAC on credit supply), its depth represented by the private sector's credit aggregate sensitivity to the Central Bank's impulses. Finally, we established a two-year time limit for the transmission of this policy to real economy. However, to correct the shortcomings noted, it would be wise to give more power to the Central Bank vis-à-vis secondary banks. For instance, it is worth defining a credit quota to be allocated to productive activities by each bank, particularly in terms of its monetary policy decisions. It appears therefore necessary to strengthen the control of banking activities, by ensuring that the BEAC's decisions are actually applied by banks. This balance should be in such a way that money supply corresponds to economic financing needs. Thus, as long as monetary policy cannot allow the banking system to fund capital formation which is a production and development tool, as long as it can't help to finance SMEs and SMIs which create employment, as long as it cannot allow the restructuring of the productive system to go from an intermediation economy to production economy, it will remain ineffective for this zone. The question of monetary policy transmission efficiency through credit channel therefore lies in the perspective of a public action, able to generate necessary funds to push ahead the limits of maximum production potentials for economic emergence desired by the sub-regional leaders. The Central Bank could therefore be democratically controlled by the sub-regional parliament, so as to pursue an economic growth objective (in a dual mandate) coupled with that of monetary stability already underway.

Notes

- ¹ Unconventional monetary policies consist of three types of measures: 1) quantitative easing aimed at increasing the quantity of money in the economy; 2) Credit easing by the intervention of the Central Bank; and 3) the anticipated action on rates' curve to influence private agents' behavior.
- ² United Nations Conference on Trade and Development (UNCTAD, 2000), Report 2000, p.31. United Nations Development Program (UNDP, 2000), Report on Human Development in the World, p. 120. Arnaud Zacharie, (2000), "The ten boundaries of the HIPC' initiatives," <http://www.initiativehipc.org>. United Nations Industrial Development Organization (UNIDO, 2006), 2006 report.
- ³ World Bank (1981). Accelerated Development in Africa south of the Sahara. This report is generally called Berg Report.
- ⁴ This is another reason for keeping currency introduced by Keynes in his analysis between 1937 and 1939.
- ⁵ Hysteresis is a term borrowed from physical sciences which means that a system's equilibrium state is not independent of the path followed by this system to reach there. This argument is used by post-Keynesians against the idea of a conceived economy's spontaneous balance designed by classical economists.
- ⁶ Policy rates being already closed to zero, he proposes the use of unconventional policies.
- ⁷ Mundell Robert quoted by Bénassy-Querré (2004), p.324
- ⁸ Since the beginning of the Douala Stock Exchange's (DSX) operations on June 30, 2006, only three companies are listed as follows: the Cameroon mineral water Company (SEMC), Cameroonian subsidiary of the French group Castel; the Cameroon Agricultural and Forestry Company (SAFACAM) and the Cameroon Palm Corporation ([SOCAPALM](http://www.socapalm.com)). On March 5, 2012 for example, the market capitalization amounted to 106,958,558,645 CFA francs, while the bond market capitalization stood at 219,335 billion CFA francs, a total of 326,293,558, 645 CFA francs funding.
- ⁹ The BVMAC sub-regional stock exchange recorded the following bonds: 100 billion FCFA by the Gabonese government in 2008; 7 billion FCFA by the Gabon Petro Company in 2010, 30 billion FCFA by the BDEAC to finance developmental projects in the sub-region.
- ¹⁰ Particularly in developing countries' financial markets such as those of the CEMAC zone, many information asymmetries are observed between lenders and borrowers, institutional nominal rigidities in particular, and market incompleteness leading to financial exclusion of many SMEs, of Very Small Enterprises and the working masses.
- ¹¹ The Chairman of the Federal Reserve, the US Central Bank from 2005 to 2013, Ben Bernanke who successfully applied the lending channel model through "quantity easing", the monetary policy called quantitative easing with special performance which earned him the title of Man of the year in United State thanks to good measures taken to solve the 2007/2010 financial crisis.
- ¹² The causalities of this relationship were tested below; they should be used in building the autoregressive vector's model (VAR).
- ¹³ Stocks' and bonds' cumulative values of the two sub-regional financial markets' stock exchanges: Douala Stock Exchange (DXE) and the Central Africa Stock Exchange, the BVMAC of Libreville. Source: www.dxe.cm and www.bvmac.com official sites.
- ¹⁴ Interview with the head of Association of Professionals of credit institutions in Cameroon (APEC), reported in the Cameroon national daily news, See Cameroon Tribune N°. 8650/4849 of July 27. 2006, p. 5.
- ¹⁵ Values in parentheses represent: for the 1st line, the standard deviations of the regression estimated coefficients; for the 2nd line, the calculated values of t-Student statistics. Their use leads to conduct significance tests of the estimated coefficients of this regression.
- ¹⁶ The results of forecast error variances' analysis are available from the authors.

