WEST AFRICAN MONETARY AGENCY

AGENCE MONETAIRE DE L'AFRIQUE DE L'OUEST

The West African Economic Review
La Revue Economique de l'Afrique de l'Ouest

ARTICLES

Vol. 2 - N° 2

Décembre
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EDITORIAL

The West African Economic Review provides a forum for the participation of all the stakeholders relevant to the monetary integration process of the ECOWAS region, in respect of providing evidence-based policy recommendations. The Review is a bilingual publication (French and English) which comes out twice a year (June and December) from The West African Monetary Agency (WAMA), whose mandate includes but not limited to enhancing Monetary Cooperation and Consultation among the ECOWAS Member States and facilitating the harmonization and coordination of monetary and fiscal policies.

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EDITORIAL

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11-13 ECOWAS Street, Freetown, Sierra Leone
P.M.B. 218, Freetown, Sierra Leone
Tel: +232 22224485/6
http://www.amao-wama.org
e-mail: wamao@amao-wama.org
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ISSN: 2305-3011

The West African Economic Review
La Revue Economique de l'Afrique de l'Ouest

The impact of fiscal cominance on monetary policy in Ghana

Akpan H. EKPO, Johnson P. ASIAMA and Nana K. AKOSAH

Abstract

We explore the presence of fiscal dominance in Ghana, and in particular how fiscal policy influences monetary policy. Fiscal dominance occurs when monetary policy is driven by fiscal policy, and this happens when the fiscal position of the economy effectively sets a target that monetary policy has to follow, such that monetary policy plays a subordinate role, keeping interest rates low and allowing inflation to erode the real value of government debt. We employ various tests and also estimate the monetary policy reaction function using a non-linear two-state Markov Regime Switching Model (MRSM). The results suggest evidence of fiscal dominance in Ghana over the period 2000Q1-2014Q2. The paper recommends the need for the conduct of monetary policy to internalize the fiscal stance of government, and to ensure fiscal consolidation with more effective fiscal anchors.

Key Words: *Fiscal dominance, intertemporal budget constraint, seigniorage.*

JEL Classification: E40, E52, E58, E62

1. Introduction

Fiscal dominance, by definition, is the extent to which government deficits condition the growth of the money supply. Generally, fiscal policy can affect monetary policy through: (i) inflationary process as a result of fiscal expansion requiring monetization and the effect on aggregate demand which may even be the main determinant of inflation; (ii) interest rates, (ii) exchange rates; and (iv) interest spreads. Fiscal dominance (FD), if not checked could create problems for economic management particularly monetary policy management. However, the precise impact of fiscal policy on monetary policy and vice-versa remains an empirical matter. In a period of economic depression when monetary management becomes ineffective, the aftermath of the utilization of fiscal stimulus creates further distortions when an economy finally recovers.

Fiscal developments in the ECOWAS sub-region in recent times suggest a resurgence of fiscal deficits which if not curtailed could pose problems for not only the management of individual economies but also could raise challenges for the proposed economic integration of the region (Ekpo and Afangideh, 2010). The recent global economic crisis which increased the expenditures of countries in the sub-region further underscores the importance of 'optimal' coordination between fiscal and monetary policy to ensure effective and efficient economic management. Moreover, in most of the economies in the region, deficits are not financed through the capital markets thus the heavy reliance on central banks through ways and means complicates the issue of FD. In addition, if external borrowing is an option then FD could result in excessive inflation, exchange rate instability, high interest rates etc. with inherent negative impact on growth and development. FD therefore remains one of the greatest threats to the smooth functioning of any monetary framework in the sub-region.

The main objective of this paper is to examine how fiscal policy influences monetary policy in one of the countries in the ECOWAS sub region, specifically Ghana. A research on the issue is important given the recent trends in central bank financing in the midst of fiscal imbalances over the last couple of years in the particularly country. The paper is organised in six sections. Section two (2) reviews the recent macroeconomic developments in Ghana and also outlines some of the fiscal trends in recent times. Section three (3) reviews the related literature with emphasis on the theoretical and empirical underpinnings. Section four (4) presents the empirical analyses; while Section five (5) discusses the findings. Section six (6) concludes the study with policy recommendations.

2. Background

2.1 Recent Macroeconomic Developments in Ghana

Ghana's economy recorded significant output expansion over the last two decades with real GDP averaging 8.3 percent from 2007 to 2012 in spite of the global economic slowdown. The economy grew consistently from 3.7 percent in 2000 to 7.9 percent in 2012 even though economic growth in 2013 subsequently fell below the target of 8.0 percent. The period also

covered the declaration of Highly Indebted Poor Country (HIPC) status in the context of an IMF Program from 2002-06 and an ECF Program from 2009-12. This significant debt relief provided the country some fiscal space that enabled the Government to embark on critical infrastructure investments, particularly in energy and road sectors, as well as targeted social spending. The period also witnessed the commencement of production and export of petroleum in 2011, as prospects for Ghana's oil and gas resources attracted large foreign direct investment inflows. The rebasing of GDP in 2010 and the onset of oil production in 2011 boosted Ghana's growth further. This resulted in an improvement in per capita income from US$1,292.5 in 2010 to US$1,570 in 2012, and placed the country within a Lower Middle-Income Country (LMIC) category.

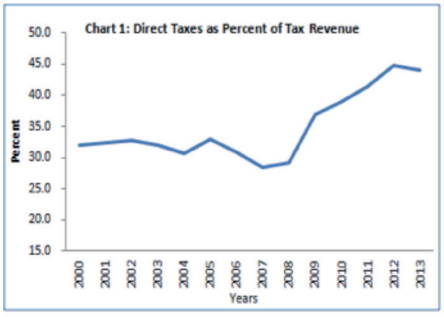
These developments led to a change in the country's classification by the multilateral institutions and, hence, its access to concessional financing. At the same time, Ghana has had to contend with the negative impact of winding down of stimulus and quantitative easing (QE) programs that were designed to stimulate growth in the major global economies. The main impact on the economy has been the continued slump in gold and cocoa prices on the international commodity markets which worsened external sector performance in 2013 and the first quarter of 2014, and continue to exert pressure on the country's international reserves. In 2013, a number of measures were taken to contain the mounting fiscal pressures among others. These included, the imposition of new direct and indirect taxes, moratorium on the award of new contracts, moratorium on the contracting of new loans, net freeze on employment into some sectors of the public service, refinancing of short term expensive debt, and adjustment of petroleum prices, among others. Even though these measures are helping to improve the situation, the adverse global and domestic pressures continue to pose challenges to economic management generally.

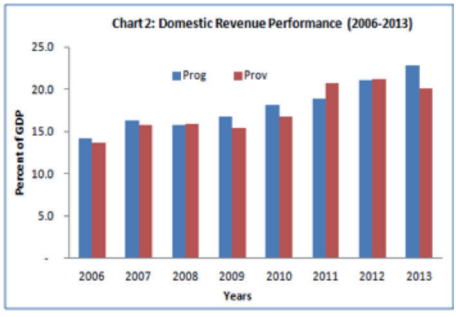
Generally, economic developments over the last two years were driven by volatility in prices of Ghana's major export commodities (cocoa and gold) as well as domestic pressures that impacted on the general economy. The persistent fiscal pressures and deteriorating external balances led to pressures in the foreign exchange market and a reduction in the country's international reserves, as inflation and inflation expectations also mounted due to cost push factors such as adjustments in petroleum and utility prices. To contain these pressures, the Bank of Ghana in 2014 implemented a cumulative 300 basis point increase in the policy rate this year and tightened the reserve requirements of banks while reducing the net open position for foreign Exchange. Additional measures were also taken to restore macroeconomic stability. These include the recent successful floatation of the $1 billion Eurobond which is to be used to fund capital expenditure in the 2014 Budget as well as providing counterpart funding for pipeline projects and the refinancing of domestic and external debt.

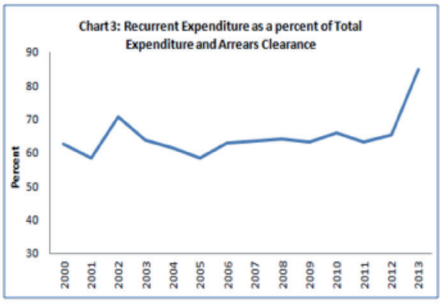
There are early indications of declining pressures in the foreign exchange markets, as the earlier policy measures work through the system. The inflows from Ghana's third Eurobond which was issued in October 2014 and proceeds from the cocoa syndicated loan have evidently helped to boost liquidity on the foreign exchange market, while a formal engagement with the IMF could further support fiscal consolidation and provide balance of payments buffers. The declining pressure in the forex market is expected to continue with the onset of gas production which would also reduce the oil import bill going forward. These developments are expected

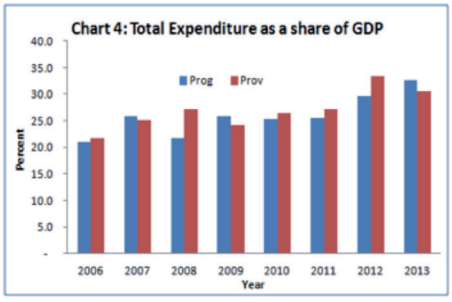
to help shore up the country's gross international reserves above prudential levels.

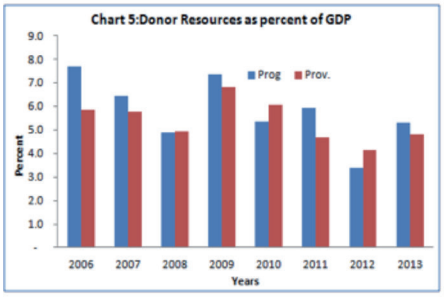
Figure 1: Fiscal Trends in Ghana

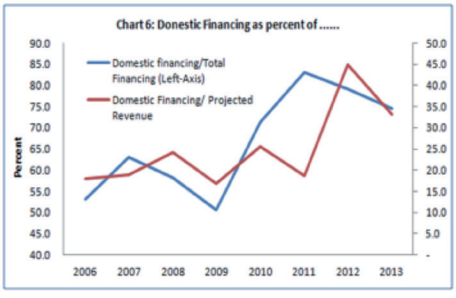


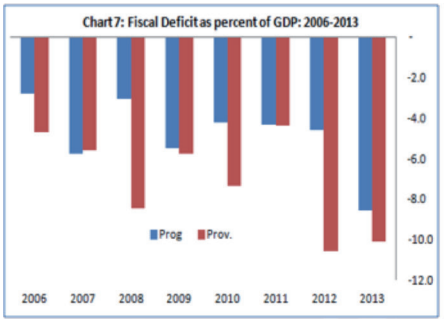


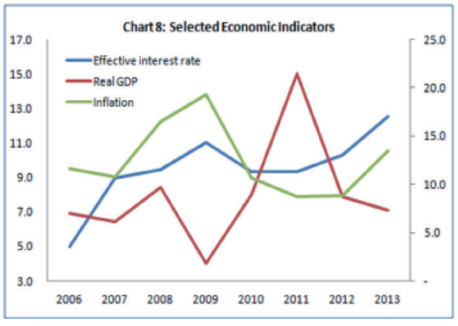












2.2 Trends in Fiscal Performance in Ghana

Ghana was on the path toward fiscal sustainability thanks to the HIPC/MDRI initiatives that were introduced in the early 2000s. The authorities were able to utilize the fiscal space created, coupled with the introduction of some new taxes, to successfully engineer fiscal consolidation that saw the overall level of fiscal deficit (cash basis) reduced from 9.81 percent of GDP in 2000 to 2.96 percent of GDP in 2005. The stock of public debt which was 187.3% of GDP in 2000, also declined to a low of 26.2% of GDP in 2006. Total interest payments as a share of total revenue also reduced from a high of 42.3 percent in 2000 to 15.3 percent in 2005, significantly reducing the burden of debt service on public finance. Things however turned different again from 2006 and this has brought to the fore, discussions about the inherent structural weaknesses in Ghana's revenue mobilization capacity and poor public financial management systems, in spite of decades of reforms in these areas.

One of the difficulties of revenue mobilization has been the existence of a large informal sector, and how to mobilise appropriate tax revenues from the sector. Consequently, the country depends largely on the formal sector for direct taxes as well as international trade taxes. For example, as seen in Chart 1, although direct taxes as a share of total taxes witnessed some improvement from an average of 31.2 percent over 2000-2008 to almost 37.0 percent from 2009, it has remained largely below 45 percent , even with the onset of oil production and the associated revenues from 2011. Another area of concern is about the setting of annual revenue targets. As seen in Chart 2, revenue targets have been missed for most of the years, over the period 2006-2013, suggesting either a non-effective forecasting framework or over optimism about revenues.

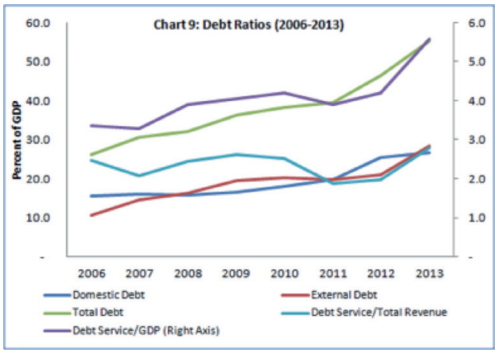
In 2009, the three tax revenue agencies, the Customs, Excise and Preventive Service (CEPS), the Internal Revenue Service (IRS), the Value Added Tax Service (VATS) and the Revenue Agencies Governing Board (RAGB) Secretariat were merged in accordance with the Ghana Revenue Authority Act 2009 (Act 791). This was done with the view to bring a number of benefits to taxpayers and tax administration; reduced administrative and tax compliance cost; better service delivery; Improved departmental information flow; holistic approach to domestic tax and customs administration; and enhanced revenue mobilization. This notwithstanding, the envisaged benefits from the restructuring of the revenue agencies are yet to be seen. In particular, this could be seen by adjusting for oil revenues for 2011-2013 which contributed an average of 1.46 percent of GDP, as well as the upward revision in GDP numbers in 2011.

Government's spending since 2006 has been generally high both relative to domestic revenue outturns and annual spending ceilings (compare Chart 2 and 4). The surge in spending in 2006 was to address the energy challenges in 2006, which probably started the new round of fiscal profligacy. In 2007, Ghana celebrated 50 years of nationhood with its associated large spending programs. Then the onset of the global financial crisis, coupled with some domestic activity regarding election 2008 and CAN 2008[1] widened significantly the gap between the end year spending outturn and the annual target. Spending restraint aimed at

1- (French: Coupe d'Afrique des Nations, also referred to as African Cup of Nations, African Nations Cup)

achieving some consolidation from 2009 was short-lived, as spending ceilings were breached consistently from 2010 to 2012. In particular, the relics of election 2012 coupled with the implementation of the Single Spine Pay Policy once again stretched the narrowed fiscal space which had placed public finance under severe stress resulting in austere fiscal measures in the 2014 budget statement aimed at some adjustment. It would be observed from figure 3, that disproportionately significant amount of government's spending has been executed in favour of recurrent expenditure, denying the country the opportunity to invest in critical capital projects to spearhead its growth agenda. After almost two decades of implementing a public financial management reform program (PUFMARP) which culminated in the launching of the Ghana Integrated Financial Management and Information System (GIFMIS), efficient management of public finance with the view to eliminating waste and getting value for money is still a challenge.

Ghana's fiscal operations are also susceptible to donor flows (both bilateral and multilateral). There have been instances where due to perceived lack of domestic effort and short falls in meeting some required conditions, donors failed to honour their pledges which always had a severe toll on the budget. Donor resources[2] since 2006 has generally experienced significant shortfalls which have been replaced with higher levels of domestic financing with its resultant crowding out effects. The country's inability to synchronize its spending programmes with its revenue mobilization capacities has resulted in persistent fiscal deficit levels at variance with programmed limits. With the exception of 2007, the fiscal targets have been consistently breached, a testament of the difficulties with the country's consolidation efforts.



It is evident from Chart 6, that besides the significant portion of total budget financing being domestically driven, the legal limit in the Bank of Ghana Act 2002, which restricts domestic financing of government's budget to the tune of 10 percent of projected revenues in the current year has hardly been met, not to think of the ECOWAS benchmark of central bank financing of 10 percent of previous year's tax revenue. It stands to reason that years of running budget deficits with overshooting annual deficit targets have built some momentum in the evolution of the stock of public debt. The total public debt that amounted to US$5,296.57 million (26.1% of GDP) in 2006, increased to US$ 7,988.79 million (36.1% of GDP) in 2008 and further surged to US$18,067.45 million (46.5% of GDP) and US$23,454.55 million (55.2% of GDP) in 2012 and 2013 respectively. As seen in Chart 9, all the debt ratios are moving upward.

Ghana's access to concessional external borrowing has muted subsequent to completion of the enhanced HIPC initiative and the attainment of lower middle income status. Currently, the country borrows a lot from domestic sources and the international capital market with

2 - Define to include programme and project, loans and grants.

relatively higher debt servicing implications. From Chart 8, the average effective interest rate (defined as total interest payments/total stock of public debt) for 2006 to 2013 was 7.5 percent compared with an average real GDP growth rate of 8.1 percent (7.1% excluding 2011) for the same period. This implies that if this trend should continue, the cost of Ghana's total debt could outstrip the benefits generated from the debt.

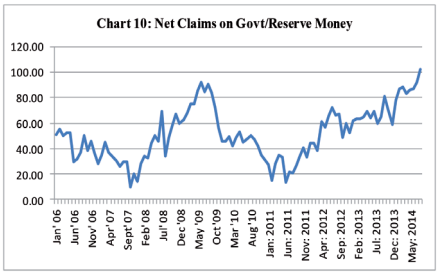
TABLE 2: Ghana's Performance on the ECOWAS Convergence Criteria

Primary Convergence Criteria	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Ratio of budget deficit (excluding grants) to Nominal GDP (commitment basis) ≤3% of GDP	-6,38	-8,86	-10,64	-7,04	-8,22	-3,03	-7,07	-8,07
Ceiling on central bank Financing of budget deficit ≤10 % of Prev. Yr Tax Rev.	-9,86	15,63	17,28	-2,16	-3,92	10,5	22,47	9,41
Secondary Convergence Criteria								
Tax revenue / GDP Ratio ≥ 20% of GDP	12,44	14,31	14,25	12,73	13,62	17,37	17,24	15,31
Salary mass / Tax revenue ratio ≤ 30% of Tax revenue	47,58	42,83	46,23	53,22	50,56	46,39	53,8	56,72
Capital expenditure/Tax revenue ≥ 20% of Tax revenue	24,43	27,28	36,39	15,07	18,05	20,08	19,67	11,82

Source: MOFEP and authors' calculations

From table 2, Ghana's performance relative to some of the primary and secondary convergence criteria of ECOWAS has also not been encouraging. With the exception of the criteria on the ceiling for central bank financing of budget deficit where some successes were achieved, albeit on few occasions, the country largely and consistently failed as indicated above.

2.3 Evidence of Fiscal Dominance



A simple way to assess the dominance of fiscal policy on the path of monetary policy could be a plot of net claims on government as a ratio of the central bank's balance sheet, and to check for trends in the relationship. In the case of Ghana (Chart 10), the trend has been erratic since 2006. The ratio began to fall from 2005 thanks to relief from the HIPC/MDRI initiatives, and it got as far down as 12% of reserve money by 2007. In 2008, the ratio climbed back to as high as 68 percent apparently due to the impact of fiscal pressures brought on by the global financial crisis as well as increased government spending related to the national elections held that year. Thereafter, the trend declined again steadily until June 2011 before it began to pick up again sharply and currently almost equals the size of the central bank's balance sheet.

Even though monetary and fiscal policy coordination in Ghana is not formalized per se, there are frameworks for broad policy discussions and consultations between the monetary and fiscal authorities. The key committees whose functions have some elements of coordination include the Economic Management Team (EMT), Monetary Policy Committee, and the various technical committees which are constituted between the two institutions. The EMT is chaired by the Vice President of the Republic, and comprises the Finance Minister, the Governor of the Bank of Ghana, and other economic experts appointed from the private sector. The Finance Ministry is represented by two members of the MPC although they are expected to be independent in their roles. Finally, the budget process is also consultative with a high extent of coordination. The budget is formulated with inputs from various institutions such as the Bank of Ghana, business community, academia, and civil society organizations. After the budget is completed, it is submitted to Parliament where it goes through a lot of scrutiny before it is finally approved. In sum, there is an appreciable extent of fiscal and monetary policy coordination in Ghana. However, given the developments in fiscal stresses on the balance sheet of the central bank, the framework needs to be formalized and institutionalized to guide coordination efforts going forward.

3. Literature Review[3]

3.1 Theoretical Literature

The concept of *fiscal dominance* refers to a situation in which monetary policy is driven by fiscal policy. Theoretically, and as demonstrated by King and Plosser (1985), the effect of fiscal policy on monetary policy can be illustrated with a basic model as below. Assume a *t*– single period government budget constraint of the form:

$$D_t - D_{t-1} = G_t + TR_t + R_{t-1}D_{t-1} - Z_t - T_t \tag{3.1}$$

where D_t is the stock of public debt in year-*t*, R_t is nominal interest rate; TR_t is nominal transfer payments; Z_t is funds transferred from the Central bank to Treasury, (in other words, the seigniorage) and T_t is tax revenue.

We can divide all variables in equation (3.1) by the product of real income Yt and the price level Pt and solving forward[4] to obtain:

$$d_t + \sum_{j=1}^{\infty} \gamma_{tj} g_{t+j} = \sum_{j=1}^{\infty} \gamma_{tj} (\tau_{t+j} + z_{t+j}) \tag{3.2}$$

where lower case letters denote the fact that the variables have been divided by nominal income and γ_{t+j} denotes one plus real income growth divided by one plus the real interest rate. Thus, equation (3.2) represents the intertemporal budget constraint. To integrate monetary policy

3 - A disproportionately large share of the recent literature associated with fiscal dominance (Blanchard, 2004; Favero and Giavazzi, 2004; Razin and Sadka, 2004; Tanner and Ramos, 2002) focuses on Brazil, apparently because Brazil is perceived to be particularly susceptible to fiscal dominance.

4 - The real interest rate is denoted as $(1 + r_{t-1}) = P_{t-1} \dfrac{(1 + R_{t-1})}{P_t}$

in this intertemporal budget constraint, consider a t single-period behaviour of the Central bank[5] :

$$F_t - F_{t-1} = r_{t-1}F_{t-1} + (MB_t - MB_{t-1}) - Z_t \tag{3.3}$$

where Ft is the stock of assets held by the Central bank in year t and MB is the monetary base. Transforming these variables in the same way as those of the single-period budget constraint and substituting Z in equation (2.2), the consolidated intertemporal budget constraint becomes:

$$(d_t - f_t) + \sum_{j=1}^{\infty} \gamma_{tj} g_{t+j} = \sum_{j=1}^{\infty} \gamma_{tj} (\tau_{t+j} + \Delta mb_{t+j}) \tag{3.4}$$

where $\Delta mb_{t+j} = mb_{t+j} - mb_{t+j}$

According to this constraint, fiscal policy is dominant when the fiscal authorities autonomously fix the path of spending, taxation and debt; leaving the monetary authorities to decide only about the rhythm of money creation revenues to satisfy such an intertemporal budget constraint. Thus, under a regime of fiscal dominance, the theoretical relationship is between deficits and the present value of the revenue from seigniorage. This implies that the hypothesis of fiscal dominance requires the existence of a dynamic causal link from deficits to money creation. Empirically, the interaction between monetary and fiscal policy has been investigated by several economists with different tendencies. One strand of the literature examines the issues related to the coordination of monetary and fiscal policy. Others examined the channels through which fiscal actions affect monetary variables emphasizing the constraints imposed by fiscal policy on central banks.

Fiscal policy can affect monetary policy in different ways such as: (i) through the impact of government inter-temporal budget constraint on monetary policy; and (ii) via the effect of fiscal policy on a list of monetary variables such as interest rates, interest spreads, and exchange rates. Consequently, fiscal dominance may be defined as "a situation in which the government adopts a stance that is incompatible with sustaining low inflation without recourse to distortionary measures such as heavy taxation of financial intermediations through reserve requirements or more draconian restrictions such as those underpinning the multiple exchange rate regimes prevalent in much of Africa throughout the 1980s" (Adam, 2008). Under extreme fiscal dominance, the actions of the central banks become fully subsumed to the over-riding requirements of funding fiscal deficits, so that it loses control over the size and composition of its balance sheet. Thus, its capacity to separate liquidity management objectives from its government funding obligations eliminates its capacity to conduct monetary policy beyond the very short-run.

In recent times, the fiscal theory of the price level has indicated another channel through which the monetary authority can lose control of inflation, even in the case of an independent central bank that need not accept seignorage targets dictated by the treasury (Cochrane, 1999, Bergin 2000; Benhabib, et al 2001; Sala, 2003; Afonso, 2002). The fiscal theory of the price

5 - See King and Plosser (1985)

level perceives the government's inter-temporal budget constraint as an equilibrium condition and maintains that, "if the sequence of future budget surpluses is exogenously given, the price level is the only variable that can make the stock of nominal bonds inherited from the past consistent with the present value of these primary surpluses. Hence, it is the government's inter-temporal budget constraint that determines the price level "(Zoli, 2005, p.3).

The fiscal theory of the price level challenges the traditional notion that inflation is always and everywhere a monetary phenomenon (monetary dominance) and argues that rising and uncontrolled budget deficits may accelerate inflation if economic agents expect that monetary independence will not be possible under rising government debt. Thus, high inflation induced by expansionary fiscal policy may hinder the conduct of monetary policy (fiscal dominance). Consequently, the monetary authority will have to adjust to accommodate fiscal policy. Regarding the relationship between fiscal policy and interest rates, there appears to be some consensus that higher fiscal deficits are linked with higher intermediate-term and long-term interest rates.

3.2 Empirical Literature

The issues concerning the interaction between monetary and fiscal policy have long being subjected to empirical analysis in developed as well as emerging economies. However, studies on developing countries particularly sub-Sahara Africa (SSA) have been scanty. The present study is relevant in that regard.

Sargeant and Wallace (1981) discussed the difficulties of running monetary policy in an environment where fiscal policy is unsustainable. They introduce the concept of a "monetary dominant" regime, where the central bank independently sets monetary policy versus a "fiscal dominant" regime in which the fiscal authority independently sets its budget, announcing current and future deficits and thus determining the amount of revenues that must be raised through bond sales and seignorage. Sageant and Wallace indicate that, under this second regime, the monetary authority loses its ability to control inflation whenever the real rate of interest exceeds the growth rate of the economy. Within that context, a decline in monetary growth today, meant to reduce inflation, will increase the debt to GDP ratio, as bond finance replaces money finance, thus raising interest payment and deficits in the future. Consequently, deficit financing will increase the debt to GDP ratio, as bond finance replaces money finance, thus raising interest payment and deficits in the future. Therefore, deficit financing will require more money growth which will in turn generate higher inflation. Most studies on industrialized countries have indicated mixed results (Melitz, 2002; Wyplosz, 1999; Favero, 2002; Von Hagen et al, 2002).

Melitz (2002) estimated reaction functions on a pool of 19 OECD countries for the period 1960-95 and found that monetary and fiscal policies have tended to move in opposite directions. Favero (2002| concludes that stabilization of inflation has been achieved independently from the absence of fiscal discipline, supporting the notion that the monetary authorities in the euro area have been able to affect inflation rates. Favero and Monacelli (2003) also found some evidence of fiscal dominance in the United states during the period 1960 – 87.

Agénor and Montiel (1996) and Easterly et al (1994) found some evidence of a significant impact of fiscal deficits and real interest rates. Fiscal policy can also affect exchange rate movements and exchange rate policy. However, the theoretical effect of a fiscal action on exchange rates depends on the changes in sovereign default risk, on the openness of the capital account, and on the exchange rate system. The evidence on the impact of fiscal policy on exchange rate movement is mixed. For developed countries, some studies found a positive and significant relationship between fiscal expansion and the exchange rate (Feldstein, 1986; Melvin et al, 1989. Beck, 1993). Others do not find any statistically significant relationship (McMillan and Koray, 1990; Chan, 1991; Kopits, 2000).

A very recent study on the subject matter investigates the cyclical behaviour of fiscal and monetary policy in Kenya during the period (1979 – 2007) using an output gap as a benchmark (Nyamongo et al 2010). Their findings show that fiscal and monetary policy coordination in Kenya was absent in some years while monetary dominance was evident in few years. Furthermore, fiscal and monetary policy exhibited pro-cyclical and countercyclical behaviour and that even years in which both fiscal and monetary policies were not coordinated, the economy maintained macroeconomic stability. According to Adams (2008), what matters from a monetary policy perspective, is not just the **ex post** fiscal outcome but also the **ex ante** risk that fiscal dominance problems might re-emerge and, in particular, that the private sector doubts the willingness of the fiscal authorities, or capacity, to resist such pressures.

Empirical work for emerging market countries includes Tanner and Ramos (2002), who evaluate whether the policy regime in Brazil during the 1990s can be better characterized as fiscal or monetary dominant. Another study on Brazil by Loyo (2000) find evidence consistent with the fiscal theory of the price level where a tight monetary policy along with lose fiscal policy resulted in hyperinflation even without seignorage increase. A relatively recent study by Baldini and Ribineiro (2008) reported that in the case of Sub-Saharan Africa for the period 1980-2005, the evidence was mixed. Their findings suggest that whilst some countries were dominated by fiscal regime, others were dominated by monetary regimes and some still had no clear results. They also reported that changes in nominal debt impact price variability via aggregate demand effects suggesting that fiscal outcomes could be a direct source of inflation variability, as predicted by the fiscal theory of price level. The results of these studies seem to suggest that fiscal dominance might be an issue for developing economies just as for developed ones.

4. Methodology

4.1 Testing for Fiscal Dominance

Generally, it is straight forward to show the difference between a monetary dominant (MD) regime in which the government adjusts primary balances to limit debt accumulation and a fiscal dominant (FD) regime where fiscal balances are set independently of public sector liabilities. Yet, it is a challenge to build a formal test to discriminate between MD and FD. Following Canzoneri et al. (2001) and Tanner et al. (2002), an empirical test for fiscal dominance can also be done based on the VAR model. This model allows an assessment as to whether primary

balances[6] are set exogenously and independently from public sector liabilities in the country of interest:

$$X_t = a_0 + a_1 X_{t-1} + a_2 X_{t-2.} + a_j X_{t-j} ..... + U_t \quad (4.1)$$

where:

X_t = real primary balances, real public sector liabilities
a_j = vector of coefficients
u_t = vector of error terms

From equation (4.1), considering the temporary relationships running from current liabilities to future primary balances, a MD regime is ruled out if future primary balances respond negatively to increases in liabilities or if no relationship exists between the two variables implying that primary balances are exogenous. A positive relationship between current primary balance innovations and future liabilities could indicate that higher primary balances are created to compensate for positive changes in liabilities in order to limit debt accumulation, which would be consistent with a MD regime. But considering the fiscal theory of the price level, a positive relationship could arise also under the FD regime in which the price level falls and the real value of liabilities increases in anticipation of future highest primary balances (Zoli, 2005). In addition, under a MD regime, considering the temporal relationship from current primary balances to future liabilities, current innovations to primary balances should be negatively related to future government liabilities since increases in the primary balances would be used to pay down the debt. However, under an FD regime, there would be no relationship between shocks to current primary balances and future government liabilities.

From the above, it is possible to discriminate between a MD and FD regime by performing Granger Causality tests that evaluates whether lagged values of public sector liabilities help to explain current movements in primary balances and vice versa. Also, to account for possible lags in the variable responses, impulse responses functions can help in determining the effect of the relationship between the variables over-time. The benefits of this approach are that it allows for the estimation of a relatively small number of parameters and does not impose any structure on the economy. From equation (4.1), the model in estimated form is stated as:

$$\Delta RPB = \delta_0 + \sum_{j=1} \delta_j \Delta RPB_{t-1} + \sum_{j=1} \beta_j \Delta LIAB_{t-j} + \varepsilon_t \quad (4.2)$$

$$\Delta LIAB_t = \theta_0 + \sum_{j=1} \vartheta_j \Delta RPB_{t-j} + \sum_{j=1} \gamma_j \Delta LIAB_{t-j} + \eta_t \quad (4.3)$$

where ΔRPB = *change in real primary balance*
$\Delta LIAB$ = *change in real public sector liabilities*

6 - The primary balance excludes payment from the fiscal balance to reflect current fiscal stance. It measures how the current fiscal stance affects the net indebtedness of the public sector. Because interest payments are the result of past deficits, excluding them from the fiscal balance provides a transparent measure of current behavior. The measure is useful in determining the long-term sustainability of fiscal policy. "If an economy is to sustain high long-run growth above the real rate of interest, the primary balance must at some point become positive to allow repayment of interest on current government debt" (Oshikoya et al, 2010, p.91)

(Zoli, 2005) performed equations (4.2) and (4.3) on six emerging markets (Argentina, Brazil, Colombia, Mexico, Poland and Thailand) for the periods 1990s and 2000s. The results did not distinguish unambiguously between periods of fiscal dominance (FD) and monetary dominance (MD). FD were found in Argentina, Brazil during the 1990s and early 2000s; but for Thailand, Poland, Colombia and Mexico the results were ambiguous. Based on data availability, equations (4.2) and (4.3) are applied to Ghana for the period 2000Q1 – 2014Q2. Data was mainly sourced from the Bank of Ghana, Ministry of Finance and the Ghana Statistical Service.

As shown from the specification in equation (4.4), fiscal policy is dominant when the fiscal authorities autonomously fix the path of spending, taxation and debt; leaving the monetary authorities to decide the path of money creation revenues to satisfy the intertemporal budget constraint. Hence, in the presence of fiscal dominance, the theoretical relationship is between deficits and the present value of the revenue from seigniorage. This follows that the hypothesis of fiscal dominance requires the existence of a dynamic causal link from deficits to money creation. We therefore augment the VAR with a monetary variable.

4.2 Assessing the Effect of Fiscal Policy on Monetary Policy

The VAR approach examines the dynamic relationship between public sector liabilities and primary deficits to determine whether deficits are exogenously set, independent of public sector liabilities – prerequisite for fiscal dominance. However, the test says nothing about the behaviour of the monetary authority and how fiscal policy affects monetary policy. It is necessary to ascertain the coordination between monetary and fiscal policy. Theoretically, the interaction could be explained by analyzing the reaction function of the central bank.

$$r = f(r_{t-1}, INF_{t-1}, Y_p, \Delta PB) \tag{4.4}$$

$$r_t = b_0 + b_1 r_{t-1} + b_2 INF_{t-1} + b_3 Ygap_{t-1} + b_4 PB_{t-1} + V_t \tag{4.5}$$

where:

r_t = monetary policy rate

INF = annual inflation rate

Y_{gap} = Output gap is the difference between actual output and potential output

ΔPB = change in real primary balance

V_t = error term

Since Ghana's monetary policy is based on inflation targeting, the estimated equation is:

$$r_t = b_0 + b_1 r_{t-1} + b_2 (INF^e - INF^x) + b_3 Ygap_{t-1} + b_4 PB_{t-1} + V_t \tag{4.6}$$

where

INF^e = expected inflation at time t.

INF^X = inflation target

Equations (4.4) and (4.5) can assist in the evaluation of the direct impact of fiscal policy on monetary policy, over and above the indirect effect through aggregate demand pressures and inflation. A significant and positive relation between primary balances and the monetary policy rate would support the notion that the Central Bank loosens in response to increases in budget deficits supporting the contention that fiscal expansion could eventually trigger a monetary relaxation. No significant relation between the two variables would suggest that fiscal policy does not affect the conduct of monetary policy directly. But a significant and negative relation between primary balances and the policy rate could suggest that monetary and fiscal policy move in opposite directions, affecting each other.

5. Empirical Results

5.1 Unit Root Tests

We examined the time series properties of the variables in the model by performing both Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) unit root tests. Both tests included a constant, a constant and linear time trend, or neither of the two in the test regressions, assuming a null hypothesis of non-stationarity against the alternative of stationarity. Table 3 shows the results of both ADF and PP unit root tests. The results from both ADF and PP tests showed primary balance to GDP ratio (PRIMBG) and output gap (YGAP)[7] to be stationary, *I(0)*, at levels, while log of nominal cedi-dollar exchange rate (LXRATE), log of public debt (LLPUD) and Monetary Policy rate (MPR) exhibited non-stationary properties, *I(1)* at levels.

TABLE 2: Unit Root Test Results

	ADF Tests				PP Tests			
	None	Intercept	Intercept and Trend	First Difference	None	Intercept	Intercept and Trend	First Difference
MPR	0.27	0.34	0.89	0.00*	0.22	0.42	0.95	0.00*
INF	0.35	0.33	0.19	0.00*	0.30	0.17	0.05***	0.00*
PRIMBG	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LLPUD	1.00	0.99	0.98	0.00*	1.00	0.99	0.98	0.00*
YGAP	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
LXRATE	0.99	1.00	0.94	0.00*	0.66	0.89	0.40	0.00*
PUBDG	0.03**	0.18	0.98	0.02**	0.11	0.72	0.70	0.00*

*Note: *, ** & *** denotes 1%, 5% and 10% significant levels respectively*

the other hand, while ADF test showed CPI inflation (INF) to be non-stationary at level, the PP test however established a trend stationary for CPI inflation at levels. In addition, public debt to GDP ratio (PUBDG) however exhibited stationary properties without trend or

7 - YGAP was computed using Hodrick-Prescott (HP) filter.

intercept from the ADF but this was contradicted by the PP test which indicated a stationary property for PUBDG only at first difference.

5.2 Granger Causality Test

In testing for fiscal dominance, we investigated the direction of causality between primary balance and public liability (debt), all scaled by GDP. The result from Pairwise Granger Causality test is displayed in table 3. There is evidence that public sector liabilities Granger cause primary balances as the lagged orders of the former showed significant impacts on the latter. Indeed, a graphical illustration (chart 10) using a plot of net claims on government and the central bank's balance sheet also gave some indication of the presence of fiscal dominance.

TABLE 3: Pairwise Granger-Causality Test Result

Null Hypothesis:	lag 1	lag 2
PUBDG does not Granger Cause PRIMBG	[0.00]*	[0.06]***
PRIMBG does not Granger Cause PUBDG	[0.35]	[0.55]

*Note: *, ** & *** denote 1%, 5% & 10% significant levels respectively*

As exhibited in Table 3, the test established a one-way causality, running from public liability to primary balance. This implies that the response of fiscal authority to rising public liability is inadequate to obviate debt build-up, and suggests that monetary policy is largely subjugated by the fiscal policy.

5.3 Evidence from the VAR model: Impulse Response and Variance Decomposition

We further discriminated between fiscal dominance (FD) and monetary dominance (MD) using a bivariate impulse-response and variance decomposition functions from VAR framework that comprised primary balance and public liability, all scaled by GDP. Consistent with the preceding results, a significant positive response of primary balance to innovations in public liability was only noticed during the 3rd quarter (see, Figure 11). However, no significant negative response of public liability to innovations in primary balance was established for the entire 16 quarters.

Figure 11: Response of Primary Balance to Innovations in Public Debt

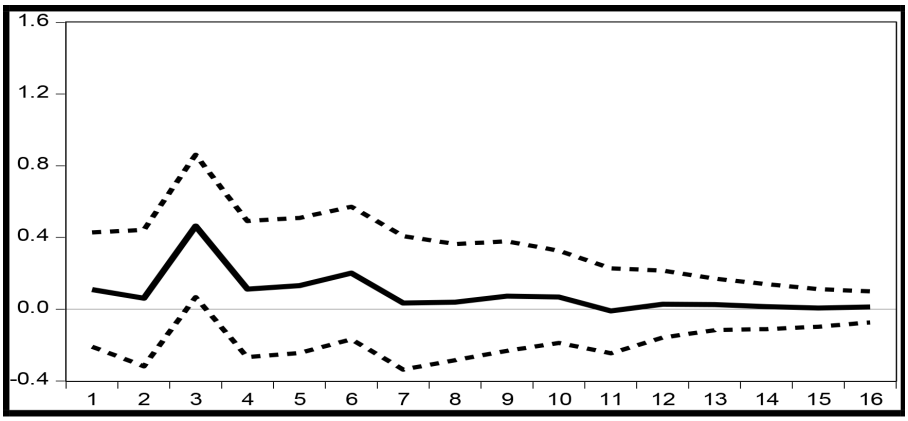
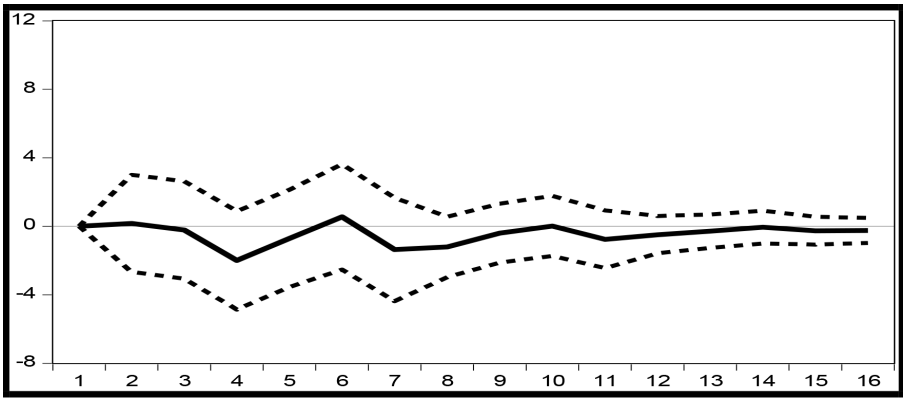


Figure 12: Response of Public Debt to Innovations in Primary Balance



Similarly, the results from the variance decomposition in table 3 also indicate a much greater or increasing explanation of public debt to the variations in primary balance, than the reverse explanation of the latter to changes in the former.

TABLE 3: Variance Decomposition Results

	Variance decomposition of PRIMBG:		Variance Decomposition of ΔPUBDG:	
Period	ΔPUBDG	PRIMBG	ΔPUBDG	PRIMBG
1	0.9	99.1	100.0	0.0
2	1.1	98.9	100.0	0.0
3	13.8	86.2	99.9	0.1
4	13.2	86.8	95.5	4.5
5	13.7	86.3	95.8	4.2
6	15.4	84.6	95.6	4.4
7	15.1	84.9	94.1	5.9
8	15.0	85.0	93.0	7.0
9	15.2	84.8	93.0	7.0
10	15.4	84.6	93.0	7.0

While public liability explained approximately 13% of the variations in primary balance at the end of the 4th quarter, primary balance only explains less than 5% of the variation in public liabilities during the same period. This reinforces the dominant role of fiscal policy in the Ghanaian economy.

5.4 Effect of Fiscal Policy on Monetary Policy

We further evaluated the effect of fiscal policy on monetary policy be estimating monetary policy reaction function based on equations 4.5 and 4.6 above. We augmented the models by controlling for two key factors including election cycle effects which often associated with large fiscal overruns and nominal exchange rate depreciation which among others results in rising stock of public (external) debt. Besides the primary balance indicator, we examined the direct and the indirect effect of public liability on monetary policy rate decision by including log of total public liability and an interaction term for lagged public debt and inflation, respectively. The interaction term between public debt and inflation helps to evaluate how monetary policy reacts to inflationary pressures induced by fiscal vulnerabilities. In addition, since election cycles in Ghana are often characterized by fiscal excesses, we also introduced an interaction term for election dummy and previous levels of primary balance in order to capture monetary policy reaction to changes in primary balance during election years. Table 4 shows the linearly specified parametric estimates of the monetary policy reaction function in the case of Ghana. As exhibited in Panels A to E, all the coefficients had the expected signs and the models generally satisfied the diagnostic tests with the exception of Panel A which violated the tests for normal distribution (Panel B also) and model stability (both Ramsey Reset and Cusum of squares tests).