Appendices

Unit Root Test for M2, CRI, INV, PIB, CRP

Null Hypothesis: D(CRI) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=1)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.656913	0.0000
Test critical values:		
1% level	-4.148465	
5% level	-3.500495	
10% level	-3.179617	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(CRI,2)

Method: Least Squares

Date: 11/11/16 Time: 18:21

Sample (adjusted): 3 53

Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CRI(-1))	-0.980746	0.147327	-6.656913	0.0000
C	-4.72E+10	8.03E+10	-0.587652	0.5595
@TREND(1)	5.16E+09	2.68E+09	1.924720	0.0602
R-squared	0.480827	Mean dependent var		1.15E+10
Adjusted R-squared	0.459195	S.D. dependent var		3.73E+11
S.E. of regression	2.74E+11	Akaike info criterion		55.56834
Sum squared resid	3.61E+24	Schwarz criterion		55.68198
Log likelihood	-1413.993	Hannan-Quinn criter.		55.61176
F-statistic	22.22737	Durbin-Watson stat		1.967922
Prob(F-statistic)	0.000000			

Unit Root Test for M2

Null Hypothesis: D(M2,2) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=1)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-13.37324	0.0000
Test critical values:		
1% level	-4.152511	
5% level	-3.502373	
10% level	-3.180699	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(M2,3)

Method: Least Squares

Date: 11/11/14 Time: 16:10

Sample (adjusted): 4 53

Included observations: 50 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(M2(-1),2)	-1.583592	0.118415	-13.37324	0.0000
C	-5.20E+10	5.63E+10	-0.925050	0.3597
@TREND(1)	3.25E+09	1.82E+09	1.785303	0.0807
R-squared	0.791893	Mean dependent var		1.38E+09
Adjusted R-squared	0.783037	S.D. dependent var		3.96E+11
S.E. of regression	1.84E+11	Akaike info criterion		54.77681
Sum squared resid	1.60E+24	Schwarz criterion		54.89153
Log likelihood	-1366.420	Hannan-Quinn criter.		54.82050
F-statistic	89.42248	Durbin-Watson stat		2.281168
Prob(F-statistic)	0.000000			

Unit Root Test for INV

Null Hypothesis: D(INV) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=1)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.474027	0.0002
Test critical values:		
1% level	-4.148465	
5% level	-3.500495	
10% level	-3.179617	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(INV,2)

Method: Least Squares

Date: 11/11/14 Time: 16:13

Sample (adjusted): 3 53

Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INV(-1))	-0.766361	0.140000	-5.474027	0.0000
C	-1.68E+11	1.04E+11	-1.606054	0.1148
@TREND(1)	1.29E+10	3.94E+09	3.268651	0.0020
R-squared	0.384679	Mean dependent var		1.44E+10
Adjusted R-squared	0.359041	S.D. dependent var		4.27E+11
S.E. of regression	3.42E+11	Akaike info criterion		56.00870
Sum squared resid	5.60E+24	Schwarz criterion		56.12234
Log likelihood	-1425.222	Hannan-Quinn criter.		56.05213
F-statistic	15.00403	Durbin-Watson stat		2.055660
Prob(F-statistic)	0.000009			

Unit Root Test for GDP

Null Hypothesis: D(GDP) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=1)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-10.19820	0.0000
Test critical values:		
1% level	-4.148465	
5% level	-3.500495	
10% level	-3.179617	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(GDP,2)

Method: Least Squares

Date: 11/11/14 Time: 16:15

Sample (adjusted): 3 53

Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-1.367523	0.134095	-10.19820	0.0000
C	-6.59E+11	3.97E+11	-1.658973	0.1036
@TREND(1)	6.18E+10	1.41E+10	4.393736	0.0001
R-squared	0.684224	Mean dependent var		3.37E+10
Adjusted R-squared	0.671067	S.D. dependent var		2.33E+12
S.E. of regression	1.34E+12	Akaike info criterion		58.73993
Sum squared resid	8.60E+25	Schwarz criterion		58.85357
Log likelihood	-1494.868	Hannan-Quinn criter.		58.78336
F-statistic	52.00321	Durbin-Watson stat		1.944518
Prob(F-statistic)	0.000000			

Unit Root Test for CRP

Null Hypothesis: D(CRP) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=1)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.343592	0.0059
Test critical values:		
1% level	-4.148465	
5% level	-3.500495	
10% level	-3.179617	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(CRP,2)

Method: Least Squares

Date: 11/11/14 Time: 16:17

Sample (adjusted): 3 53

Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CRP(-1))	-0.590189	0.135876	-4.343592	0.0001
C	-4.10E+10	4.69E+10	-0.873627	0.3867
@TREND(1)	3.28E+09	1.62E+09	2.029136	0.0480
R-squared	0.284944	Mean dependent var		8.96E+09
Adjusted R-squared	0.255150	S.D. dependent var		1.84E+11
S.E. of regression	1.59E+11	Akaike info criterion		54.47409
Sum squared resid	1.21E+24	Schwarz criterion		54.58773
Log likelihood	-1386.089	Hannan-Quinn criter.		54.51752
F-statistic	9.563800	Durbin-Watson stat		2.068207
Prob(F-statistic)	0.000319			

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