TABLE 4: Linearly Specified Estimation Results for Monetary Policy Reaction Function (MPRF)

Dependent Variable: ΔMPR					
	Panel A	*Panel B*	*Panel C*	*Panel D*	*Panel E*
Variable	*Coeff[P-Value]*	*Coeff[P-Value]*	*Coeff[P-Value]*	*Coeff[P-Value]*	*Coeff[P-Value]*
C	*-0.11[0.51]*	*-0.49[0.00]**	*-0.49[0.00]**	*-0.46[0.00]**	*-0.49[0.00]**
ΔINF_{t-1}	*0.07[0.02]***	*0.11[0.00]**	*0.06[0.07]****	*0.06[0.06]****	*0.06[0.07]****
$PRIMBG_{t-1}$	***-0.19[0.09]******	***-0.32[0.02]*****	***-0.27[0.00]****	***0.28[0.00]****	***-00.27[0.00]****
$YGAP_{t-1}$	*0.02[0.45]*				*0.01[0.49]*
$\Delta LPUD_{t-1}$			*2.03[0.00]*	*2.08[0.00]**	*2.01[0.00]**
$\Delta LPUD_{t-1}$*DINF		*0.02[0.00]**	*2.076[0.00]**	*2.061[0.00]**	*2.75[0.00]**
$ELECDUM_t$		*0.70[0.03]***	*0.080[0.00]**	*0.080[0.00]**	*0.79[0.00]**
$ELECDUM*PRIMBG_{t-1}$		*0.53[0.02]***	*0.44[0.00]**	*0.47[0.00]**	*0.44[0.00]**
$\Delta LXRATE_{t-1}$		*9.41[0.00]**	*6.44[0.01]***	*5.71[0.06]****	*6.60[0.01]***
ΔMPR_{t-1}	*0.27[0.00]**			*0.06[038]*	
Adjusted R-squared	*0.16*	*0.48*	*0.65*	*0.64*	*0.64*
Sum squared resid	*58.47*	*34.43*	*11.47*	*11.36*	*11.42*
Log likelihood	*-75.85*	*-61.62*	*-32.35*	*-32.13*	*-32.24*
F-statistic	*3.45*	*8.65*	*11.81*	*10.10*	*10.09*
Prob(S-statistic)	*[0.01]**	*[0.00]**	*[0.00]**	*[0.00]**	*[0.00]**
Schwarz criterion	*3.36*	*3.01*	*2.25*	*2.33*	*2.33*
Durbin-Watson stat	*1.92*	*1.92*	*2.21*	*2.27*	*2.22*
Observations	*51*	*50*	*42*	*42*	*42*
Normality Test	*[0.00]**	*[0.00]**	*[0.73]*	*[0.63]*	*[0.81]*
Serial Correlation LM Test:	*[0.82]*	*[0.34]*	*[0.38]*	*[0.34]*	*[0.16]*
Heteroskedasticity Test	*[0.35]*	*[0.18]*	*[0.98]*	*[0.99]*	*[0.97]*
Ramsey RESET Test	*[0.05]****	*[0.95]*	*[0.27]*	*[0.19]*	*[0.90]*
Cusum Test	*Within*	*Within*	*Within*	*Within*	*Within*
Cusum of Squares Test	*Not Within*	*Within*	*Within*	*Within*	*Within*

*Note: *, ** & *** denote 1%, 5% & 10% significant levels respectively*

Importantly, the monetary policy rate (MPR) has significant negative response to changes in primary balance, implying that rising primary deficits are countered by monetary policy tightening (hike in monetary policy rate) and the opposite is also true. The magnitude of the coefficient also suggests that a 1% increase in primary deficit to GDP ratio leads to an approximately 27 basis points (bps) increase in MPR. The positive response of MPR to changes in primary deficit reaffirms the dominance of fiscal policy over monetary policy as the direction of the latter is largely dictated by the behaviour of the former.

In addition, MPR has positive and significant response to lagged changes in inflation, growth in public liability and previous nominal exchange rate depreciations. A percentage increase in lagged inflation, public debt and nominal exchange rate depreciation reflects increases in MPR by approximately 6 bps, 204 bps and 704 bps respectively for the sample period. Although output gap had the expected positive sign, it was generally insignificant.

On the other hand, monetary authority tends to tighten monetary policy during election cycles. This is indicated by a positive and highly significant coefficient of election dummy which suggests an average shift in the intercept of MPR by 80 bps during election years. In the same vein, the interaction term for election dummy and lagged primary balance assumes a positive and significant coefficient, also indicating an upward shift in the slope of MPR during election years. Similarly, monetary policy responds positively to inflationary episodes precipitated by public debt as the interaction term for lagged public liability and changes in inflation has a positive and significant coefficient.

Notwithstanding the lucid preponderance of fiscal policy over monetary policy, we verified the robustness of the linear estimates by carrying out BDS test on the residuals to assess model mis-specification and possibly an omitted non-linear structure as well as investigating for potential structural breaks using Quandt-Andrews Unknown Breakpoint and Chow Breakpoint tests. The rational for the unknown test was to allow the model to identify the break and verified with the subsequent test. The BDS independent test developed by Brock, Dechert and Scheinkman (1987) is designed for the null hypothesis of independent and identical distribution (iid) of the residual for the purpose of detecting non-random "chaotic" dynamic (that is the series follows a non-linear deterministic process but looks random). In this case, if the null hypothesis cannot be rejected, then the original model cannot be rejected. However, if the null hypothesis is rejected, then the fitted linear model is mis-specified and hence, warranting the use of nonlinear models.

Table 5 displays the results of the BDS independent tests on the residuals generated from Panel E. The BDS tests on the residuals generated from models in Panel C to E reject the null hypotheses of the respective models at least 5% significant levels after the 4th correlation dimensions. This connotes that the models in Table 4 were mis-specified and possibly omitted a nonlinear structure.

TABLE 5: BDS test of Independent and identical distribution (iid) of residuals

	Residuals from Panel C			Residuals from Panel E			Residuals from Panel D		
Dimension	BDS Statistic	z-Statistic	Prob.	BDS Statistic	z-Statistic	Prob.	BDS Statistic	z-Statistic	Prob.
2	0.002	0.180	0.857	-0.004	-0.317	0.751	0.000	-0.46	0.964
3	-0.027	-1.532	0.126	-0.026	-1.405	0.160	-0.030	-1.700	0.089
4	-0.051	-2.392	0.017	-0.051	-2.226	0.026	-0.050	-2.358	0.018
5	-0.045	-1.990	0.047	-0.043	-1.801	0.072	-0.039	-1.740	0.082
6	-0.068	-3.043	-0.002	-0.079	-3.340	0.001	-0.061	-2.766	0.006
7	-0.063	-2.992	0.003	-0.078	-3.535	0.000	-0.053	-2.567	0.010
8	-0.044	-2.321	0.020	-0.056	-2.820	0.005	-0.036	-1.901	0.057

Table 6 presents the results of the tests for possible structural breaks in the data from Quandt-Andrews unknown breakpoints test and Chow Breakpoint tests. The upper panel (UP) of Table 6 displays the result of Quandt-Andrew unknown breakpoint test while the lower panel (LP) exhibits the result of the Chows test. Both tests identified a structural break at the period 2006Q2 as the respective null hypothesis of no breakpoint is rejected at 10% significant level or better. The identified breakpoint was not surprising as it was associated with two major events, namely the period with the multilateral debt relief under the HIPC/MDRI which led to significant external (also overall government) debt reduction as well as the rebasing of the Ghanaian economy.

TABLE 6: Test for Structural Breaks

A: Quandt-Andrews unknown breakpoint test			
Null Hypothesis: No breakpoint within 15% trimmed data			
Statistic	Value		Prob.
Maximum LR F-statistic (2006Q2)	3.821		0.071
Maximum Wald F-statistic (2006Q2)	15.285		0.071
Exp LR F-statistic	1.198		0.069
Exp Wald F-statistic	5.526		0.035
Average LR F-statistic	2.264		0.018
Average Wald F-statistic	9.055		0.018
Note: probabilities calculated using Hansen's (1997) method			
B: Chow Breakpoint Test 2006Q2			
Null Hypothesis: No breaks at specified breakpoints			
F-statistic	2.234	Prob. F(5,46)	0. 067
Log likelihood ratio	12.174	Prob. chi-Square(5)	0.033
Wald statistic	11.170	Prob. chi-Square(5)	0.048

In view of the rejection of null hypothesis of linearity and the evidence of structural break, our decision to use a non-linear regime switching model in this study is justified. We therefore proceeded to capture the structural break and any possible non-linear dynamics in the time series by fitting a non-parametric monetary policy reaction function to ascertain how the central bank reacts to fiscal developments. In this approach, the monetary policy reaction function was estimated using non-linear two-state Markov Regime Switching Model (MRSM) in equation (4.7) below:

$$MPR_t = \alpha(S_t) + \beta(S_t)primbg_{t-1} + \theta(S_t)ygap_{t-1} + \theta(S_t)\Delta inf_{t-1} + \vartheta(S_t)C_t + \sigma(S_t)\mu_t, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.7)$$

where $primbg_t$ represents primary balance to GDP ratio, inf_{t-1} is previous debt to GDP ratio, $ygap_{t-1}$ is lagged output gap, C_t is vector of other macroeconomic variables such nominal exchange rate depreciation (LXRATE), lagged public liabilities ($LPUD_{t-1}$), election cycle dummy (ELECDUM), dummy for 2006Q2 structural breakpoint (BREAK2006), interaction terms and lagged dependent variable; and S_t represents the policy regime that follows a two-state Markov chain with transition probability matrix:

$$\begin{pmatrix} \lambda_{11} & 1-\lambda_{22} \\ 1-\lambda_{11} & \lambda_{22} \end{pmatrix},$$

whose *(i,j)* element indicates the probability that the policy regime move to Regime *i* from Regime *j*. The usual interpretation of "regimes' would be different monetary policy stance by different administration. The structural break dummy also entered the model either as a common parameter for both regimes or as a regime specific parameter to ascertain its relative importance.

Table 7 presents the results of the MRSM with the upper panel (UP) showing the outcomes of regime 1, while the middle panel (MP) displays the results for regime 2. This is followed by the results for the common parameter variables, then the transitory probability and lastly the model diagnostics. Also Panel F presents results of a simple-regime switching model (SRSM), while Panels G to J contain the results of MRSM. The SRSM estimation was essentially used to verify the MRSM results, and these were consistent. The coefficient of the structural break dummy (BREAK2006) was significant both as a common parameter (positive) and regime specific parameter (negative and significant in regime 2). In addition, the coefficient of log (sigma) was negative and significant, lending support to the use of non-linear model.

In general, the results in Table 7 were consistent with the earlier linearly estimated results in Table 4 as the explanatory variables largely maintained their respective sign. The results confirm a significant and positive response of MPR to rising primary deficit, rising inflation, high nominal exchange rate depreciation, rapid public debt accumulation and its pass-through to inflation (interaction) as well as political election cycle effect. In addition, the coefficient of lagged MPR was generally positive and statistically significant for both regimes, averaging 21 bps in regime 1 compared to 144 bps in regime 2. This suggests that not only do monetary authorities consider the evolution of MPR within the policy process, but also the magnitude of lagged MPR, especially in regime 2, indicates a considerable inertia in the decision process

of the Monetary Policy Committee (MPC). However, the response of MPR to previous developments in output gap appears to be generally mixed and insubstantial.

In terms of relative responses, MPR reacts substantially to rapid nominal exchange rate depreciation, followed by fiscal developments that expose the economy to elevated currency and economic risks such as rising public debt accumulation and its pass through to inflation, as well as rising primary deficits triggered by election cycles. In synthesis, we established that monetary authorities in Ghana have higher tendency to react almost instantaneously and aggressively to fiscal policy developments in the quest to mollify the pass through of the latter to inflation and nominal exchange rate depreciation.

TABLE 7: Non-Linear Simple and Markov Switching Results

	Panel F	**Panel G**	**Panel H**	**Panel I**	**Panel J**
			Regime 1		
Variable	**Coeff[P-Value]**	**Coeff[P-Value]**	**Coeff[P-Value]**	**Coeff[P-Value]**	**Coeff[P-Value]**
C	-018[0.16]	010[0.51]	-0.22[0.09]***	-0.06[0.52]	-015[0.21]
ΔINF_{t-1}	0.03[0.18]	0.03[0.29]	0.001[0.95]	-0.02[0.37]	0.01[0.43]
$PRIMBG_{t-1}$	-0.18[0.07]***	-0.11[0.28]	-0.23[0.00]*	-0.10[0.06]***	-0.16[0.02]**
$YGAP_{t-1}$	0.02[0.59]	0.00[0.97]	0.03[0.39]	0.001[0.98]	0.01[0.73]
ΔMPR_{t-1}	0.21[0.05]***	0.23[0.03]**	0.22[0.00]*	0.20[0.00]*	0.17[0.01]**
$\Delta LPUD_{t-1}$			-1.81[0.17]	-1.46[0.15]	-3.06[0.00]*
$\Delta LXRATE_{t-1}$			10.56[0.00]*	7.73[0.00]*	8.66[0.00]*
$\Delta LUPD_{t-1}$*DINF				0.01[0.94]	-0.03[0.85]
BREAK2006		-0.06[0.92]			
ELECDUM		-0.07[0.81]			
			Regime 2		
C	0.40[0.41]	0.46[0.35]	0.28[0.41]	0.02[0.92]	-1.83[0.00]*
ΔINF_{t-1}	1.13[0.00]*	0.01[0.91]	0.57[0.00]*	0.07[0.05]***	0.22[0.01]**
$PRIMBG_{t-1}$	0.14[0.79]	-2.54[0.00]*	0.94[0.00]	-2.32[0.00]*	-0.44[0.03]**
$YGAP_{t-1}$	0.01[0.97]	-0.10[0.52]	0.01[0.93]	-0.11[0.25]	-0.61[0.00]*
ΔMPR_{t-1}	0.80[0.04]**	1.55[0.00]*	2.78[0.00]*	1.01[0.00]*	1.05[0.02]**
$\Delta LPUD_{t-1}$			1.56[0.18]	11.71[0.00]*	5.22[0.00]*
$\Delta LXRATE_{t-1}$			4.55[0.51]	-6.49[0.08]***	18.20[0.07]***
$\Delta LUPD_{t-1}$*DINF				3.43[0.00]***	3.15[0.00]*
BREAK2006		-6.46[0.00]*			
ELECDUM		2.41[0.00]*			
			Common Parameters		
BREAK2006					0.30[0.09]***
LOG(SIGMA)	-0.31[0.01]**	-0.42[0.00]*	-0.71[0.00]*	-1.03[0.03]**	1.33[0.00]*

Transition Matrix Parameters					
P1-C	2.01[0.00]*				
P11-C		1.49[0.01]**	1.37[0.02]**	1.03[0.03]**	1.33[0.00]*
P21-C		1.03[0.49]	22.66[0.97]	2.16[0.15]	2.28[0.09]***
log likelihood	-72.57	-72.70	-56.21	-48.10	-47.30
Sum squared resid	71.96	80.97	64.93	86.33	71.04
Durbin-Watson stat	1.89	1.90	1.83	1.82	1.86
Schar criterion	3.45	3.82	3.23	3.08	3.13
Prob [Normaly Test]	[0.10]	[0.58]	[0.23]	[0.37]	[0.92]
No. of Observations	56	56	56	56	56

Note: *, ** & *** denote 1%, 5% & 10% significant levels respectively; Dependent Variable is ΔMPRt

6. Conclusion and Policy Recommendations

This paper uses alternative quantitative approaches to examine the presence of fiscal dominance in Ghana during the period 2000Q1 to 2014Q2, and explores how fiscal policy influences monetary policy. Fiscal dominance occurs when the fiscal position of the economy effectively sets a target that monetary policy has to follow; such that monetary policy plays a subordinate role, keeps interest rates low and allows inflation to erode the real value of government debt. By contrast, monetary dominance implies that fiscal policy plays a passive role while monetary policy goes about keeping inflation under control without a concern about the adverse effect of higher interest rates on the ability of governments to sustain the debt burden. More recently, the fiscal theory of the price level also introduced the argument that monetary policy needs to accommodate fiscal dominance by providing lower real interest rates as inflation rises.

From the empirical analysis of the subject matter and also trends in net claims on government on the balance sheet of the central bank, there is evidence of fiscal dominance in Ghana over the period of the study. The evidence of fiscal dominance suggests: (i) a problem of coordination between monetary authorities and government; (ii) a need for the central bank to adhere to legal limits on central bank financing of government deficits (iii) a need to intensify efforts at expanding the domestic resource base to deal with deficits, and (iv) a need to deepen the market for private bonds as an alternative source of financing.

Other suggestions include the need for the conduct of monetary policy to be coordinated well with the fiscal stance of government if monetary policy is to be effective. Furthermore, the literature suggests that the link between fiscal and monetary variables change with different levels of financial development and inflation. Hence, the need to promote financial development as a way to strengthen the conduct of monetary policy. Finally, the role of fiscal consolidation cannot be overemphasised. Going by the experience of emerging markets, a successful fiscal consolidation wipes out the constraint of fiscal dominance and restores the potentials of traditional monetary policy and inflation targeting for example.

References

Adam, C (2008) *"Factors in the choice of Monetary Policy Regime"* in Central Bank of Nigeria. Proceedings of the one-day Seminar on Monetary Policy and Inflation Targeting, Abuja.

Afonso, A (2002) *"Distributing the Fiscal Theory of the Price Level: Can it fit the EU – 15?"* Processed.

Agenor, P. R and P. J Montiel (1996): **Development Macroeconomics**, Princeton, New Jersey: Princeton University Press.

Assaf Razin; Sadka, Efraim (2004), "Transparency, Specialisation and Foreign Direct Investment". CESifo WP Series 1161.

Baldini, Alferdo and M. P. Ribeiro (2008) *"Fiscal and Monetary Anchors for Price Stability: Evidence from Sub-Saharan Africa"*. **IMF Working Paper** WP/08/121.

Benhabib, J. Schmitt-Grohe and M Uribe (2001) *"Monetary Policy and Multiple Equilibria"*, **American Economic** Review 91, March, pp. 167-86.

Bergin, P (2000) *"Fiscal Solvency and Price Level Determination in a Monetary Union"* **Journal of Monetary Economics**, 45 (1), February, pp. 37-55

Beck, S. E (1993) *"Ricardian Equivalence Proposition: Evidence from Foreign Exchange Markets"*, **Journal of International Money and Finance 12**, May, pp. 154-69.

Blanchard, Olivier (2004) *"Fiscal Dominance and Inflation Targeting: Lessons from Brazil*. **NBER Working Paper 10389**

Carlo A. Favero; Francesco Giavazzi (2004), *"Inflation Targeting and Debt: Lessons from Brazil"*. **NBER WP 10390**

Central Bank of Nigeria (2008) Proceedings of one day Seminar on Monetary Policy and Inflation Targeting, Abuja.

Cochrane, J., (1999) *"Long term debt and Optimal Policy in the Fiscal Theory of the Price Level"* **Econometrica**

Chari V, L. J Christiano and P.J Kehoe (1991) *"Optimal Fiscal and Monetary Policy: Some recent results"* **Journal of Money, Credit and Banking** 23, pp. 519-39.

Easterly, W, C. Rodrignez and Schmidt – Hebbel, K., (1994). **Public Sector Deficits and Macroeconomic Performance**, New York, Oxford University Press

Ekpo, A.H., (2011) *"Fiscal Dominance and Economic Management in Selected ECOWAS countries"*, Paper presented at the American Economic Association Conference, Denver Colorado, USA, January.

Ekpo, A. H and Afangideh, U. J., (2010a) *"Fiscal Operations in the West African Sub-region: Implications for Regional Economic Integration"* International Conference on Financial and Monetary Integration in West Africa, Accra, Ghana, June.

Ekpo, A. H and Afangideh, U. J., (2010b) *"Implications of Economic and Financial Integration for Monetary Management in Nigeria"* **West African Financial and Economic Review**, vol.2, No.2, pp. 1-21.

Ekpo, A. H and Ndebbio, J.E.U., (1993) *"Fiscal Operations in a Depressed Economy: Nigeria"*, AERC, Narobi, Kenya.

Ekpo, A. H., (2005), *"West African Monetary Union: Is it Sustainable?"* Paper Presented at the AEA/AFEA Conference, Boston, MA, USA, January.

Ekpo, A. H., (2005), **Fiscal Theory and Policy: Selected Essays**. Somaprint, Lagos

Ekpo, A. H., (1995) "*Openess and Economic Performance in Nigeria: A Times Series Analysis"* in **External Trade and Economic Development in Nigeria**, Nigerian Economic Society, Ibadan.

Ekpo, A. H., (2001), *"Interest Rate Management in Nigeria: Lessons from Conceptual and Empirical Reviews"*. **Policy Analysis Series**, NCEMA, Vol.7, No.2, pp. 1-24.

Ekpo, A. H., (2003), *"Macroeconomic Policy Framework: Issues and Challenges"* in Issues in Fiscal **Management: Implications For Monetary Policy in Nigeria**. CBN Third Annual Monetary Policy Conference, December, pp. 11-44.

Favero, C., (2002), *"How do European Monetary and Fiscal authorities behave?* I**GIER Working Paper, No. 214**.

Favero, C and T. Monaccelli (2003) *"Monetary – Fiscal mix and Inflation Performance: Evidence from the US"* **IGIER Working Paper Series** No. 234.

Feldstein, M. S (1986) *"The budget deficit and the dollar"* in S. Fisher (ed), **NBER Macroeconomic**, Cambridge, Mass.

King, R., and Plosser, C., (1985), *"Money, Deficits and Inflation"*. **Carnegie Rochester Conference Series on Public Policy** *22*, 147-196

Kopits, G. (2000), *"How Can Fiscal Policy Help Avert Currency Crisis?"* **IMF Working Paper** No. 00/195.

Melitiz J. (2002) *"Debts, deficits and the behaviour of monetary and fiscal authorities"* in MarcoButi et al., **The Behaviour of Fiscal Authorities–Stabilization, Growth and Institutions**, Palgrave, pp. 215 – 40.

MCMihillin, W. D., and Koray, F., (1990), *"Does Government Debt affect exchange rate?"* An Empirical Analysis of the US–Canada Exchange Rate" **Journal of Economics and Business** 42, November, pp. 279–88.

Melvin, M.D Schlagenhanf and A. Talu (1989): "*US budget deficits and the Foreign Exchange value of the dollar"* **Review of Economics and Statistics** 71, August, pp. 500-05.

Nyamongo, M. E., Sichel, M., and Mutai, N. K., (2010), *"The Monetary and Fiscal Policy Interactions in Kenya"* Research Paper, Central Bank of Kenya.

Nyong, M. O., (2010), *"Fiscal and Monetary Coordination and Implications for Economic Performance in The Gambia"* Dept of Economics, University of Calabar, Processed.

Oyejide, A., (2003), *"The Challenges of Monetary Management in an Environment of Fiscal Dominance"* in **Issues in Fiscal Management: Implications for Monetary Policy in Nigeria**, CBN, Abuja.

Oshikoya, T.W., (2010), *"***Monetary And Financial Integration in West Africa."** London, Routledge

Onwioduokt, E. A., (2004), *"Fiscal Sustainability in the West African Monetary Zone: Emerging Issues"* **CBN Economic and Financial Review** Vol. 42, No. 3, September, pp. 21 – 48.

Sala, L., (2003), *"Testing the Fiscal Theory of the Price Level"* Mineo.

Sargent, T., and Wallace, N. (1981) *"Some Unpleasant Monetarist Arithmetic"* Federal Reserve **Bank of Minneapolis Quarterly Review**, Fall, pp. 1 – 77.

Tanner, Evan; Ramos, Alberto (2002), *"Fiscal Sustainability and Monetary Versus Fiscal Dominance: Evidence from Brazil (1991-2000)"*. **IMF WP /02/5**

Von Hagen et al., (2002) *"Quality and Success of budgetary Consolidations"* in The behaviour of **Fiscal Authorities – Stabilization, Growth And Institutions**, Palgrave, pp. 17 – 38.

Wyplosz, C (1999) *"Economic Policy Coordination in EMU: Strategies and Institutions"* Processed

Zoli, E., (2005), *"How does Fiscal Policy Affect Money Policy in Emerging Market Countries?"* Bank of International Settlement, **Working Paper No. 174**.

Empirical Assessment of Ghana's Public Debt and Stability of Fiscal Policy: *Non-Linear Estimates of Fiscal Reaction Function and Debt Dynamics*

Nana K. AKOSAH*

Abstract

Ghana's public debt dynamics was explored using the three main approaches in the literature. This includes the analysis of the long run mean-reverting properties of the debt using unit root techniques, the estimation of the fiscal policy reaction function to understand whether government pursues appropriate policies to avert excessive debt accumulation and also investigate the evolution of interest-adjusted growth rates over the last three decades. The findings from these approaches consistently revealed that fiscal instability prevailed in the late 1990s and early 2000. Although public debt appears to satisfy the intertemporal budget constraint of fiscal sustainability after 2001 following the adoption of HIPC, the fiscal profile is weakly sustainable as escalating pressures remain since 2009 largely driven by election spending excesses. The policy implication is that government should keep the budget deficits under control by rationalizing expenditures and enhancing tax revenue mobilization efforts, while reducing debt financing of the budget deficit.

Key Words: *Fiscal Sustainability, Transversality Condition, Debt Dynamics, Fiscal Reaction Function, Ghana.*

JEL Classification: E62, H6

* Nana K Akosa is at the Research Department, Bank of Ghana. Email: akosahk@gmail.com or nana.akosah@bog.gov.gh. The views expressed in this paper reflect those of the author but not those of the Bank of Ghana

1. Introduction

The concept of fiscal sustainability has recently gained prominence in the assessment of macroeconomic conditions of an economy. This reflects the increasing focus on the state of government finances in most country surveys and reports by international organisations, especially the International Monetary Fund (IMF) and ratings agencies. The rising interest in fiscal sustainability has also been bolstered by the recent global financial turmoil and the lingering European sovereign debt crisis which plunged the global economy into recession. Though the issues pertaining to fiscal deficits and national debts are not rare, a threat to fiscal sustainability has stern repercussions on macroeconomic growth and financial stability of a country. Consequently, the attainment of a sound fiscal policy has received an utmost attention in the overall objectives of both developed and developing economies.

However, the meaning of fiscal sustainability remains ambiguous in Economics as the term is defined in myriad ways depending on the methodology employed. For instance, Wilcox (1989) defined a sustainable fiscal policy as a policy that generates a series of debt and deficits such that the Transversality Condition (TC) would hold. If this condition is violated, perpetual deficits will be impossible and hence changes in the fiscal policy will be unavoidable. Blanchard (1990) and Cuttington (1997) also defined sustainable fiscal policy as a policy that ensures that the debt to GDP ratio converges back towards its initial level. Although the precise definition of fiscal sustainability remains unsettled, it is generally accepted that fiscal sustainability is closely allied to the financial situation of the government, which often reflects the economical strength and stability of a country. Therefore, the exigency to revise current fiscal policy symbolizes an unsustainable fiscal policy, while a modest change in fiscal policy to satisfy debt is a sign of sustainable fiscal policy. Besides, the sustainability of fiscal policy becomes equivocal as soon as debt to GDP ratio reaches above a certain level and revenues are insufficient to cover financing costs related to new levels of debt issued or when it is apparent that the government needs are higher than the taxpayers can support (Shijaku, 2012).

It is against this background that the issue of fiscal sustainability is particularly critical for economies with persistent budget deficits, rising debt burden, macroeconomic instability and vulnerable to shocks. While most economies in Africa face such acute macroeconomic vulnerabilities, studies on fiscal sustainability that apply to African economies remain inadequate and this motivates the current study. Notable studies include Lusinya and Thorsten (2009), and Burger et al (2011) for South Africa; Oshikoya and Tarawalie (2010), and Mohammed (2014) for WAMZ countries (including Ghana); Nseera (2013) for Lesotho; Ndoricimpa (2014) for East Africa Community (EAC) countries; Ariyo (1993) and, Oyeleke and Ajilore (2014) for Nigeria. Doh-Nani (2011), Kwakye (2012) and Asiama et al (2014) have also addressed the sustainability issue in the case of Ghana using mainly linearly specified parametric methods. The question is whether linear methods are capable of capturing the complexities involved in the fiscal sustainability dynamics? This paper goes beyond the linear analysis to establish a more robust non-linear relationship between debt and primary balance using Markov Regime Switching models which permit regime changes.

The paper is thus organized as follows: the next section presents Ghana's fiscal profile, while section 3 highlights the literature on fiscal sustainability. Section 4 outlines the main methodologies for the empirical analysis. The empirical results and inferences are reported in Section 5, while the final section provides the conclusion and policy recommendations.

2. Ghana's Fiscal Profile

Ghana's fiscal policy objectives have mainly focused on mobilizing more fiscal resources, efficient and judicious allocation and usage of financial resources, reducing the debt weight and also strengthening the private sector to spearhead economic growth. As a result, fiscal policy framework is set to foster macroeconomic stability in order to goad sustained economic growth and poverty alleviation. In this regard, there have been numerous bilateral agreements with the International Monetary Fund (IMF) under the Article IV of the IMF's Extended Credit Facility (ECF) to among others, facilitate structural reforms that sanction efficient expenditure and debt management. This notwithstanding, Ghana's public finance over the years has been characterized by persistent budget deficits, largely via the predominance of recurrent expenditures (see the Upper Panel, UP, of Figure 1). Undoubtedly, the Multilateral Debt Relief (especially in 2006) that followed the adoption of Heavily Indebted Poor Countries' (HIPC) initiative (2001) remarkably improved the fiscal situation. The overall budget deficit declined from 8.6% of GDP in 2000 to 1.9% of GDP in 2005 (-4.8% in 2006), while total government debt to GDP ratio also plummeted from a peak of 187.3% in 2000 to a two-decade low of 26.2% in 2006. Accordingly, interest payments as a ratio of tax revenue also declined considerably from 46.1% in 2000 to 15.9% in 2006. However, subsequent events from 2006 uncovered the intrinsic structural weakness in Ghana's fiscal policy regime as government has been beset with growing budget deficits and debt levels. The rapid build-up in government debt since 2006 has been largely attributed to persistent expenditure overruns. In recent years, the fiscal slippages have been exacerbated by the rising public sector wage bill due to the implementation of single spine salary structure (in 2010) accompanied by the weakening fiscal revenue generation efforts despite numerous reforms.

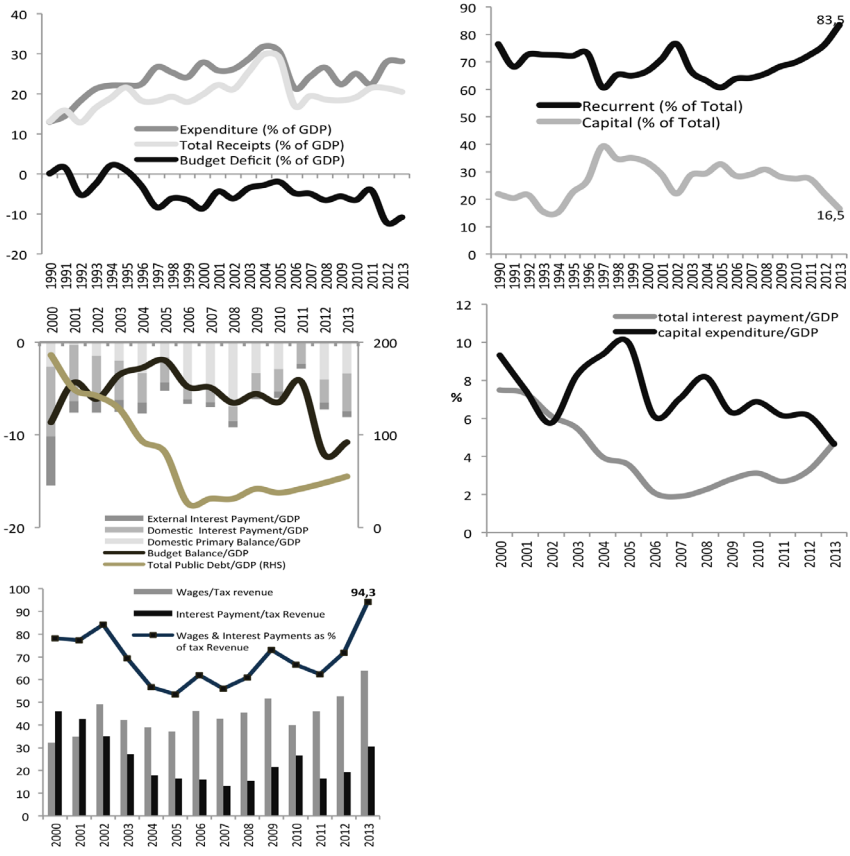
From as low as 26.2% of debt to GDP ratio in 2006, Ghana's public debt was estimated at 57.7% of GDP at the end of 2013 (see MLP in Figure 1), rapidly approaching the IMF's critical debt threshold[8] of 60% of GDP[9]. Overall budget deficit has rocketed from the low of 1.9% of GDP in 2005 to 12.1% of GDP in 2012, but moderated to 10.1% of GDP at the end of 2013 following post-election fiscal consolidation efforts by government. The rapid rate of growth in public debt, largely driven by consumption expenditures (see URP of Figure 1) potentially poses a substantial risk to sustained economic growth. This is reflected in escalating interest cost, which exceeded total capital expenditure in 2013 by a percentage

8 - Although such a deterministic indicator gives clear signals of fiscal sustainability and is easily interpreted, no consensus has been reached among economists about the theoretical foundations of this threshold level of debt to GDP ratio.

9 - While in some cases high levels of deficit and debt may be appropriate, it is impossible for a country to adhere to a consistent ratio throughout the time (Shijaku, 2012). Accordingly, Jonas (2010) articulated that determining a low ratio while the initial level is too high would require implementation of a tight fiscal policy for a long period of time. This, among others, could cause a decline in public investment and slow down potential economic growth. On the other hand, determining a higher level would increase the level of debt to GDP ratio and interest payments and subsequent rise in general concerns about sustainability (Shijaku, 2012).

point[10] (see MRP of figure 1). Collectively, the interest burden and public sector wage bill absorbed approximately 94% of tax revenue as at the end of 2013 (see LLP of Figure 1), compelling government to source for additional funds to meet various statutory payments such as educational trust fund (GETFUND), National Health Insurance Scheme (NHIS) etc. Consequently, the fiscal profile of Ghana has lately attracted considerable academic, political and international attention. In the midst of these discourses, the international rating agencies (including Moody's, Fitch, and Standard & Poors) downgraded Ghana's sovereign rating to B- with negative outlook in 2014.

Figure 1: Ghana's Fiscal Profile



Source: Author's construct using data from Ministry of Finance, Bank of Ghana and IMF's World Economic Outlook for April 2014

10 - On average, interest payment on Ghana's debt alone absorbed approximately 15.3% of total government expenditure per year over the last three decades. This goes to emphasize the extent of debt service burden on the economy and hence the looming concerns about fiscal sustainability.

Boosted by crude oil production and export (since 2011), Ghana is among the fastest growing economies in Sub-Saharan Africa (SSA). However, the Ghanaian economy is also beleaguered by higher inflation compared to her peers in SSA (see LRP of Figure 1). Also critical is the fact that government is determined to develop some key sectors of the economy, including the fledgling oil and gas industry as stipulated in the 2014 Fiscal Budget. Even though such investments are crucial to guarantee a sustained economic growth, the Budget Statement paradoxically indicated a capital expenditure projection of 5.7% of GDP for 2014, below a projected interest payment of 5.9% of GDP for the same period. This epitomizes the pinnacle of interest burden on Ghana's public finance.

Against this background, the study seeks to address three fundamental aspects of the same question:

- Does the current fiscal policy stance satisfy the intertemporal budget constraint (IBC)?
- Does the fiscal authority pursue active policies to obviate excessive debt build up?
- How do interest rate and economic growth compare over the years?

In particular, the paper primarily follows an empirical approach to evaluate the sustainability of Ghana's past and current fiscal policy. Thus, the study focuses on the question whether Ghana's fiscal profile has a stable behaviour in the long run. First and foremost, the paper investigates the stochastic behaviour of key fiscal indicators (such as public debt, primary balance, revenue and expenditure) by assessing their long run mean-reverting properties. Secondly, the study also estimates the fiscal reaction function for Ghana. This analysis is long overdue as the activity of public debt management has monetary policy and economic growth implications. The study therefore provides some motivations to underscore, in advance, the expectations in favour of monetary policy of the central bank. Indeed, elimination of fiscal volatility originating from an unstable behaviour of fiscal authority is critical for effective implementation of monetary policy by an inflation targeting central bank.

3. Literature Review

The conceptual literature has focused on two prominent approaches applied in the analysis of fiscal sustainability; namely the Accounting Approach and Present Value Budget Constraint (PVBC) econometric approach. However, both approaches rely mainly on the government intertemporal budget constraints (IBC)[11] in equation (1);

$$G_t + (1+i_t)\, D_{t-1} = T_t + D_t \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

or

$$D_t = D_{t-1}\,(1 + r_t) - Pb_t \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

11 - The IBC stipulates that government's total receipts including tax (T_t) and borrowing (D_t) of the current period should equal the government's total spending (G_t) plus debt service (including principal from the previous period (D_(t-1)) and interest payment (i_t D_(t-1))).

From equation (1), government's total receipts including tax (T_t) and borrowing (D_t) of the current period should equal the government's total spending (G_t) plus debt service (including principal from the previous period (D_{t-1}) and interest payment ($i_t D_{t-1}$). Equation (2), however, explores the relationship between government debt (D_t), primary balance (Pb_t), which is tax revenue minus non-interest government expenditure (+ surplus; - deficit); and the gross interest factor (r_t). Due to the fact that government's capacity to repay its debt increases as the economy expands over time, it is convenient to rewrite equation (2) in terms of GDP ratios. Consequently, dividing equation (2) by GDP (Y) yields:

$$\frac{D_t}{Y_t} = -\frac{Pb_t}{Y_t} + \frac{1+r}{1+g}\frac{D_{t-1}}{Y_{t-1}}, \dots\dots\dots\dots\dots\dots\dots\dots (3)$$

or

$$d_t = \frac{1+r}{1+g} d_{t-1} - pb_t, \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

where d_t, πb, g and r denote current debt to GDP ratio, primary balance to GDP ratio, growth rate of real GDP and real interest rate respectively, with the last two variables assumed to be constant. Solving forward while expressing the current debt to GDP ratio as a function of the future debt/GDP ratio and the future primary surplus, we get;

$$d_t = \left(\frac{1+r}{1+g}\right)^{-n} d_n - \sum_{t=1}^{n} \left(\frac{1+r}{1+g}\right)^{-t} pb_t, \dots\dots\dots\dots\dots\dots\dots (5)$$

Based on equation (5), the Accounting Approach focuses on a particular debt ratio and also assesses mutual consistency of pre-defined macroeconomic targets in the economy including inflation, growth rate of GDP, and interest rate. In particular, this approach defines primary balance as sustainable if it generates constant debt to GDP ratio, given a specified real GDP growth target and constant real interest rate.

The PVBC also known as the "Transversality Condition (TC) or no Ponzi Game Condition" states that the initial debt stock when measured in present value terms vanishes in the limit. This implies that the debt-to-GDP ratio at some distant future '**n**' comes back to the level at the period zero. In other word, future government debt will mature and will eventually be repaid in full. By implication, government debt is finite and the market will not tolerate Ponzi games under which government services its debt (principal and interest) in perpetuity by merely issuing new debt on a regular basis (Cuddington, 1996; Escolano, 2010). Thus, the primary balance is sustainable if the stock of government's debt is expected to grow less than the average real interest rate, which is considered as a proxy for the growth rate of the economy. In this regard, a sufficient and necessary condition for fiscal sustainability under PVBC requires that as n approaches infinity[12],

$$\lim_{n\to\infty} \varphi^{-n} d_n = 0, \dots\dots\dots\dots\dots\dots\dots (6)$$

12 - Escolano (2010) provides a proof of equation (5a).

Where $\varphi = \left(\frac{1+r}{1+g}\right)$.

From equation (6), the TC holds if φ follows a stochastic process bounded by $1+\varphi$ (φ>0). Thus, the TC is tested against the alternative that the limit exists and is strictly positive using unit root tests. The null hypothesis ($\varphi = 0$) corresponds to d_t stationary against the alternative hypothesis that the agents anticipate part of the debt never to be repaid, hence φ_t follows a non-stationary process ($\varphi_t \neq 0$). Consequently, if equation (6) is true, then equation (5) reduces to:

$$d_t = -\sum_{t=1}^{n} \left(\frac{1+r}{1+g}\right)^{-t} pb_t, \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Equation (7) suggests that the current debt to GDP ratio is a function of the future primary surplus.

The preceding PVBC framework has extensively found applications in most existing empirical analysis of fiscal sustainability. Essentially, the empirical literature also documents two main approaches in analyzing the PVBC. On one hand, equation (6) is evaluated by examining the mean-reverting properties of key fiscal variables such debt to GDP ratio, primary balance, etc. Pioneering this approach, Hamilton and Flavin (1986) implemented the Flood-Garber (1980) test for price bubble to the PVBC for the postwar United States using variables such as real primary surplus, seigniorage and real debt stock for the period 1960-1981. They found that the US budget balance was on a long run sustainable path, despite its systematic budget deficits. Trahan et al (1991) however argued that as long as the stock of the outstanding debt (d_{t-1}) follows a trend stationary process (mean-reverting), then equation (7) holds and hence, IBC were satisfied. Otherwise, it becomes inevitable to undertake the necessary adjustments to restore the deficit and public debt at sustainable levels. Therefore, the IBC imposes restrictions on the long run fiscal behavior concerning the link between revenues and expenditures. The first restriction is that revenue and expenditure do not drift far-off from one another, by avoiding the creation of large negative imbalances between them. The second restriction requires government to generate enough future net primary surpluses to repay the outstanding stock of debt. In this regard, Trahan et al (1991) used primary surplus and previous debt to demonstrate that transversality condition (TC) holds if these variables are cointegrated (with cointegrating vector (1,)) and if the primary surplus follows an AR (1) process. Others studies that have followed this approach included Penalver and Thwaites (2006), Budina et al (2008), Shijaku (2012), Lame, Lequien and Pionnier (2012).

On the other hand, recent studies go beyond the unit root analysis to estimate the fiscal policy reaction function (FPRF). The FPRF is a rule that helps government forecast and prepare to react against some macroeconomic changes. To establish how the fiscal authority reacts to its debt burden, the FPRF estimates the reaction of primary balance to GDP ratio to changes in one-period lagged debt to GDP ratio. To derive FPRF, d_(t-1) is subtracted from both sides of equation (4) and after setting $\Delta d_{t-1} = 0$ to stabilize d_t, we get:

$$pb_t = \varphi d_{t-1}, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

where $\varphi = \frac{r-g}{1+g}$

Equation (8) implies that if $r>g$ but $0< \varphi <1$, then debt converges and fiscal policy is said to be sustainable. This approached was ignited by Bohn's (1998) influential study on the USA fiscal policy for the period 1916-1995. He used a bivariate analysis that regress primary balance on the debt variable. Bohn however cautioned that if primary balance (pbt) and debt (d_t) are both non-stationary while the residual term is stationary, one could interpret a simple regression of pb_t on d_t as a cointegrating regression without having to model the process explicitly. But if primary balance and debt do not have unit root, then a regression of pb_t on d_t that omits other determinants of the primary surplus will produce inconsistent estimates due to omitted variable bias. Accordingly, Bohn suggested that empirical analyses should be based on an explicit theoretical model for fiscal policy. Following Barro's (1979) tax-smoothing model, Bohn (1998) subsequently extended the simplified model to include temporal government spending ($GVAR_t$) and business cycle indicator (YVAR _t). Using the US data, he found a significant positive response of primary surplus to changes in debt/GDP in the USA. He further argued that positive coefficient of debt to GDP provides reliable information about sustainability irrespective of the levels of real interest rate and real GDP growth. Thus, if debt to GDP ratio keeps growing, a sustainable fiscal policy must ultimately respond by moving towards primary surpluses.

Burger et al (2011) extended the Bohn's (1998) model by including lagged primary balance and output gap to examine the fiscal sustainability and fiscal reaction function of South Africa using, among others, State-Space and threshold VAR models. The inclusion of lagged primary balance was to allow for inertia in government behavior. They found that the South African government indeed did tighten fiscal policies when facing shocks to the debt to GDP position during the sample period.

Similarly, Doi et al (2011) examined Japan's fiscal sustainability incorporating a quadratic term (deviation of the previous debt from the mean), output gap and government expenditure using both simple linear (OLS) and non-linear Markov-Switching models. Doi et al. (2011) found Japan's government debt to be explosive as both models showed significant negative response of primary balance to changes in debt to GDP. In line with Doi et al (2011), Hall (2013) examined US fiscal reaction function with the assumption that the economy follows a Markov process. He found that the US fiscal policy had a strong tendency to lower primary deficit when debt to GDP is high.

Using annual time series for the period 1980-2008, Oshikoya et al (2010) employed cointegration and Granger causality methods to examine fiscal sustainability for West African Monetary Zone (WAMZ) including Ghana, Nigeria, Sierra Leone, Gambia and Guinea. They found that fiscal policy was weakly sustainable for all the countries, except Sierra Leone whose fiscal policy was found to be unsustainable. Similarly, Mohammed (2014) applied unit root and cointegration methods to evaluate fiscal sustainability for six WAMZ countries including Ghana, Nigeria, Sierra Leone, Gambia, Guinea and Liberia over the period 1985-2013. The study established that fiscal policy was sustainable for all the countries, with the exception of Liberia. Oyeleke et al (2014) also used an error correction model to investigate

whether fiscal policy in Nigeria has violated the IBC over the period 1980-2010. The study revealed that fiscal policy was weakly sustainable during the sample period. Again, Ndoricimpa (2014) investigated the structural breaks and fiscal deficit sustainability for economies under East Africa Community (EAC), comprising Burundi, Kenya, Rwanda, Tanzania and Uganda, by examining the long run relationship between government revenue and expenditure for the period 1985-2012. Applying Gregory and Hansen (1996) and Hatemi-J (2008) model that account for structural breaks in cointegrating equations, Ndoricimpa (2014) found a strong fiscal sustainability for Rwanda and weak fiscal sustainability in the case of Burundi, Kenya, Tanzania and Uganda.

Using cointegration method, Doh-Nani (2011) investigated the sustainability of Ghana's budget deficit by assessing the long run relationship between government revenue and expenditure for the period 1960-2007. The paper established a stable long run relationship between government revenue and expenditure for the sample period. In addition, Kwakye (2012) examined Ghana's debt profile and sustainability for the period 2000-2012 using Debt Sustainability Analysis (DSA). He found Ghana's debt to be unsustainable during the period 2000-2003 but sustainable during the period 2004-2012. Also, Asiama et al (2014) assessed Ghana's fiscal sustainability for the period 1990-2013 using a number of econometric techniques including Autoregressive Distributed Lag (ARDL) and OLS with Breakpoints methods. The study also forecasted Ghana's debt dynamics for the period 2014-2016 using interest adjusted-growth rates from the projections of total interest payment and real GDP growth in the 2014 Fiscal Budget of Ghana. They found Ghana's public finance to be weakly sustainable as significant pressure remains in the ensuing years.

4. Methodology and Data Issues

The paper examines fiscal sustainability of Ghana by employing three main approaches in an attempt to respond to the preceding questions (in section 2). First, the study investigates mean-reverting properties of public debt by assessing whether Ghana's fiscal policy satisfies the transversality condition (TC)[13]. In this case, if the null hypothesis of the presence of unit root is rejected, then the fiscal policy is said to satisfy the transversality condition. On the other hand, if the null hypothesis is not rejected, then the present value of the budget constraint is continually violated and the current policy is not sustainable, hence, it has to be changed. Here, both Augmented Dickey-Fuller (ADF) and Philip and Perron (PP) unit root tests were applied. The Augmented Dickey-Fuller (ADF) test constructs a parametric (linear) correction for higher-order correlation by assuming that the *"Z"* series follows an AR (p) process and adding *"p"* lagged difference terms of the dependent variable *"Z"* to the right-hand side of the test regression:

$$\Delta Z_t = \alpha Z_{t-1} + x_t'\sigma + \beta_1 \Delta Z_{t-1} + \beta_2 \Delta Z_{t-2} + \cdots + \beta_p \Delta Z_{t-p} + \mu_t, \ldots\ldots\ldots (9)$$

13 - The concept of intertemporal budget constraint is based on the assumption that government expects some future tax revenue and thus makes payments on debt at present. Due to this expectation, it is crucial to discount the present value of the expected tax revenues in the future. The discounted value is compared with government's needs to make payments on time t. if the present value of expected revenue is equal or higher that the present value of government debt, then fiscal policy is regarded as stable (Shijaku, 2012).

With the testing hypothesis

$$H_0: \alpha = 0$$

against the alternative hypothesis

$$H_1: \alpha < 1$$

Unlike ADF test, the PP unit root test is a non-parametric (non-linear) method that controls for serial correlation[14]. Both tests included a constant, a constant and linear time trend, or neither of the two in the test regressions. The paper also explores the assertion by Tehran et al (1991) by investigating the long run relationship between government revenue and expenditure (including interest payment).

However, the above approach fails to capture any possible structural breaks and non-linear behaviour in the time series. Thus, the study also estimates non-parametric fiscal reaction function to ascertain how government reacts to rising debt levels. In this approach, the fiscal reaction function is estimated using non-linear Markov regime switching Model. Following Doi et al (2011), the paper assumed a two-state Markov switching model in equation (10) below:

$$pb_t = \alpha(S_t) + \beta(S_t)d_{t-1} + \theta(S_t)pb_{t-1} + \vartheta(S_t)C_t + \sigma(S_t)\mu_t, \ldots\ldots(10)$$

where pb_t represents primary balance to GDP ratio, d_{t-1} is previous debt to GDP ratio, and S_t is policy regime that follows a two-state Markov chain with transition probability matrix

$$\begin{pmatrix} \lambda_{1,1} & 1-\lambda_{2,2} \\ 1-\lambda_{1,1} & \lambda_{2,2} \end{pmatrix},$$

whose (i, j) element indicates the probability that the policy regime move to Regime i from Regime j. Although the usual interpretation of "regimes' would be different fiscal policy stances by different administrations, for purposes of this paper, the number of fiscal policy administrative regimes is initially limited to two, similar to Doi et al (2011).

However, since there could be more than two structural breaks in the time series, the study further applied OLS with Breakpoints method to specifically detect various regimes (or breaks) in order to ensure more reliable estimates. This would indeed help to pin down the exact periods of stability or otherwise of fiscal policy in Ghana. This analysis is deemed critical as it enables the determination of fiscal sustainability for the immediate past policy, preferably, since 2006. The break type was identified using the Bai-Perron (1998 & 2003) test that combines the global and sequential testing approaches with the null hypothesis of B+1 breakpoints versus the alternative hypothesis of B breakpoints. Each test begins with the set of B global optimizing breakpoints and performs a single test of parameter constancy using the sub-sample break that minimizes the-sum-of-squared residuals (see, Eviews 8 manual).

The preceding approaches are based on the premise of "no-Ponzi game" condition which stipulates that under a sensible condition, at least in the long term, when interest rate exceeds

14 - The PP method estimates the non-augmented DF test equation and modifies the t-ratio of the "α» coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic.

growth rate, the following holds: (i) debt and interest rate are not rolled over systematically; (ii) existing debt is eventually paid in full through future primary surplus and (iii) debt ratio is kept below a ceiling. However, this condition fails to hold in an economy where growth rate exceeds interest rate. Conventional economic theory suggests that in those cases, the inter-temporal allocation could be improved. That is, government can incur a given amount of debt and postpone payments as long as growth rate exceeds interest rate without growing the debt. This is because the decline in debt ratio due to economic growth will (more than) counteract the increase in the debt ratio originating from capitalization on interest (Escolano, 2010). Therefore, keeping the debt ratio stable no longer implies abiding by the no-Ponzi game condition. Against this background, the study also attempts to provide an answer to the third question in section 2 by investigating the trends in real effective interest-adjusted growth rate (the difference between effective interest rate and GDP growth rate) over the last three decades.

This study employed annual and quarterly time series data covering the period 1983-2012 and 1990q1 to 2013q2 respectively. Data were obtained from Bank of Ghana, Ministry of Finance and Ghana Statistical Services.

5. Empirical Results

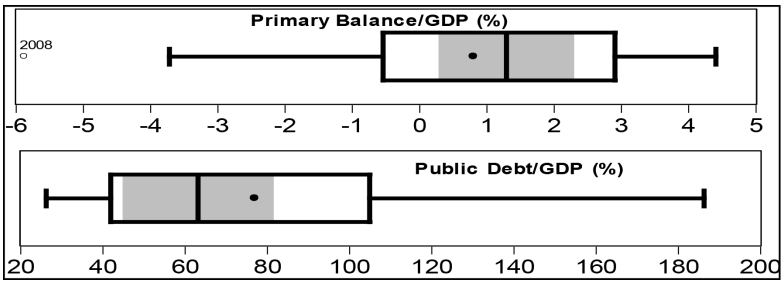
This section presents the analysis of the empirical results. Trends in primary balance and public debt were scrutinized, the stationarity of the variables were established, cointegration analysis was pursued and the extent to which fiscal authority reacts to debt accumulation was also evaluated.

5.1 Movements in Public Debt and Primary Balance

For the past 30 years (1983-2012), government budgetary operations have resulted in 21 episodes of primary surpluses (averaging in the neighbourhood of 2.03% of GDP) and 9 years of primary deficits (averaging at 2.60% of GDP).

Table 1: Average movements of Primary Balance/GDP and Public Debt/GDP ratios (%)

	Primary Balance/GDP	Public Debt/GDP
1983 - 1988	0.05	47.75
1989 - 1994	0.68	73.19
1995 - 2000	2.58	115.56
2001 - 2006	1.55	103.46
2007 - 2012	-1.66	38.55
1983 - 2012	0.64	75.70



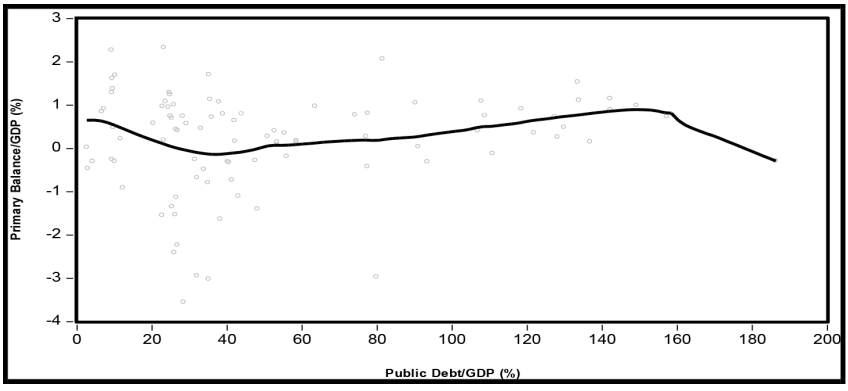
Source: Author's construct

The higher primary deficits for the 9 years reflected excessive government spending during election periods in 1992, 2008 and 2012 which was also associated with higher build-up in public debt (except 2008). The top panel of table 1 presents the 6-year average of primary balance and public debt since 1983.

Clearly, primary balance appears to be positively associated with public debt. With exception of the period 2007-2012, the government budgetary operations, on average, resulted in primary surpluses. The average primary deficit of 1.66% of GDP observed in the period 2007-2012 was not surprising as this period did not only contain two election years (2008 and 2012) but also coincided with the global financial and European sovereign debt crises. The bottom panel provides the box plots of primary balance and public debt. The box plot of primary balance indicates that the primary deficit for 2008 was an outlier, reinforcing the highest deficit recorded during the period 2007-2012. Also, the long whisker of the box plot is an indication that public debt has the tendency to increase over time.

The outlier value observed in the primary balance could possibly induce a non-linear relation with the public debt. This assertion appears to be confirmed by the kernel density fit depicted in figure 2. However, the subsequent section further explores the issue of nonlinearity between primary balance and public debt using a more robust empirical technique.

Figure 2: Kernel Density Fit for Primary Balance and Public Debt to GDP Ratios



Source: Author's construct

5.2 Unit Root and Cointegration Tests

The time series properties of the variables in the model were investigated by performing unit root tests. The order of integration of the variables was determined by using Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests. Table 3 shows the results from the ADF unit root test, while Table 4 displays the results from the PP unit root test.

Table 2: ADF Unit Root Test for Transversality Conditions (TC)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Primary Balance/GDP					
	1990q1-2013q2	Lag[1]	1990q1-2000q2	Lag[1]	2001q1-2013q2	Lag[1]
None	[0.0054]*	2	[0.0002]*	0	[0.0001]*	0
Intercept	[0.0000]*	0	[0.0002]*	0	[0.0012]*	0
Intercept and Trend	[0.0000]*	0	[0.0005]*	0	[0.0050]*	0
First Difference	[0.0000]*	1	[0.0000]*	1	[0.0000]*	1
	Public Debt/GDP					
None	[0.2155]	0	[0.9419]	0	[0.0000]*	0
Intercept	[0.3489]	0	[0.9893]	0	[0.0287]**	3
Intercept and Trend	[0.6752]	0	[0.9989]	0	[0.9970]	3
First Difference	[0.0000]*	0	[0.0000]*	0	[0.0000]*	0
	Total government Expenditure/GDP					
None	[0.8536]	7	[0.9660]	3	[0.5380]	4
Intercept	[0.0967]***	7	[0.7037]	3	[0.1173]	4
Intercept and Trend	[0.1854]	4	[0.0001]*	0	[0.2354]	4
First Difference	[0.0000]*	6	[0.0000]*	2	[0.0000]*	3
	Domestic Revenue/GDP					
None	[0.7716]	3	[0.7542]	3	[0.7318]	3
Intercept	[0.0262]**	8	[0.0011]*	0	[0.4380]	4
Intercept and Trend	[0.1058]	8	[0.0036]*	0	[0.7661]	4
First Difference	[0.0000]*	2	[0.0000]*	2	[0.0000]*	2
	Total Interest Payment/DGP					
None	[0.6115]	5	[0.9969]	3	[0.0471]**	4
Intercept	[0.3233]	5	[0.8633]	7	[0.1084]	4
Intercept and Trend	[0.5923]	5	[0.0105]**	6	[0.9969]	4
First Difference	[0.0018]*	4	[0.0140]**	3	[0.0004]*	3
[1] Automatic lag selection based on SBC criteria						
*, ** & ***denotes 1%, 5%, et 10% significance levels respectively						

Source: Author's construct

Table 3: Philip-Perron Unit Root Test for Transversality Conditions (TC)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Primary Balance/GDP					
	1990q1-2013q2	Lag[1]	1990q1-2000q2	Lag[1]	2001q1-2013q2	Lag[1]
None	[0.0000]*	5	[0.0002]*	3	[0.0000]*	4
Intercept	[0.0000]*	5	[0.0002]*	2	[0.0007]*	4
Intercept and Trend	[0.0000]*	5	[0.0004]*	1	[0.0026]*	4
First Difference	[0.0000]*	10	[0.0000]*	41	[0.0000]*	3
	Public Debt/GDP					
None	[0.2157]	1	[0.9245]	1	[0.0007]*	49
Intercept	[0.3402]	1	[0.9810]	2	[0.0089]*	25
Intercept and Trend	[0.6656]	1	[0.9995]	3	[0.3360]	8
First Difference	[0.0000]*	2	[0.0000]*	2	[0.0000]*	3
	Total government Expenditure/GDP					
None	[0.4554]	17	[0.8418]	14	[0.3116]	14
Intercept	[0.0000]*	2	[0.0086]*	2	[0.0000]*	4
Intercept and Trend	[0.0000]*	1	[0.0001]*	3	[0.0000]*	7
First Difference	[0.0000]*	17	[0.0000]*	21	[0.0000]*	13
	Domestic Revenue/GDP					
None	[0.4074]	17	[0.6240]	18	[0.4181]	13
Intercept	[0.0000]*	1	[0.0013]*	2	[0.0000]*	1
Intercept and Trend	[0.0000]*	1	[0.0038]*	1	[0.0002]*	1
First Difference	[0.0000]*	17	[0.0000]*	16	[0.0000]*	14
	Total Interest Payment/DGP					
None	[0.3323]	18	[0.9331]	13	[0.0736]***	15
Intercept	[0.0009]*	13	[0.2348]	17	[0.0109]**	13
Intercept and Trend	[0.0054]*	14	[0.0000]**	1	[0.0494]**	5
First Difference	[0.0000]*	91	[0.0000]**	6	[0.0000]*	49
[1] Automatic lag selection based on SBC criteria						
*, ** & ***denotes 1%, 5%, et 10% significance levels respectively						

Source: Author's construct

For the full sample (see column 2 in Table 2 & 3), the results from both ADF and PP tests show that public debt ratio was non-stationary, that is *I(1)*, at levels, while primary balance ratio was found to be stationary, *I(0)* at levels. Domestic revenue (scaled by GDP) exhibited stationarity with either a drift or trend in both the ADF and PP tests at levels, while total expenditure and interest payment (scaled by GDP) were weakly stationary with drift and non-stationary respectively from the ADF test. Both total expenditure and interest payment however appear to be stationary with drift and trends from the PP test.

For robustness, columns 4 and 6 (in tables 2 and 3) present unit root test results for the sub-periods 1990Q1-2000Q4 and 2001Q1-2013Q2 respectively. From both the ADF and PP tests, public debt was found to be non-stationary for the period 1990q1-2000q4, but was stationary during the period 2001q1-2013q2. Primary balance, on the other hand, exhibited stationary properties in both sub-periods, supporting the full sample results. In both sub-samples, domestic revenue, total expenditure and interest payment exhibited stationarity with either drift or trend from both ADF and PP tests. In synthesis, the results showed public debt to be integrated (non-stationary) during the period 1990-2000, indicating that Ghana's public debt violated the transversality condition of fiscal sustainability in the 1990s, although some adjustments were made to help stabilize the debt.

However, the Ghana's fiscal policy appeared to be coherent with the transversality condition during the period 2001-2013 as both primary balance and public debt were found to be stationary, *I(0)*. This implies a comparatively reduced fiscal pressure since 2001, largely underpinned by the adoption of HIPC initiative and the rebasing of the economy (2006) which provided some fiscal space.

Furthermore, the paper fitted two linear cointegration models to investigate the long run relationship between primary balance and public debt, and revenue (LDREV) and expenditure (LTEXP) to explore the assertion by Tehran et al (1991). Table 4 presents a bivariate ARDL estimates for primary balance, while Table 5 displays the result of cointegration tests for government revenue and expenditure (including interest payment) using both Single Equation Philips-Ouliaris and Granger 2-Step cointegration methods.

Table 4: Bivariate Linear ARDL Estimates for Primary Balance (1990Q1-2013Q2)

Dependent Variable: $PRIMBG_t$				
Variable	Coefficient	Std.Error	t-statistic	Prob.
C	-0.755	0.254	-2.972	0.004
$PUBDG_{t-1}$	0.012	0.003	3.688	0.000
$\Delta PUBDG_{t-1}$	0.003	0.008	0.419	0.677
$PRIMBG_{t-1}$	0.241	0.102	2.366	0.020
Adjusted R^2		0.26		
F-statistic		12.16		
DW stat		2.02		

Table 5: Cointegration Test Results for Revenue and Expenditure (1990Q1-2013Q2

Single Equation Philips-Ouliaris Cointegration				
Dependent	tau-statistic	Prob.	z-statistic	Prob.
$LDREV_t$	-7.073	0.000	-70.408	0.000
$LTEXP_t$	-7.063	0.000	-70.110	0.000
Granger 2-Step Method (G2SM)				
1st Step (Long Run Equation)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004	0.054	-0188	0.852
$LTEXP_t$	0.953	0.009	100.791	0.000
2nd Step (Long Run Equation)				
C	0.016	0.008	2.109	0.038
$\Delta LTEXP_t$	0.484	0.088	5.511	0.000
ECM_{t-1}	-0.569	0.091	-6.250	0.000
Wald Restriction Test				
Null Hypothesis: $\beta=1$				
Test Statistic		Value	df	Prob.
t-statistic		-5.01	92	0.000
F-statistic		25.05	(1,92)	0.000
Chi-square		25.05	1	0.000
Null Hypothesis Summary:				
Normalized restriction (= 0)			Value	Std. Err.
$-1 + \beta$			-0.0473	0.0095

The results from ARDL, Philips-Ouliaris cointegration and G2SM models demonstrate that Ghana's fiscal policy was generally sustainable for the period 1990Q1-2013Q2. In particular, as exhibited in table 5, Philips-Ouliaris cointegration test establishes a stable long run bi-directional relationship between government revenue and expenditure for the sample period, consistent with Doh-Nani (2011) and Oshikoya et al (2010). Results from the Granger 2-Step method[15] also corroborate with that of Philips-Ouliaris cointegration test, as the adjustment coefficient (ECM_{t-1}) was negative, significant and less than one. In term of magnitude, the results from Granger 2-Step method suggest that a 1% increase in government expenditure leads to 95% increase in revenue in the long run. The response rate of revenue to changes in expenditure is high because annual expenditure projections are closely dependent on revenues expected to be collected by Ghana Revenue Authority (GRA) for the period. However, the Wald restriction test (in the lower panel of Table 5) for the null of $\beta=1$ was rejected at 99% confidence level, suggesting that Ghana's fiscal policy was weakly sustainable for the sample period.

15 - Log of government revenue is the independent variable.

Notwithstanding, the bivariate linear cointegration analysis (especially, the ARDL and G2SM) suffers from mis-specification error as demonstrated by the BDS[16] test for independence and identical distribution (iid) of the respective residual terms in Table 6. The upper panel (UP) of Table 6 displays BDS test results on residuals generated from the ARDL model for primary balance, while the lower panel (LP) shows BDS test on residuals generated from G2SM model for government revenue.

Table 6: BDS Test for Nonlinearity

BDS Test on Residuals from Primary Balance Equation (ARDL)				
Dimension	BDS Statistic	Std. Error	z-statistic	Prob.
2	0.001	0.008	0.141	0.888
3	0.008	0.009	0.919	0.358
4	0.009	0.008	1.260	0.208
5	0.011	0.006	2.006	0.045
6	0.011	0.004	2.678	0.007
BDS Test on Residuals from Revenue Equation (G2SM)				
Dimension	BDS Statistic	Std. Error	z-statistic	Prob.
2	0.020	0.008	2.586	0.010
3	0.029	0.012	2.363	0.018
4	0.040	0.015	2.760	0.006
5	0.046	0.015	3.044	0.002
6	0.037	0.015	2.508	0.012

While the BDS test on ARDL residuals rejects the null hypothesis of iid at the 5th and 6th correlation dimensions (at least 5% alpha level), the test on G2SM residuals also rejects the null hypothesis in all the six correlation dimensions. This implies that the models were mis-specified and possibly omitted a nonlinear structure. It is noteworthy to emphasize that the BDS test also corroborates with the preceding kernel density fit (figure 2 in section 4.1). This underpins the use of non-parametric techniques in the subsequent section to appraise the extent to which Ghana's fiscal authority reacts to rising public debt.

4.3 Estimation of Fiscal Policy Reaction Function

In view of the BDS test results, the paper proceeds to estimate Ghana's fiscal policy reaction function using a number of non-linear econometric techniques. First and foremost, Table 7 presents the results from two-state Markov Regime Switching Models (MRSM). As shown in

16 - BDS Independent test was developed by Brock, Dechert and Scheinkman (1987). The BDS test is designed to test for the null hypothesis of independent and identical distribution (iid) of the residuals for the purpose of detecting non-random "chaotic" dynamics. In this case, time series is said to be "chaotic" if it follows a nonlinear deterministic process but looks random. If the null hypothesis cannot be rejected, then the original linear model cannot be rejected. However, if the null hypothesis is rejected, the fitted linear model is mis-specified and hence, warranting the use of nonlinear models.

table 7, the inclusion of the quadratic term improved the model by slightly minimizing the sum of squares residuals and also maximizing the log-likelihood. This confirms the non-linearity between primary balance and public debt.

The coefficient of previous year's public debt was positive but statistically insignificant for the full sample. This suggests a generally weak fiscal response to debt accumulation. In addition, the magnitude of lagged public debt is generally low (far away from one), reinforcing a weak fiscal adjustment to commensurate the rapid debt build up. On the other hand, primary balance is linked positively to its previous development with a higher magnitude (averaging in the neighborhood of 0.41). This implies that not only do the fiscal policy-makers analyze the evolution of previous primary balance within the decision-making process; the magnitude of lagged primary balance parameter also shows a substantial inertia in Ghana's fiscal behaviour.

Table 7: Non-Linear Markov Switching Results for the Full Sample

Dependent variable: $PRIMBG_t$	Full Sample			
	MRSM 1		MRSM 2	
	Regime 1	Regime 2	Regime 1	Regime 2
Transition Probabilities	0.6042	0.3957	0.4616	04.4329
Expected Duration	2.32	1.65	1.86	1.76
C	0.3523	-2.4158	-2.2228	0.6549
	[0.3512]	[0.0000]*	[0.0000]*	[0.2010]
$PUBDG_{t-1}$	***0.0049***	***0.0039***	***0.0140***	***0.0041***
	[0.2588]	***[0.5119]***	***[0.0205]****	***[0.3166]***
$\Delta PUBDG_t$	***-0.0101***	***-0.0129***	***-0.0083***	***0.0088***
	[0.2803]	***[0.2439]***	***[0.3807]***	***[0.6094]***
$GVAR_t$	-0.4501	-0.6197	-0.6320	-0.2704
	[0.0128]**	[0.0000]*	[0.0000]*	[0.2814]
$\Delta YGDP_{t-1}$	0.0151	0.0114	0.0128	0.0133
	[0.0022]*	[0.1196]	[0.0705]***	[0.0109]**
$INTRATE_{t-1}$	-0.0095	0.0637	0.0386	-0.0114
	[0.3937]	[0.0087]*	[0.0201]**	[0.4064]
$PRIMBG_{t-1}$	0.2682	0.6107	0.5121	0.2354
	[0.0181]**	[0.0000]*	[0.0003]*	[0.0474]**
$\Delta DREVG_t$	0.1878	0.5641	0.5535	0.0840
	[0.1528]	[0.0000]*	[0.0000]*	[0.5381]
$(d_{t-1} - \mu^d)^2$			-0.0001	-0.0001
			[0.0731]***	[0.2813]
Log (δ)	-0.6827		-0.7046	
	[0.0000]*		[0.0000]*	

Sum of Squares Residuals	***64.93***	***62.54***
Log-Likelihood	***-94.74***	***-93.08***
Normality Test	***[0.7905]***	***[0.6632]***

Note: *, ** & *** denote 1%, 5% & 10% significant level respectively.

For robustness, Table 8 presents the results from the Markov regime switching estimation for the sub-periods 1990Q1-2000Q4 and 2001Q1-2013Q2. Similarly, the estimates for the period 1990Q1-2000Q4 show that fiscal policy could somewhat satisfy the sustainability condition as the coefficient estimates of lagged and contemporaneous change in public debt (see MRSM 3) assumed significant positive and negative values respectively. Although fiscal policy appears to be sustainable, the net effect of the coefficient estimates is still negative. Besides, the adjustment coefficient is very low, averaging 0.01% of GDP for a 1% growth in public debt to GDP ratio. This indicates that considerable fiscal pressures persisted between 1990 and 2000.

The fiscal situation however improved remarkably since 2001, satisfying the sustainability condition, as the coefficients of public debt are all positive and statistically significant (in MRSM 5 & 6). At the same time, the magnitude of fiscal response to debt build-up during the period remains very low, averaging at 0.025% of GDP for a 1% growth in debt to GDP ratio, implying some lingering fiscal pressures.

Table 8: Non-Linear Markov Switching Results for Sub-Periods

Dependent variable: PRIMBG	Sub Period: 1990Q1 - 2000Q4				Sub Period: 2001Q1 - 2013Q2			
	MRSM 3		MRSM 4		MRSM 5		MRSM 6	
	Régime 1	Régime 2	Régime 1	Régime 2	Régime 1	Régime 2	Régime 1	Régime 2
Transition Probability	0.4926	0.5445	0.6882	0.6221	0.8096	0.8384	1.83E-10	0.4353
Expected Duration	1.97	2.20	3.21	2.65	5.25	6.19	1.00	1.77
C	-1.6676	-0.0189	-0.2953	-1.8749	-2.8921	0.0319	-1.8951	0.4044
	[0.0000]*	[0.9587]	[0.3060]	[0.0368]**	[0.0000]*	[0.9462]	[0.0001]*	[0.3730]
$PUBDG_{t-1}$	***0.0080***	***0.0230***	***-0.0025***	***0.0160***	***0.0304***	***0.0290***	***0.0215***	***0.0181***
	[0.0196]*	***[0.0000]****	***[0.6101]***	***[0.0685]******	***[0.0000]****	***[0.0000]****	***[0.0009]****	***[0.0070]****
$\Delta PUBDG_t$	***-0.0189***	***-0.0245***	***-0.0368***	***0.0188***	***0.0140***	***0.0872***	***0.0138***	***0.1195***
	[0.0431]***	***[0.0013]****	***[0.0051]****	***[0.0545]******	***[0.3340]***	***[0.0005]****	***[0.3469]***	***[0.0000]****
$GVAR_t$	-0.8336	0.1956	-0.6272	-0.3888	-0.2026	-0.6960	-0.5220	-0.9409
	[0.0000]*	[0.1143]	[0.0000]*	[0.0004]*	[0.3996]	[0.0000]*	[0.0028]*	[0.0000]*
$\Delta YGDP_{t-1}$	0.0192	0.0019	0.0107	0.0154	-0.0091	-0.0032	0.0165	0.0086
	[0.0000]*	[0.7027]	[0.0022]*	[0.0078]*	[0.3994]	[0.6459]	[0.1460]	[0.4181]
$INTRATE_t$					-0.0141	-0.0614	0.0331	-0.0133
					[0.6373]	[0.0162]**	[0.1685]	[0.6034]

$INTRATE_{t-1}$	0.0364	-0.0362	0.0123	0.0349				
	[0.0043]*	[0.0001]*	[0.1071]	[0.0009]*				
$PRIMBG_{t-1}$	0.2402	0.3050	0.3082	0.2815	-0.0317	-0.1871	0.4088	0.2050
	[0.0168]**	[0.0001]*	[0.0000]*	[0.0050]*	[0.8412]	[0.1430]	[0.0194]**	[0.0967]***
$\Delta DREVG_t$	0.6179	0.2532	0.8026	0.1361	0.3054	0.1004	-0.1049	-0.0087
	[0.0000]*	[0.0004]*	[0.0000]*	[0.1391]	[0.1890]	[0.4188]	[0.4489]	[0.9552]
$(d_{t-1} - \mu^d)^2$			0.0001	-0.0002			-0.0004	-0.0004
			[0.0198]**	[0.0009]*			[0.0081]*	[0.0012]*
Log (δ)	-1.6361		-1.7643		-0.7205		-0.6294	
	[0.0000]*		[0.0000]*		[0.0000]*		[0.0000]*	
Sum of Squares Residuals	15.57		12.29		49.89		47.95	
Log-Likelihood	-12.26		-6.01		-54.50		-55.60	
Normality Test	[0.0001]*		[0.7837]		[0.1718]		[0.2294]	

Note: *, ** & *** denote 1%, 5% & 10% significant level respectively.

Source: Author's construct

The inconclusive results from the Markov switching models, even from the sub-samples analysis, suggest that there could be more than two structural breaks (regimes) in the times series. To obtain more reliable and robust estimates, the study further applied Least Squares with Breakpoints (LSB) method. The LSB used Bai-Perron (1998 & 2003) tests with globally optimizing and sequentially determined breaks. The term "break" in this study is defined as the first date of subsequent regime. The LSB model allowed for a maximum of 5 breaks at 95% confidence interval with a trimming percentage of 15 (minimum sample size for estimating a break). Unlike the Bai-Perron (1998) test which used common error distribution, this study allowed the error distribution to differ across breaks[17]. The rationale for allowing heterogeneous error distribution is to pin down the exact periods of stability or otherwise of fiscal policy in Ghana. This is also deemed very critical as it would enable the determination of fiscal sustainability for the immediate past policy, preferably, since 2006. Table 9 presents the results of the Bai-Perron (1998 & 2003) test for the period 1990Q1-2013Q2 that compares the scaled F-statistics to the Bai-Perron (2003) critical values. The test identified four breakpoints as it could not reject the null hypothesis of 4 breaks versus 5 breaks. The four (4) breaks identified were 1994Q1, 1999Q3, 2005Q4 and 2009Q1.

17 - Selecting this option will provide robustness of the test to error distribution variation at the cost of power if the error distributions are the same across regimes (Bai-Perron, 2003). However, the estimated model was robust as it minimized the residual sum of squares and optimized the log-likelihood when compared to the model that assumed common error distribution. The standard errors and covariance matrix computed by heteroskedasticity and autocorrelation consistent (HAC) estimation using Bartlett kernel and Newey-West fixed bandwidth. That is, the estimation allows for serial correlation that differs across regimes through the use of HAC covariance estimation.

Table 9: Results of Bai-Perron test for B+1 versus B sequentially determined breaks

Maximum number of breaks: 5 Breakpoint variables: C D(PUBDG(-1)) PUBDG(-1) D(PUBDG) HYVAR D(HYGDP) PRIMBG(-1)			
Sequential F-statistic determined breaks:		4	
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	12.66818	88.67728	21.87
1 vs. 2 *	8.938084	62.56659	24.17
2 vs. 3 *	8.349990	58.44993	25.13
3 vs. 4 *	0.000000	0.000000	26.65
*Significant at the 0.05 level. ** Bai-Perron (Econometric Journal, 2003) critical values. Break dates:			
	Sequential	Repartition	
1	2005Q4	1994Q2	
2	1994Q1	1999Q3	
3	1999Q3	2005Q4	
4	2009Q1	2009Q1	

The four detected breakpoints in turn yield five subsample estimation results and this is reported in Table 10. The LSB model satisfied all the diagnostic tests including normal distribution, autocorrelation and heteroskedasticity assumptions, while the residuals lay within 95% confidence interval of Cusum and Cusum of squares tests[18].

Ghana's fiscal profile was generally stable (sustainable) for the period 1990Q1-1994Q1 as all the coefficients of public debt to GDP ratio (difference terms) were positive and statistically significant. Besides, the magnitude of the contemporaneous fiscal response to the public debt build-up was relatively higher to ensure stable fiscal profile. The relative stability during this period could be attributed to the prudent fiscal policy measures under the implementation of both ERP and SAP which facilitated continuous budget surpluses between 1986 and 1991. Nevertheless, some lingering pressures were still apparent during the early 1990s as the lagged coefficient was negative and significant, which could be linked to the large budget deficit recorded during the 1992 presidential and parliamentary elections.

18 - Ramsey Reset test did not apply as it requires homogeneous error distribution.

Table 10: Estimation Results from Least Square with Breakpoints

Dependent Variable: $PRIMBG_t$			
	Coefficient	**T-Statistic**	**Probability**
1990Q3-1994Q1			
C	0.730	1.247	0.218
$PUBDG_{t-1}$	0.029	2.689	0.009*
$PUBDG_t$	-0.016	-2.066	0.043**
$\Delta PUBDG_t$	0.055	2.515	0.014**
$HYVAR_t$	-0.950	-4.120	0.000*
$\Delta HYGDP_t$	-0.002	-0.431	0.668
$PRIMBG_{t-1}$	-0.193	-1.642	0.106
1994Q2-1999Q2			
C	-1.490	-0.652	0.517
$PUBDG_{t-1}$	0.013	0.854	0.397
$PUBDG_t$	0.027	1.114	0.270
$\Delta PUBDG_t$	0.022	1.046	0.300
$HYVAR_t$	0.117	0.532	0.597
$\Delta HYGDP_t$	-0.007	-0.785	0.436
$PRIMBG_{t-1}$	-0.141	-0.660	0.512
1999Q3-2005Q3			
C	-0.244	-0.554	0.582
$PUBDG_{t-1}$	-0.006	-1.114	0.270
$PUBDG_t$	0.008	2.331	0.023**
$\Delta PUBDG_t$	0.006	0.831	0.410
$HYVAR_t$	-0.163	-2.020	0.048**
$\Delta HYGDP_t$	0.004	0.893	0.375
$PRIMBG_{t-1}$	-0.289	-1.607	0.114
2005Q4-2008Q4			
C	-4.301	-5.863	0.000*
$PUBDG_{t-1}$	0.025	0.555	0.581
$PUBDG_t$	0.080	4.208	0.000*
$\Delta PUBDG_t$	0.100	1.709	0.092***
$HYVAR_t$	-0.615	-1.087	0.282
$\Delta HYGDP_t$	0.014	0.771	0.444
$PRIMBG_{t-1}$	-0.107	-0.559	0.579

2009Q1-2013Q2			
C	-1.279	-1.185	0.241
$PUBDG_{t-1}$	0.000	-0.006	0.996
$PUBDG_{t}$	0.035	1.215	0.230
$\Delta PUBDG_{t}$	0.064	0.959	0.342
$HYVAR_{t}$	-0.690	-2.902	0.005*
$\Delta HYGDP_{t}$	-0.020	-2.773	0.008*
$PRIMBG_{t-1}$	0.037	0.234	0.816
R2	0.763	Log likelihood	-77.584
Adjusted R2	0.621	F-statistic	5.394
S. E. of regression	0.714	Prob(F-statistic)	0.000*
Sum squared resid	29.094	Durbin-watson	2.092

Note: *, ** & *** denote 1%, 5% & 10% significant level respectively.

Considerable fiscal pressures subsequently ensued during the fiscal period 1994Q2-1999Q2. This is based on the fact that though all the coefficients of public debt to GDP ratio were positive, they were statistically not different from zero. This suggests inadequate fiscal adjustment to contain the debt accumulation during the mid-to-late 1990s.

The fiscal profile however improved during the period 1999Q3-2005Q3 as the level coefficient of previous lagged public debt to GDP ratio assumed a significant positive value. This is not surprising as the debt trajectory reversed downwards from its peak in 2000 following multilateral debt relief under the HIPC initiative. The improvement in the fiscal profile further strengthened during the period 2005Q4-2008Q4. In this regime, the coefficients of both previous lagged (level) and contemporaneous term of public debt to GDP ratios are both positive and statistically different from zero. In addition, the regime recorded the highest positive magnitudes of fiscal adjustments of 0.08% and 0.09% of GDP respectively to a percentage increase in the public debt to GDP ratio.

Nevertheless, the fiscal situation seems to have relapsed since 2009 as the coefficients of public debt to GDP ratios are statistically insignificant during the period 2009Q1-2013Q2. This suggests that the fiscal adjustments in recent years do not commensurate with the rate of public debt accumulation. This may be attributed to the post-election fiscal consolidation (2008) which led to subdued economic growth, implementation of single spine salary structure (SSSS) since 2010 and expenditures related to parliamentary and presidential elections in 2012. It is noteworthy to emphasize that a deviation of the current fiscal profile from its sustainable path warrants a drastic change in policy direction to guarantee long term fiscal sustainability and hence, enhance investors' confidence in the economy.

For plausibility, the study further examines the long run tax policy reaction function using the most recent data, following both Trehan et al (1991)[19] and Davig et al (2006) to explore the long run relationship between tax revenue (instead of primary balance) and the state of government expenditure or indebtedness. Consequently, the paper estimates a fiscal rule that links tax revenue ($taxrg_t$) to current government expenditure ($texpg_t$), lagged public debt (d_{t-1}) and output gap ($ygap_t$)[20] using Markov Regime Switching regression.

Table 11 shows the estimates of the Markov Regime Switching regression for the period 2006Q1-2013Q2. The model specification was satisfied as the constant terms in both regimes were found to be positive and statistically different from zero (significant). In addition, the coefficient of the error (σ) was also significant, lending support to different fiscal policy regimes. The inclusion of terms of trade shock[21] in Model 8 to control for the effect of external shocks to fiscal (tax) policy improved the model fit, but it did not change the result. As exhibited in Table 11, the two fiscal states reaffirmed the earlier results.

The long run response of tax revenue to current government expenditure is positive, suggesting an active fiscal policy. The results suggest that a 1% increase in government spending leads to an approximately 0.3% growth in tax revenue. However, the long run response of tax revenue to public debt is negative, indicating that a percentage increase in previous debt causes a reduction in tax revenue by approximately 0.03% in the long run. The result thus reinforces that government effort at ensuring long term fiscal sustainability seems inadequate in the recent years (since 2006) as the tax revenues appear to be insufficient to cover for total government indebtedness.

19 - According to Trehan et al (1991), fiscal policy is deemed to be stable and sound (sustainable) if a positive long run relationship is established between tax revenue and the state of government expenditure or indebtedness.

20 - The fiscal rule is thus modeled by allowing the recent tax policy regime to obey a Markov chain with the specification (equation 10); $taxrg_t = \alpha(S_t) + \beta(S_t)\, d_{t-1} + \theta(S_t)\, texpg_{t-1} + \vartheta(S_t)\, ygap_t + \sigma(S_t)\, \mu_t$ Where S_t is the fiscal (tax) policy regime, which obey a Markov chain with transition matrix P^F, for two fiscal states, and $\mu_t N(0, \delta^2)$. Likewise, this equation allows for heteroskedastic errors as emphasized by Sims and Zha (2006).

21 - The inclusion of term of trade shock improved the model fit as both the residuals sum of squares and the log-likelihood were optimized, compared with that of model 7.

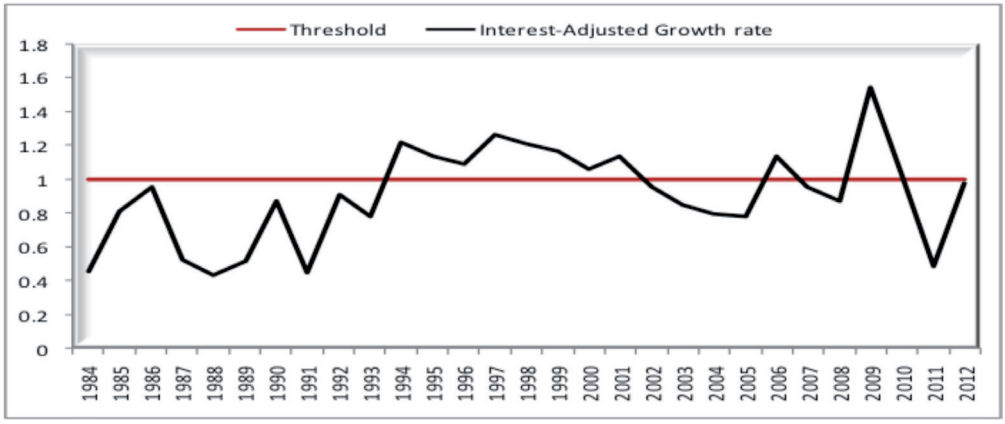
Table 11: Markov Regime Switching Result for Recent Tax Policy (2006Q1-2013Q2)

Dependent variable:	Model 7		Model 8	
$TAXRG_t$	Regime 1	Regime 2	Regime 1	Regime 2
Transition Probabilities	0.9688	0.9570	0.9569	0.9682
Expected Duration	32.079	23.270	23.212	31.424
C	2.4822	4.0107	2.8044	2.6273
	[0.0093]*	[0.0034]*	[0.0131]**	[0.0006]*
$TEXPG_t$	0.2039	0.3895	0.3925	0.1830
	[0.1042]	[0.0037]*	[0.0002]*	[0.0714]***
$PUBDG_{t-1}$	-0.0103	-0.0594	-0.0311	0.0113
	[0.2236]	[0.0689]***	[0.2683]	[0.0984]***
$YGAP_t$	4.2307	1.2108	3.0691	3.8993
	[0.0949]***	[0.7296]	[0.2845]	[0.521]***
SD_TOT_t			1.424617	-0583661
			[0.0024]*	[0.1307]
Log (δ)	-1.2211		-1.4934	
	[0.0000]*		[0.0000]*	
Sum of Squares Residuals	4.3473		2.5116	
Log-Likelihood	-10.2377		-2.4381	
Normality Test	[0.4994]		[0.7091]	

Note: *, ** & *** denote 1%, 5% & 10% significant level respectively.

Since the above deliberations are based on the premise of "no Ponzi game" such that interest rate exceeds the growth rate, the paper subsequently evaluated the debt dynamics of Ghana's fiscal profile by investigating the trend in interest-adjusted growth over the years. This analysis is based on the fact that Ghana is among the fastest growing economies in Sub-Saharan African (SSA), thanks to the nascent oil and gas industry since 2011. It is thus very crucial to explore how interest rate and growth compare over the year to help proffer policy suggestions that would engender stability in Ghana's fiscal profile. In this regard, if interest-adjusted growth rate is negative ($r_t < g_t$) or $\varphi_t=(1+r_t)/(1+g_t) < 1$, then the debt converges (or is sustainable). On the contrary, the debt explodes (or is unsustainable), if interest-adjusted growth rate is positive ($r_t > g_t$) or $\varphi_t=(1+r_t)/(1+g_t) > 1$. Figure 3 displays the debt dynamics of Ghana's fiscal policy for almost three decades (1984-2012) using effective interest rate and real GDP growth.

Figure 3: Trends in Interest-Adjusted Growth Rates



Source: Author's Own Construct

The black line denotes debt dynamics (interest-adjusted growth rate), while the red line indicates the threshold level. Points below the threshold line suggest that public debt is sustainable, while points above the threshold line suggest that public debt is unsustainable.

The evolution of interest-adjusted growth rate in Figure 3 is consistent with the results of the preceding LSB model and the findings of Asiama et al (2014). The dynamics of interest-adjusted growth rate suggests that fiscal prudence in the late 1980s and early 1990s on the back of ERP and SAP helped to avert public debt explosion. This was also boosted by the real GDP growth of 5.2% per year between 1984 and 1993.

The debt level however became unsustainable in the late 1990s and early 2000 as the interest-adjusted growth rate exceeds the threshold, corroborating with the findings from OLS with breakpoints method. It is important to note that the deterioration in the fiscal profile during the period 1994-2001 may be attributable to expenditure excesses related to the election cycles in 1996 and 2000. This reflected an average overall budget deficit of 6.5% of GDP per year between 1996 and 2000, accompanied by an astronomical increase in external borrowings, relatively higher inflation rate (averaging 31% per annum), and a relatively lower GDP growth of 4.2% per year. The debt dynamics subsequently improved between 2002 and 2005, underscored by the adoption of HIPC initiatives and its associated multilateral debt relief, and a relatively higher average real GDP growth of 5.3% per annum. Despite the external debt forgiveness by donor agencies, the debt dynamics surprisingly worsened in 2006, largely driven by a 13.2% increase in total interest payments. The rise in interest payments may be attributable to a 64.5% growth in domestic debt which almost countered the 67.7% decline in external debt.

The debt dynamics improved between 2007 and 2008 but worsened thereafter in 2009, following the post-election fiscal consolidation which led to a subdued real GDP growth of 4.0% in 2009. Boosted by strong economic growth rates of 8.0% and 15.0% in 2010 and 2012 respectively,

the fiscal profile improved significantly during the period. The unprecedented growth in 2011 was mainly due to the commencement of crude oil production and export. Nevertheless, the remarkable improvement in the fiscal profile during 2010-2011 was ephemeral as significant fiscal pressures resurfaced in 2012, underpinned by excessive fiscal slippages which are usually associated with election cycles in Ghana. Overall budget deficit rocketed to 12.1% of GDP in 2012 from a deficit of 4.3% in 2011. Financing of the deficit reflected an increase of 56.5% in domestic debt stock between 2011 and 2012, thus, contributing to a rise in effective interest rate in 2012.

In general, even though Ghana's public finance is consistent with the intertemporal budget constraints for the sample period; the sustainability is weak due to lingering fiscal pressures often exacerbated by election cycles.

6. Conclusion and Policy Recommendation

The study assesses the sustainability of the past behaviour of Ghana's public finance using three complementary approaches including: (i) the data generating processes of debt and primary balance using unit root tests; (ii) empirical estimation of the fiscal policy reaction function using non-parametric techniques; and (iii) examining the historical trends of interest-adjusted growth rates over the last three decades. The analysis of Ghana's fiscal profile reveals that the reaction of fiscal authorities to the pace of debt accumulation has been inadequate, most especially in the late-1990s to early 2000s. Although, the fiscal sustainability profile improved considerably between 2002 and 2008, underscored by the HIPC initiatives and its accompanied multilateral debt relief, significant fiscal pressures remain prevalent since 2009. The paper thus accentuates a general weakness in Ghana's public finance in recent times, underpinned by the fiscal profligacy during election cycles. In addition, a significant negative coefficient of the quadratic term of public debt also lends support to the existence of a deterministic threshold level of debt GDP ratio (non-linear relation) for Ghana.

In synthesis, the study establishes that Ghana's fiscal policy is weakly sustainable for the sample period, consistent with the findings of Oshiyoka et al (2010), Kwakye (2012), Mohammed (2014) and Asiama et al (2014). The policy implication is that government should keep the budget deficits under control by rationalizing expenditures and enhancing tax revenue mobilization efforts, while reducing debt financing of the budget deficit.

References

Akosah, N. K. 2013. *Dynamics of Ghana's Twin Deficits: Causality, Transmission Channels and Potential Threats*. Public Economics eJournal, Vol. 8, No. 30.

Asiama, J., Akosah, N. K., and Owusu-Afriyie, E. 2014. *An assessment of fiscal sustainability in Ghana*. Bank of Ghana Staff Working Papers, WP/BOG-2014/09, pp. 1-32.

Alfonso, A., and Jalles, J. T. 2011. *Appraising fiscal reaction functions*. Technical University of Lisbon, Working Paper 23.

Barro, R., 1979. *On the determination of public debt*. Journal of Political Economy, Vol. 87, No. 5, p. 940-971.

Bohn, H., 1998. *The behaviour of US public debt*. Quarterly Journal of Economics, Vol. 113, No. 3, p. 949-63.

Burger, P., Stuart, I., Jooste, C. and Cuevas, A. 2011. *Fiscal sustainability and fiscal reaction function for South Africa*. International Monetary Fund (IMF) Working Paper 11/69, p. 1-27.

Cuddington, J. T., 1996. *Analyzing the sustainability of fiscal deficits in developing countries.* Georgetown University, Working Paper 97/01.

De Mello, L. 2005. *Estimating a fiscal reaction: the case of sustainability in Brazil. OECD Economic Department Working Paper No. 423. OECD*, Paris.

Doh-Nani, R. 2011. *Is Ghana's budget sustainable? A cointegration analysis*. As a partial fulfillment of the requirement of the award of master in Economics, Kwame Nkrumah University of Science and technology, Faculty of Social Sciences.

Doi, T., Hoshi, T. and Okimoto, T. 2011. *Japanese government debt and sustainability of fiscal policy*. National Bureau of Economic Research (NBER) Working Paper, No. 17305, p. 1-59.

Davig, T. and Leeper, E. M. 2007. *Fluctuating macro policies and the fiscal theory*. NBER Macroeconomics Annual 2006, vol. 21, chapter. 4, p. 247-315.

Den Haan, W. J. 2011. *Impulse Response Function*. University of Amsterdam.

Escalano, J. 2010. *A practical guide to public debt dynamics, fiscal sustainability and cyclical adjustment of budgetary aggregates: Technical notes and manuals*. International Monetary Fund, p. 1-25.

Hall, R. E. 2013. *Fiscal stability of high-debt nations and under volatile economic conditions*. NBER Working Paper, No. 18797, p. 1-24.

Hamilton, D. J. and Flavin, M. A. 1986. *On the limitations of government borrowing: a framework for empirical testing*. The American Economic Review, Vol. 76, No. 4, p. 808-819.

Jonas, J. 2010. *Fiscal objectives in the post IMF programme world: in the case of Albania*. IMF Working Paper, WP/10/77.

Khalid, M., Malik, W, Sh., and Sattar, W. A. 2007. *The fiscal reaction function and the transmission mechanism in Pakistan*. The Pakistan Development Review, vol. 46: part 11 (Winter 2007), p. 435-447.

Kwakye, J. K. 2012. *Ghana's debt profile and sustainability*. Institute of Economic Affairs, Monograph, No. 34, pp. 1-34.

Kwon, G., McFarlane, L. and Robinson, W. 2006. *Public debt, money supply and inflation: A cross-country study and its application to Jamaica*. IMF Working Paper 06/121, p. 1-32.

Lamé, G., Lequien, M. and Pionnier, P. A. 2012. *Interpretation and limits of sustainability tests in public finance*.

Mohammed, A. H. 2014. *Fiscal policy framework in West Africa Monetary Zone (WAMZ): the matter of debt sustainability*. International Journal of Economics and Finance, Vol. 6, No. 11, pp. 60-71.

Ndoricimpa, A. 2014. *Structural Breaks and fiscal deficit sustainability in EAC countries: empirical evidence*. International Journal of Economics, Finance and Management Sciences, Vol. 1, No. 6, pp. 391-399.

Nguyen, T. 2013. *Estimating India's fiscal reaction function. ASARC Working paper 2013/05*, p. 1-33.

Oshikoya, T. W. and Tarawalie, A. B. 2010. Sustainability of fiscal policy: The West African Monetary Zone (WAMZ) experience. Journal of Monetary and economic Integration, Vol. 9, No. 2, pp. 1-29.

Oyeleke, O. J and Ajilore, O. T. 2014. Analysis of fiscal deficit sustainability in Nigerian Economy: An error correction approach. Asian Economic and Financial Review, vol. 4, No. 2, pp. 199-210.

Shijaku, G. 2012. *Sustainability of fiscal policy: the case of Albania*. Bank of Albania Working Paper, p. 5-33.

Trehan, B. and Walsh, C. 1991. *Testing intertemporal budget constraints: theory and application of US federal budget and current account deficits. Journal of Money, Credit and Banking, Vol. 23, p. 210-223*.

Turrini, A., 2008. Fiscal policy and cycle in the euro area: the role of government revenue and expenditure. Economic and Financial Affairs, Directorate-General.

Uctum, M., Thurston, T. and Uctum, R., 2006. *Public debt, the unit root hypothesis and structural breaks: a multi-country analysis*. Economica, No. 73, p. 129-156.

Ministry of Finance, 2013. *The Budget Statement and Economic Policy of the Government of Ghana for the 2014 Financial Year, November, (2013)*.

Monetary Policy Under Uncertainty in WAEMU Countries: Evidence From a DSGE Model

by

*N'Yilimon NANTOB**

Abstract

This paper uses a DSGE model to investigate the design of monetary policy when the central bank faces uncertainty regarding the true structure of the economy. Mobilizing available data of WAEMU over the period 1975:1 through 2010:2 and applying Bayesian method to estimate parameters of the model, the econometric results yield that (i) under commitment on a policy rule or a simple rule, optimal responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following shocks of preference, rental prices of capital, technology, prices mark-up, wages mark-up, labor supply and inflation objective are relatively flat under uncertainty and optimal policies are relatively aggressive, (ii) furthermore, under the same optimal monetary regimes, optimal responses of the same variables following now shocks of investment, wages mark-up and government expenditure are relatively persistent under parameter uncertainty and optimal policies are relatively cautious.

Key Words: Policy of Ramsey, Simple rules, Model uncertainty, Bayesian method, WAEMU.

JEL Classification: C11, C22, E31, E52, E61, E63

* N'Yilimon Nantob is at the University of Lome. Emai: nyilimon@yahoo.fr.

1. Introduction

Central bankers have to make decisions in a world of pervasive uncertainty[22]. Following Greenspan (2003), uncertainty is not just an important feature of the monetary policy landscape; it is the defining characteristic of that landscape. Thus, monetary policy is inevitably made in an environment of substantial uncertainty (Feldstein, 2003).

Uncertainty is one of the challenges most relevant to past, present and future central bankers and still not fully explored by the academic world (Issing, 2002). The first challenge that faces all central banks when preparing monetary policy decisions is to assess accurately the prevailing economic conditions, which are sometimes referred to as the state of the economy. In addition to, and intimately linked with, the uncertainty about the state of the economy, central banks also have limited knowledge about the structure and functioning of the economy. A third broad category of uncertainty facing central banks is sometimes referred to as strategic uncertainty. This form of uncertainty relates to the interaction between private agents and policymakers and, in particular, to the role of expectations.

In this study we investigate the design of monetary policy in West-African Economic and Monetary Union (WAEMU) when the central bank faces uncertainty regarding the true structure of the economy. Of course, a long-established literature (McCallum, 1988; Craine, 1979; Soderstrom, 2002; Rudebusch, 2001; Taylor, 1999; and Brock, Durlauf et *al.*, 2003)[23] has considered this topic using traditional structural macroeconomic models, building on the seminal work of Brainard (1967). Nevertheless, recent analysis of small stylized micro-founded models (Smets and Wouters, 2003; Christiano et *al.*, 2005; Levin et *al.*, 2005; etc.) has demonstrated that the implications of uncertainty can be markedly different when the policymaker's goal is to maximize household welfare, because the welfare function itself depends on the specification and parameter values of the model.

Uncertainty about the structure of the economy itself arises from two sources. First, there is fundamental uncertainty about which models provide suitable descriptions of the structural relationships in the economy. As a result, central banks cannot afford to rely on one single model of the economy, but need to have a number of alternative modelling tools available. For example, there is a widespread consensus that inflation is, as indicated by the quantitative theory of money, a monetary phenomenon in the long run. At the same time, there are a multiplicity of different approaches, such as Phillips curve models, to modelling the inflation process at short and medium-term horizons. Second, even if there were a consensus on a suitable model of the economy, considerable uncertainty would remain regarding the strength of the structural relationships, for example the value of parameters, within that particular model. Inevitably, available parameter estimates are affected by data imperfections and

22 - Knight (1921) emphasized the distinction between risk and uncertainty and argued that uncertainty is more common in economic decision-making. The risk corresponds to the situations in which the decision-makers can affect some probabilities to different events that they are susceptible to be confronted but the uncertainty is applied to the situations where this stochastic character cannot be translated in terms of probabilities.

23 - Robust control methods have also been used in investigating monetary policy under uncertainty; see Hansen and Sargent (2003), Onatski and Stock (2002), Onatski (2000), Giannoni (2002), and Tetlow and von zur Muehlen (2002).

by the particular econometric techniques that are employed for estimation. An even more fundamental problem is that parameters may vary over time as a result of structural change in the economy. Uncertainty about parameters confronts all central banks, but seems relevant for empirical models of the WAEMU countries, since their estimation has to rely on historical back data which were not always sufficiently harmonised because of the economic disparities of the member countries. Moreover, insofar as models are estimated for the WAEMU in his whole from the aggregates data on the member countries, going from an empirical analysis to the definition of structural connections can also give place to aggregated problems. These problems are due to aggregated methods of data on the member countries which cannot, in some case, be sufficiently harmonized, and to the aggregated structural connections themselves which can differ from one country to other and lead as this to complex relationship, possibly non linear, on the WAEMU scale. If data and their interpretation by central bankers are uncertain and variable, how should monetary policy respond to this form of uncertainty?

The WAEMU implements a common monetary policy for over forty years and the same instruments of monetary policy are applied in the member countries. The Central Bank of West-African States (CBWAS in French BCEAO[24]) opted since the late 80s for a policy of indirect monetary management with as operational instrument, interest rate (Tenou, 2002). Under these conditions, it is necessary to have rules which can act as the basic to the process of determination of short term interest rate level compatible with fundamental economic variables. The practices of monetary policy in the WAEMU are variable because of the economic disparities. The transmissions channels do not work in the same way from one country to another, as financial structures do not have the same level of development, the economies members depend on the export of a few primary products and these differ from one country to another.

Monetary policy conducted by the BCEAO suffers from a low efficiency, in the eyes of the absence of connections existing between the objective of fighting against inflation that WAEMU assigned him and the instruments (interest rate policy) available to it (Nubukpo, 2007). Thus, the author shows that some specificity of the WAEMU, in particular the strength of many uncertainties in the Union and the high extraversion which characterizes structure and functioning of its institutions are the bottom of this inefficiency. The monetary policy of the WAEMU has already known since his birth, four types of reform (*loan policy* from 1962 to 1972, *development and economies africanisation* from 1973 to 1988, *monetary plus liberal* from 1989 to 2007 and *maturity reform* from 2007). In addition, the Union is preparing himself to merge with other countries in West Africa in the context of Monetary Union of the Economic Community of West African States (ECOWAS). However, uncertainty is an essential and permanent feature of the real world and is found to be particularly the mark of the periods comprising important structural changes (Trichet, 2005).

To analyze the design of monetary policy in WAEMU when the central bank faces uncertainty regarding the true structure of the economy, we use Dynamic Stochastic General Equilibrium (DSGE) model which opened other tracks of study and research concerning monetary policy analysis. An example of this is the studies on how the policymakers incorporate uncertainty

24 - Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO).

into their decision making. Given the fact that the DSGE models are *"micro-founded"*, it seems convenient and realistic to examine the central bank behavior in such a setting: central bank can express their preferences through a criterion (maximization of a function of social welfare, etc…) as the other agents (Avouyi-Dovi et *al*, 2007). The central bank may then make, for example, the assumption that perception of the economy through the models can be erroneous and/or that the materialization of their preferences can also be a source of uncertainty. Then it is for the central bank to determine its optimal behavior taking into account the different types of uncertainty. According to the case, we may recommend a more aggressive policy or rather conservative. According to Avouyi-Dovi et *al* (2007), because DSGE are models offering a very coherent analytical framework and respectful of the critique of Lucas, they are a very natural candidate for the analysis of monetary policy in a world of uncertainty. Thus, the DSGE models are good tools to analyze the uncertainty about the structure of the economy. It is possible to introduce an uncertainty source at a given structural parameter or whether compare uncertainty related at the differences of the modeling block.

Of course, Diop (2011) had already used a DSGE model to forecast inflation at the medium term in WAEMU countries and Diop (2007) also had used a DSGE model to investigate the reaction of the Senegalese economy following the changes of the régime of change. Nevertheless, this is the first known attempt to use DSGE models in the WAEMU to investigate the design of monetary policy under uncertainty regarding the true structure of the economy. The aim of this paper is to analyze the responses of optimal monetary policy in WAEMU under commitment on a policy rule (Ramsey policy) or a simple rule, the both under certainty equivalent and parameter uncertainty.

The paper is organized as follow : section (2) is devoted to DSGE models section (3) presents the calibration of priors, section (4) data and model estimation, section (5) *posteriors*, section (6) optimal monetary policy and section (7) concludes.

2. Model

In this section, we develop a DSGE model similar to those of Christiano et *al* (2005) and Smets and Wouters (2003). The log-linearization of the model is described in the sub-section 2.5 of this paper.

The basic principle of DSGE models is that the modeling of economic activity, even at the scale of a large economic area as a country, should start with a series of microeconomics problems (at the level of individuals) who once resolved, are aggregated to form the macroeconomic reality described by the model. Therefore, a DSGE model consists first in a precise statement of the choices available to different economic actors (firms and households, governments and central bank) setting in the model, the preferences of these actors, the planning horizon which they hold, and finally specifying uncertainty with which they must deal.

Naturally, Keynesian modeling approach entails inconvenient. Without microeconomic foundations, normative analysis is impossible. More importantly, the fact to formulate directly macroeconomic relationships can lead to neglect some important effects and thus increases

uncertainty. Finally, the global relationship may change depending on the economy structure and economic policies. So working on aggregated relationships rather than microeconomic assumptions can distort the assessment of the economic policy changes consequences: this is essentially the critique of Lucas (1976) to traditional macroeconomic models. Basically, that is the reason for attraction to use DSGE model.

To arrive at a wise choice, economic agents must form an opinion on the likely path which the variables will take. These expectations are assumed *"rational"*.[25]

However, until very recently, the craze for DSGE approach as an analytical tool of economic policy has remained relatively low, and the Vector Autoregerssion (VAR) models approach was often preferred. Several reasons explain this preference. On the one hand, the VAR modeling of dynamics macroeconomic variables requires a very small number of constraints and offers a quality of adjustment to the data (and forecasts) relatively well. However, increasing the constraints number on the data and facing a misspecification risk, DSGE models of the first generation (models of real business cycle (RBC) theory) are resulted in the performance adjustment and very poor forecasts. On the other hand, emergence of a more structural approach of the VAR models (relative to *a-theoretical* approach, Sims (1980)) – allowing shocks identification procedures from contemporary restrictions of short-term (Sims (1986), Bernanke (1986)) or long-term (Blanchard and Quah (1986)) – led to require that any theoretical model can reproduce the response functions of macroeconomic variables to structural shocks identified in the VAR models (Rotemberg and Woodford, 1997, Christiano et al., 2005). Finally, the absence of a convincing econometric treatment has only strengthened the recommendation of Kydland and Prescott (1982) – calibration[26]– is preferable.

However, there has been a renewed interest to DSGE models and this is mainly due to two reasons: *(i)* the theoretical advanced and including notably microeconomic foundations of nominal rigidities and/or real *(ii)* the progress in the estimation and models evaluation based on formal statistical methods. In this perspective, the idea that such models are useful for prediction and analysis of economic policy is prevalent in academic world as well as through international institutions and central banks. Among all these econometric approaches, the literature favors for "good" and "bad" reasons, Bayesian statistics. Among the "good" reasons, we could highlight the fact that the likelihood function of a high dimension model (many parameters to be estimated) is often "flat" in some directions. In other words, the data may not be sufficiently informative to identify (accurately) the structural parameters. Deforming the likelihood function using prior information on the parameters, that is to say favoring a Bayesian approach, the identification becomes possible. It is nevertheless too often ignored that the implementation and interpretation of the Bayesian estimation results requires a number of assumptions and conditions of validity, or that many problems in classical econometrics have

25 - Technical term which expresses the idea that households are keen observers of the economic scene, which can certainly be surprised by unexpected events, but which, if any, will not be constantly amazed at these events recur with some regularity.

26 - The calibration is quite an art and not a technique. It is itself the first method used by economists to simulate DSGE models. Thus, this phase is an important step in DSGE modeling. It allows you to assign values to different parameters on preferences, technology, etc. To do this, some parameters are taken from literature and others are determined so that they reflect the economy studied at the steady state

their counterpart in the Bayesian econometrics. The fact is that Bayesian approach has greatly promoted development of DSGE models as a tool of analysis and forecasting monetary policy.

Sure enough, DSGE model is an application of the real business cycle (RBC) methodology to an economy with sticky prices and wages. The households maximize an utility function with three arguments (goods, money and leisure) at the infinite horizon. The consumption appears in the utility function relative to a time-varying external habit variable[27]. The labour is differentiated over households, so that there is some monopoly power over wages which results in an explicit wage equation and allows for the introduction of sticky nominal wages à la Calvo. The households allocate wealth among cash on the one hand and riskless bonds on the other hand. The households also rent capital services to firms and decide how much capital to accumulate given certain capital adjustment costs. As the rental price of capital goes up, the capital stock can be used more intensively according to some cost schedule[28]. The firms produce differentiated goods, decide on labour and capital inputs, and set prices, again according to the model of Calvo. The model of Calvo in both wage and price setting is augmented by the assumption that prices that cannot be freely set, are partially indexed to past inflation rates. The prices are therefore set in function of current and expected marginal costs, but are also determined by the past inflation rate. The marginal costs depend on wages and the rental rate of capital. In this Section we sketch out the main building blocks.

2.1 The household sector

We suppose that there is a continuum of households indexed by t. Sure enough, households differ in what they offer different kinds of labors. Thus, each household has a monopoly power beyond the offer of his labor. Each household t maximizes the intertemporal utility function given by:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} b^t U_t^t \tag{1}$$

where is a discount factor and instantaneous utility function depends on consumption, labor (leisure) and real money balances are given by:

$$U_t^t = e_t^B \left(\frac{1}{1- s_c} \left(C_t^t - H_t \right)^{1- s_c} - \frac{e_t^l}{1+ s_l} \left(l_t^t \right)^{1+ s_l} + \frac{e_t^M}{1- s_m} \left(\frac{M_t^t}{p_t} \right)^{1- s_m} \right) \tag{2}$$

In this equation (2), the utility function depends positively on the consumption of goods, C_t^t, relative to an external habit variable H_t, positively on real cash balances, $\frac{M_t^t}{p_t}$ and negatively on labor supply l_t^t . s_c is the coefficient of relative risk aversion of households or the inverse of the intertemporal elasticity of substitution, and s_m represents the inverse of the elasticity of money holdings with respect to the interest rate. This equation (2) also contains three

27 - The habit depends on aggregate delayed consumption is affected by any decision of the agents. The term used by Abel for such preferences is "Catching up with the Joneses", literally "catch (standard of living) of Dupont.
28 - See King and Rebelo (1999).

preference shocks: e_t^B represents a general shock to preferences which affect the intertemporal substitution of households (preference shock); e_t^l represents a shock to the labor supply and e_t^M is a money demand shock. Moreover, the external habit shock is assumed to be proportional to aggregate consumption of the previous period[29]:

$$H_t = hC_{t-1} \tag{3}$$

The households maximize their objective function subject to an intertemporal budget constraint which is given by:

$$\frac{M_t^t}{p_t} + b_t \frac{B_t^t}{p_t} = \frac{M_{t-1}^t}{p_t} + \frac{B_{t-1}^t}{p_t} + Y_t^t - C_t^t - I_t^t \tag{4}$$

The households hold their financial wealth in the form of cash balance and bonds M_t. Bonds are one period securities with price B_t. Current income and financial wealth can be used for consumption and investment in physical capital. The total income of household is given by:

$$Y_t^t = \left(w_t^t l_t^t + A_t^t\right) + \left(r_t^t z_t^t k_{t-1}^t - \Upsilon\left(z_t^t\right)k_{t-1}^t\right) + Div_t^t \tag{5}$$

Total income has three components: labor income plus the net cash flows from participating in state contingent security $\left(w_t^t l_t^t + A_t^t\right)$; the return on the real stock of capital minus the cost associated with variations in the degree of capital utilization $\left(r_t^t z_t^t k_{t-1}^t - \Upsilon\left(z_t^t\right)k_{t-1}^t\right)$ and the dividend derived from imperfect competitive intermediate firms (Div_t^t).

Following Christiano et *al*. (2005) and Smets and Wouters (2003a), we assumed that there exist state contingent security which insure the households against variations in household specific labor income[30].

Income from renting out capital services depends not only on the level of capital which was installed last period, but also on its utilization rate (z_t^t). As in Christiano et al. (2005), we assume that the cost of capital utilization is zero when capital utilization is one ($\Upsilon(1)=0$). In the following we discuss each of the household decisions in turn.

2.1.1 Consumption and Savings behavior

We assume that the maximization of the objective function (1) subject to the budget constraint (4) respectively to consumption and holdings of bonds yields the following first-order conditions for consumption:

$$E_t = \left[b \frac{l_{t+1}}{l_t} \frac{R_t P_t}{P_{t+1}} \right] = 1 \tag{6}$$

29 - Abel (1990) hypothesized that the stock is usually equal to the level of aggregate consumption of the previous period.

30 - See Christiano and *al*. (2005) for more complete analysis.

where R_t is the net nominal rates of income on the holding bonds ($R_t = 1+ i_t = 1/b_t$) and l_t is the marginal utility of consumption which is given by[31]:

$$l_t = e_t^b \left(C_t - H_t\right)^{-\sigma_c} \tag{7}$$

The equations (6) and (7) extend the usual first-order condition for consumption growth by taking into account the existence of external habit formation.

Demand for cash which follows from the optimization problem of households is given by:

$$e_t^M \left(\frac{M_t}{P_t}\right)^{-\sigma_m} = \left(C_t - H_t\right)^{-\sigma_c} - \frac{1}{1+ i_t} \tag{8}$$

The real cash holding depends positively on consumption (relative to the habit) with an elasticity equal to s_c/s_m (which is elasticity of real cash holding to consumption relative to habit) and negatively on the nominal interest rate. In what follows, we will take the nominal interest rate as the monetary policy instrument of the central bank.

According to the hypothesis that the consumption and cash detention are additively separable in the utility function, cash holding will not appear in any other structural equation. The equation (8) which we will ignore in the rest of the paper then becomes completely recursive to the rest of the system of equations.

2.1.2 Labor supply decisions and the wage setting equation

The households act as price-setters on the labor market. Following Kollmann (1997) and Erceg et *al*. (2000), we assume that wages can only be optimal adjusted after some random "wage-change signal" is received. The probability that a particular household can change its nominal wage in period t is constant and equals to $1 - X_w$. A household t which receives such a signal in period t, will set a new nominal wage, W_t^t, taking into account the probability that it will not re-optimizes in the near future. In addition, we allow for a partial indexation of the wages that cannot be adjusted to past inflation. More formally, the wages of households that cannot be re-optimized are adjusted according to equation (9):

$$W_t^t = \left(\frac{P_{t-1}}{P_{t-2}}\right)^{g_w} W_{t-1}^t \tag{9}$$

where g_w is the degree of wage indexation. When $g_w = 0$, there is no indexation and wages which cannot be re-optimized remain constant. When $g_w = 1$, there is perfect indexation to past inflation.

The households set their nominal wages to maximize their inter-temporal objective function subject to inter-temporal budget constraint and the demand for labor which is determined by:

$$l_t^t = \left(\frac{W_t^t}{W_t}\right)^{-\frac{1+l_{w,t}}{l_{w,t}}} L_t \tag{10}$$

31- Here we have already used the fact that the marginal utility of consumption is identical across households.

where is the aggregate labor demand and W_t the aggregate nominal wage. L_t and W_t are given by the following Dixit-Stiglitz type aggregator functions:

$$L_t = \left[\int_0^1 \left(l_t^t\right)^{\frac{1}{1+l_{w,t}}} dt\right]^{1+l_{w,t}} \tag{11}$$

$$W_t = \left[\int_0^1 \left(W_t^t\right)^{-\frac{1}{l_{w,t}}} dt\right]^{l_{w,t}} \tag{12}$$

This maximization problem results in the following mark-up equation for the re-optimised wage:

$$\frac{W_t^*}{P_t} E_t \sum_{i=0}^{\infty} b^i x_w^i \left(\frac{P_t/P_{t-1}}{P_{t+i}/P_{t+i-1}}\right)^{g_w} \frac{l_{t+i}^t U_{t+i}^C}{1+l_{w,t+i}} L_t = E_t \sum_{i=0}^{\infty} b^i x_w^i l_{t+i}^t U_{t+i}^l \tag{13}$$

where U_{t+i}^l is the marginal disutility of labor and U_{t+i}^C the marginal utility of consumption. Equation (13) shows that nominal wage in period *t* for a household t that is allowed to change its wage is set so that the present value of the marginal return to working is a mark-up over the present value of marginal cost (the subjective cost of working). When wages are perfectly flexible ($x_w = 0$), the real wage will be a mark-up (equal to $l_{w,t}$) over the current ratio of the marginal disutility of labor and the marginal utility of an additional unit of consumption. We assume that shocks to the wage mark-up, $l_{w,t} = l_w + h_t^w$ are *iid*-normal around the constant.

Giving the equation (12), the law of motion of the aggregate wage index is given by:

$$\left(W_t\right)^{1/l_{w,t}} = x\left(W_{t-1}\left(\frac{P_{t-1}}{P_{t-2}}\right)^{g_w}\right)^{-1/g_{w,t}} + (1-x)\left(W_t^*\right)^{-1/g_{w,t}} \tag{14}$$

2.1.3 Investment and accumulation capital

We assume that the households finally own the capital stock, a homogeneous factor of production, which they rent out the firm-producers of intermediate goods at a given rental rate of r_t^k. They can increase the supply of rental services from capital either by investing in additional capital (I_t), which takes one period to be installed or by changing the utilization rate of already installed capital (Z_t). Both actions are costly in terms of foregone consumption (see the intertemporal budget constraint (4) and (5))[32].

The households choose the capital stock, investment and the utilization rates in order to maximize their intertemporal objective function subject to the intertemporal budget constraint and the capital accumulation equation which is given by:

$$K_t = (1-\ t)K_{t-1} + \left[1-\ S\left(\varepsilon_t^I I_t / I_{t-1}\right)\right] I_t \tag{15}$$

where I_t is gross investment, *t* is the depreciation rate and the function of adjustment cost *S*(g) is a positive function of the variation in s investment. *S*(g) is zero in the steady state with a

32 - See Smets and Wouters (2003a).

constant level of investment. In addition, we assume that the first derivative also equals zero around the equilibrium, so that the adjustment costs will only depend on the second-order derivative as in Christiano and (2005) *al*. We also introduce a stock to the investment cost function, which is assumed to follow a first-order autoregressive process with an *iid-normal* error term: $e_t^I = r_I e_{t-1}^I + h_t^I$.

The first-orders conditions result in the following equations for the real value of the capital, investment and the rate of capital utilization:

$$Q_t = \mathrm{E}_t\left\{b\frac{l_{t+1}}{l_t}\left[Q_{t+1}(1- t)+ z_{t+1}r_{t+1}^k - \psi(z_{t+1})\right]\right\} \tag{16}$$

$$Q_t S'\left(\frac{\varepsilon_t^I I_t}{I_{t-1}}\right)\frac{\varepsilon_t^I I_t}{I_{t-1}} + b\mathrm{E}_t Q_{t+1}\frac{l_{t+1}}{l_t}S'\left(\frac{\varepsilon_{t+1}^I I_{t+1}}{I_t}\right)\left(\frac{\varepsilon_{t+1}^I I_{t+1}}{I_t}\right)\frac{I_{t+1}}{I_t} = 1 \tag{17}$$

$$r_t^k = \psi'(z_t) \tag{18}$$

The equation (16) states that the value of installed capital depends on the expected future value taking into account the depreciation rate and the expected future return as captured by the rental rate times the expected rate of capital utilization.

The first order condition for the utilization rate (18) equates the cost of higher capital utilisation with the rental price of capital services. As the rental rate increases it becomes more profitable to use the capital stock more intensively up to the point where the extra gains match the extra output costs. One implication of variable capital utilization is that it reduces the impact of changes in output on the rental rate of capital and therefore smoothes the response of marginal cost to fluctuations in output.

2.2 Technologies and firms

We make hypothesis that monetary union produces a single final good and a continuum of intermediate goods indexed by *j* where *j* is distributed over the unit interval ($j \in [0,1]$). The final good-sector is perfectly competitive. The final good is used for consumption and investment by the households. There is monopolistic competition in the markets for intermediate goods: each intermediate good is produced by a single firm.

2.2.1 Final-good sector

We assume that the final good is produced using intermediate goods in the following technology:

$$Y_t = \left[\int_0^1 \left(y_t^j\right)^{\frac{1}{1+l_{p,t}}} dj\right]^{1+l_{p,t}} \tag{19}$$

where y_t^j denotes the quality of domestic intermediate good of type j which is used in final goods production at date *t*. $l_{p,t}$ is a stochastic parameter that determines the time-varying

mark-up in the goods market. Shocks to this parameter will be interpreted as a "cost-push" shock on the inflation equation. We assume that $l_{p,t} = l_p + h_t^p$ where h_t^p is a *iid-normal*.

The cost minimizing conditions in the final goods sector can be written as follows:

$$y_t^j = \left(\frac{P_t^j}{P_t}\right)^{-\frac{1+l_{p,t}}{l_{p,t}}} Y_t \tag{20}$$

and where P_t^j is the price of intermediate good j and P_t is the price of the final good. The perfect competition in the final goods market implies that the latter can be written as follows:

$$y_t^j = \left(\frac{P_t^j}{P_t}\right)^{-\frac{1+l_{p,t}}{l_{p,t}}} Y_t \tag{21}$$

2.2.2 Intermediate goods producers

We suppose that each intermediate good j is produced by a firm j using the following technology:

$$y_t^j = e_t^a \tilde{K}_{j,t}^{\alpha} L_{j,t}^{1-\alpha} - F \tag{22}$$

where e_t^a is the productivity shock, $\tilde{K}_{j,t}$ is the effective utilization of the capital stock given by $\tilde{K}_{j,t} = z_t K_{j,t-1}$ $L_{j,t}$ is an index of different types of labor used by the firm given by (11) and is a fixed cost.

Cost minimization implies:

$$\frac{W_t L_{j,t}}{r_t^k \tilde{K}_{j,t}} = \frac{1-\alpha}{\alpha} \tag{23}$$

The equation (23) implies that the capital-labor ratio will be identical between across intermediate goods producers and equal to the aggregate capita-labor ratio. The firms' marginal costs are given by:

$$MC_t = \frac{1}{e_t^a} W_t^{1-\alpha} r_t^{k^{\alpha}} \left(\alpha^{-\alpha} (1-\alpha)^{-(1-\alpha)}\right) \tag{24}$$

This implies that the marginal cost, too, is independent of the intermediate goods produced.

Nominal profits of firm j are then given by:

$$p_t^j = \left(p_t^j - MC_t\right)\left(\frac{p_t^j}{p_t}\right)^{-\frac{1+l_{p,t}}{l_{p,t}}} (Y_t) - MC_t F \tag{25}$$

Each firm *j* has market power in the market for its own good and maximizes the expected profits using a discount rate (br_t) which is consistent with the pricing Kernel for nominal returns used by shareholders-households: $r_{t+k} = \frac{l_{t+k}}{l_t}\frac{1}{p_{t+k}}$.

As in Calvo (1983), firms are not allowed to change their prices unless they receive a random "signal of price change". The probability a given price can be re-optimized in a particular period is constant $(1-x_p)$. Following Christiano et *al.* (2005), prices of firms that do not receive a price signal are indexed's inflation rate. Profit optimization by producers that are "allowed" to re-optimize their prices time t results in the following first-order condition:

$$E_t \sum_{i=0}^{\infty} b^i x_p^i l_{t+i} y_{t+i}^j \left\{ \frac{p_t^*}{p_t} \left[\frac{(p_{t-1+i}/p_{t-1})}{p_{t+i}/p_t} \right]^{g_p} - (1+l_{p,t+i}) mc_{t+i} \right\} = 0 \tag{26}$$

The equation (26) shows that the price set by firm *j*, at time *t*, is a function of excepted future marginal costs. The price will be a mark-up over these weighted marginal costs. If prices are perfectly flexible ($x_p = 0$), the mark-up in period *t* is equal to $1+l_{p,t}$. With sticky price the mark-up becomes variable over time when the economy is hit by exogenous shocks. A positive demand shock decreases the mark-up and stimulates employment, investment and real output.

The definition of the price index in equation (21) implies that its law of motion is given by:

$$(p_t)^{-1/l_{p,t}} = x_p \left[p_{t-1} \left(\frac{p_{t-1}}{p_{t-2}} \right)^{g_p} \right]^{-1/l_{p,t}} + (1-x_p)\left(p_t^*\right)^{-1/l_{p,t}} \tag{27}$$

2.3 Fiscal and monetary policy

We assume that government expenditures are determined exogenously and show the persistent variations; in particular, their logarithms following a process AR (1). As is clearly in the earlier discussions, the government expenditure does not have direct effect either on the utility (through the pursuit of public goods) or on the production (may be via a public capital shock). In addition, we assume that Government compensates the effects of steady-state of the monopolistic distortions by the representation of the appropriate magnitude by subsidies from production and employment, which are funded through a constant level of taxes. Thus, the deterministic steady state is Pareto-optimal in the base model with an inflation rate equal to zero. Under these assumptions, we can set our analysis on the stabilization of monetary policy tasks, excluding implications that will result if the central bank plays a role by trying to offset the distortions effects of the steady state.

In the model estimation, we use a monetary policy rule, quite simple, in which the nominal interest rate responds to the short-term interest rate as well as the lagged deviations of the aggregate price of inflation to the target and the current output in level which prevails in the absence of the nominal inertia. This specification includes two additional exogenous shocks; namely, persistent AR (1) changes in the inflation target and the white noise shocks transitional to the current policy rate. In our normative analysis, of course, we consider the full policy of Ramsey, as well as alternative specifications of the simple policy rules. We assume that monetary policy does not display exogenous stochastic variation.

2.4 Market equilibrium

We suppose that final goods market is in equilibrium if production equals demand by households for consumption and investment and government:

$$Y_t = C_t + G_t + I_t + \Upsilon\left(z_t\right)K_{t-1} \tag{30}$$

Capital rental market is in equilibrium when demand for capital by the intermediate goods producers equals the supply by the households. The labor market is in equilibrium if firms' demand for labor equals labor supply at the wage level set by households.

The interest rate is determined by a reaction function that describes monetary policy decisions. This rule will be discussed in the following sections of the paper. In order to maintain money market equilibrium, money supply adjusts endogenously to meet money demand at those interest rates.

In the capital market, equilibrium means that the government debt is held by domestic investors at the market interest rate R_t.

2.5 Linearised model

For the empirical analysis of section 3 we linearise the model equations described above around the nonstochastic steady state. Below we summarise the resulting linear rational expectations equations. The "^" above a variable denotes its log deviation from steady state. Variables dated at time t+1 refer to the rational expectation of those variables.

The consumption equation with external habit formation is given by:

$$\hat{C}_t = \frac{h}{1+h}\hat{C}_{t-1} + \frac{1}{1+h}\hat{C}_{t+1} - \frac{1-h}{(1+h)s_c}\left(\hat{R}_t - \hat{p}_{t+1}\right) + \frac{1-h}{(1+h)s_c}\left(\hat{e}_t^b - \hat{e}_{t+1}^b\right) \tag{31}$$

where $h = 0$, this equation reduces to the traditional forward-looking consumption equation. With external habit formation, consumption depends on a weighted average of past and expected future consumption. Note that in this case the interest elasticity of consumption depends not only on the intertemporal elasticity of substitution, but also on the habit persistence parameter. A high degree of habit persistence will tend to reduce the impact of the real rate on consumption for a given elasticity of substitution.

The investment equation is given by:

$$\hat{I}_t = \frac{1}{1+b}\hat{I}_{t-1} + \frac{b}{1+b}\hat{I}_{t+1} + \frac{j}{1+b}\hat{Q}_t + b\hat{e}_{t+1}^I - \hat{e}_t^I \tag{32}$$

where $j = 1/\bar{S}''$. As discussed in Christiano et al (2001), modelling the capital adjustment costs as a function of the change in investment rather than its level introduces additional dynamics in the investment equation, which is useful in capturing the hump-shaped response of investment

to various shocks including monetary policy shocks. A positive shock to the adjustment cost function, $\hat{e}_t^I$, (also denoted a negative investment shock) temporarily reduces investment.

The equation corresponding of Q is given by:

$$\hat{Q}_t = -\left(\hat{R}_t - \hat{p}_{t+1}\right) + \frac{1- \ t}{1- \ t + \bar{r}^k}\hat{Q}_{t+1} + \frac{\bar{r}^k}{1- \ t + \bar{r}^k}\hat{r}_{t+1}^k + h_t^Q \tag{33}$$

where $b = 1/\left(1- \ t + \bar{r}^k\right)$. The current value of the capital stock depends negatively on the ex-ante real interest rate, and positively on its expected future value and the expected rental rate. The introduction of a shock to the required rate of return on equity investment, h_t^Q, is meant as a shortcut to capture changes in the cost of capital that may be due to stochastic variations in the external finance premium. In a fullyfledged model, the production of capital goods and the associated investment process could be modeled in a separate sector. In such a case, imperfect information between the capital producing borrowers and the financial intermediaries could give rise to a stochastic external finance premium. For example, in Bernanke et *al.* (1998), the deviation from the perfect capital market assumptions generates deviations between the return on financial assets and equity that are related to the net worth position of the firms in their model. Here, we implicitly assume that the deviation between the two returns can be captured by a stochastic shock, whereas the steady-state distortion due to such informational frictions is zero.

The capital accumulation equation is standard:

$$\hat{K}_t = \left(1- \ t\right)\hat{K}_{t-1} + t\,\hat{I}_{t-1} \tag{34}$$

With partial indexation, the *inflation equation* becomes a more general specification of the standard new-Keynesian Phillips curve:

$$\hat{p}_t = \frac{b}{1+ bg_p}\hat{p}_{t+1} + \frac{g_p}{1+ bg_p}\hat{p}_{t-1} + \frac{1}{1+ bg_p}\frac{\left(1- bx_p\right)\left(1- x_p\right)}{x_p}\left[a\hat{r}_t^k + \left(1- a\right)\hat{w}_t - \hat{e}_t^a + h_t^p\right] \tag{35}$$

Inflation depends on past and expected future inflation and the current marginal cost, which itself is a function of the rental rate on capital, the real wage and the productivity parameter. When $g_p = 0$, this equation reverts to the standard purely forward-looking Phillips curve. In other words, the degree of indexation determines how backward looking the inflation process is. The elasticity of inflation with respect to changes in the marginal cost depends mainly on the degree of price stickiness. When all prices are flexible ($X_p = 0$) and the price-mark-up shock is zero, this equation reduces to the normal condition that in a flexible price economy the real marginal cost should equal one.

Similarly, partial indexation of nominal wages results in the following real wage equation:

$$\hat{w}_t = \frac{b}{1+b}\hat{w}_{t+1} + \frac{1}{1+b}\hat{w}_{t-1} + \frac{b}{1+b}\hat{p}_{t+1} + \frac{1+bg_w}{1+b}\hat{p}_t + \frac{g_w}{1+b}\hat{p}_{t-1} - \frac{1}{1+b}\frac{(1-bx_w)(1-x_w)}{\left[1+\frac{(1-l_w)s_l}{l_w}\right]x_w}\left[\hat{w}_t - s_l\hat{L}_t - \frac{s_l}{1-h}\left(\hat{C}_t - h\hat{C}_{t-1}\right) - \hat{e}_t^l - h_t^w\right] \quad (36)$$

The real wage is a function of expected and past real wages and the expected, current and past inflation rate where the relative weight depends on the degree of indexation of the non-optimised wages. When $g_w = 0$, real wages do not depend on the lagged inflation rate. There is a negative effect of the deviation of the actual real wage from the wage that would prevail in a flexible labor market. The size of this effect will be greater, the smaller the degree of wage rigidity, the lower the demand elasticity for labor and the lower the inverse elasticity of labor supply (the flatter the labor supply curve).

The equalisation of marginal cost implies that, for a given installed capital stock, labor demand depends negatively on the real wage (with unit elasticity) and positively on the rental rate of capital:

$$\hat{L}_t = -\hat{w}_t + (1+y)\hat{r}_t^k + \hat{K}_{t-1} \quad (37)$$

where $y = \frac{y'(1)}{y''(1)}$ is the inverse of the elasticity of the capital utilization cost function.

The goods market equilibrium condition can be written as:

$$\hat{y}_t = (1 - tk_y - g_y)\hat{C}_t + tk_y\hat{I}_t + g_y\hat{e}_t^G = f\hat{e}_t^a + fa\hat{K}_{t-1} + fay\hat{r}_t^k + f(1-a)\hat{L}_t \quad (38)$$

where k_y is the ratio of capital-output steady state, the ratio of government expenditure-output steady state and f is the distribution of fixed costs in one production +1.

Finally, the model is closed by adding the empirical reaction function of the monetary policy. It is assumed that the behavior of the central bank can be characterized by the following Taylor rule:

$$\hat{i}_t = r\hat{i}_{t-1} + (1-r)\left[\bar{p}_t + r_p(\hat{p}_{t-1} - \bar{p}_t) + r_y\hat{y}_t\right] + r_{\Delta p}(\hat{p}_t - \hat{p}_{t-1}) + r_{\Delta y}(\hat{y}_t - \hat{y}_{t-1}) - r_a h_t^a - r_l h_t^l + h_t^i$$

The policymakers gradually respond to deviations of lagged inflation from an inflation objective. The parameter *r* captures the degree of interest rate smoothing. In addition, there is also a feedback effect from the current change in inflation, the current growth rate in output and current innovations in the technology and labor supply shock variables. The latter two shocks were introduced to capture changes in potential output. Finally, we assume that there are two monetary policy shocks: one is a persistent shock to the inflation objective ($\bar{p}_t$); the other is a temporary interest rate shock (h_t^i).The latter will also be denoted a monetary policy shock.

Equations (31)-(39) determine the new endogenous variables in our model: $\hat{\pi}_t$, $\hat{w}_t$, $\hat{K}_{t-1}$, $\hat{Q}_t$, $\hat{I}_t$, $\hat{C}_t$, $\hat{i}_t$, $\hat{r}_t^k$ and $\hat{L}_t$. The stochastic behavior of the system of linear rational expectations equations is driven by ten exogenous shocks variables: five shocks arising from technology and preferences (e_r^a, e_r^I, e_t^b, $\hat{e}_t^l$, e_t^G), three "cost-push" shocks (h_t^w, h_t^p and h_t^Q) and two monetary policy shocks ($\bar{p}_t$ and h_t^i).The first set of shock variables are assumed to follow an independent first-order autoregressive stochastic process, whereas the second set are assumed to be *iid* independent processes.

3 Calibration of priors[33]

Uncertainty concerns the specification of shocks and the model parameters. The beliefs about the model parameters are summarized in table 1. As recognized in the previous works, certain structural parameters are not identified from the dynamic cycles of data. Thus, we use long-term historical averages to specify the values of these parameters: the setting of capital share in the production $\alpha = 0.3$; the discount factor $b = 1/1+r^*$ with r^* the external interest rate risk ($r^* = 0.01$) as in Batté et *al*. (2009); and the depreciation parameter (depreciation rate of capital stock) d is set to 0.5, however Diop (2007) had set it to 0.1. We set habit consumption h to 0.9; Levin. and *al*. (2005) were set it to 0.7 for the United States and Diop (2007) was set it to 1.16 for Senegal. We set inverse of intertemporal substitution elasticity of consumption S_c equal to 0.5 ; and Batté et *al*. (2009) were set it to 2 for WAEMU. We set the rate of return on capital $\bar{r}^k$ to 1.4. Price adjustment g_w is set to 0.085. Wages indexation g_p is assumed to be 0.4. Standard deviations of shocks are assumed equals to one.

Giving *priors* (table 1) we characterize *posteriors* distribution by using the Metropolis-Hastings algorithm Markov Chain Monte Carlo (MCMC). Our estimation methodology is similar to Levin et *al*. (2005).

TABLE 1: Specifcation of Priors

Parameter	Description	Calibration
h	Habit consumption	0.900
S_c	Inverse of intertemporal substitution elasticity	0.500
b	Discount factor	0.990
t	Depreciation rate of capital stock	0.500
$\bar{r}^k$	Rental rate of capital	1.400
g_p	Prices indexation	0.085
x_p	Price à la Calvo	0.300
a	Share of steady-state of labor income in total output	0.300
g_w	Wages indexation	0.400

33 - Calibration is an art and not a technique. It allows you to assign values to different parameters on preferences, technology, etc. To do this, some parameters are taken from literature and others are determined so that they reflect the economy studied at the steady state (Diop, 2007).

x_w	Wages à la Calvo	1.000
k_y	Ratio of capital-output	0.800
g_y	Ratio of government expenditure-output	0.400
j	Share of steady-state of investment	0.200
f	Share of fixed cost in production + 1	1.200
y	Inverse of used capital cost elasticity	0.900
r_p	Politicy, lagged inflation	1.800
r_y	Politicy, lagged output	0.300
r_a	Politicy, productivity shock	0.750
r_t	Politicy, labor supply shock	0.700
$r_{\Delta p}$	Politicy, change in inflation	0.350
$r_{\Delta y}$	Politicy, change in output gap	1.600
l_w	Wages mark-up	0.500
s_l	Inverse of labor supply elasticity	1.000
r	Politicy, lagged interest rate	0.500
s_a	Technology shock	0.300
s_b	Preference shock	0.200
s_p	Prices mark-up shock	0.020
s_I	Investment shock	0.020
s_l	Labor supply shock	0.010
sg	Government expenditure shock	0.200
sr	Interest rate shock	0.030
sq	Rental price of capital shock	0.200
s_w	Wages mark-up shock	0.300
s_p	Inflation objective shock	0.100

Source: Autor, based on calibration.

4 Data and model estimation

We use Bayesian methods to estimate the log-linearized version of the model, using quarterly WAEMU data over the period 1975:1 through 2010:2. Bayesian approach consists in practice to modify the form of the likelihood function of the model by supplementing it with econometrician beliefs on the model parameters[34]. Data come from the database « International Financial Statistics (IFS) » of International Monetary Fund (CD-ROOM 2010) and the database « Live Data Base (LDB) » of World Bank (CDROOM 2010). In particular, we treat five aggregates variables considered as directly observed: *real consumption*, *investment*, *inflation rate*, output and nominal short-run interest rate (money market rate). Because the rest of the model variables (such as *the real wages, the labor hours, the capital stock, the capital*

34 - See Adjemian and Pelgrin (2008) for more presentation of this approach.

utilization rate and the real value of capital) are treated as unobservable variables, we use the Kalman filter in computing the likelihood function of the model.

Figure 1 in appendix B shows the share of *prior* of the log-linearized model. Figure 23 of appendix B shows the MCMC univariate diagnostics. This is the main source of feedback to win the confidence of the results. Specifically, the red and the blue lines (figure 23 of appendix B) represent the measurements of the parameters vectors both within and across channels. So that the results are sensitive, the red and the blue lines must be relatively constant (although there will be some variations) and should converge.

DYNARE[35] reports three measures: *"interval"*, being constructed from an 80% confidence interval around the parameter mean, "*m* 2" being a measure of the variance and "*m* 3" based on third moments. In each case, DYNARE reports both the within and the between chains measures. The figure entitled "multivariate diagnostic" (see figure 24 of appendix B) presents results of the same nature, except that they reflect an aggregate measure based on the eigenvalues of the variance-covariance matrix of each parameter.

In our case, we can say in fact that we got the convergence and the relative stability in all steps moments of the model parameters. Note however that the horizontal axis are the number of iterations of Metropolis-Hastings taken into account and the vertical axes the step of the parameters moments with the first corresponding to the step value initial iterations of Metropolis-Hastings. Moreover, figure 25 of appendix B shows historical and smooth variables.

5 Posteriors

The last columns of table 2 give estimation results of posterior distribution mode and variance. Posterior density mode is obtained by using an optimization routine and posterior variance is approximated by the inverse of the opposite posterior nucleus hessian matrix evaluated to the mode. This approximation is valid only if the posterior distribution is quite close to a Gaussian. Note that we are content with mode estimation, but we could estimate the posterior distribution in his whole using a Monte Carlo (see Adjemian and Pelgrin, 2008). Estimation here helps us to select values for the parameters in order to implement experiments on monetary policy in the next section.

Table 2 summarizes the results of the parameters values. It includes: *prior* mean values, *posterior* mode values, standard deviations and *t-Student* modes, as well as a *prior* distribution and standard deviations (*pstdev*).

35 - DYNARE is a preprocessor developed by Juillard (2001). Part of DYNARE is programmed in C++, while the rest is written using the MATLAB programming language.

TABLE 2 : Estimation results

Parameter	Prior mean	Posterior mean	Confidence intervalle			Distribution	Std. Dev.
h	0.900	0.9812	0.9802	☐	0.9819	beta	0.0200
S_c	0.500	0.4553	0.4527	☐	0.4577	normal	0.0300
b	0.990	0.8285	0.8035	☐	0.8461	normal	0.1000
t	0.500	0.4622	0.4579	☐	0.4666	beta	0.0200
$\overline{r}^k$	1.400	1.3848	1.3797	☐	1.3910	normal	0.0500
g_p	0.085	0.0728	0.0651	☐	0.0816	beta	0.0200
x_p	0.300	0.2394	0.2318	☐	0.2449	beta	0.050
a	0.300	0.3210	0.3180	☐	0.3240	beta	0.0300
g_w	0.400	0.5877	0.5830	☐	0.5922	beta	0.0300
x_w	1.000	0.9813	0.9805	☐	0.9823	normal	0.0100
k_y	0.800	0.7878	0.7858	☐	0.7899	beta	0.0250
g_y	0.400	0.4096	0.4090	☐	0.4104	beta	0.010
j	0.200	0.0003	0.0000	☐	0.0006	normal	0.040
f	1.200	1.4892	1.4723	☐	1.4099	normal	0.3000
y	0.900	0.9333	0.9238	☐	0.9456	beta	0.0500
r_p	1.800	1.7122	1.6697	☐	1.7644	normal	0.4000
r_y	0.300	0.5111	0.5001	☐	0.5207	normal	0.1000
r_a	0.750	0.5650	0.5073	☐	0.6247	normal	0.2000
r_t	0.700	0.7178	0.7122	☐	0.7233	normal	0.0300
$r_{\Delta p}$	0.350	0.0768	0.0667	☐	0.0860	normal	0.1000
$r_{\Delta y}$	1.600	1.7934	1.7851	☐	1.8047	normal	0.080
l_w	0.500	0.5325	0.4825	☐	0.5940	beta	0.1500
s_l	1.000	0.8902	0.8879	☐	0.8937	normal	0.0400
r	0.500	0.9451	0.9404	☐	0.9499	beta	0.1500
s_a	0.300	0.1515	0.0675	☐	0.2295	inv. gamma	∞
s_b	0.200	14.8319	14.6245	☐	15.1461	inv. gamma	∞
s_p	0.020	38.4517	37.7980	☐	39.0122	inv. gamma	∞
s_I	0.020	0.0628	0.0560	☐	0.0679	inv. gamma	∞
s_l	0.010	1.8905	1.6750	☐	2.0259	inv. gamma	∞
sg	0.200	0.1206	0.1099	☐	0.1328	inv. gamma	∞
sr	0.030	0.0224	0.0085	☐	0.0392	inv. gamma	∞
sq	0.200	0.1374	0.0525	☐	0.2465	inv. gamma	∞
s_w	0.300	6.9728	6.7668	☐	7.1668	inv. gamma	∞
s_p	0.100	0.0662	0.0262	☐	0.1177	inv. gamma	∞

Source: Autor, based on estimations.

Figure 2 in appendix B shows the *prior* and *posterior* distributions. The green line represents the *posterior* mode. This figure allows comparison of the two distributions.

We can write the reaction function of the monetary policy stem from the DGSE model estimation. It is as follows:

$$\hat{i}_t = \underset{(0.15)}{0.94\hat{i}_{t-1}} + \underset{(0.40)}{0.06\left[\bar{p}_t + 1.67\left(\hat{p}_{t-1} - \bar{p}_t\right)\right]} + \underset{(0.10)}{0.50\hat{y}_t} + \underset{(0.10)}{0.07\left(\hat{p}_t - \hat{p}_{t-1}\right)}$$

$$+ \underset{(0.08)}{1.78\left(\hat{y}_t - \hat{y}_{t-1}\right)} - \underset{(0.20)}{0.55h_t^a} - \underset{(0.03)}{0.72h_t^l} + h_t^i$$

where coefficients standard deviations are in parentheses. This reaction function shows a high degree of inertia, a strong long-term reaction of inflation, a moderate sensitivity of output level, a weak response in the variation of inflation and a strong reaction in the variation of output. The estimated monetary policy rule is only an indication of how the interest rate of short-term (here the money market rate) in WAEMU responded to macroeconomic developments over the period 1975:1 through 2010:2.

6 Optimal monetary policy

In this section, we investigate the monetary policy implications of the basic model at the level of the *posterior* mean values estimated under uncertainty on the true structure of the model. As in Levin et al. (2005), we first consider the optimal monetary policy with commitment that maximizes welfare[36].

6.1 Problem of optimal policy

Monetary policy with commitment can be calculated by formulating the Lagrangian problem at infinite horizon, in which the central bank maximizes conditional welfare expected under constraints of a vast set nonlinear composed with the behavior equations of the private sector and the market conditions of the economy model. The first-order condition of this problem is obtained by differentiating the Lagrangian relative to each endogenous variable (including policy instrument) and by setting those deriving equal to zero. However, calculate manually these derivations would be very tedious. So we use the symbolic MATLAB procedures developed in the preprocessor DYNARE of Juillard (2001). Then, we analyze this economy behavior under optimal policy by combining central bank first-order condition with behavioral equations of private sector and market conditions. Thus, the size of the model is greater in the optimal policy because these first-order conditions take the place of the simple reaction function of interest rate, when all Lagrange multipliers are added to the list of the model variables, however, it should be noted that no new parameter is added to the model, because

36 - As in Levin et al. (2005), the welfare equation has the following form: $W_t = E_0 \sum_{t=0}^{\infty} b^t U_t^t$

these first-order conditions of central bank require the same structural parameters as in the behavioral equations and the market conditions. Because all of these non-linear equations require rational expectations, the numerical methods are required to characterize the properties of the stochastic economy equilibrium. In addition, when the first-orders dynamics can be studied by a log-linear model, superior order methods are needed to assess the expected welfare condition. So we use the preprocessor DYNARE of Juillard (2001) to calculate the first-order approximation of the log-linearized model of the economy. Finally, our analysis is focalized on welfare business cycle assessment. For each regime of monetary policy, we measure the effects on expected welfare when a stochastic shock hits the economy.

6.2 Characterization of uncertainty.

We do not know with certain way the model that generates data. Thus, uncertainty in the obtained results must be given an account, by reasoning in terms of range. Uncertainty in the generating model of data may relate to the specification of a parameterized model and the value of its parameters. We set the models form and we characterize the uncertainty in the generating model of data using a joint density on the models parameters. Then we will project this uncertainty in the variants space.

The approach we follow in this study proceeds in three steps. At first, we define a DSGE model in a closed economy on the WAEMU. We follow Christiano et al. (2005) and Smets and Wouters (2003). The model contains a number of nominal rigidity on the prices and wages as well as real, with adjustment cost on investment and capital used. Second step is to characterize the uncertainty in the model by constructing the joint density of its parameters; that is why we adopt a Bayesian approach. The model defines the joint density of a set of variables (inflation, real wages etc.) conditionally to the parameters; his Bayesian method can reverse it and update our prior on the generator model of data to construct the joint density parameter conditionally to the data (posterior density). In the last step, we translated the posterior density of the parameters uncertainty on the variants. The variant exercise is based on a deterministic version of DSGE model (that is to say. stochastic shocks variances are zero). DSGE model is necessary only in the second stage to write the likelihood function associated with theoretical model and characterize uncertainty in the structural parameters. The choice of the model is obviously questionable. We take the party to remain as close as possible to the model considered by Smets and Wouters (2003). This choice is motivated by the relatively good performance of the models when it is confronted with data and the fact that it is imposed in institutional world as a canonical model[37].

6.3 Characteristics of the optimal policy

The deterministic steady state of the economy is characterized by zero inflation. In particular, as before; we assume that tax subsidies offset monopolistic distortions in the steady state of production and employment, although, the currency is essentially absent from the baseline. Thus, in the absence of stochastic shocks, the exclusive task of the central bank is to choose

37 - Smets and Wouters (2003) show for example that the quality of adjustment of this model is comparable to that of a VAR model (that is to say a model that uses no theoretical constraint).

the constant inflation rate that minimizes the degree of cross-sectional dispersion in prices and wages. In fact, indeed, by maintaining a zero inflation rate, monetary policy succeeds in implementing the Pareto-optimal equilibrium in steady state.

We present and interpret optimal monetary policy responses under central banker commitment on a policy rule (Ramsey policy) in WAEMU (see figures 3-12 of appendix B). In these representations, the standard deviations of shocks are assumed equal to one. Optimal policy reproduces the path of short-term real interest rate (here the money market rate is abbreviated as "im" in each figures). The solid lines represent the optimal paths of the variables including the instrument of interest rate under certainty equivalent and the dotted lines the optimal paths of the variables under parameter uncertainty of the structural model.

Responses and interpretations under commitment on a policy rule (Ramsey policy)

Preference shock

The responses of welfare[38] (real consumption), investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following preference shock are flat under parameter uncertainty, persistent under certainty equivalent and optimal policies are aggressive (see figure 3 of appendix B). There is no worry in this condition for the stabilization of monetary policy instrument; policymaker modifies vigorously interest rate in order to stabilize the economy more quickly after a preference shock.

Investment shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following investment shock are relatively persistent and not flat under parameter uncertainty, but in general these responses are flat under certainty equivalent and optimal policies are very aggressive (see figure 4 of appendix B). Also in this condition, policymaker modifies vigorously interest rates in order to stabilize the economy more quickly after a shock.

Rental prices of capital shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following rental prices of capital shock are very flat under parameter uncertainty, however, these responses are relatively flat and persistent under certainty equivalent and optimal policies are less aggressive (see figure 5 of appendix B). Consequently, there is also no worry in this condition for the stabilization of

38 - A DSGE model gives natural measure of welfare: the utility of the representative household. The criterion is defined as the conditional expectation of the present and future values of the approximation of the household utility function. We assume that the central bank expresses its preferences through the maximization criterion of social welfare. Using log-linearized form of the structural model, we calculated a first-order approximation of welfare. By log-linearizing the model, only the Taylor first-order approximation of social welfare can be generated by the preprocessor DYNARE.

monetary policy instrument; central banker modifies less vigorously interest rate in order to stabilize the economy more quickly after a shock.

Technology shock

The responses of investment, real value of capital, capital stock, inflation rate, real wages, labor hours and capital utilization rate following technology shock are flat under parameter uncertainty but those of welfare and production are not flat under the same parameter uncertainty. However, the responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production are relatively flat under certainty equivalent and optimal policies are very aggressive (see figure 6 of appendix B). In this condition, policymaker modifies vigorously interest rate in order to stabilize the economy more quickly after a technology shock.

Prices mark-up shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following prices mark-up shock are flat under parameter uncertainty and certainty equivalent and optimal policies are relatively aggressive (see figure 7 of appendix B). In this condition, policymaker modifies vigorously interest rate in order to stabilize the economy more quickly after a shock.

Wages mark-up shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following wages mark-up shock are relatively flat and in general very persistent under parameter uncertainty, moreover, these responses are also relatively flat under certainty equivalent and optimal policies are relatively aggressive (see figure 8 of appendix B). In this condition, policymaker modifies vigorously interest rate in order to stabilize the economy more quickly after a shock.

Interest rate shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following interest rate shock (monetary policy shock) are very flat under parameter uncertainty, these responses are also relatively flat and persistent under certainty equivalent and optimal policies are less aggressive especially under parameter uncertainty (see figure 9 of appendix B). Consequently, there is also no worry in this condition for the stabilization of monetary policy instrument; central banker modifies less vigorously interest rate under parameter uncertainty but vigorously under certainty equivalent in order to stabilize the economy more quickly after a shock.

Government expenditure shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following government expenditure shock are in general very persistent and not flat under parameter uncertainty but these responses are relatively flat under certainty equivalent and optimal policies are very aggressive (see figure 10 of appendix B). In this condition, policymaker modifies also vigorously interest rate in order to stabilize the economy more quickly after government expenditure shock.

Labor supply shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following labor supply shock are relatively flat under parameter uncertainty and certainty equivalent and optimal policies are less aggressive (see figure 11 of appendix B). There is also no worry in this condition for the stabilization of monetary policy instrument; central banker modifies less vigorously interest rate in order to stabilize the economy more quickly after a labor supply shock.

Inflation objective shock

The responses of welfare, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following inflation objective shock are flat under parameter uncertainty, persistent under certainty equivalent and optimal policies are aggressive (see figure 3 of appendix B). There is again no worry in this condition for the stabilization of monetary policy instrument; policymaker modifies vigorously interest rate in order to stabilize the economy more quickly after an inflation objective shock.

TABLE 3: Taylor first-order approximation of welfare

	Certainty equivalent	Parameter incertainty
k(-1)	0.014047	0.001404
im(-1)	-0.047926	-0.086477
y(-1)	0.152235	0.164097
c(-1)	0.849874	0.946028
inv(-1)	-0.019825	-0.08460
pi(-1)	-0.075731	-0.00464
w(-1)	-0.066712	-0.00594
e_b	0.057553	0.008252
e_inv	0.050821	0.154964
e_q	-0.005133	-0.000025
e_a	0.119237	0.05913
e_p	-0.035883	-0.006194

e_l	0.063177	0.065673
e_w	-0.000724	-0.000006
e_r	-0.093972	-0.09150
e_g	-0.014892	-0.00388
e_pi	0.037758	0.00357

Source: See tables 6 and 7 in Appendix A.

TABLE 4 : Taylor first-order approximation of interest rate

	Certainty equivalent	Parameter incertainty
k(-1)	-0.065639	-0.011957
im(-1)	0.398268	0.907833
y(-1)	-1.265086	-1.722684
c(-1)	0.304152	0.391314
inv(-1)	0.461535	0.629223
pi(-1)	0.461003	0.042796
w(-1)	0.128825	0.050846
e_b	0.021098	0.003424
e_inv	-0.990151	-1.152703
e_q	0.100015	0.000189
e_a	-0.755723	-0.606421
e_p	0.107428	0.053079
e_l	-0.529626	-0.689447
e_w	0.780917	0.960569
e_r	0.001397	0.000049
e_g	0.643479	0.747412
e_pi	-0.313772	-0.037558

Source: See Tables 6 and 7 in appendix A.

Furthermore, table 3 which is an extract of tables 6 and 7 of appendix A shows the Taylor first-order approximation of welfare measured here by the real consumption. When the lagged interest rate decreases by one unit optimal, welfare increases by 0.086477 and 0.047926 (approximately the double of the precedent) respectively under parameter uncertainty and certainty equivalent. However, when the lagged inflation lowers by one unit the optimal welfare increases by 0.004647 and 0.075731 respectively under parameter uncertainty and certainty equivalent. Moreover, welfare derived from the optimal policy depends more heavily on the lagged consumption (that is to say 0.946028) under parameter uncertainty than welfare under certainty equivalent (that is to say 0.849874). However, table 4 shows the Taylor first-order approximation of interest rate function. Optimal policy under parameter uncertainty is

in part more aggressive than optimal policy under certainty equivalent as we consider only the lagged variables. The optimal policy under parameter uncertainty depends more heavily on lagged interest rate than the optimal policy under certainty equivalent (0.907833 for optimal policy under uncertainty against 0.398268 for optimal policy under certainty equivalent). It is the same for lagged capital stock, lagged consumption and lagged investment (respectively -0.011957, 0.391314 and 0.629223) for optimal policy under parameter uncertainty against (respectively -0.065639, 0.304152 and 0.461535) for the optimal policy under certainty equivalent. The optimal policy under parameter uncertainty is less aggressive than the optimal policy under certainty equivalent for the lagged output gap and inflation (respectively -1.722684 and 0.042796 for optimal policy under uncertainty against -1.265086 and 0.461003 under certainty equivalent).

6.4 Simple optimal rules

In this sub-section, we analyze the optimal policy through optimal simple rules. Central bank has for objective here to minimize a quadratic loss function under DSGE model constraint. The intertemporal loss function of the central bank is given by:

$$L_0 = E_0 \sum_{t=0}^{\infty} b^t \left[\hat{p}_t^2 + l_y \hat{y}_t^2 + l_i \hat{i}_t^2 \right]$$

where and are positive weights and represent the preference of central bank for the monetary policy. It is respectively set to 0.5 and 0.2. Unlike most previous studies (Angelini et al., 2002, or Monteforte and Siviero 2003), we do not assume that central bank has a simple optimal rule which is not depend only on inflation, output gap and interest rate lagged. The simple optimal rule depends on all the state variables of the Taylor rule (equation 39):

$$\hat{i}_t = r\hat{i}_{t-1} + (1-r)\left[\bar{p}_t + r_p\left(\hat{p}_{t-1} - \bar{p}_t\right) + r_y\hat{y}_t\right] + r_{\Delta p}\left(\hat{p}_t - \hat{p}_{t-1}\right) + r_{\Delta y}\left(\hat{y}_t - \hat{y}_{t-1}\right) - r_a h_t^a - r_l h_t^l + h_t^i$$

We consider the performance of estimated rules and optimal monetary policy under certainty equivalent and under parameters uncertainty[39]. Table 5 contains the coefficients of the three monetary policy rules. All coefficients of the optimal rule under certainty equivalent are lower than those of estimated rule except the long-term reaction of output. Similarly, all the coefficients of the optimal rule under uncertainty are lower than the optimal rule under certainty equivalent except for interest rate inertia. Thus, taking into account uncertainty in the DSGE model causes a prudent monetary policy reaction.

Figures 13-22 in appendix B show the responses of monetary policy under uncertainty and certainty equivalent. As before, the solid lines represent the optimal paths of the model variables including the instrument of interest in certainty equivalent and dotted lines the optimal paths of the model variables under parameters uncertainty in the structural model. However, following the investment

39 - The optimal simple rules derivation is performed through the DYNARE code of Juillard (2001).

TABLE 5: Estimated rule, optimal simple rules and optimal loss

	r	r_p	r_y	r_p	r_y	r_a	r_t	Optimal loss
Empirical	0.510	1.820	0.250	0.370	1.600	0.800	0.680	-
Certainty equivalent	0.299	0.757	1.178	0.298	–0.319	–0.149	0.002	1.587
Parameter incertitude	0.475	0.585	0.877	0.216	–0.573	–0.167	–0.012	4.495

Source: Autor, based on estimations.

shock, the simple optimal policy under uncertainty is generally less aggressive than under certainty equivalent.

The analysis of each figure shows optimal responses to shocks which are not uniform. Figure 13 in appendix B shows that due to a shock of preference, the optimal responses of the all variables are less strong under uncertainty. It is the same for figures 15, 16 and 19. However for figure 14, we note that following investment shock, optimal responses of the all variables are stronger under parameters uncertainty. Figures 17, 18, 20, 21 and 22 in appendix B show stronger responses of optimal consumption under parameters uncertainty.

Tables 8 and 9 of appendix A indicate policies and transition functions which represent the Taylor first-order approximations when the policymakers aim to minimize a quadratic loss function of inflation, output and interest rate under the structural model constraint. The results of these tables confirm those of figures 13 to 22 in appendix B. We can remark that optimal monetary policy responses under a simple rule in the WAEMU countries are relatively the same as under commitment on a policy rule (Ramsey policy) in WAEMU and thus imply relatively the same interpretations and recommendations.

Moreover, recent evaluations of optimal rules were made using ad-hoc loss criteria. Sure enough, the approach based on the ad-hoc loss functions has two advantages over more natural approach of social welfare. First, it does not require as complex as the social welfare approach. Then, it allows easily incorporate a stabilization objective of interest rate. Loss functions are traditionally constructed by taking a weighted average of the variances of inflation, output gap and change in the nominal interest rate (an objective of interest rate smoothing). We choose to evaluate the simple rules under parameter uncertainty and certainty equivalent using ad-hoc loss criteria. We always assume that the central bank objective is to minimize a quadratic function of inflation, output gap and interest rate. The result is also shown in table 5. The loss under optimal parameter uncertainty is greater than those under certainty equivalent. This difference can be explained by the level of uncertainty in the structural parameters of the model. Under certainty equivalent, the central bank changes more strongly the interest rate to stabilize the economy more quickly after a shock.

7 Conclusion

There has been over the past decade remarkable progress in developing empirical micro-founded macroeconomic models namely Dynamic Stochastic General Equilibrium (DSGE) models for monetary policy analysis. This study has drawn on and extended this literature to consider the design of policy under uncertainty. By confronting a fully-specified DSGE model with the WAEMU countries data, we can directly gauge the uncertainty associated with the model parameters as well as the implications of alternative assumptions about the model specification. We have used Bayesian method to estimate parameters of the model which incorporate friction necessary to reproduce the persistence of WAEMU historical data and we determined monetary policy under commitment which maximizes household welfare. Bayesian approach consists in practice to change the shape of the likelihood function of the model by supplementing it with the econometrician beliefs on the model parameters. Our analysis indicates two types of responses depending on optimal monetary regime: commitment on a policy rule (Ramsey policy) or a simple rule, both under certainty equivalent and parameter uncertainty. First, under commitment on a policy rule or a simple rule in the WAEMU, the optimal responses of real consumption (welfare), investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production (output) following preference shock, rental prices of capital shock, technology shock, prices mark-up shock, wages mark-up shock, labor supply shock and inflation objective shock are relatively flat under parameter uncertainty, relatively persistent under certainty equivalent and the optimal policies are relatively aggressive. In these conditions, policymaker modifies vigorously interest rate in order to stabilize the economy more quickly after a shock. Second, under commitment on a policy rule or a simple rule in the WAEMU, the optimal responses of real consumption, investment, real value of capital, capital stock, inflation rate, real wages, labor hours, capital utilization rate and production following investment shock, wages mark-up shock and government expenditure shock are not flat but very persistent under parameter uncertainty and certainty equivalent and the optimal policies are relatively cautious. In these conditions, however, central banker modifies less vigorously interest rate in order to stabilize the economy more quickly after a shock.

The problem of the analysis making in this study is that even if our interpretation provides an original insight of the effects of misspecification of a model, the model is quite complex. DSGE model of the last generation which incorporate the most recent theoretical and empirical advances are today most successful tool of macroeconomic analysis. Their application field limited at first time to the analysis of particular phenomena has expanded notably through the work carried out in the central banks. This is without doubt one of the best recent examples of cooperation between academic circles and policymakers world. However, the fact remains that these models are not always sufficiently detailed either because they assume a single-sector structure of production or because they include only partly international trade. One of the next steps would be the development of multi-sectoral and multi-models which allow for example a better consideration of heterogeneity (including intra-zone) and at run, to analyze more finely the transmission channels of monetary policy.

Apendix:
Apendix A: Tables

TABLE 6: Policy and transition fonctions (Parameters Uncertainty)

	c	*inv*	*q*	*k*	*pi*	*w*	*l*	*im*	*im_rk*	*y*
k(-1)	0.001404	-0.000085	-0.239589	0.537800	-0.162486	0.171898	-0.230805	-0.011957	-0.547720	0.000287
im(-1)	-0.086477	-0.001542	-1.246057	0	-0.007838	0.003279	-0.016817	0.907833	-0.007003	-0.020129
y(-1)	0.164097	0.002925	2.364489	0	0.014874	-0.006222	0.031912	-1.722684	0.013288	0.038197
c(-1)	0.946028	-0.000533	-0.443127	0	0.022842	-0.027706	0.177357	0.391314	0.077407	0.213872
inv(-1)	-0.084603	0.998300	-1.095269	0.462200	0.025895	-0.020859	0.281151	0.629223	0.134636	0.344358
pi(-1)	-0.004647	-0.000005	0.159556	0	0.358268	0.076078	-0.014985	0.042796	0.031601	-0.001053
w(-1)	-0.005949	0.000061	0.398593	0	0.693451	0.200267	-0.038279	0.050846	0.083789	-0.001324
e_b	0.008252	-0.000005	-0.003786	0	0.000338	-0.000202	0.001540	0.003424	0.000692	0.001865
e_inv	0.154964	-1.825598	1.496638	0	-0.075235	0.073059	-0.520585	-1.152703	-0.231483	-0.629674
e_q	-0.000025	0.000300	0.999754	0	0.000012	-0.000012	0.000085	0.000189	0.000038	0.000103
e_a	0.059131	0.001202	1.241454	0	-0.867047	0.899510	-1.355111	-0.606421	-0.235660	0.013818
e_p	-0.006194	-0.000234	-0.414434	0	0.726398	-0.751964	0.138529	0.053079	-0.317300	-0.001487
e_l	0.065673	0.001171	0.946760	0	0.006621	-0.002297	0.012736	-0.689447	0.005399	0.015287
e_w	-0.000006	0	0.000384	0	0.000668	0.000193	-0.000037	0.000049	0.000081	-0.000001
e_r	-0.091500	-0.001631	-1.318440	0	-0.008294	0.003469	-0.017794	0.960569	-0.007410	-0.021298
e_g	-0.003882	-0.00019	-0.755590	0	0.039960	-0.041063	0.336674	0.747412	0.152905	0.408652
e_pi	0.003578	0.000064	0.051551	0	0.000324	-0.000136	0.000696	-0.037558	0.000290	0.000833

Source: Autor, based on estimations.

TABLE 7: Policy and transition fonctions (Certainty Equivalent)

	c	*inv*	*q*	*k*	*pi*	*w*	*l*	*im*	*im_rk*	*y*
k(-1)	0.014047	-0.022047	-0.160753	0.530000	-0.150510	0.141334	-0.235709	-0.065639	-0.579035	-0.005711
im(-1)	-0.047926	-0.124419	-0.487698	0	-0.018126	0.008218	-0.067452	0.398268	-0.031341	-0.060273
y(-1)	0.152235	0.395212	1.549159	0	0.057578	-0.026103	0.214260	-1.265086	0.099554	0.191455
c(-1)	0.849874	-0.053011	-0.248481	0	0.039229	-0.026922	0.186791	0.304152	0.084587	0.166219
inv(-1)	-0.019825	0.669164	-0.747044	0.470000	0.008994	-0.005499	0.288776	0.461535	0.149882	0.262960
pi(-1)	-0.075731	-0.180029	-0.480454	0	0.253036	0.090869	-0.113468	0.461003	-0.011957	-0.088620
w(-1)	-0.066712	-0.124251	0.119251	0	0.651219	0.298339	-0.124541	0.128825	0.091957	-0.064348
e_b	0.057553	-0.004011	-0.016500	0	0.004804	-0.000851	0.012289	0.021098	0.006052	0.011088
e_inv	0.050821	-1.408919	1.017939	0	-0.078076	0.061659	-0.614909	-0.990151	-0.292725	-0.551657
e_q	-0.005133	0.142315	0.897178	0	0.007886	-0.006228	0.062112	0.100015	0.029568	0.055723
e_a	0.119237	0.347416	1.366959	0	-0.657791	0.651081	-1.141263	-0.755723	-0.259355	0.165085
e_p	-0.035883	-0.125137	-0.501307	0	0.563045	-0.554757	0.037264	0.107428	-0.273806	-0.057905
e_l	0.063177	0.164544	0.651558	0	0.031233	-0.007720	0.088585	-0.529626	0.042786	0.079666
e_w	-0.000724	-0.001348	0.001294	0	0.007064	0.003236	-0.001351	0.001397	0.000998	-0.000698
e_r	-0.093972	-0.243958	-0.956271	0	-0.035542	0.016113	-0.132259	0.780917	-0.061453	-0.118182
e_g	-0.014892	-0.043372	-0.576715	0	0.046603	-0.037964	0.400196	0.643479	0.191657	0.359389
e_pi	0.037758	0.098022	0.384230	0	0.014281	-0.006474	0.053142	-0.313772	0.024692	0.047486

Source: Autor, based on estimations.

TABLE 8: Policy and transition fonctions (Parameters Uncertainty)

	c	*inv*	*q*	*k*	*pi*	*w*	*l*	*im*	*im_rk*	*y*
k(-1)	0.001142	-0.000083	-0.210700	0.537800	-0.162527	0.171912	-0.230855	-0.035189	-0.547738	0.000228
im(-1)	-0.007281	-0.000269	-0.549755	0	-0.000405	0.000222	-0.001447	0.475820	-0.000633	-0.001746
y(-1)	-0.008774	-0.000325	-0.662533	0	-0.000488	0.000268	-0.001744	0.573432	-0.000763	-0.002104
c(-1)	0.950666	-0.000175	0.058808	0	0.022935	-0.027826	0.178329	-0.019373	0.077848	0.215052
inv(-1)	-0.078918	0.998889	-0.280766	0.462200	0.025842	-0.020979	0.282382	-0.033546	0.135211	0.345859
pi(-1)	-0.001680	-0.000049	0.005778	0	0.358677	0.075940	-0.014431	0.168349	0.031815	-0.000398
w(-1)	-0.000273	0.000019	0.257989	0	0.694150	0.200021	-0.037211	0.150187	0.084214	-0.000055
e_b	0.008293	-0.000002	0.000565	0	0.000339	-0.000203	0.001548	-0.000139	0.000696	0.001876
e_inv	0.144360	-1.826672	0.017950	0	-0.075169	0.073287	-0.522874	0.055306	-0.232549	-0.632464
e_q	-0.000024	0.000300	0.999997	0	0.000012	-0.000012	0.000086	-0.000009	0.000038	0.000104
e_a	0.004090	0.000184	0.436351	0	-0.872006	0.901594	-1.365825	-0.021395	-0.240123	0.000992
e_p	-0.005547	-0.000233	-0.525435	0	0.726507	-0.752002	0.138654	0.157333	-0.317254	-0.001340
e_l	-0.000186	-0.000007	-0.013791	0	0.000658	0.000198	-0.000073	0.012296	0.000065	-0.000045
e_w	0	0	0.000249	0	0.000669	0.000193	-0.000036	0.000145	0.000081	0
e_r	-0.015305	-0.000566	-1.155651	0	-0.000851	0.000467	-0.003041	1.000231	-0.001332	-0.003669
e_g	-0.003067	-0.000119	-0.051692	0	0.039773	-0.041021	0.336836	-0.037662	0.153011	0.408863
e_pi	-0.003325	-0.000123	-0.251047	0	-0.000185	0.000101	-0.000661	0.217284	-0.000289	-0.000797

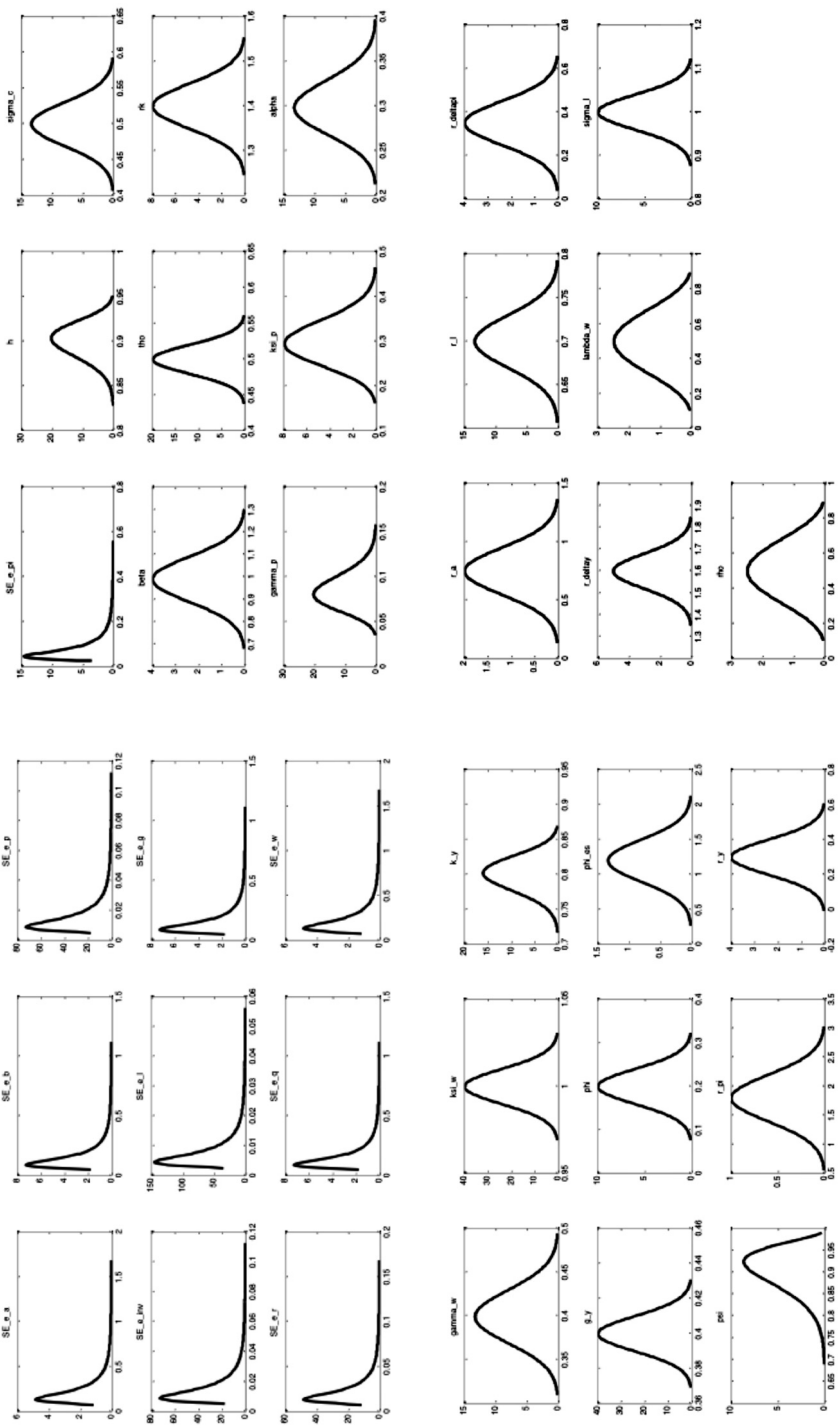
Source: Autor, based on estimations.

TABLE 9: Policy and transition fonctions (Certainty Equivalent)

	c	*inv*	*q*	*k*	*pi*	*w*	*l*	*im*	*im_rk*	*y*
k(-1)	0.011484	-0.035196	-0.191530	0.530000	-0.149742	0.141907	-0.242180	-0.050505	-0.582155	-0.011529
im(-1)	-0.019239	-0.055072	-0.308396	0	-0.004007	0.002763	-0.029222	0.285083	-0.014000	-0.026244
y(-1)	-0.020547	-0.058816	-0.329361	0	-0.004279	0.002950	-0.031208	0.304463	-0.014951	-0.028028
c(-1)	0.839040	-0.056817	-0.074375	0	0.022190	-0.023852	0.181956	0.088724	0.083653	0.162310
inv(-1)	-0.035130	0.643664	-0.482924	0.470000	-0.006985	-0.000781	0.273078	0.124073	0.144073	0.249398
pi(-1)	-0.018823	-0.050180	-0.195687	0	0.284259	0.079812	-0.040959	0.304968	0.020557	-0.024198
w(-1)	-0.006748	-0.007294	0.183540	0	0.693292	0.285769	-0.056656	0.204606	0.121224	-0.004402
e_b	0.057014	-0.003886	-0.004454	0	0.003783	-0.000684	0.012183	0.006703	0.006084	0.011019
e_inv	0.080101	-1.369116	0.448863	0	-0.044112	0.052497	-0.588780	-0.280905	-0.283748	-0.529300
e_q	-0.008091	0.138295	0.954660	0	0.004456	-0.005303	0.059473	0.028374	0.028661	0.053465
e_a	0.022776	0.083100	0.421628	0	-0.691512	0.668130	-1.283193	-0.037704	-0.325430	0.038220
e_p	-0.026810	-0.091747	-0.479864	0	0.565326	-0.556933	0.054446	0.147125	-0.265866	-0.042565
e_l	0.000079	0.000356	0.004425	0	0.007552	0.003078	-0.000384	-0.000031	0.001426	0.000159
e_w	-0.000073	-0.000079	0.001991	0	0.007521	0.003100	-0.000615	0.002220	0.001315	-0.000048
e_r	-0.064226	-0.183848	-1.029517	0	-0.013377	0.009222	-0.097551	0.951693	-0.046735	-0.087609
e_g	-0.020474	-0.061896	-0.263050	0	0.038245	-0.034852	0.390186	0.188840	0.188007	0.350758
e_pi	-0.010900	-0.031200	-0.174717	0	-0.002270	0.001565	-0.016555	0.161509	-0.007931	-0.014868

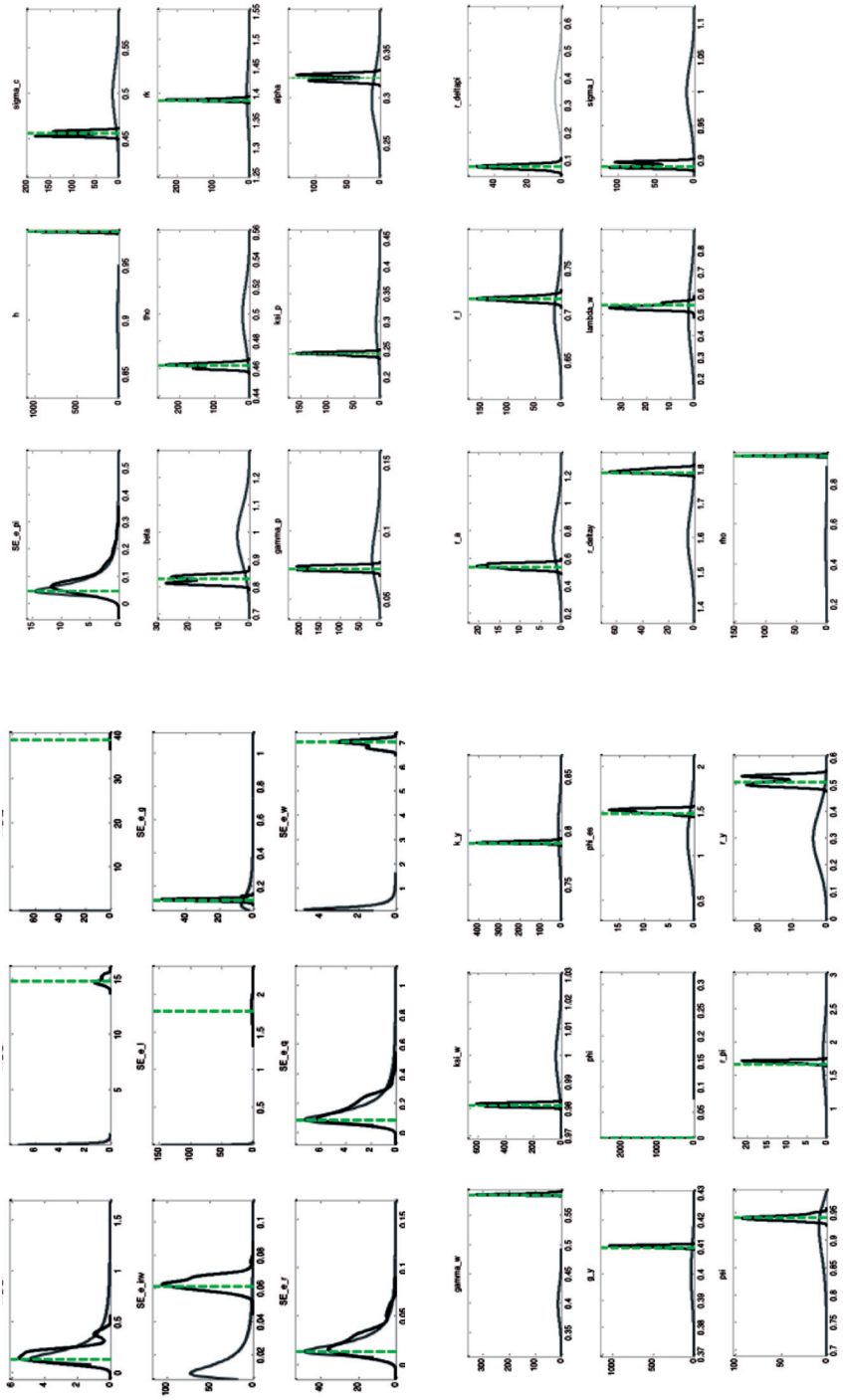
Source: Autor, based on estimations.

Appendix B: Figures
Figure 1: Prior distribution



Source: Autor, based on simulations.

Figure 2 : Prior distribution (gray line) and posterior distribution (black line)



Source: Autor, based on simulations.

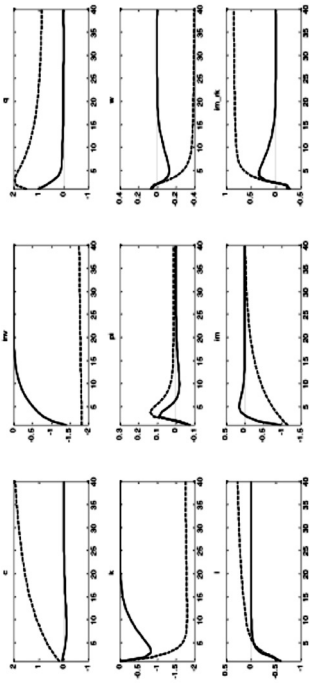


Figure 4: Investment shock

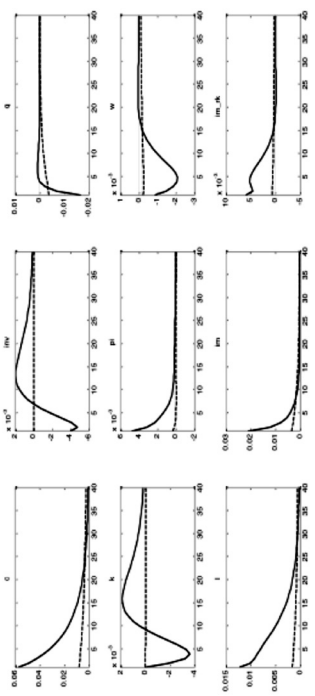


Figure 3: Preference shock

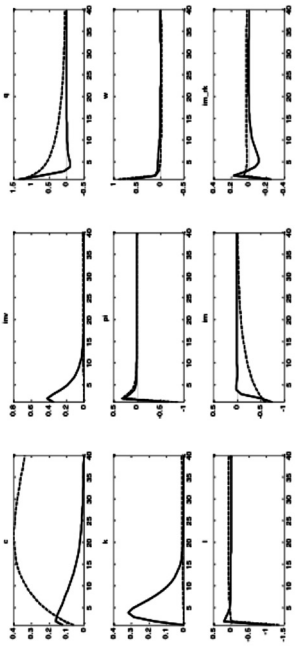


Figure 6: Technology shock

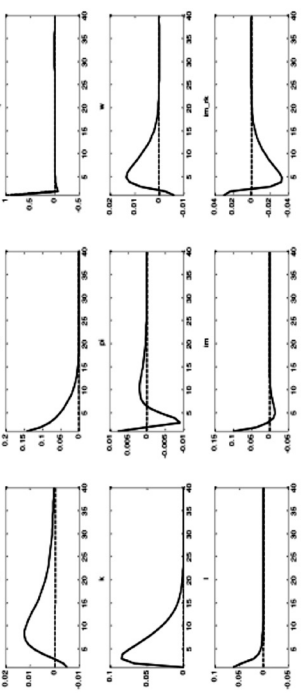


Figure 5: Rental price of capital shock

Figure 7: Price mark-up shock

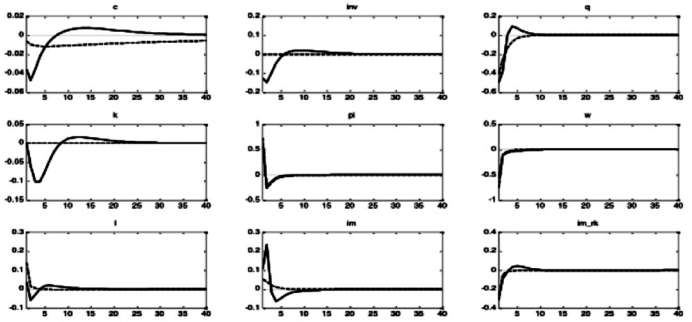


Figure 8: Wages mark-up

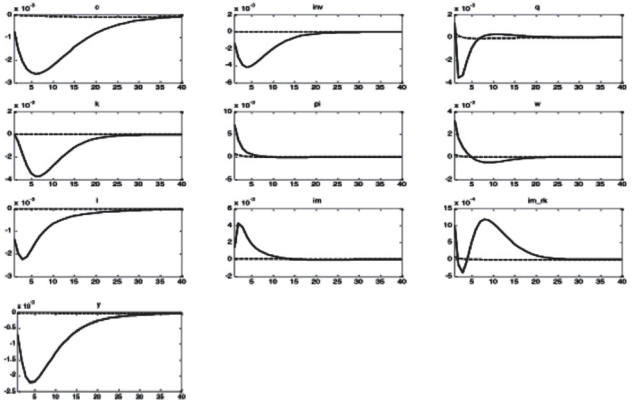


Figure 9: Interest rate shock

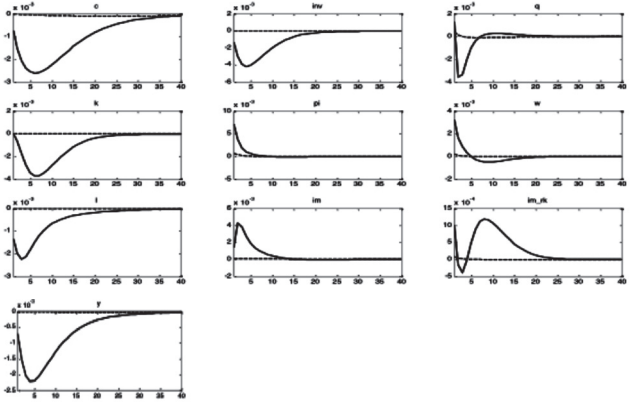


Figure 10: Government expenditure shock

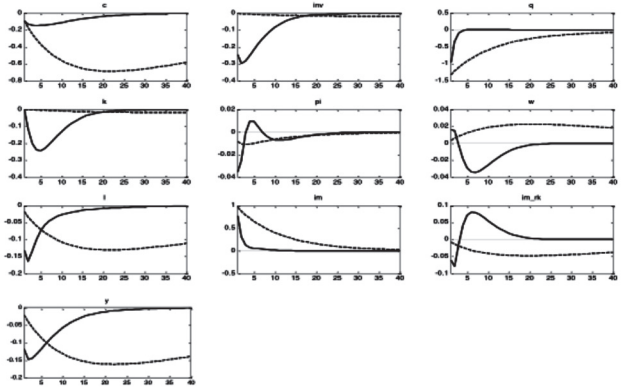


Figure 11: Labor supply shock

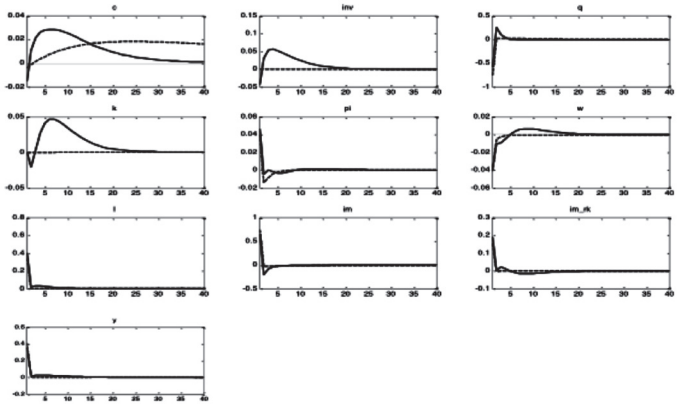
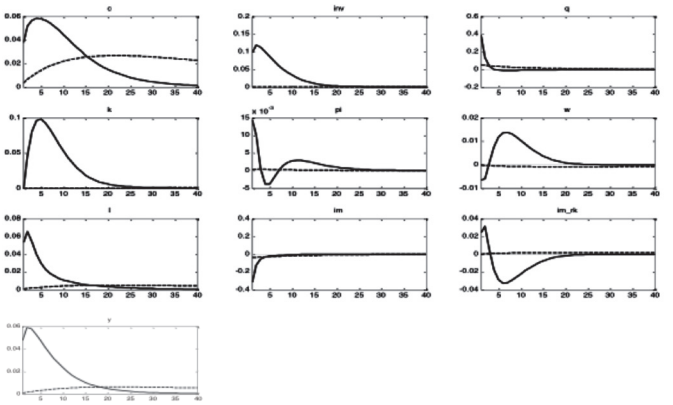


Figure 12: Inflation objective shock



Source: Autor, based on simulations.

Figure 13: Preference shock

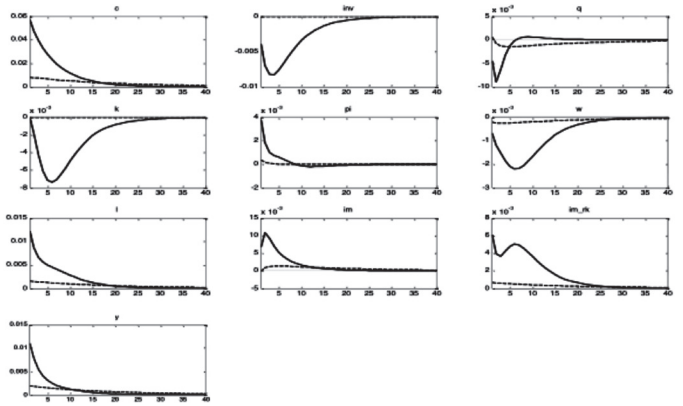


Figure 14: Investment shock

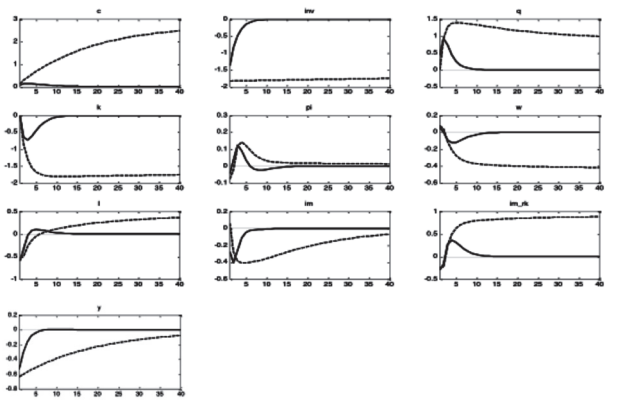


Figure 15: Rental prices of capital shock

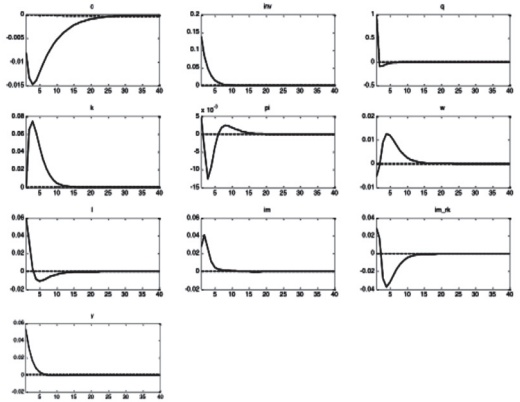


Figure 16: Technology shock

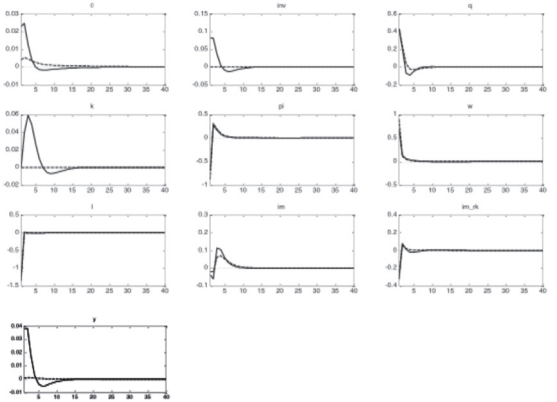


Figure 17: Prices mark-up shock

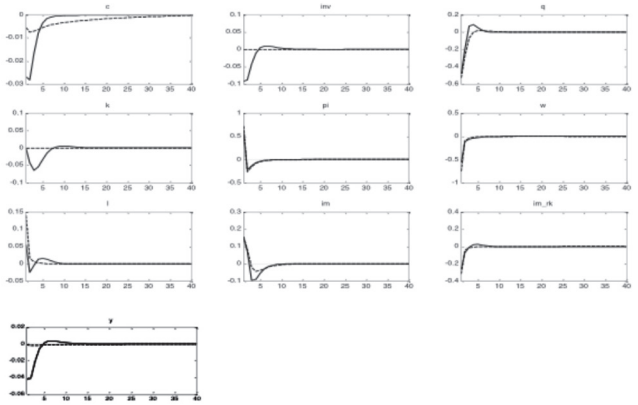


Figure 18: Wages mark-up shock

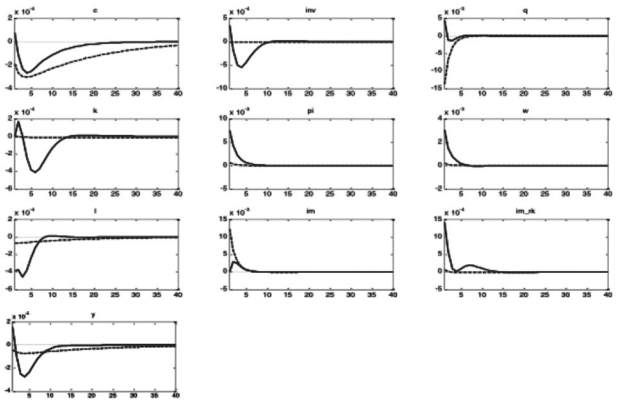


Figure 19: Interest rate shock

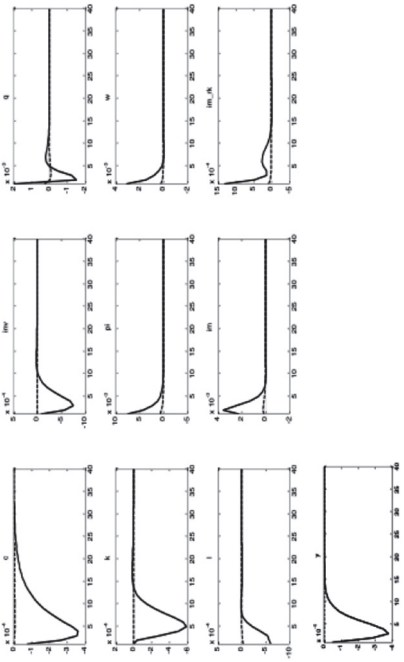


Figure 20: Government expenditure shock

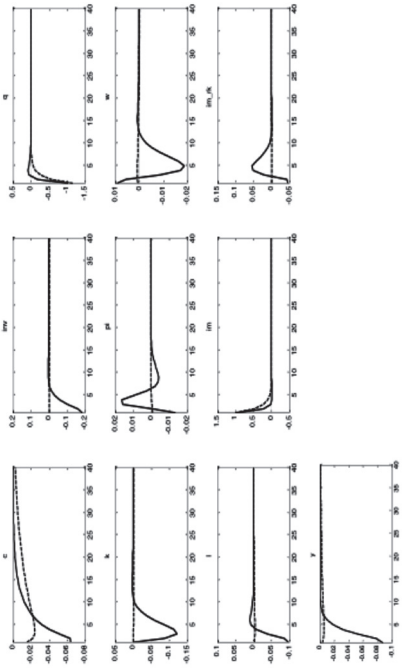


Figure 21: Labor supply shock

Figure 22: Inflation objective shock

Source: Autor, based on simulations.

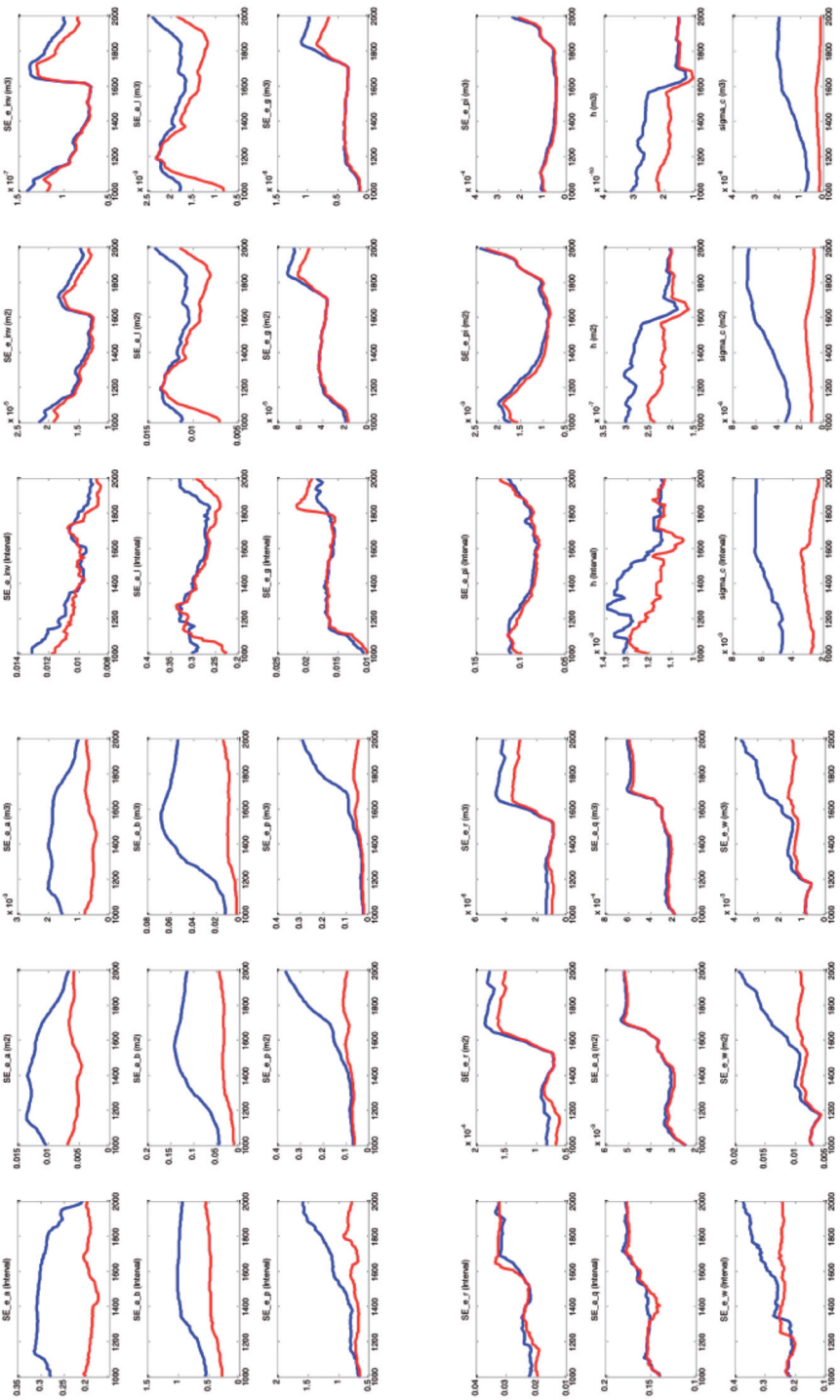
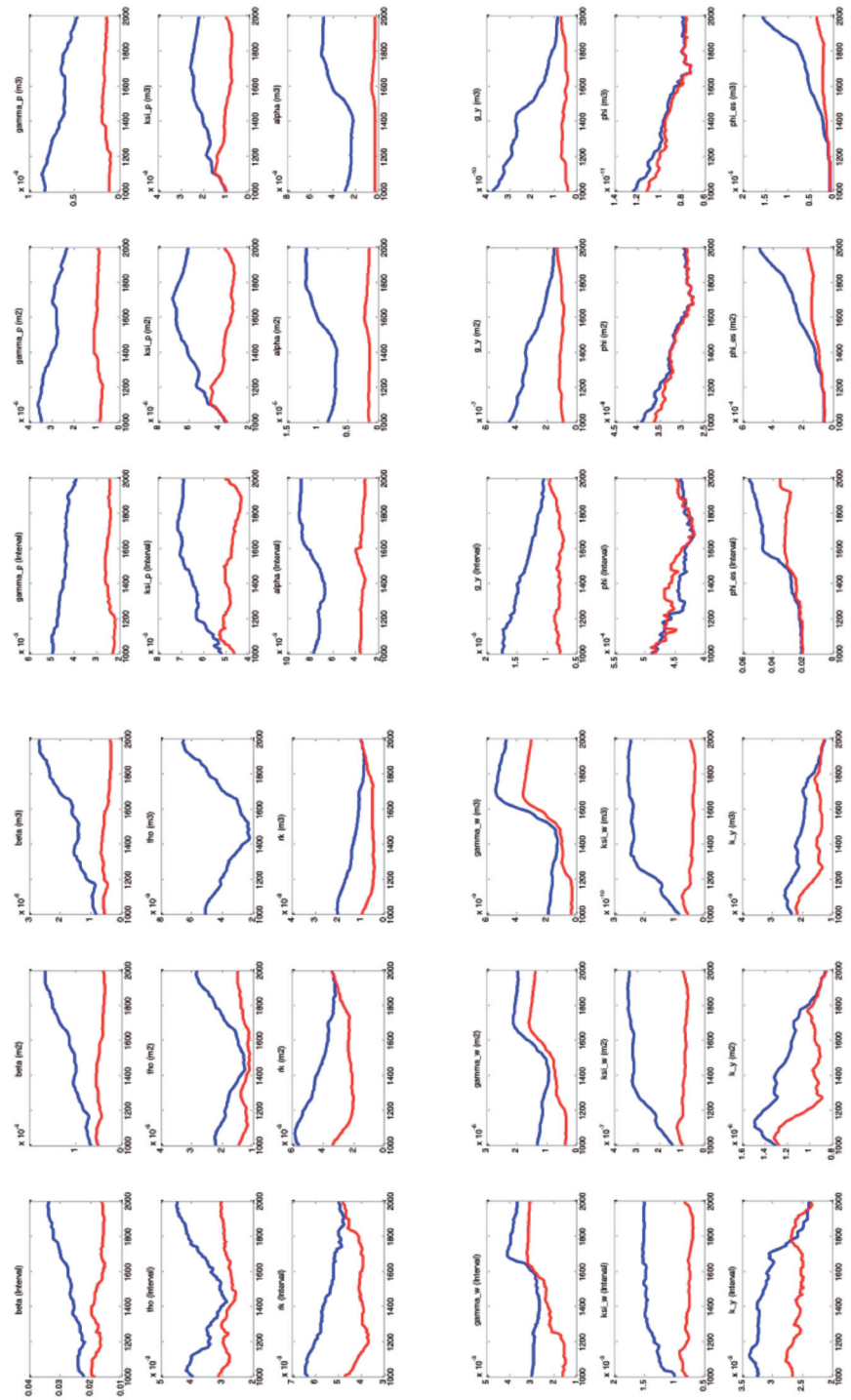
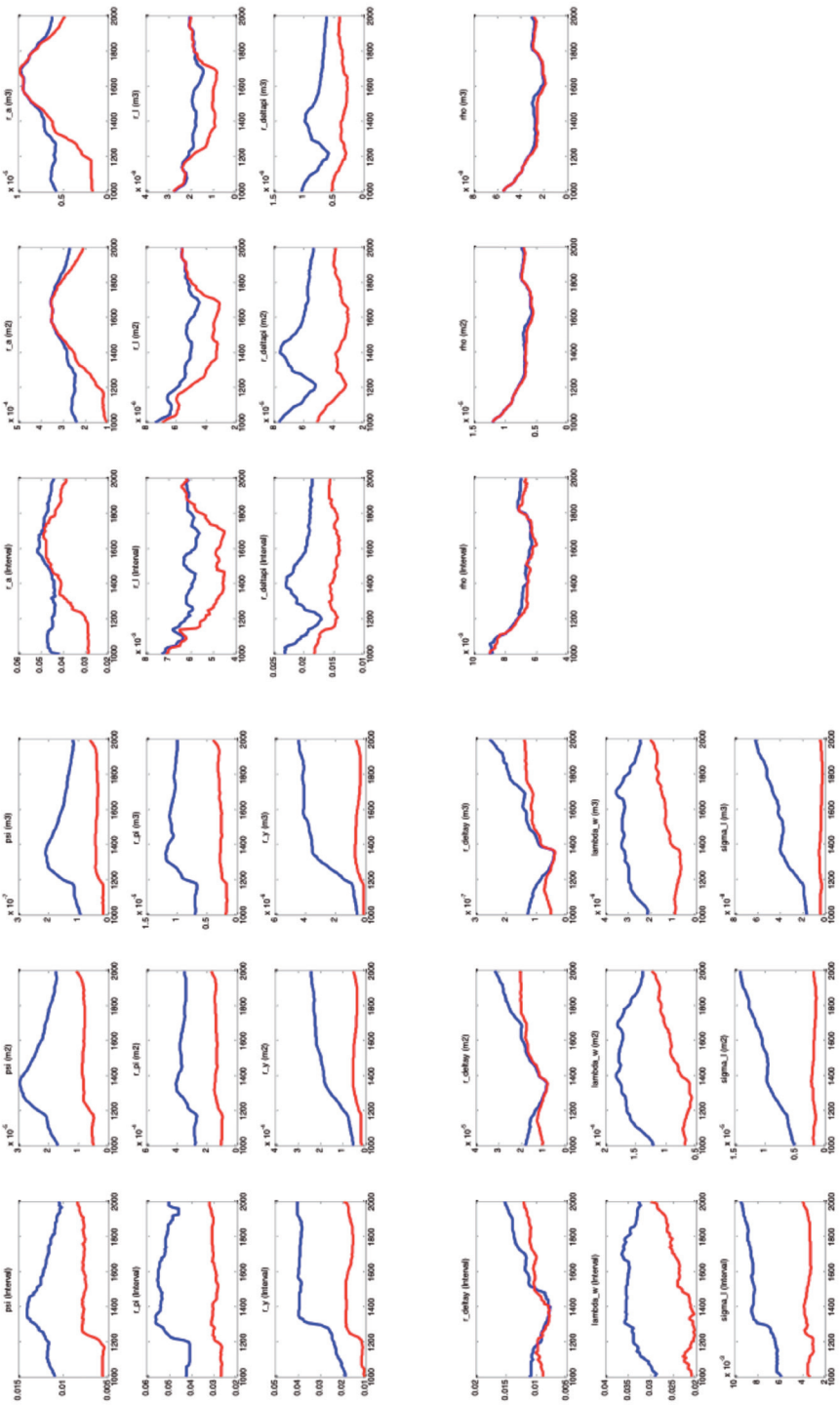


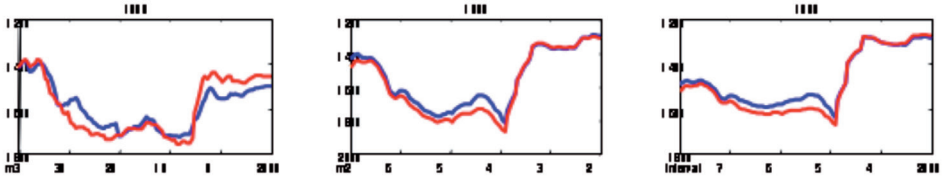
Figure 23: MCMC univariate diagnostic (Brooks and Gelman. 1998)





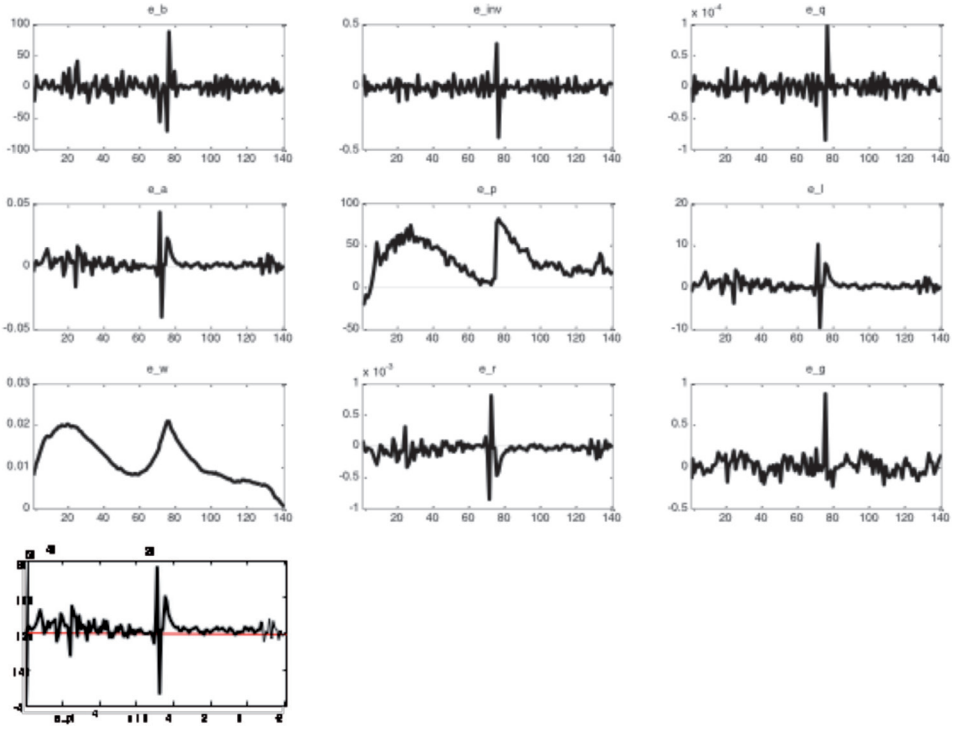
Source: Autor, based on simulations.

Figure 24: Multivariate diagnostic



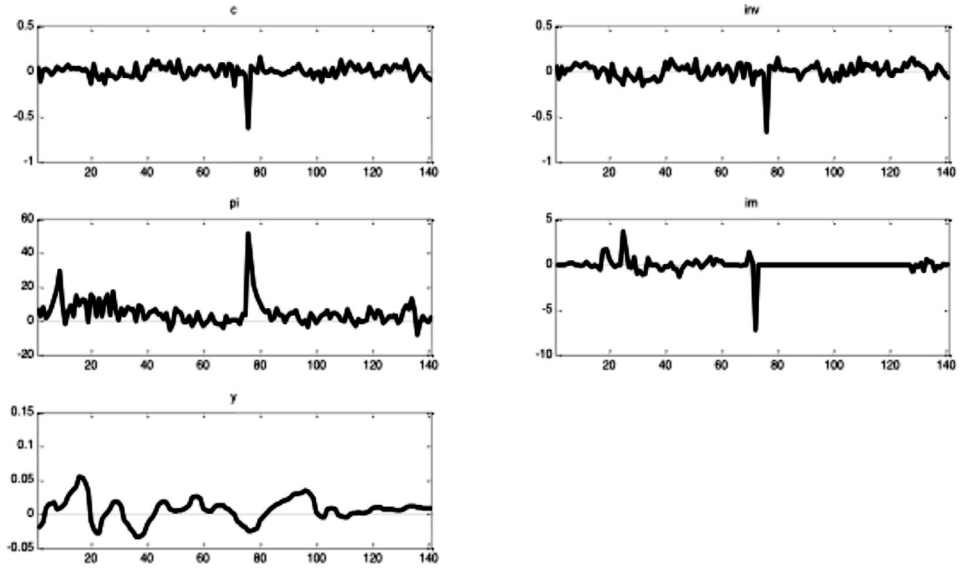
Source: Autor, based on simulations.

Figure 25: Shocks smoothing



Source: Autor, based on simulations.

Figure 26: Historical and smooth variables



Source: Autor, based on simulations.

References

Abel. A, (1990), "Asset prices under habit formation and catching up with the Joneses", *American Economic Review*, 80, 38-42.

Adjemian, S. and Pelgrin, F. (2008), "Un regard Bayésien sur les Modèles Dynamiques de la Macroéconomie"; *mimeo*. CEPREMAP; April.

Adjemian, S. and Devulder, A. (2011). "Evaluation de la politique monétaire dans un modèle DSGE pour la zone euro", *Working Paper, nφ7,* CEPREMAP, July.

Angelini, P., Del Giovane, P., Siviero, S. and Terlizzese, D. (2002), "Monetary policy rules for the euro area: What Role for National Information?", *Working Paper. nφ457*, Banca of Italia.

Avouyi-Dovi, S., Matheron, J. and Fève. P. (2007), "Les modèles DSGE: Leur intérêt pour les banques centrales", *Bulletin de la Banque de France, n°* 161, May.

Batté, L., Bénassy-Quéré. A., Carton, B. and Dufrénot, G. (2009), "Term of Trade Shocks in a Monetary Union: An Application to West-Africa", *CEPII*, WP, n° 2009-07.

Bernanke, B. (1986), "Alternative Explanations of the Money-Income Correlation", *Carnegie Rochester Conference Series on Public Policy*, 25(10), 49–99.

Blanchard, O. J. and Fischer, S. (1989), "*Lectures on Macroeconomics*", MIT press.

Blanchard, O. and Quah, D. (1986a), "The Dynamic Effects of Aggregate Demand and Supply Disturbances", *The American Economic Review*, 79, 655–673.

Brainard, W. (1967), "Uncertainty and the effectiveness of policy", *American Economic Review*, 57, 411-425.

Brock, W. A., Durlauf, S. N. and West, K. D. (2003). "Policy evaluation in uncertain economic environments", *Brookings Papers on Economic Activity*, 235-301.

Calvo, G. (1983), "Staggered prices in a utility-maximizing framework", J*ournal of Monetary Economics*, 12, 383-398.

Christiano, L., Eichenbaum, M. and Evans, C. (2005), "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy", *Journal of Political Economy,* 113, 1–45.

Craine, R. (1979), "Optimal monetary policy with uncertainty", J*ournal of Economic Dynamics and Control* 1, 59-83.

Diop, M. (2007), "Régimes de change et bien-être: une approche par un modèle DSGE", *mimeo.*

Erceg, C. J., Henderson, D. W. and Levin, A.T. (2000), "Optimal monetary policy with staggered wage and price contracts", *Journal of Monetary Economics*, 46, p. 281-313.

Feldstein, M. (2003), "Monetary policy in an uncertain economy", *Working Paper*, n° 9969, NBER.

Giannoni, M. (2002), "Does model uncertainty justify caution? Robust optimal monetary policy in a forward-looking model", *Macroeconomic Dynamics 6*, 111-144.

Greenspan, A. C. (2003), "Monetary policy under uncertainty", *remarks,* Symposium sponsored by the Federal Reserve Bank of Kansas City.
(*http ://www.federalreserve.gov/boarddocs/speeches/2003/20030829/*).

Hansen, L. P. and Sargent, T. J. (2003), "*Robust Control and Econmic Model Uncertainty"* Mimeo. University of Chicago.

Issing, O. (1999), "The monetary policy of the ECB in a world of uncertainty", *Contribution to policy panel* at the conference on "Monetary policy-making under uncertainty" organize by ECB and Center for Financial Studies, 3-4, Frankfort, December.

Juillard, M. (2001), "DYNARE: A program for solving and estimating rational expectation models", (*http://www.cepremap.cnrs.fr/dynare*).

Knight, F. (1921), "*Risk, Uncertainty and Profit*", Houghton Mifflin Company, Boston.

Kollmann, R. (1997), "The exchange rate in a dynamic-optimizing current account model with nominal rigidities : a quantitative investigation", *IMF Working Paper*, WP/97/7 (January).

Kydland, F. and Prescott, E. (1982), "Time to Build and Aggregate Fluctuations", *Econometrica*. 50, 1345–1370.

Levin, A. T., Onatski, O., Williams, J. C. and Williams, N. (2005). "Monetary policy under uncertainty in micro-founded macroeconometric models", in Gertler, M. and Rogo, K.. NBER *Macroeconomics Annual*, The MIT Press.

Lucas, R. (1976), "Econometric policy evaluation: a critique", *Carnegie-Rochester Series on Public Policy*, 1, 19-46.

McCallum, B. T. (1988), "Robustness properties of a rule for monetary policy", *Carnegie-Rochester Conference Series on Public Policy* 29, 175-203.

Monteforte, L. and Siviero, S. (2003), "Aggregate vs. disaggregate euro-area macro-modelling", *Working Paper*, Banca of Italia.

Nubukpo, K. (2007), "L'efficacite de la Politique Monetaire en Situation d'Incertitude et

d'Extraversion: Le Cas de l'Union Economique et Monetaire Ouest Africaine (UEMOA)", *The European Journal of Development Research*, Vol 19, Issue 3, pages 480 – 495, September.

Onatski, A. (2000), "*Robust monetary policy under model, data, and shock uncertainty in a forward-looking model of the US economy*", Manuscript, Harvard University.

Onatski, A. and Stock, J. H. (2002), "*Robust monetary policy under model uncertainty in a small model of the US economy*", Macroeconomic Dynamics 6, 85-110.

Rotemberg, J. and Woodford, M. (1997), "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy", NBER *Macroeconomics Annual*, 12, 297–346.

Rudebusch, G. D. (2001), "Is the Fed too timid ? Monetary policy in an uncertain world", *Review of Economics and Statistics 83*, 203-217, May.

Sims, C. (1980), "Macroeconomics and Reality", *Econometrica*, 48(1), 1-48.

Sims, C. (1986), "Are Forecasting Models Usable for Policy Analysis", *Federal Reserve Bank of Minneapolis Quarterly Review*, 10(1), 2-16.

Smets, F. and Wouters. R. (2003), "An estimated dynamic stochastic general equilibrium model of the Euro area", *Journal of the European Economic Association* 1, 1123 -1175.

Soderstrom, U. (2002), "Monetary policy with uncertain parameters", *Scandinavian Journal of Economics* 104, 125-145.

Taylor, J. B. (1999), "*Monetary Policy Rules*", Chicago: University of Chicago Press for the NBER.

Tenou, k. (2002), "La règle de Taylor: un exemple de règle de politique monétaire appliquée au cas de la BCEAO", *Information and Statistics Notes*, BCEAO, no 523, March.

Tetlow, R. J. and Muehlen, P. von zur (2002), "Avoiding Nash inflation: Bayesian and robust responses to model uncertainty", *Finance and Economics Discussion Series*, Federal Reserve Board.

Oil Prices, Macroeconomic Policies and Stock Market Price Movements in Nigeria

by
Elija A. P. UDOH*
and
EliasA. UDEAJA*

Abstract

In this article, we investigate the extent of the impact of international oil price volatility on the average stock index. Our study extends the empirical literature by developing a more robust high frequency econometric method, EGARCH, that incorporates volatility but also generate coefficients that can be interpreted as impact of policy variables on stock prices. Using quarterly data spanning 2000 to 2014 we found that international oil price have significant positive impact on average stock index in Nigeria. The findings show that the volatility in the stock prices is explained to a large extent by the volatility in international oil prices and the real exchange rate. The inclusion of the macroeconomic variables and oil prices in the model increases the importance of news about previous period volatility in stock prices. The positive and significant asymmetry effect indicates that negative shocks, such as those arising from economic recession have larger effects on volatility of the stock price than positive shocks probably from economic boom. There is need to protect the domestic economy from the international oil market volatility. Stock market performance is a barometer of economic activity in a country; hence oil money should not be allowed to be the main driver of stock market activity. The idea of establishing a sovereign wealth fund by the government should be applauded.

JEL Classification: G14, G15, C52, N27

Key Words: stock market, volatility models, EGARCH, Oil price

* Dr Elijah A. P. Udoh is at the Business Development Unit, West African Institute for Financial and Economic Management (WAIFEM), Lagos and Dr. Elias A. Udeaja is Head, Economics and Statistics Unit, Central Bank of Nigeria (CBN) Learning Centre, Lagos.

1. Introduction

The significance of the petroleum sector for the overall economic activity in Nigeria is well known and long standing. This sector accounts for substantial government revenue, foreign earnings and thus a big determinant of government spending. Through its influence on the macroeconomic management, the petroleum sector also affects the stock market. In view of this, an empirical investigation of the effect of oil price shock on the behaviour of stock prices is pertinent. Apart from its implication for investors and the regulatory authority on effective monitoring of the performance of the stock market; the study can also be helpful in portfolio construction and risk management of the Nigerian stock market.

In Nigeria oil price shock affect every other macroeconomic variable. It affects corporate performance, output and earnings, stock market returns and aggregate demand. High oil price provides additional income and wealth leading to higher level of economic activity and savings. Thus the effect of oil price changes transmits to economic activity through macroeconomic factors. Increase or decrease in oil price lead to increase or decrease in the level of aggregate demand through rising or decreasing national income or per capita income. This improvement in economic activity will alter expectations of economic agents and consequently stock prices will be affected.

Studies have shown that volatility in stock prices reflects the arrival of new information. Bad and good news both seem to increase the volatility of the stock market (Ali, 2013). Information related to oil price fluctuations affects the volatility of the stock market (Killian and Park, 2009, Miller and Ratti, 2009, Fayyad and Daly, 2011; Arouri and Rault, 2012, Adebiyi et al, 2010, Chuku, 2012). Ali (2013) observes that negative shocks have a much larger and long lasting impact than positive shocks of the same magnitude.

Following the global financial crises that affected the financial market leading to collapse of the 'too big to fail' financial institutions, loss in asset value/share prices of mortgages related securities, and collapse of stock markets across the world, the Nigeria stock market, which experienced bullish in early year 2008 at Average stock index of 58,580 with a market capitalization of N10.284 trillion, crashed. Nigeria equally faced a major decline in portfolio equity flows as a result of the fall in stock market. The foreign portfolio investors withdrew $15 billion from Nigerian capital market in January 2009. All share indexes shred a total share of 67 percent from March 2008 to March 2009. Most macroeconomic variables were affected by the global meltdown, for instance, oil prices went down from peak of US$147 per barrel in July 2008 to US$40 per barrel in February 2009. The currency depreciated from ₦118 to ₦145 per dollar. Inflation rate rose markedly in the fourth quarter of 2008 reaching a 3 – year high of 15.1 percent in December from 7.8 per cent at end March 2008 (CBN, 2011).

The continued deterioration in macroeconomic variables necessitated different reforms in the economy. The Central Bank of Nigerian embarked on reforms to restore stability in the banking sector that was highly exposed to stock market through margin loan and exposure to oil and gas, the Nigerian Securities and Exchange Commission came up with various reforms aimed to rescue, revive and restore the confidence of investors in the market. To crown it

all, the Federal Government of Nigeria initiated national economic reforms anchored on the transformation agenda and vision 2020 with the aim to restoring macroeconomic stability.

In recent years, the economic outlook appears to be brighter. The reforms seem to have achieved some positive results. Oil price has risen from as low as US$45.87 per barrel in fourth quarter of 2008 to as high as US$112.75 in fourth quarter of 2013 (CBN, 2013). Hence we would expect this to be fully reflected in the speedy recovery of the stock market. This paper therefore investigates the nature of the relationship between macroeconomic oil price shocks and stock market performance in Nigeria. The paper employs E-GARCH model to confirm whether the degree of response of stock price to positive shocks in oil price and macroeconomic variables differs from the response to negative shocks in oil price and macroeconomic policies. In other words, does positive macroeconomic development and increase in international oil prices stimulate stock prices faster than when negative development occur. The choice of E-GARCH, a non-normal distribution model, is based on the results of similar studies in the literature such as Nelson(1991) for United States stock market returns.

The rest of the paper is organized as follows: the next section briefly reviews related literature, section three presents the data and methodology, section four presents and discusses the empirical results, while the last section is on the conclusion and policy recommendations.

2. Literature Review

Theoretically, oil price shocks may have positive or negative impact depending on whether the economy in question is a net oil-importer or exporter. In oil-exporting countries, a rise in world oil prices represents a positive shock. It improves the trade balance and net foreign asset position as well as increase private disposable income of the citizens. This increases aggregate domestic demand and stock prices (Abdelaziz et al, 2008; Adebiyi et al, 2010). In oil-importing countries, a rise in world oil prices represents a negative shock. It affects the cost of production of firms and their profitability (where the cost cannot be transferred to consumers) as well as their dividends which directly determine the stock price. From a macroeconomic perspective, a rise in oil price reduces the disposable income and thus their demand for financial assets, with obvious negative effect on stock prices. In addition, according to the equity pricing model of Huang et al (1996), it exert inflationary pressure and create uncertainty which may lead to increase in cost of capital with adverse impact on stock prices.

The relationship between macroeconomic variables and stock prices has been at the center of scholarly debates among policy-oriented researchers and financial economists in both developed and developing countries. For instance, Chen et al (1986) argue that movements in macroeconomic variables affect future dividends as well as discount rates, thus affecting stock prices. Smith (1996) observes that American stock prices usually decline shortly before a recession ends.

Changes in consumption and investment opportunities are priced in the capital market, hence stock price changes are related to innovations in economic variables (Goswami and Jung 1997). Two major hypotheses explain these linkages. The first hypothesis is the expected real interest rate, which posits that stock prices decrease because the real component of nominal

interest rates is expected to increase. This affect stock prices directly because the real discount rate at which future cash flows are capitalized is expected to increase indirectly because real output is adversely affected by higher real interests and thus future cash flows are expected to decrease. The second hypothesis focused on the expected inflation, this hypothesis asserts that stock prices decrease because of inflation premium in nominal interest rates increases, which decreases the after tax real dividends (Hardouvelis 1987; Thorbecker 1997; Aranjo 2009). The two hypotheses above depend on how markets perceive future macroeconomic policies.

Empirical evidence have shown that expansionary monetary policy exerts real effects on stock returns by increasing future cash flows or by decreasing the discount factors at which those cash flows are capitalized. Fama (1981) documents a strong positive correlation between common stock returns and real economic variables like capital expenditures, industrial production, real output, money supply, inflation and interest rates.

The study by Ibrahim and Aziz (2003) focus on the relationship between stock prices and industrial production, money supply, consumer price index and exchange rate in Malaysia. They found that stock prices have positive long run relationship with industrial production and consumer price index. On the other hand, they conclude that stock prices have a negative relationship with money supply and exchange rate.

A similar study was conducted by Serkan (2008) in Turkey and the findings were that exchange rate; interest rate and world market return affect portfolio return, while industrial production, money supply and oil price do not have significant effect on Turkish stock returns.

In their own contribution, Adan and Tweneboah (2008), examine the impact of macroeconomic variables on stock prices in Ghana and find that lagged values of interest rates and inflation have a significant influence on the stock market. Also, the inward foreign direct investments, oil prices, and the exchange rate demonstrate weak influence on stock price changes.

In Nigeria, several attempts have been made to investigate the relationship between stock prices and macroeconomic variables (see Akinnifesi 1987; Soyode 1993; Amadi et al 2000), using simple statistics. Other studies such as Nwokoma (2002), Adebiyi et al (2001), Adegoke and Abraham (2012), Osamwonyi and Evbayiro-Osagie (2012), Ikoku (2010), and Maku and Ntanda (2010), attempted to establish the short run and long run relationship between stock prices and macroeconomic variables adopting different methodologies including co-integration, vector error correction model (VECM) ARIMA VAR model and concluded that macroeconomic policy variables cannot be ignored when accounting for the dynamics of stock returns in Nigeria.

This study extends the existing literature by developing a more robust high frequency economic method, EGARCH that incorporates volatility but also generates coefficients that can be interpreted as impact of policy variables on stock prices. As a point of departure from previous studies, international oil price is introduced along with macroeconomic variables. There has been a large body of literature focusing on the links between oil prices and macroeconomic variables. It has been confirmed that oil price fluctuations have significant effects on economic activity in many developed and emerging countries [Lunado and Perez de Garcia (2005),

Balaz and londarev (2006) Grouwald (2008), Cologui and Manera (2008) and Kilian (2008)]. However, there are relatively few works done on the relationship between oil price variations, macroeconomic policies and stock markets.

The pioneering paper by Jones and kaul (1996) tests the reaction of international stock markets to oil price shocks on the basis of a standard cash flow dividend valuation model. They find that for the US and Canada, this reaction can be accounted for entirely by the impact of the oil shocks on cash flows. The results for Japan and the UK were inconclusive using an unrestricted vector autoregressive (VAR), Huang et al (1996) shows a significant link between some American oil company stock returns and oil price changes. However, they find no evidence of a relationship between oil prices and market indices such as the Standard and Poor's 500 (S&P 500).

By contrast, Sadorsky (1999) applies an unrestricted VAR with GARCH effects to American monthly data and shows a significant relationship between oil price changes and aggregate stock returns. Papapetrou (2001) using a VAR model shows a significant relationship between oil price changes and stock markets in Greece.

Hammoudeh and Alesia (2004) find interesting results in the case of the oil sensitivity of the stock markets in some oil exporting countries namely Bahrain, Kuwait and Oman except Saudi Arabia. Based on their study, the stock returns of these oil exporter counties have no casual relationships with oil price changes. Using VAR approach and utilizing variance decomposition and impulse response analysis, Maghyereh (2004) find that oil price shocks have no impact on stock market.

Cong et al (2008) investigate the interactive relationships between oil price shock and Chinese stock market. Using multivariate vector auto regressive, they conclude that oil price shocks do not have statistically significant impact on the real stock returns of most Chinese stock market indices, except for manufacturing index and some oil companies. Apergis and Miller (2009) examined whether structural oil- market shocks affect stock returns in eight developed countries, and show no significant responses to international stock market returns to oil price shocks. In a seminal study, Nandha and Brooks (2009) examine the reaction of the transport sector to oil price fluctuations in thirty-eight counties and document the influence of oil prices on the stock returns in this sector in developed economies.

Arouri et al (2009) investigate the effects of oil shocks on the stock market of GCC regions (oil exporting) countries, applying linear and non-linear, the result shows that stock market returns significantly react to oil price changes in Qatar, Oman, Saudi Arabia and UAE except Bahrain and Kuwait. Bjornland (2009) employs the structural VAR model to examine the effects of oil price movements on stock price behavior, and the findings suggests that the Norwegian economy responds to higher oil prices by increasing aggregate wealth and demand, in the short term, stock prices fluctuates owing to the monetary policy shocks.

Wang et al (2012) using a structural VAR investigate the effects of oil price shocks on stock market returns, differentiating oil-exporting countries from oil-importing countries. They find that the magnitude, duration, and even direction of response by stock market in a country to oil

price stocks highly depends on whether the country is a net importer or exporter in the world oil market and whether changes in oil price are driven by supply or aggregate demand. Also that the effects of aggregate demand uncertainty on stock markets in oil exporting countries are much stronger and more persistent than in oil-importing countries.

In recent years, in view of well documented typical characteristics or stylized facts, for example non-normality, skewness, leptokurtosis, highly significant linear and non- linear serial correlation and volatility clustering of stock returns and changes in oil prices, series of studies on the relationship between stock market and oil market have turned to application of GARCH modeling approach. Using a trivariate GARCH_M model, Hammoudeh et al show that there are two way interaction between Standard and Poor's (S&P) oil composite index, oil spot and futures prices. Also Aloni and Jammazi (2009) applied the Markova-switching E-GARCH model, and find out that the net oil price variables plays a significant role in determining both the volatility of real returns and the probability of transition across regimes in developed stock markets of France, UK and Japan.

Generally in Africa and Nigeria in particular, attention has been paid to the impact of oil prices on stock prices. Apart from Adebiyi et al 2009, no explicit investigation has been conducted on oil price stocks, macroeconomic policies and stock price movement. In spite of the fascinating findings from Adebiyi et al (2009), this study intends to investigate the nature of the relationship further by testing for asymmetry effects. By employing EGARCH, the paper hopes to confirm whether degree of response of stock price to positive shocks in oil price and macro-variables differs from the response to negative shocks in oil price and macroeconomic policies. In others words, does positive macroeconomic development and increase in international oil prices stimulate stock prices faster than when negative developments occur.

3. Methodology and Data Issue

3.1 Model Specification

Given the high level of volatility usually associated with stock market activities, indexes and prices, conditional variance models tend to be most appropriate for analyzing the stock market prices. There are different types of conditional variance models, beginning from the Autoregressive Conditional Heteroscedasticity (ARCH) model, developed by Engle (1982) seminal study, to GARCH, TARCH, ARCH-M, IGARCH and EGARCH.

In a typical ARCH model, the mean equation is given by AR(q) process. The conditional variance is regressed on constant and lagged values of the squared error term obtained from the mean equation:

$$Y_t = \theta_0 + \theta_1 Y_{t-1} + \varepsilon_t \tag{1}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 \tag{2}$$

Where Y_t denotes the average stock index, Y_{t-1} is the lagged average stock index, $\square_0$ is a constant term and $\square_t$ represents the error term in equation (1). The variance (h_t) is a function of the mean $\square_0$ and the long term average volatility.

Bollerslev (1986) focused on extending the ARCH model to allow for a more flexible lag structure. He introduced a conditional heteroscedasticity model that included lags of the conditional variance (h_{t-1}, …, h_{t-p}) as regressors in the model for the conditional variance. Thus, the GARCH (p,q) can be represented as follows:

$$Y_t = \theta_0 + \theta_1 Y_{t-1} + \varepsilon_t \tag{3}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \tag{4}$$

The variance (h_t) is a function of the mean $\square_0$, the ARCH term and the GARCH term notated by h_{t-j}. The ARCH term represents news or information about volatility from the previous period, while the GARCH term captures the previous period forecast variance. The degree of persistence in shocks to volatility, measured by the GARCH process is the sum of the coefficients $\square_i$ and $\square_j$ which must be less than or equal to unity for stability to hold.

The ARCH and GARCH models do not capture adequately the asymmetry effect in shocks; since the lagged error terms are squared in the equations for the conditional variance, and therefore a positive error has the same effect on the conditional variance as a negative error. The exponential GARCH (EGARCH) model proposed by Nelson (1991) is designed specifically to address the asymmetry effect. The asymmetry effect refers to the characteristics of time series on asset prices that an unexpected drop tends to increase volatility more than an unexpected increase of the same magnitude.[40] The EGARCH (p,q) model for the conditional variance can be written as:

$$\ln(h_t) = \omega + [1 - \beta(L)]^{-1}[1 + \alpha(L)] f(u_{t-1} / h_{t-1}^{1/2}) \tag{5}$$

Where $f(u_{t-1} / h_{t-1}^{1/2}) = \varpi u_{t-1} + \gamma(\left|u_{t-1} / h_{t-1}^{1/2}\right| - E\left|u_{t-1} / h_{t-1}^{1/2}\right|)$ (6)

And $\square(L)$ and $\square(L)$ are q- and p-order lag polynomials, respectively. For p=q=1, the EGARCH(1,1) model is given as:

$$\ln(h_t) = \delta + (1 + \alpha_1 L) f(u_{t-1} / h_{t-1}^{1/2}) - \beta_1 h_{t-1} \tag{7}$$

The function $f(u_{t-1} / h_{t-1}^{1/2})$ in the EGARCH model allows for the asymmetry effect. If ϖ is less than zero, there is asymmetry but if ϖ=0, there is none.

40 - Or that "bad news" tends to increase volatility more than "good news", (Harris and Sollis, 2003)

In this study the quarterly conditional volatility of the average stock index is estimated using the EGARCH(1,1) model. In order to fully appreciate the impact of the explanatory variables on the ASI, two models are specified. Model 1 estimates the volatility of the ASI without any exogenous variable whereas in model 2 the explanatory variables are introduced.

Model 1:

$$ASI_t = \theta_0 + \theta_1 ASI_{t-1} + \varepsilon_t \tag{8}$$

$$\ln(h_t) = \alpha_0 + \alpha_1\left(\left|\varepsilon_{t-1} / h_{t-1}^{1/2}\right| + \pi_1(\varepsilon_{t-1} / h_{t-1}^{1/2})\right) + \beta_1 \ln(h_{t-1}) \tag{9}$$

Model 2:

$$ASI_t = \theta_0 + \theta_1 ASI_{t-1} + \theta_2 INFLA_t + \theta_3 RER_t + \theta_4 MPR_t + \theta_5 OP_t + \varepsilon_t \tag{10}$$

$$\ln(h_t) = \alpha_0 + \alpha_1\left(\left|\varepsilon_{t-1} / h_{t-1}^{1/2}\right| + \pi_1(\varepsilon_{t-1} / h_{t-1}^{1/2})\right) + \beta_1 \ln(h_{t-1}) + \gamma_1 INFLA_t + \gamma_2 RER_t + \gamma_3 MPR_t + \gamma_4 OP_t \tag{11}$$

Where θk (k=0,…,5), α0, α1, β1,ϖ1 and γi (i= 1,…,4) are constant terms.

Given non-normality of the series, we use Generalized error distribution in the estimation of the EGARCH model. This density distribution and their skewed version have additional shape parameters, which are altered in the estimation of models. Thus it allows estimation of various versions of the same model (Ali, 2013). However, only the results with the best fit are reported in the paper.

3.2 Data Issue

The study used quarterly series for the period beginning from first quarter 2000 and ending on second quarter 2014. The variables used in the study include average stock index, real exchange rate, inflation rate, international oil price and monetary policy rate. Data on these time series were obtained from the CBN statistical database available on the CBN website: www.cenbank.org. The dependent variable in this study is the average stock price index (ASI). The explanatory variables include lagged one period ASI, inflation rate (INFLA), real exchange rate (REER), oil price (OP), and monetary policy rate (MPR). These variables are employed to examine their impact on the ASI volatility.

The data for oil price and the average stock price for the period under consideration show evidence of significant co-movement. Figure 1 indicates that both oil price and average stock index rose rapidly up till the last quarter of 2007 when there was a sharp drop in both series. After the global financial crisis in 2008, oil price recovered from the crashed faster than the stock price. It is further demonstrated in figure 2 that both series exhibited high levels of volatility, both before and after the global financial crisis. The percentages range between negative 55 per cent and positive 45 per cent for oil price, while the average stock index percentage changes range between -32.75 per cent and 27.06 per cent.

Figure 1: Trends in Average Stock Index and Oil Price

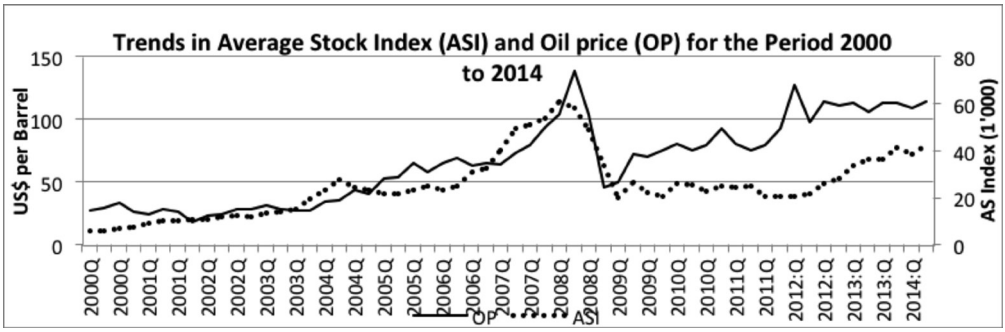


Figure 2: Percentage Changes in Average Stock Index and Oil Price

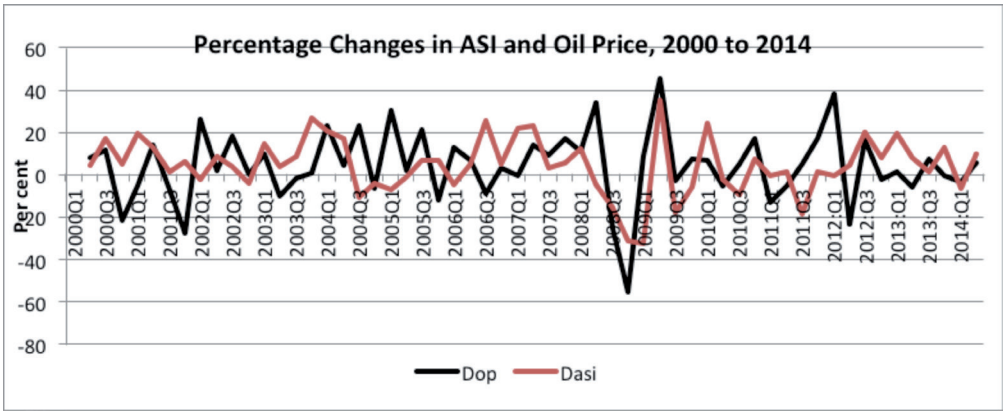


Table 1 reports the summary statistics of the variables used in the paper. The summary statistics include mean, median, maximum, minimum, standard deviation, skewness, kurtosis, Jarque-Bera and Ljung-Box Q statistics for each of the variables used in the study.

Table 1: Summary Descriptive Statistics

	OP	INFLA	MPR	ASI	RER
Mean	65.95466	4.253621	12.59741	25525.47	99.85862
Median	65.15000	3.710000	12.00000	23554.80	91.51500
Maximum	138.7400	12.90000	20.50000	60952.95	162.8100
Minimum	18.65000	-5.960000	6.000000	5891.600	55.17000
Std. Dev.	32.99235	3.986963	3.980397	13292.21	31.45117
Skewness	0.272210	0.026003	0.088369	0.805720	0.527260
Kurtosis	1.916095	3.000326	2.315359	3.222756	2.045895
Jarque-Bera	3.555505	0.006536	1.208260	6.395374	4.887297
Probability	0.169018	0.996737	0.546550	0.040857	0.086843
Ljung-Box Q	250.70 (0.000)	29.28 (0.001)	311.88 (0.000)	148.73 (0.000)	227.06 (0.000)
Observations	58	58	58	58	58

Source: Authors' Computations

The average stock index and oil prices have the largest standard deviation among all the variables. This supports the general intuition that average stock index and oil price are highly volatile relative to other macroeconomic indicators. It is also suggestive of some association between the two series. All of the series are skewed to the right indicating that the distributions are not symmetric. The kurtosis statistics are below the normal value of three in some of the variables, OP, MPR, and REER, implying that the sample data are highly platykurtic (flat) relative to normal. Kurtosis for inflation data indicates normal distribution while ASI is above the normal value of three, implying that the distribution of ASI puts more mass on the tails of its support than a normal distribution does. In other words, it has more extreme values and is, therefore, said to be leptokurtic (heavy tailed). The normality is accepted in all series, except ASI, based on the Jarque-Bera statistics. If the null hypothesis of normality is rejected, it implies that the conventional regression model would lead to a rejection of the estimated specification (Harris and Solis, 2003). Significant autocorrelation is detected by the Ljung-Box Q statistic for up to 10 lag orders in all cases. Given these indication of asymmetric shocks and non-normality, EGARCH model appears most appropriate for analyzing this relationship between oil price, macroeconomic variables and the stock market.

3.3 Tests for Stationarity

The stationarity of the time series was examined using the Augmented Dickey Fuller (ADF) test developed by Dickey and Fuller (1979). Due to the general low power against stationarity near unit root processes usually associated with the use of ADF statistics, the ADF test was augmented with a confirmatory Kwiatkowski, Phillips, Schmidt, and Shin (KPSS, 1992) test. The number of lags was selected according to the Schwarz Information criterion (SIC).

The results of the ADF unit root test and KPSS test are reported in Tables 2 and 3, respectively. Both ADF and KPSS tests confirmed that INFLA is integrated of order zero or I(0) series, while the other series, namely ASI, MPR, OP and REER are integrated of order one I(1).

Table 2: Test for unit root using Augmented Dickey-Fuller (ADF) Test

VARIABLE	LEVEL		FIRST DIFFERENCE		ORDER OF INTEGRATION
	NO TREND	TREND	NO TREND	TREND	
ASI	-1.9354	-2.2841	-4.9277	-4.8798	I(1)
RER	-1.1763	-1.4653	-5.8384	-6.1981	I(1)
MPR	-1.6801	-1.8320	-4.7141	-4.7231	I(1)
INFLA	-5.4156	-5.8241	-9.2859	-9.2122	I(0)
OP	-1.4552	-3.7916	-7.5776	-7.5116	I(1)

Source: Authors' computation

Note: Optimum lag length is selected according to SIC, critical values are based on Mackinnon (1996); critical values are -3.5503 (1%), -2.9135 (5%), -2.5945 (10%) and -4.1273 (1%), -3.4906 (5%), -3.1739(10%) with no trend and with trend, respectively.

Table 3: Test for unit root using Kwiatkowski, Phillips, Schmidt and Shin (KPSS) Test

VARIABLE	LEVEL		FIRST DIFFERENCE		ORDER OF INTEGRATION
	NO TREND	TREND	NO TREND	TREND	
ASI	-0.1424	-0.0674	-0.0636	-4.8798	I(1)
RER	-0.2348	-0.2145	-0.5116	-0.0721	I(1)
MPR	-0.6269	-0.1805	-0.1562	-0.0704	I(1)
INFLA	-0.4340	-0.2301	-0.1326	-0.1278	I(0)
OP	-0.8506	-0.0697	-0.3156	-0.2901	I(1)

Source: Authors' Computation

Note: Optimum lag selected according to Newey-West using Bartlett Kernel; critical values are 0.216, 0.146, 0.119 for model with trend, 0.739, 0.463, 0.347 for the model without trend and for 1%, 5% and 10%, respectively (KPSS, 1992).

4. Empirical Results

The estimation results for EGARCH(1,1) for models 1 and 2 are reported in Tables 4 and 5, respectively. In model 1, the coefficient of ASI lagged one period is significant at one percent. This implies that previous period stock index is a determinant of current period stock price index. In the variance equation, the volatility persistency parameter ($\alpha 1 + \beta 1$) indicates long memory, while the asymmetry parameter is both significant and correctly signed. The constant term ($\alpha 0$) in the variance equation is significant indicating that there is a significant

time-invariant component in the average stock price index generating process. The magnitude of the GARCH parameter is higher than the ARCH. This implies that volatility is more sensitive to its own lagged values than news about volatility from the previous period.

With the inclusion of the international oil price and other macroeconomic variables, it is clear in table 5 that the coefficients of MPR and inflation rate are not statistically significant. In other words, these variables do not directly impact average stock index. However, the coefficients of oil price and real exchange rate are significant at 1 percent and positive; meaning that rising oil prices and real depreciation will increase the demand for stock and therefore the market price of stock. In the variance equation, $\alpha 1$ and $\beta 1$ are correctly signed but $\alpha 1$ is significant at 1 per cent while $\beta 1$ is only significant at 10 per cent. The volatility persistency parameter ($\alpha 1 + \beta 1$) indicates fair short memory, while the asymmetry parameter is both significant and correctly signed. Also, the magnitude of the GARCH effect has reduced while ARCH effect has increased together with the asymmetry effect parameter. Hence, the inclusion of these variables raised the importance of news about volatility from the previous period.

To keep the analysis tractable and robust, we dropped the two macroeconomic variables (MPR and INFLA) from the equation. Table 6 presents the new results with the variance equation. The model output shows that the coefficients of all the variables are significant, although oil price is significant at 8 per cent. The asymmetry parameter is both significant and correctly signed. The volatility persistency parameter ($\alpha 1 + \beta 1$) has increased indicating longer memory. The ARCH effect has increased while the GARCH effect is statistically insignificant. To check the adequacy of the model, we estimated the Ljung-Box Q-statistics for the standardized residual process (Q) and squared process (Q^2). The Ljung-Box Q-statistics indicate no serial correlation or conditional heteroscedasticity in the standardized residuals of the fitted model. Hence, the estimated EGARCH(1,1) model is adequate.

The findings of this study have been corroborated by other studies using different methodology. For instance, Effiong (2014) found that oil-specific demand shocks emanating from expansion in global economic activities are positively and significantly associated with higher stock market prices using impulse response function and variance decomposition analysis from structural vector Autoregression (VAR) model.

Table 4: Model 1: Estimates of EGARCH(1,1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.0862	0.3115	0.2768	0.7819
lnASI(-1)	0.9960	0.0312	31.9186	0.0000
Variance Equation				
α0	-2.1769	1.3640	-1.5960	0.1105
Π	-0.4688	0.1710	-2.7403	0.0061
α1	0.4534	0.1856	2.4420	0.0146
β1	0.5354	0.3431	1.5604	0.1187
R-squared	0.9295	Akaike info criterion		-1.1670
Adjusted R-squared	0.9282	Schwarz criterion		-0.9519
Q(5)	9.7791 (0.082)			
$Q^2(5)$	5.1740(0.395)			

Q(5) and Q2(5) are Ljung-Box Q-statistics. P values are shown in Parentheses.

Table 5: Model 2: Estimation Results for EGARCH(1,1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.2372	0.1547	7.9962	0.0000
lnASI(-1)	0.8278	0.0070	117.7257	0.0000
OP	0.0027	0.0009	2.7812	0.0054
RER	0.0023	0.0005	4.6565	0.0000
MPR	0.0086	0.0057	1.5195	0.1286
INFLA	-0.0028	0.0081	-0.3453	0.7298
Variance Equation				
α0	-4.3252	0.0711	-60.7604	0.0000
Π	-0.6480	0.0815	-7.9448	0.0000
α1	0.2931	0.0852	3.4396	0.0006
β1	0.0293	0.0174	1.6836	0.0923
R-squared	0.9492	Akaike info criterion		-1.1160
Adjusted R-squared	0.9443	Schwarz criterion		-0.7576
Q(5)	9.0698 (0.106)			
$Q^2(5)$	4.6247 (0.463)			

Source: Authors' computation

Note: Q(5) and Q2(5) are Ljung-Box Q-statistics. P values are shown in Parentheses

Table 6: Model 2 without MPR and INFLA: Estimation Results for EGARCH(1,1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.3107	0.5986	2.1895	0.0286
lnASI(-1)	0.8363	0.0654	12.7850	0.0000
OP	0.0019	0.0011	1.7560	0.0791
RER	0.0020	0.0009	2.1828	0.0290
Variance Equation				
$\alpha 0$	-4.0810	2.2757	-1.7932	0.0729
Π	-0.4417	0.1824	-2.4210	0.0155
$\alpha 1$	0.5594	0.2606	2.1467	0.0318
$\beta 1$	0.0899	0.5172	0.1739	0.8619
R-squared	0.9464	Akaike info criterion		-1.1655
Adjusted R-squared	0.9434	Schwarz criterion		-0.8788
Q(5)	10.413 (0.064)			
$Q^2(5)$	4.4229 (0.490)			

Source: Authors' computation

Note: Q(5) and Q2(5) are Ljung-Box Q-statistics. P values are shown in Parentheses

5. Conclusion and Policy Recommendations

The findings show that the volatility in the stock prices is explained to a large extent by the volatility in international oil prices and the real exchange rate. The inclusion of the macroeconomic variables and oil prices in the model increases the importance of news about previous period volatility in stock prices. The negative and significant asymmetry effect indicates that negative shocks, such as those arising from economic recession have larger effects on volatility of the stock price than positive shocks probably from economic boom. The message therefore from the study is to guard against negative economic fluctuations. Economic agents hold pessimistic view about future economic outcomes, and therefore, even when there is a positive shock they tend to take a 'wait and see' attitude to ensure that it will last before reacting to it. The implication of this for policy is quite important. It shows that good economic management will bear positive fruits; although, it may take some time for the economic variables to respond to the positive shocks. On the contrary, the slightest economic downturn, tend to trigger rapid response from the stock market. Policy-makers should therefore be careful in the management of the economy bearing in mind that confidence building is quite important. Whenever confidence is eroded and expectations become pessimistic, it will take longer to reverse.

Most importantly, the findings show that the stock market performance is highly vulnerable to shocks from the international oil price. There is a direct impact or influence of the oil price or revenue on the stock market. This should not be encouraged. The oil money should not be

the main driver of stock market activity. There is need to protect the domestic economy from the international oil market volatility. It is on this note, that the idea of establishing a sovereign wealth fund by the government should be applauded provided it is properly managed not just another trick to siphon public resources. There should be strong drive towards investing the oil money to diversify the economy and create new source of wealth for the economy.

References

Adam, A. M. and Tweneboah, G. (2008). 'Do Macroeconomic Variables Play Any Role in the Stock Market Movement in Ghana?' MPRA, Paper No. 9368.

Adebiyi, M.A., Adenuga, A.O., Abeng, M.O. and Omanukwue, P.N. (2009) 'Oil Price Shocks, Exchange Rate and Stock Market Behavior: Empirical Evidence from Nigeria.' *African Econometrics Society Conference Proceedings*, Sheraton Hotels and Towers, Abuja.

Adegoke I A. and A. O. Gbadebo (2012), Macroeconomic Policy and Returns on Equities: Empirical Evidence from Nigerian Capital Market, *International Research Journal of Finance and Economics*, Issue 83.ed

Akinnifesi, O.E (1987). 'The Role and Performance of the Capital Market.' in Adedotun, P.O and Ndekwu, E. (Eds), *Economic Development in Nigeria*, Ibadan: NISER.

Ali, G. (2013), 'EGARCH, GJR-GARCH, TGARCH, AVGARCH, NGARCH, IGARCH and APARCH Models for Pathogens at Marine Recreational Sites,' *Journal of Statistical and Econometric methods*, vol. 2. No. 3, pp.57-73.

Aloui, C. and Jammazi, R. (2009). 'The effects of crude oil shocks on stock market shifts behavior: A regime switching approach,' *Energy Economics*, 31, 789-799.

Amadi, S. N., Onyema J. I. and Odubo, T. D. (2000) Macro-economic Variables and Stock Prices: A Multivariate Analysis. *African Journal of Development Studies*. 2(1 and 2):159-164.

Apergis, N. and Miller, S.M. (2009). 'Do structural oil-market shocks affect stock prices?' *Energy Economics*, 31, 569–575.

Apergis, N. and Miller, S.M. (2009). 'Do Structural Oil-Market Shocks Affect Stock Prices?' *Energy Economics*, 31, 569–575

Araugo, E. (2009); 'Macroeconomic shocks and the co-movement of stock returns in Latin America,' *Emerging Markets Review*, 10: 331-344.

Arouri, M. E. and Rault, C. (2009). 'On the Influence of Oil Prices on Stock Markets: Evidence from Panel Analysis in GCC Countries,' CESifo *Working Paper Series* 2690, CESifo Group Munich

Balaz, P., Londarev, A. (2006). 'Oil and its position in the process of globalization of the world economy,' *Politicka Ekonomie* 54 (4), 508-528.

Bjornland, C.H. (2009). 'Oil price shocks and stock market booms in an oil exporting country,' *Scottish Journal of Political Economy,* 2(5), 232-254.

Bollerslev, T. (1986). 'Generalized Autoregressive Conditional Heteroscedasticity', *Journal of Econometrics*, 31: 307-327.

Chen, N. F., Roll, R., and Ross, S. A. (1986). 'Economic forces and the stock market,' J*ournal of Business*, 59, 383–403.

Cologni, A., and Manera, M. (2008). 'Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries,' *Energy economics*, 30, pp.856-888.

Cong, R.G., Wei, Y. M. Jiao, J. L. and Fan, Y. (2008). 'Relationships between oil price shocks and stock market: An empirical analysis from China,' *Energy Policy*,36(9), 3544–3553.

Cunado, J. and Perez de Gracia, F.(2005). «Oil prices, Economic Activity and Inflation: Evidence for Some Asian Countries,» *The Quarterly Review of Economics and Finance*, vol. 45(1): 65-83.

Dickey, D. and Fuller, W. A. (1979). 'Distribution of the Estimates for Autoregressive Time Series with a Unit Root,' Journal of the American Statistical Association, 74: 427-31.

Effiong, E. L. (2014), Oil Price Shocks and Nigeria's Stock Market; What have we learned from Crude oil Market Shocks? OPEC *Energy Review* vol 38, Issue 1.

Fama, E. F. (1981). 'Stock Returns, Real Activity, Inflation and Money,' *American Economic Review*, 71: 545-65.

Goswami, G. and Jung, S. C. (1977). 'Stock Market and Economic Forces: Evidence from Korea.' *IMF Working Paper*, April.

Gronwald, M. (2008). 'Large oil shocks and the US economy: Infrequent incidents with large effects,' *Energy Journal*, 29: 151-71.

Hammoudeh, S. and Aleisa, E. (2004). 'Dynamic relationships among GCC stock markets and NYMEX oil futures,' *Contemporary Economic Policy*, 22(2): 250–269.

Hardouvelis, G.A. (1987). 'Macroeconomic Information and stock prices' *Journal of Economics and business*, 39: 131-140.

Harris, R. and Sollis, R. (2003). *Applied Time Series Modelling and Forecasting*. Chichester W. Sussex, John Wiley and Sons.

Huang, R.D., Masulis, R.W. and Stoll, H.R. (1996). 'Energy shocks and financial markets', *Journal of Futures Markets*, 16: 1–27.

Ibrahim, M. H. and H. Aziz (2003). 'Macroeconomic Variables and the Malaysian Equity Market, Through Rolling Sub Samples,' *Journal of Economic Studies*, 30: 6-27.

Ikoku, A. E. (2010). 'Is Stock Market a Leading Indicator of Economic Activity in Nigeria', *Journal of Applied Statistics*, 1(1).
Jones, C. and Kaul, G. (1996). 'Oil and the stock markets,' *Journal of Finance*, 51, 463–491.

Kilian, L. (2008). 'Exogenous oil supply shocks: How big are they and how much do they matter for the U.S. economy?' *Review of Economics and Statistics*, 90: 216-240.

Kilian, L. and Park, C. (2008). 'The impact of oil price shocks on the U.S. stock market', *International Economic Review*, 50(4):1267-1288.

Kwiatkowski, D., Phillips, P., Schmidt, P. and Shin, Y. (1992). 'Testing the Null Hypothesis of Stationarity Against Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root?' *Journal of Econometrics*, 54:159-78.

Maghyereh, A. (2004). 'Oil price shocks and emerging stock markets: a generalised VAR approach', *International Journal of Applied Econometrics and Quantitative Studies*, 1: 27–40.

Maku, E. O. and Atanda, A. A. (2009). 'Does Macroeconomic Indicators Exert Shock on the Nigerian Capital Market?' Paper No. 17917, Munish Publication, University of Denmark.

Nandha, M. and Brooks, R. (2009). 'Oil prices and transport sector returns: an international analysis', *Review of Quantitative Finance and Accounting* 33: 393–409.

Nelson, D. B. (1991). 'Conditional heteroskedasticity in asset returns: A new approach', *Econometrica*, 59: 347-370.

Nwokoma, N. I. (2002). 'Stock Market Performance and Macroeconomic Indicators Nexus in Nigerian: An Empirical Investigation,' *Nigerian Journal of Economic and Social Studies*, 44(2).

Osamwonyi, I.O. and Evbayiro-Osagie, E. I (2012), 'The Relationship between Macroeconomic Variables and Stock Market Index in Nigeria', *Journal of Economics, 3(1) 55-63, Kamal Raj*

Papapetrou, E. (2001). 'Oil Price Shocks, Stock Market, Economic Activity and Employment in Greece,' *Energy Economics*, 23: 511–532.

Sadorsky, P. (2001). 'Risk factors in stock returns of Canadian oil and gas companies,' *Energy Economics*, 23: 17–28.

Serkan, Y. (2008). 'Macroeconomic Variables, Firm Characteristic and Stock Returns: Evidence from Turkey.' *International Research Journal of Finance and Economics*, 16.

Smith, L. H. (1990). 'Stock Prices Behaviour in the American Economy,' *American Economic Review*, Proceedings 71: 419- 430.

Soyode, A. (1993). 'Structural Adjustment Programme and Its Impact on the Nigerian Stock Market" *Research in Third World Accounting*, 2, pp 335-352.

Thorbecke, W. (1977). 'On Stock Market Returns and Monetary Policy' *Journal of Finance*, 52 (2): 635-654.

Wang Y., Wu C. and Yang L. (2012). 'Oil price shocks and stock market returns: Evidence from oil-importing and oil-exporting countries,' Working paper SSRN, available at Electronic copy available at: http://ssrn.com/abstract=2189575.

Initiative d'Allegement de la dette et relance économique dans l'espace CEDEAO.

by

AMADOU Ousmane*

Résumé

Le but de ce travail, est d'analyser l'impact de l'allègement de la dette extérieure sur la relance économique dans l'espace CEDEAO. Les premiers résultats sous forme d'analyses statistiques montrent que les pays bénéficiaires de ces initiatives ont connu un progrès notable par rapport à l'ensemble des pays en terme de croissance économique. Les variables comme les dépenses publiques d'éducation et de santé ont parfaitement accompagné cette croissance. A l'aide d'un modèle non linéaire, les seconds résultats montrent que, l'allègement de la dette a eu un impact positif et significatif dans l'échantillon des pays bénéficiaires de ces initiatives que dans l'ensemble des pays de l'espace.

Mots clés : *Initiative PPTE et IADM- et relance économique- CEDEAO*

JEL-F43

AMADOU Ousmane est enseignant chercheur à la Faculté des Sciences Economiques et Juridiques (FSEJ) de Université Abdou Moumouni de Niamey (Niger)

1. Introduction

La Communauté Economique des Etats de l'Afrique de l'Ouest (CEDEAO) est une organisation qui regroupe 15 pays membres. Cet ensemble à une population estimée en 2010 à près de 270 millions d'habitants et selon le FMI (2012), son Produit Intérieur Brut (PIB/PPA) global s'élève à 564,86 milliards de dollars US ce qui en fait la 25ème puissance économique du Monde. Pour passer de la CEDEAO des Etats à la CEDEAO des peuples, cet organisme a innové à travers une vision stratégique dénommée, vision 20/20.

La réalisation d'une relance économique entre les différents pays membres de la CEDEAO est conditionnée par la mise en place de véritables réformes structurelles au sein des économies de cette communauté.

Une politique de relance ou plan de relance est un ensemble de mesures de politique économique, qui s'effectue par des dépenses publiques supplémentaires et de réduction de certains impôts, et donc dégradant le solde public, décidées par le gouvernement d'un pays ou d'une zone économique, dans le but de provoquer une « relance économique », c'est-à-dire une augmentation de l'activité économique et une réduction du chômage lors des périodes de faible croissance ou de récession.

Malheureusement, comme tous les pays en voie de développement, une grande majorité des pays de cet espace économique a connu un ralentissement de sa croissance économique voire une récession au courant de la décennie 1990. Ces problèmes ont trainé une baisse des ressources internes nécessaires pour le financement des secteurs porteurs de croissance.

La raison principale de la stagnation économique dans cet espace est due au fardeau de la dette extérieure, au manque d'ajustements macroéconomiques, aux réformes structurelles et aux chocs exogènes nationaux et internationaux.

A la suite de ce scénario adverse, ces pays ont commencé à accumuler la dette externe dans les années soixante-dix et plus intensivement, dans la décennie suivante, atteignant des proportions extrêmes de ratio de dette respectivement sur PIB et exportations dans le milieu des années quatre vingt dix.

Rappelons que l'initiative majeure négociée durant cette période a été les accords bilatéraux sous la supervision des créanciers du Club de Paris[41]. En 1996, ces accords ont été complétés par l'initiative d'allègement de la dette des Pays Pauvre Très Endettés (PPTE) et ont connu une amélioration en 1999.

Au début des années soixante dix, le montant de la dette extérieure des pays de la CEDEAO est presque égale à la valeur de leurs exportations. Cette dette représente un cinquième du PIB de la communauté. Au milieu des années quatre vingt dix et surtout avec la dévaluation

41 - Le Club de Paris est un groupe informel de créanciers publics dont le rôle est de trouver des solutions coordonnées et durables aux difficultés de paiement de pays endettés. Les créanciers du Club de Paris leur accordent un allègement de dette pour les aider à rétablir leur situation financière

qu'avaient connu les pays de l'espace UEMOA, la dette extérieure des pays de la CEDEAO a atteint le montant de leur PIB annuel et plus de sept fois la valeur de leurs exportations.

L'augmentation de la dette extérieure a été vue comme insoutenable et a déterminé un certains nombres d'initiatives d'allègement de la dette pendant les années 80 et 90 (Toronto, London, Naples et Lyon), après que les donateurs bilatéraux ont accepté un rééchelonnement dans des termes concessionnels.

En dépit de ces bonnes initiatives, la dette extérieure des pays de la communauté a atteint 130% de leur PIB en (1994).

Grâce à l'initiative PPTE lancée par la Banque Mondiale (BM) et le Fonds Monétaire International (FMI), la moyenne du ratio de la dette extérieure sur PIB à 45% et le ratio de la dette sur exportation à 150% ont été identifiés comme le niveau du seuil soutenable de la dette sous l'initiative PTTE.

Finalement, les donateurs ont promis d'annuler la dette entière tenue par l'Association pour le Développement International de la Banque mondiale, le FMI, le Fonds Africain de Développement et la Banque Inter américaine pour le Développement pour les pays qui ont atteint le point d'achèvement sous l'initiative PPTE (2005).

Lorsque la crise de la dette extérieure a atteint son sommet dans l'espace CEDEAO, ces pays étaient tous caractérisés par un ralentissement de leur croissance économique voire une récession généralisée. Tous les pays avaient un crédit domestique très important du fait des arriérés de paiement interne, ce qui limitait fortement l'activement du secteur privé. Ces pays étaient aussi caractérisés par une baisse de l'investissement direct étranger, de l'investissement public aussi bien dans les secteurs productifs que sociaux. Dans l'ensemble, on assistait à une baisse du climat des affaires ce qui compliquait le processus de sortie de cette crise. Ainsi, les initiatives d'allègement de la dette extérieure étaient comme un aubaine à saisir afin de mettre fin à ce cycle de stagnation économique.

L'objectif principal de ce travail est de vérifier si l'action conjuguée de nombreuses initiatives d'allègement de la dette au milieu de la décennie 1990 a eu un effet significatif sur la relance économique dans les pays membres de la CEDEAO.

De façon spécifique on compte analyser : (i) l'effet de l'allègement de la dette sur certaines grandeurs macroéconomiques (le taux d'investissement sur le PIB, le taux du crédit domestique sur le PIB, l'investissement direct étranger sur le PIB, les dépenses gouvernementales sur le PIB les dépenses publiques d'éducation et de santé sur le PIB, (ii) l'effet de l'allègement de la dette sur le taux de croissance économique.

Le reste de l'article est organisé comme suit :

- la situation économique et financière créée par les initiatives PPTE et IADM dans les pays de la CEDEAO est décrite dans la deuxième section ;

- la revue de la littérature empirique est effectuée dans la troisième section ;
- la méthodologie à travers la spécification du modèle et les résultats de son estimation sont présentés dans la quatrième section ;
- les implications de politiques économiques constituent la cinquième section.

2. la situation économique et financière créée par les initiatives PPTE et IADM dans les pays de la CEDEAO.

Les initiatives d'allégement de la dette des pays pauvres par la BM, le FMI et la BAD étaient intervenues pour éviter que cette dette ne compromette le processus de développement économique de ces pays. Ces initiatives devraient permettre d'appliquer une politique de lutte contre la pauvreté en respectant des engagements en matière de financement des secteurs sociaux. Ce processus a été initié conjointement avec la communauté financière internationale en vue de ramener à un niveau supportable la charge de l'endettement extérieur de la plupart des pays pauvres très endettés.

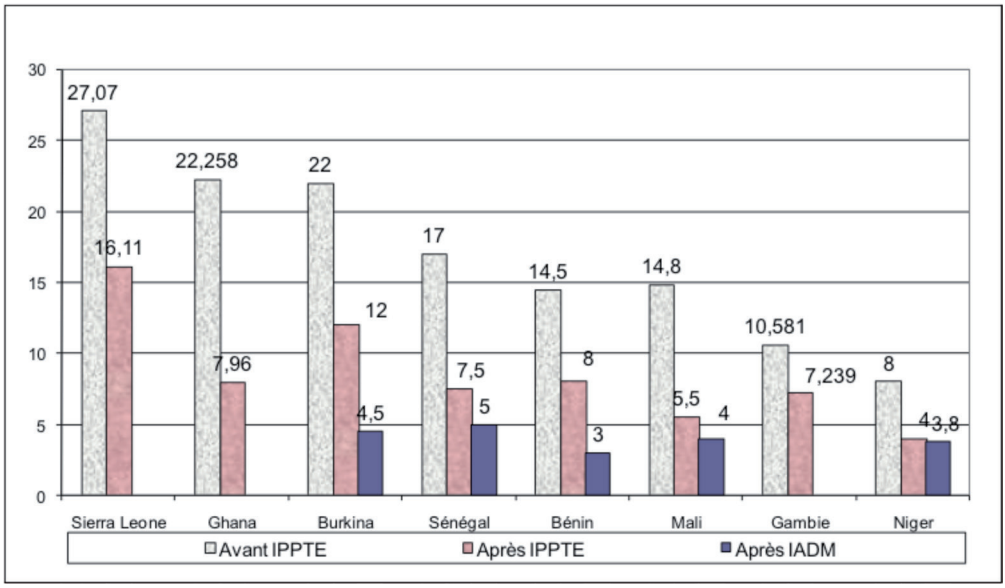
Parmi les 13 pays de la CEDEAO (le Cap Vert et le Nigéria ne font pas partie des pays pauvres très endettés), huit[42] ont dès la première phase atteint le point d'achèvement au titre de l'initiative PPTE renforcée en 1999. Dès fin 2006, l'ensemble de ces pays était aussi admissible à l'Initiative d'Annulation de la Dette Multilatérale (IADM).

Cette remise de dette se présente ainsi comme une contribution au financement du développement et doit permettre à tous ces pays qui ont franchi le point d'achèvement, de bénéficier d'une annulation de 100% de leur dette contractée auprès du FMI, de la BM et de la BAD.

Pour apprécier ce que les pays en développement supportent en matière d'effort de paiement du service de la dette, on rapporte ce dernier sur les recettes d'exportation du pays. Plus ce ratio est important, plus le pays aura moins de marge de manœuvre en matière d'exécution de ses dépenses budgétaires surtout d'investissement. Le graphique N°1 présente ce ratio, d'un côté avant PPTE et de l'autre, après PPTE et IADM. Les pays bénéficiaires de ces initiatives s'engagent à utiliser les ressources prévues au remboursement de cette dette, pour le financement des secteurs sociaux (santé, éducation) porteur de croissance à terme.

42 - Il s'agit du Bénin, Burkina Faso, Gambie, Ghana, Mali, Niger et Sénégal et Sierra Leone.

Graphique N° 1 : Service de la dette en pourcentage des recettes d'exportation

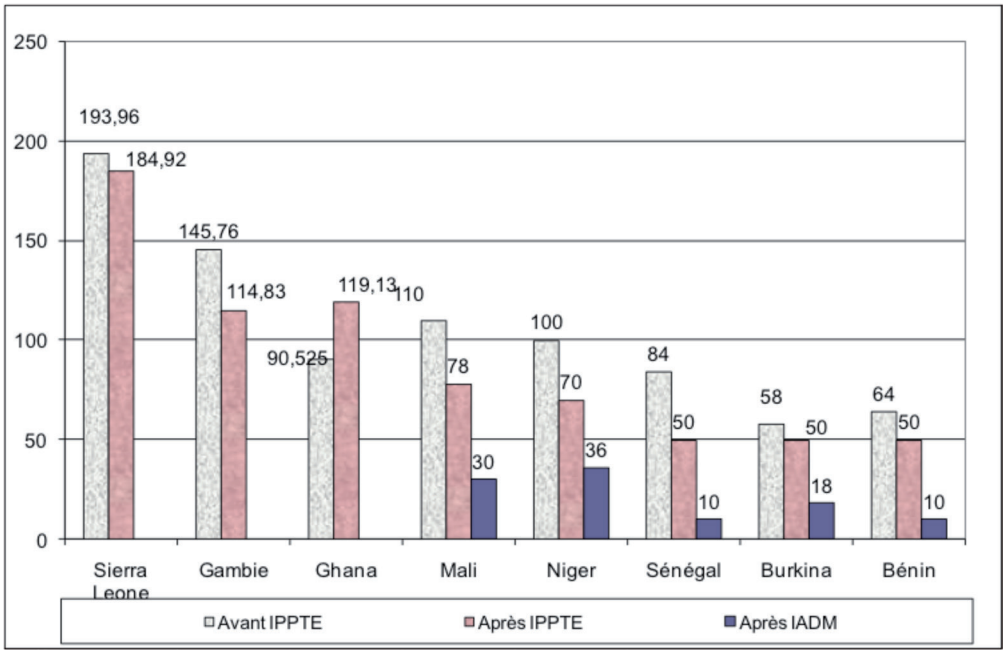


Source : Rapports annuels de l'UEMOA sur la surveillance multilatérale, FMI-2007

Le graphique N°1 montre bien une diminution du ratio du service de la dette sur les recettes d'exportations pour la majorité des pays bénéficiaires de cette initiative. Le Ghana et le Niger voient leur ratio diminuer de plus de la moitié, tandis que la Siéra Leone et le Sénégal enregistrent une baisse très significative de ce ratio.

Il remarquer que ce ratio sera d'autant plus faible qu'un pays a une capacité importante en matière d'exportation. Un pays comme le Niger n'exporte presque pas de produits agricoles en dehors de l'oignon. Ses recettes d'exportation proviennent exclusivement de la vente vers la France des minerais d'Uranium. Les pays comme le Ghana, le Mali, le Burkina exporte beaucoup d'Or, mais aussi du coton. Donc, plus un pays arrive à diversifier ses ressources d'exportations, plus il a de chance de stabiliser ce ratio. Le graphique ci-dessous présente le ratio dette sur PIB.

Graphique N°2: Dette en pourcentage du PIB



Source : Source : Rapports annuels de l'UEMOA sur la surveillance multilatérale, FMI-2007

Le graphique N°2 montre qu'avant ces initiatives, tous les pays ont un ratio dette sur PIB supérieur au seuil de 45% fixé par la Banque mondiale et le FMI. Par contre après ces initiatives, le Mali, le Niger, le Sénégal, le Burkina et le Bénin ont tous eu des ratios inférieurs à ce seuil.

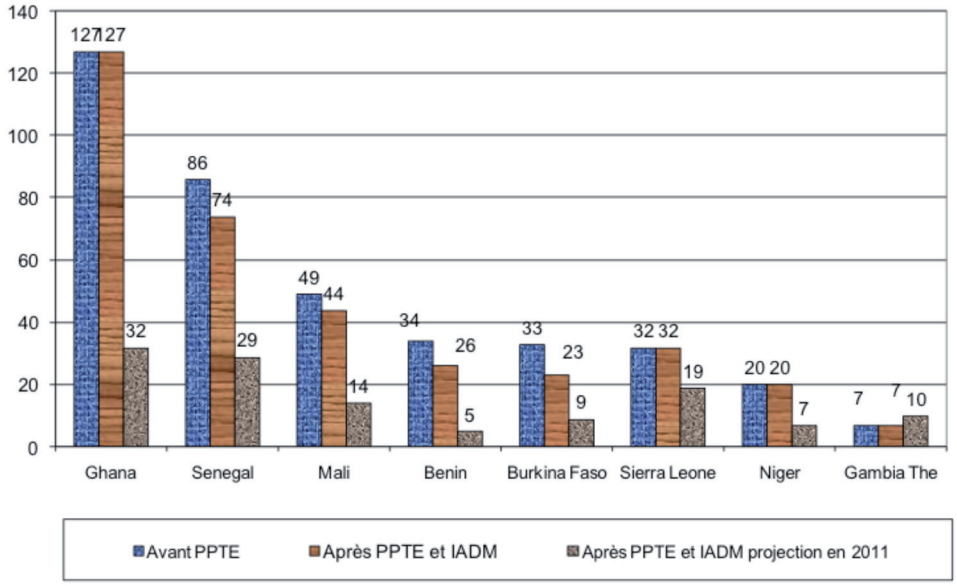
Le graphique N°3 illustre le payement du service de la dette pour l'ensemble de ces pays avant l'initiative PPTE, après PPTE et IADM ainsi qu'une projection de ce service pour 2011.

Les chiffres représentent le montant de service de la dette que chaque pays doit aux trois principales institutions concernées par cette initiative à savoir la BM, le FMI et la BAD.

En dehors de la Gambie et de la Guinée Bissau, tous ces pays ont enregistré une baisse importante de leur service de la dette avec ces deux initiatives.

Le nouvel environnement créé au niveau de l'union avec cette remise de dette favorise positivement le financement du développement économique de la zone. Il permet également la réalisation de grands objectifs économiques en matière de politique économique dans un contexte de bonne gouvernance. Cette situation favorable à la relance économique dans l'Union peut être encore vérifiée au niveau du graphique N°3 ci-dessous.

Graphique N°3: Evolution du service de la dette des pays de la CEDEAO



Source : WB-FMI : 2007

Dans l'ensemble, on note une diminution du service de la dette pour l'ensemble des pays admis à ces initiatives. Cette baisse du paiement du service de la dette devrait permettre aux différents pays d'avoir des ressources disponibles pour le financement des secteurs sociaux (éducation, santé) et secteurs porteurs de croissance économique.

3. La revue de littérature

Le cadre théorique de ce travail repose sur la théorie du surendettement (Krugman, Sachs, 1989) qui prédit qu'une dette élevée est nuisible à la croissance économique dès lors qu'elle décourage les investissements. En effet, en présence d'un surendettement, le service de la dette est une fonction croissante du niveau de production.

De plus, l'excès de dette crée une distorsion car les agents supposent qu'une part de leur revenu futur sera utilisée pour le remboursement des crédits. Ainsi, une baisse des investissements est observée, ce qui entrave la croissance économique. En outre, le gouvernement n'est plus encouragé à faire des réformes structurelles et budgétaires importantes s'il pense que celles-ci vont bénéficier surtout aux créanciers étrangers. Le surendettement peut également freiner la croissance en renforçant l'incertitude quant aux actions et politiques que le gouvernement mènera pour assurer le service de la dette.

Selon Rina et al (2004) la dette extérieure stimule la croissance économique à condition qu'elle serve à financer les investissements. De plus, ces auteurs expliquent que l'endettement doit être mesuré car la baisse du rendement du capital entraine des avantages nets pour tout nouvel investissement qui pourraient diminuer à mesure que la dette s'accroît.

Koeda (2008) adapte le débat sur l'importance de la dette à l'expérience spécifique des pays à bas revenu en développant un modèle dans lequel le taux d'intérêt sur les emprunts dépend du niveau de revenu du pays débiteur par rapport au revenu moyen. Ainsi, le surendettement dépend du stock initial de la dette et la productivité totale des facteurs. Il recommande dans cette situation que pour être efficace, il ne doit pas y avoir une suite de plusieurs allègements successifs pour un même pays et un même problème. Mais de faire cet allègement de la dette en une seule fois afin de permettre au pays bénéficiaire de mobiliser de ressources conséquentes pour accomplir son objectif de croissance économique. Si ce n'est pas le cas, ce pays a encore la motivation pour stagner autour parce qu'il anticipe qu'il recevra de futur allègement de la dette d'après les mêmes critères d'éligibilités.

Les résultats de la validation empirique de la théorie du surendettement dans les pays PPTE sont ambigus. Certains auteurs (Elbadawi, Ndulu et Ndung'u, 1997; Pattillo, Poirson et Ricci, 2002; Clements, Bhattacharya et Nguyen, 2003) ont trouvé une relation non linéaire entre l'allègement de la dette et la croissance.

Dans ce débat, certaines recherches aboutissent à des conclusions confortant l'effet positif de l'allègement de la dette sur la croissance et d'autres aboutissent à des résultats contraires.

Ainsi, d'après (Pattillo, Poirson et Ricci, 2002 ; Cordella, Ricci et Ruiz-Arranz, 2005), le service de la dette n'est pas nuisible à la croissance économique, étant donné que, les pays PPTE reçoivent réellement des flux positifs de ressources. Par contre, dans leur analyse, (Cohen, 1993; Chowdhury, 2004; Hansen, 2004; Loxley et Sackey, 2008) corroborent l'impact adverse du service obligatoire de la dette, même si son impact peut être limité à l'investissement (Presbitero, 2006) car son amplitude sur la croissance du PIB est faible (Clements, Bhattacharya et Nguyen, 2003).

La littérature récente montre l'évidence de l'impact positif de l'allègement réel de la dette sur la croissance et l'investissement (Depetris Chauvin et Kraay, 2005; Johansson, 2008) par la disponibilité du crédit au secteur privé (Harrabi, Bousrih et Mohammed, 2007) et les dépenses des services sociaux (Dessy et Vencatachellum, 2007).

Ainsi, il peut y avoir un effet positif de l'allègement de la dette sur une croissance économique subséquente, au moins, dans les pays où il y a de bonnes institutions.

Par ailleurs, l'allègement de la dette, similaire à l'aide étrangère génère un état de dépendance de l'aide du pays débiteur, lequel pourrait fragilisé la qualité institutionnelle, en affaiblissant et en déformant la responsabilité politique, en encourageant la corruption, en fomentant des conflits pour le contrôle du fonds d'aide, en absorbant le rare talent de la bureaucratie et en allégeant les pressions pour réformer les politiques et institutions inefficaces (Knack, 2001; Moss, Pettersson et van de Walle, 2006; Wood, 2008).

Contrairement à l'aide étrangère, l'allègement de la dette ne consiste pas à un flux direct de ressources mais à une réduction des dépenses fiscales à travers une baisse des paiements du service de la dette. Donc, l'allègement de la dette est de nature à réduire les effets négatifs de l'aide étrangère dus à la surévaluation du taux de change (Rajan et Subramanian, 2005). Cet allègement limite aussi les comportements qui pourraient produire une sorte de malédiction de l'aide semblable à celle des ressources naturelles (Djankov, Montalvo et Reynal-Querol, 2008).

Burnside et Dollar (2000) découvrent que l'aide a un impact positif sur la croissance dans les pays en voie de développement avec une bonne politique fiscale, monétaire et commerciale, mais cet effet est faible en présence de politiques pauvres.

Hansen et Tarp (2001) ont montré la présence d'une corrélation persistante entre les effets fixes pays et les indicateurs de la politique macroéconomique. Leurs résultats limitent la portée de l'analyse de Burnside et Dollar (2000). Ils suggèrent d'utiliser l'estimateur GMM d'Arellano-Bond qui prend en compte les effets fixes-pays par la différence première et inclut des variables endogènes retardées comme instruments pour corriger l'endogeneité. Ces auteurs montrent que l'aide agit négativement sur la croissance par une diminution des recettes.

Les travaux de Clements et al. (2003) confirment l'existence d'un surendettement. En outre, ils trouvent que le service de la dette dévie les fonds destinés à l'investissement public, en baissant le taux de croissance total d'un pays en voie de développement. Ils concluent que si les ressources libérées par l'allègement du service de la dette peuvent être dirigées vers l'investissement public, les taux de croissance dans quelques PPTE augmenteraient de 0.5% annuellement.

Une des raisons supplémentaires pour laquelle l'allègement de la dette pourrait être inefficace est qu'il n'est pas considéré comme un signal positif pour les pays entreprenant des réformes structurelles et changeant leurs politiques (Easterly 2002).

Finalement, il est raisonnable de supposer que l'allègement de la dette deviendrait plus efficace avec le temps, depuis que l'approche d'annulation de la dette des gouvernements et des Institutions Financières Internationales est conduite par « learning by doing ».

Par conséquent, l'efficacité de l'allègement de la dette pourrait diminuer par son impact limité sur le budget du gouvernement, son effet de signal négatif et par la très mauvaise qualité institutionnelle. Cependant, des facteurs institutionnels gouvernent la relation dette –croissance et le surendettement est efficace exclusivement dans les pays avec des institutions saines (Presbitero, 2008).

4. Méthodologie

Tout d'abord, dans cette section le modèle de croissance sera présenté. Ensuite, les sources de données et enfin la méthodologie.

a) Présentation du modèle théorique

Le modèle de référence s'inspire des travaux d'Andrea (2007). L'équation de la croissance qui sera estimée est la suivante :

$$\Delta Y_{it} = (\alpha - 1) Y_{i,t-1} + X_{i,t}\beta' + \delta_1 DETTE_{i,t} + \delta_2 DETTE_{i,t}^2 + \eta_i + \tau_t + \varepsilon_{i,t} \quad (1)$$

Cette équation est équivalente à celle du modèle du panel dynamique suivant :

$$Y_{it} = \alpha Y_{i,t-1} + X_{i,t}\beta' + \delta_1 DETTE_{i,t} + \delta_2 DETTE_{i,t}^2 + \eta_i + \tau_t + \varepsilon_{i,t} \quad (2)$$

Où Y_{it} est le logarithme du PIB par habitant en parité du pouvoir d'achat du pays i au temps t (et ΔY est le taux de croissance du PIB calculé en log différence), $Y_{i,t-1}$ est le logarithme décalé du revenu (représentatif du niveau de développement économique). $X_{i,t}$ est un ensemble de variables de contrôle comme le taux d'investissement brut (public et privé) en pourcentage du PIB, l'ouverture commerciale, le taux de scolarisation au secondaire, les variations des termes de l'échange (représentative des chocs externes), le taux d'inflation, le montant de l'allègement de la dette. La variable *DETTE* , représente les différents indicateurs de la dette extérieure comme le ratio de la dette publique, la garantie publique sur le PIB et le ratio de la dette totale (publique et privée) sur le PIB. η *et* τtraduisent respectivement les effets fixes et temporels des pays et ε_{it} désignent le terme d'erreur désignant la variabilité dans le temps et entre les pays.

La base des données concerne les pays de la CEDEAO sur une période de 1980 à 2006.

La majorité provient du World Development Indicators (WDI) 2007 de la Banque mondiale et du FMI, ainsi de World Bank African database. La variable éducation représentée par le taux de scolarisation du secondaire a été construite et actualisée par Barro-Lee[43] avec les données du WDI 2007.

Pour analyser l'effet de l'allègement de la dette sur la croissance économique dans les pays de la CEDEAO, on adopte une approche économétriques en données de Panel avec comme estimateur, la Méthode des Moments Généralisés (MMG).

Dans ce travail, la méthode d'estimation la plus appropriée comme le recommandent Blundell et Bond (2000) est la méthode des moments généralisés en système (MMGS) car elle réduit de manière significative le biais d'échantillonnage par rapport à l'estimateur MMG en différence et améliore les gains de précision.

Le GMM en système consiste à combiner pour chaque période les équations en différences première avec les équations en niveau dans lesquelles les variables sont instrumentées par leurs premières différences. Le système d'équations ainsi obtenu est estimé simultanément, à l'aide de la méthode des moments généralisés. Blundell et Bond (1998) ont testé cette méthode à l'aide des simulations de Monte Carlo. Ces auteurs ont trouvé que l'estimateur des GMM en système est plus performant que celui en différence première (Arellano et Bond, 1991) qui

43 - http://www.cid.harvard.edu/ciddata/ciddata.html (dernière consultation : Février, 2010).

n'exploite que les conditions de moments de l'équation en différence première avec comme instruments des variables retardées en niveau. Ce dernier donne des résultats biaisés dans des échantillons finis lorsque les instruments sont faibles.

Deux tests sont associés à l'estimateur MMG en panel dynamique: le test de suridentification de Sargan / Hansen qui permet de tester la validité des variables retardées comme instruments, et le test d'autocorrélation d'Arellano et Bond où l'hypothèse nulle est l'absence d'autocorrélation de second ordre des erreurs de l'équation en différence. Dans le modèle à estimer, l'utilisation des variables retardées comme instruments diffère selon la nature des variables explicatives. En effet, pour les variables exogènes, leurs valeurs courantes sont utilisées comme instruments; pour les variables prédéterminées ou faiblement exogènes leurs valeurs retardées d'au moins une période sont utilisées comme instruments et pour les variables endogènes, seules leurs variables retardées d'au moins deux périodes peuvent être des instruments valides.

b)-Résultats des estimations économétriques

Dans l'ensemble, ces résultats seront présentés à trois niveaux différents. Un premier paragraphe présentera quelques évidences descriptives de l'allègement de la dette sur certains indicateurs macroéconomiques. Un second paragraphe exposera ces évidences à travers un petit modèle. Enfin dans un dernier paragraphe on analysera les résultats du modèle de relance économique.

• Evidences descriptives

Dans le cadre de la présentation de ces évidences statistiques ; deux groupes de pays ont été constitués. Le groupe A comprend tous les pays de la CEDEAO. Le groupe B comprend les pays ayant bénéficié des dernières initiatives d'allègement de la dette.

Ainsi, l'une des manières d'apprécier l'efficacité de l'allègement de la dette consistera à une représentation visuelle de la corrélation actuelle entre l'allègement de la dette et les résultats d'un changement subséquent des différentes variables macroéconomiques. Ainsi, on mesure le changement de la variable dépendante$Y_t - Y_{t-l}$, pendant que la mesure correspondante de l'allègement de la dette fait référence à t - l.

Parmi les variables qui peuvent être affectées par l'allègement de la dette on retient dans l'ordre les variables suivantes :

1. Le taux de croissance réelle du PIB par habitant, calculé comme log-différence du PIB/hbt mesuré en PPA au dollar constant international.
2. le taux d'investissement (INV), calculé comme la part de la Formation Brut du Capital Fixe (FBCF) sur le PIB, pour tester de la présence du surendettement.
3. Le ratio de l'Investissement Direct Etranger sur PIB (IDE), pour évaluer si la réduction de la dette est perçue comme un signal positif par la communauté internationale afin que l'investissement privé augmente leur présence dans les pays.

4. Le ratio de la dette intérieure sur PIB (DomD). Dans ce cas, l'hypothèse testée est basée sur une conséquence involontaire de l'initiative PPTE, basée sur un ajustement asymétrique du côté réel et monétaire de l'économie, qui détermine vraisemblablement une augmentation du crédit intérieure.
5. Les dépenses gouvernementales rapportées au PIB pour apprécier l'effort du gouvernement sur l'ensemble de l'économie.
6. Les dépenses du secteur d'éducation et de la santé sur le PIB afin de mesurer l'importance des dépenses sociales pour la relance économique dans ces pays.

Les graphiques 5 à 10 (en annexe) montrent la corrélation entre l'allègement réel de la dette et un changement subséquent des variables citées ci-dessus dans les deux groupes.

Le graphique N° 5 montre une corrélation positive entre l'allègement de la dette à la période t-1 et le taux de croissance du PIB dans le groupe A à la période t, mais cette relation est plus forte dans le groupe B. Ce résultat conforte l'hypothèse selon laquelle l'allègement de la dette stimule la croissance dans les PPTE.

En référence au graphique N°6 du groupe A, la relation entre l'évolution du taux d'investissement et l'allègement de la dette est presque identique dans les deux groupes de pays. Néanmoins, on remarque une corrélation positive appréciable au niveau des pays du groupe B, ce qui signifie une réponse positive de l'allègement de la dette pour cette variable.

La relation entre le crédit domestique et l'allègement de la dette au niveau du graphique N°7 montre une relation quasi linéaire et horizontale pour les pays du groupe A. Cependant, cette même relation devient positive et significativement corrélée avec les pays du groupe B.

Ce résultat confirme l'hypothèse discutée par Arnone et presbitero (2007) qui ont trouvé une augmentation significative du crédit domestique dans les pays bénéficiaires des initiatives d'allègement de la dette.

Le graphique N°8 montre l'évidence d'une corrélation très faible voire nulle entre l'allègement de la dette et l'IDE dans les deux groupes de pays. Cette corrélation se remarque plus dans le groupe A que dans le groupe B. Cela peut être expliqué par l'importance des investissements dans le secteur pétrolier au Nigéria, en Côte d'Ivoire et au Ghana.

Le graphique N°9 reflète une corrélation négative entre les dépenses gouvernementales sur le PIB pour les deux groupes de pays. Cette relation se remarque plus au niveau des pays du groupe A, ce qui explique l'impact de l'allègement de la dette dans l'amélioration de ce ratio dans les pays du groupe B.

Enfin, le graphique N°10 montre une corrélation positive entre les dépenses publiques d'éducation, de santé et l'allègement de la dette à la période. Cette relation est plus forte au niveau des pays du groupe B, bénéficiaires des initiatives d'allègement de la dette. Ce résultat correspond globalement aux conditions qui accompagnent cet allègement en ce sens que les

ressources libérées doivent être orientées prioritairement dans les secteurs sociaux porteurs de croissance dans l'avenir.

• Analyse multivariée

Les évidences descriptives du paragraphe ci- dessus montrent quelques effets positifs de l'allègement de la dette sur la croissance économique, le taux d'investissement, l'IDE, le crédit domestique et les dépenses publiques d'éducation et de santé. Cependant, ces indicateurs devraient être confirmés par une analyse multivariée. Avec 4 sous périodes, on va regarder l'effet de l'allègement de la dette sur un panel de données sur 4 intervalles (1989-1993 ; 1994-1998 ; 1999-2003-2004-2008).

Le tableau 1 reporte les coefficients de cette simple régression pour l'échantillon entier (groupe A) et exclusivement pour l'échantillon du groupe B.

$$Y_{i,t} - Y_{i,t-1} = \alpha + \beta Dette\_alleg_{t-1} + \gamma D_t + \varepsilon_{i,t} \qquad (3)$$

L'équation (3) est estimée avec l'estimateur Within-group pour éliminer les effets spécifiques pays qui peuvent affecter la probabilité et le montant de l'allègement de la dette sur la variation de Y où les résultats sont représentés par les cinq variables macroéconomiques présentées ci-dessus.

Tableau 1: Effets de l'allègement de la dette

	[1]	[2]	[3]	[4]	[5]
Var.Dépendante	Croissance	INV	IDE	Creditdom.	Depense-educ-santé
Tous les pays de la CEDEAO					
Allège.Dette$_{t-1}$	0,251	0,008	0,070*	0,006	0,256***
	(1,05)	(0,22)	(1,72)	(0,46)	(2,74)
Observations	45	45	45	45	45
Nombre de pays	15	15	15	15	15
Pays de la CEDEAO admis au PPTE et IADM					
Allège.Dette$_{t-1}$	0,24**	0,03	0,091	0,031****	0,443***
	(1,95)	(1,44)	(1,49)	(4,13)	(4,38)
Observations	24	24	24	24	24
Nombre de pays	8	8	8	8	8

Les chiffres entre parenthèses représentent les statistiques de student.(***) Significatif à 1%, (**) Significatif à 5%, (*) Significatif à 10%

Dans le groupe A, on constate qu'il n'y a aucune corrélation statistiquement significative entre allègement de la dette à la période t-1 et la croissance économique, le taux d'investissement et le crédit domestique à la période t. Mais, on note une corrélation positive entre cet allègement et les dépenses d'éducation et de santé ainsi que l'IDE.

Cependant, en considérant le groupe B, il se révèle que l'allègement de la dette dans le passé est associé à une augmentation significative, de la croissance économique, du crédit domestique et des dépenses publiques d'éducation et de santé. Ces résultats confirment ceux des évidences descriptives.

5. Implications de politiques économiques

Dans ce travail, il a été démontré que des ressources provenant d'un allègement de la dette peuvent sous certaines conditions permettre une relance économique dans l'espace CEDAO. De façon générale, que les ressources proviennent d'un allègement de la dette, d'une aide étrangère ou sous forme d'une rente du fait de l'exploitation des ressources naturelles, elles permettent une relance économique par une croissance économique soutenue et régulière que sous certaines conditions.

Ainsi, lorsque les gouvernements ne prennent pas des mesures permettant d'aboutir à des profondes réformes économiques et financières de façon structurelle, les résultats escomptés ne seront pas atteints. Ceci se vérifie dans ce travail car tous les pays ayant bénéficié de ces initiatives d'allègement de leur dette extérieure ont préalablement accompli un effort en matière de réforme structurelle de leur économie.

Les ressources libérées à la suite de cet allègement de la dette doivent être prioritairement utilisées à des fins d'investissement dans les secteurs porteurs de croissance économique.

Les résultats de ce travail montrent aussi une corrélation positive entre les dépenses d'éduction et de santé et la croissance économique. Par conséquent, il est souhaitable de prioriser ces deux secteurs dans les choix des investissements sociaux afin que la croissance soit régulière à terme.

La promotion d'une relance économique doit se faire dans une situation socioéconomique interne saine. Par conséquent, il est souhaitable de privilégier aussi une partie des ressources libérées à l'apurement des arriérés interne (crédit domestique).

Enfin, la promotion d'une bonne gouvernance économique est nécessaire si on veut que les premiers résultats obtenus à la suite de cet allègement aboutissent à une relance économique dans la durée.

6. Conclusion générale

Les initiatives d'allègement de la dette extérieure représentent une opportunité majeure pour les pays en développement, notamment ceux de la CEDEAO dans leur plan de relance économique.

Il faut noter que l'admission de ces pays à ces initiatives d'allègement de la dette est précédée par des réformes structurelles en terme de modernisation des économies.

L'allègement de la dette au profit des pays de l'espace CEDEAO a montré que les ressources libérées ont eu un impact positif sur l'économie en général. Ceci se remarque au niveau :

- du taux de croissance économique,
- des dépenses gouvernementales,
- des dépenses publiques d'éduction et de santé,
- de l'investissement public,
- et de la réduction du crédit intérieure,

Ces résultats empiriques ont d'importantes implications de politique économique.

Par rapport aux résultats de cette étude, on peut recommander aux pays africains en général et ceux de l'espace CEDEAO en particulier que :

- pour avoir une croissance soutenue et régulière, il est indispensable de coupler l'utilisation efficace des ressources internes et externes avec le respect et le maintien des réformes économiques qui ont permis de bénéficier de ces initiatives d'allègement de la dette. La réussite de cette politique permettra à terme de sortir du cercle du sous-développement.

- les ressources mobilisées dans le cadre de cet allègement doivent êtres utilisées prioritairement dans l'investissement productif car c'est à travers l'investissement qu'on maintient la croissance dans la durée,

- les dépenses publiques d'éducation et de santé sur le PIB expliquent régulièrement la croissance économique dans cet espace. Par conséquent, toute politique de relance économique dans cette communauté doit faire une place de choix au financement et à la revalorisation du capital humain.

- Enfin, en dehors des facteurs exogènes, la mauvaise gouvernance est aussi à la base de cette situation d'endettement qu'ont connu les pays de la CEDEAO. De ce fait, il s'avère nécessaire de retenir que la bonne gouvernance économique doit être la règle pouvant permettre un vrai dynamisme économique dans cette communauté.

Références bibliographiques

Acemoglu, D., Johnson, S., and Robinson, J.A (2005). Institutions as a Fundamental Cause of Long-Run Growth, in Philippe Aghion and Stephen Durlauf (eds) Handbook of Economic Growth, Amsterdam, Elsevier.

Acemoglu, D., J. A. Robinson, Y. Thaicharoen and S. Johnson. 2003. « Institutional Causes, Macroeconomic Symptoms: Volatility, crises and Growth.» Journal of Monetary Economics, Vol. 50, pp. 49-123

Alfaro, L. et al. 2005. « Capital Flows in a Globalized World: The Role of Policies and Institutions.» Working Paper for the NBER Conference on International Capital Flows.

Arellano, M. and S. Bond. 1991. « Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations.» The Review of Economic Studies 58: 277-97.

Arnone, Marco and Andrea F. Presbitero. 2007. "External Debt Sustainability and Domestic Debt in Heavily Indebted Poor Countries." *Rivista Internazionale di Scienze Sociali* CXV(2):187- 213.

Barro, Robert J. and Jong-Wha Lee. 2001. "International data on educational attainment: updates and implications." Oxford Economic Papers 53(3):541 - 563.

Blundell, R., et S. Bond.2000. « GMM Estimation with Persistent Panel Data : An Application to Production Functions » , Econometric Reviews, vol. 19, no 1, p. 321-340.

Blundell, R., et S. Bond.1998. « Initial Conditions and Moment Restrictions in Dynamic Panel Data Models » , Journal of Econometrics, vol. 87, p. 115-143.

Burnside, Craig, and David Dollar (2000). Aid, Policies and Growth. American Economic Review 90(4), 847-868.

Chowdhury, Abdur R. 2004. External Debt, Growth and the HIPC Initiative: Is the Country Choice Too Narrow? In Debt Relief for Poor Countries, ed. Tony Addison, Henrik Hansen and Finn Tarp. New York: Palgrave Macmillan chapter 8, pp. 158- 180.

Clements, Benedict J., Rina Bhattacharya and Toan Quoc Nguyen. 2003. External Debt, Public Investment, and Growth in Low-Income Countries. IMF Working Papers 03/249 International Monetary Fund.

Cohen, Daniel. 1993. "Low Investment and Large LDC Debt in the 1980's." American Economic Review 83(3):437- 49.

Commission de l'UEMOA : (juin 2009) Rapport semestriel d'exécution de la surveillance multilatérale

Cordella, Tito, Luca Antonio Ricci and Marta Ruiz-Arranz. 2005. Debt Overhang or Debt Irrelevance? Revisiting the Debt Growth Link. IMF Working Papers 05/223 International Monetary Fund.

Depetris Chauvin, Nicolas and Aart Kraay. 2005. "What Has 100 Billion Dollars Worth of Debt Relief Done for Low-Income Countries?" The World Bank.

Dessy, Sylvain E. and Desire Vencatachellum. 2007. \Debt Relief and Social Services Expenditure: The African Experience, 1989{003.» African Development Review 19(1):200-216(17).

Djankov, Simeon, Jose Montalvo and Marta Reynal-Querol. 2008. "The curse of aid." Journal of Economic Growth 13(3):169 - 194.

Dollar, D., and Kraay, A. (2002a). Trade, Growth and Poverty, Economic Journal, Vol. 114, F22-F49.

Dollar, D., and Kraay, A. (2002b). Growth is Good for the Poor, Journal of Economic Growth, 7, 195-225.

Douglass C North. 1995. Institutions and Economic Growth: An Historical Introduction. 1989. World Development, Vol. 17, No. 9, pp. 131%1332, 1989.

Easterly, William. 2002. "How Did Heavily Indebted Poor Countries Become Heavily Indebted? Reviewing Two Decades of Debt Relief." World Development 30(10):1677- 1696.

Elbadawi, Ibrahim A., Benno J. Ndulu and Njuguna Ndung'u. 1997. Debt Overhang and Economic Growth in Sub-Saharan Africa. In External Finance for Low- Income Countries, ed. Zubair Iqbal and Ravi Kanbur. Washington D.C.: IMF Institute chapter 5.

Group, Independent Evaluation. 2006. Debt Relief for the Poorest. An Evaluation Update of the HIPC Initiative. Washington DC: The World Bank.

Guillaumont Patrick, and Lisa Chauvet (2001). Aid and Performance: A Reassessment. Journal of Development Studies 37(6), 66-92.

Hansen, Henrik. 2004. The Impact of External Aid and External Debt on Growth and Investment. In Debt Relief for Poor Countries, ed. Tony Addison, Henrik Hansen and Finn Tarp. New York: Palgrave Macmillan chapter 7, pp. 134-157.

Hansen, Hendrik, and Finn Tarp (2001). Aid and Growth Regressions. Journal of Development Economics 64, 547-570.

Harrabi, Sana, Lobna Bousrih and Salisu Mohammed. 2007. "Debt Relief and Credit to the Private Sector in African Countries." African Development Review 19(3):469 -480.

Johansson, Pernilla. 2008. Debt Relief, Investment and Growth. Working Paper 11 Lund University.

Knack, Stephen. 2001. "Aid Dependence and the Quality of Governance: Cross-Country Empirical Tests." Southern Economic Journal 68(2):310{329.

Koeda, Junko. 2008. "A Debt Overhang Model for Low-Income Countries". IMF Staff Papers advance online publication.

Komlan Fiodendji. La qualité des institutions et les investissements directs étrangers (IDE) en Afrique subsaharienne: une estimation par la méthode des moments généralisés en système.

7èmes journées scientifiques du réseau « Analyse Economique et Développement de l'AUF ». Paris- septembre 2006.

Krugman, Paul, 1988, "Financing vs. Forgiving a Debt Overhang", Journal of Development Economics, No. 29, pp. 253-268. Further information in IDEAS/RePEc

Kraat, Aart. Aide, croissance et pauvreté exposé au séminaire du FMI sur l'Aide étrangère et la gestion macroéconomique. Maputo, Mozambique, 14-15 mars 2005.

Loxley, John and Harry A. Sackey. 2008. "Aid Effectiveness in Africa." African Development Review 20(2):163- 199(37).

Moss, Todd, Gunilla Pettersson and Nicolas van deWalle. 2006. An Aid-Institutions Paradox? A Review Essay on Aid Dependency and State Building in Sub-Saharan Africa. Working Paper 74 Center for Global Development.

Pattillo, Catherine A., Helene Poirson and Luca Antonio Ricci. 2004. What Are the Channels Through Which External Debt Affects Growth? IMF Working Papers 04/15 International Monetary Fund.

Pattillo, Catherine A., Helene Poirson and Luca Antonio Ricci. 2002. External Debt and Growth. IMF Working Papers 02/69 International Monetary Fund.

Presbitero, Andrea Filippo. 2008. "The Debt-Growth Nexus in Poor Countries: A Reassessment." Economics: The Open-Access, Open-Assessment E-Journal 2(30).

Presbitero, Andrea F. 2006. "The Debt-Growth Nexus: a Dynamic Panel Data Estimation." Rivista Italiana degli Economisti 3(4):417- 462.

Rajan, Raghuram G. and Arvind Subramanian. 2005. What Undermines Aid's Impact on Growth? NBER Working Papers 11657 National Bureau of Economic Research, Inc.

Ralf, Hepp. 2005. Can Debt Relief Buy Growth? JEL Classification: F42, F43, O19

Sachs, Jerey D. 1989. The Debt Overhang of Developing Countries. In Debt, Stabilization and Development, ed. Guillermo A. Calvo, Ronald Findlay, Pentti Kouri and Jorge Braga de Macedo. Oxford: Basil Blackwell.

Wood, Adrian. 2008. "How donors should cap aid in Africa." Financial Times.

World Bank African Database 2004. Washington, DC: The World Bank.

World Bank. 2007. World Development Indicators 2007. Washington, DC: The World Bank.

World Bank. 2007. Heavily indebted poor countries (HIPC) initiative and multilateral debt relief initiative (MDRI)–status of implementation DC2007-0021. September 28, 2007

ANNEXES

Tableau N°2 : Statistiques descriptives

Variable	Nombres d'observations	Moyennes	Ecart type	Minimum	Maximum
GROWTH	405	-0.168	7,969	-50,486	89,828
PIBR	405	5,322	1,489	0,000	7,197
OUV	405	4,120	0,318	2,865	5,448
(DETTE/PIBR)	405	3,590	1,856	0,000	6,152
EDUC	405	1,073	3,894	0,000	26,000
ALLEGE	405	0,512	1,578	0,000	8,538
INVPIB	405	2,404	1,039	0,000	3,879
(DPPG/PIB)	405	4,063	1,263	0,000	6,758
DEP.EDUC.SANTE	405	0,112	0,380	-0,116	2,188
TXTERME	405	0,000	0,000	-285E+12	1356,330
INFLATION	405	8,263	15,622	-7,796	122,870
POP	405	2,674	1,115	-1,706	8,625

Tableau N°3 : Statistiques descriptives entres les variables

	GROWTH	PIB/HBT (-1)	DETTE/ PIBR	DPPG/PIBR	INV/PIBR	OUV	EDUC	ALL.	INFL.	TXPOP	TXTERME	DEP. EDUC. SANTE
GROWTH	1.0000 405											
PIBEHBT	0.0338 405	1.0000 405										
DETTE/ PIBR	-0,0451 404	0,4274* 404	1,0000 404									
DGPP/PIBR	-0,0645 405	0,573* 405	0,3519 404	1,0000 405								
INVPIBR	0,0766 404	4,4660* 404	0,3975* 403	0,4392* 404	1,0000 404							
OUV	-0,0047 405	0,0285 405	0,0104 404	0,0213 405	0,0037 404	1,0000 405						
EDUC	-0,028 405	0,0346 405	0,0793 404	0,,667 405	-0,0819 404	0,0315 405	1,0000 405					
ALLEGE	0,0611 405	-0,0605 405	0,0935 404	-0,0257 405	0,0242 404	-0,0766 405	-0,0127 405	1,0000 405				
INFLATION	0,0136 405	0,0913 405	0,2181* 404	0,1250* 405	0,1609* 404	0,1587* 405	0,1137* 405	0,0452 405	1,0000 405			
TXPOP	0,3272* 405	0,1994* 405	0,2052* 404	0,2392 405	0,222* 404	0,001 405	0,0358 405	-0,0639 405	0,0582 405	1,0000 405		
TXTERME	-0,0243 405	-0,0609 405	0,0965 404	0,002 405	-0,0259 404	-0,0019 405	0,0137 405	0,0162 405	0,0226 405	0,,014 405	1,0000 405	
DEP-EDUC-SANTE	0,0456 405	-0,3559* 405	-0,1360* 404	-0,3181* 405	-0,1796* 404	0,0435 405	-0,026 405	0,5166* 405	-0,067 405	-0,1997* 405	0,0148 405	1,0000 405

Note : *désigne un niveau de significativité de 5%. le second nombre en bas désigne le nombre d'observations

Tableau N 4: Résultats des estimations°

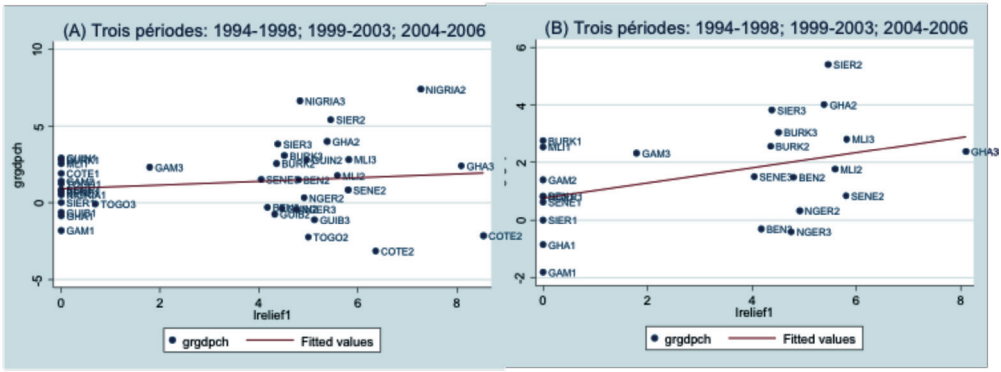
	CEDEAO			CEDEAO-PPTE-IADM		
Variable dépendante: GROWTH	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
PIBR(-1)	-1,295***	-1,30***	-15,27**	-0,455**	-0,46**	-0,455**
	(-2,60)	(-2,62)	(-2,53)	(-1,98)	(-1,99)	(-1,98)
INV	0,93*	0,95*	-1,19	1,50**	1,52**	1,502**
	(1,87)	(1,93)	(-0,63)	(2,08)	(2,13)	(2,08)
OUV	2,413**	2,64**	-0,034	4,794**	4,77**	4,79**
	(1,96)	(2,04)	(-0,02)	(2,09)	(2,08)	(2,09)
EDUC		0,004	-0,088**	-0,019		-0,019
		(1,57)	(-2,27)	(-0,50)		(-0,50)
INFLATION	0,025	0,02	0,029	-0,002	-0,005	-0,002
	(1,09)	(0,76)	(1,02)	(-0,13)	(-0,33)	-0,13)
TXTERME	1,52E-13	3,82E-13	-1,93E12	-9,55e-07***	-9,62e-07***	-9,55e-07***
	(0,37)	(1,01)	(-1,62	(-5,77)	-5,74)	(-5,74)
POP	3,77***	3,77***	3,14***	1,298**	0,127**	1,29**
	(3,24)	(3,22)	(2,68)	(1,95)	(1,90)	(1,95)
DETTE-ALLEGE	0,175	0,168	0,334**	0,22*	0,22*	0,226*
	(0,88)	(0,82)	(2,41)	(1,84)	(1,76)	(1,84)
DEPENSE-EDUCSANTE	2,09**	2,9**	1,21**	2,62*	2,68*	2,62*
	(2,02)	(2,02)	(2,00)	(1,84)	(1,74)	(1,74)
(DETTE/PIBR)	-0,87***	-1,94		-0,513***		-0,513***
	(-6,32)	(-1,30)		(-3,55)		(-3,55)
$(DETTE/PIBR)^2$		0,22			-0,111**	
		(0,72)			(-3,47)	
(DPPG/PIBR)			0,819	0,630***		
			(0,59)	(3,25)		
$(DPPG/PIBR)^2$			-0,009***	-0,0038***		
			(-2,61)	(-2,60)		
Hansentest of overid, restriction: Prob>chi2=	1,000	1,000	1,000	1,000	1,000	1,000
AR(1)	0,084	0,084	0,052	0,034	0,035	0,034
AR(2)	0,038	0,038	0,069	0,063	0,057	0,063
Nbre d'observations	373	373	371	200	200	200
Nbre d'observation par groupe	25	25	25	25	25	25
Nbre de groupe	15	15	15	15	15	15
F-test	15,45	14,28	80,04	6,43	10,20	1,30E-07

Les chiffres entre parenthèses représentent les statistiques de student, (***) Sinificatif à 1%, (**) Significatif à 5%, (*) Significatif à 10%

Graphiques

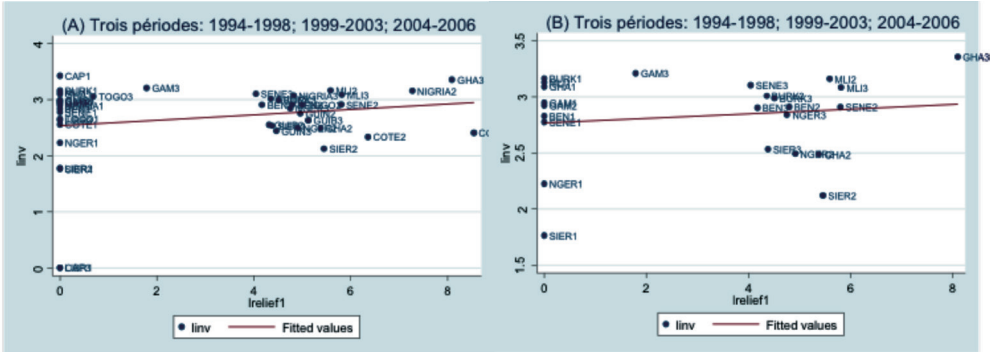
Graphique 5: Allègement de la dette et croissance économique

(A) : Tous les pays de la CEDEAO. (B) : pays ayant bénéficié des initiatives PPTE et IADM



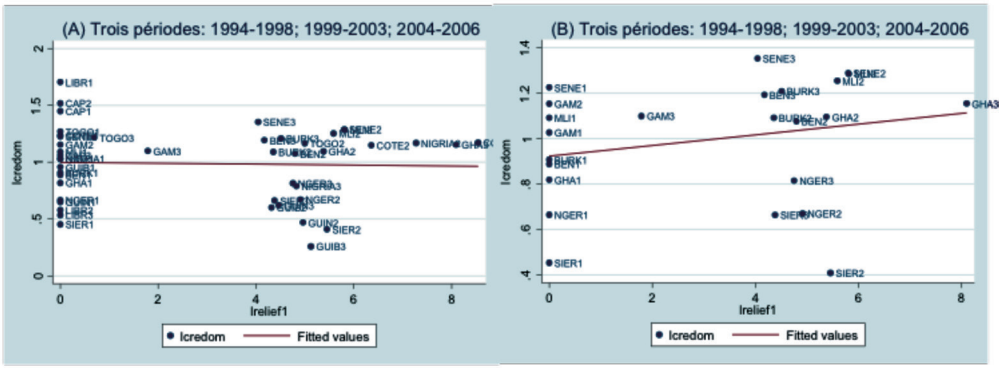
Graphique 6: Allègement de la dette et investissement

(A) : Tous les pays de la CEDEAO. (B) : pays ayant bénéficié des initiatives PPTE et IADM



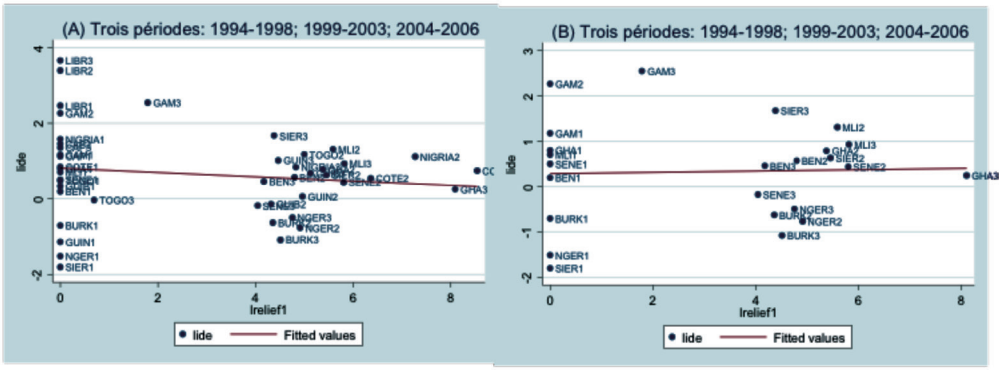
Graphique 7: Allègement de la dette et crédit domestique

(A) : Tous les pays de la CEDEAO. (B) : pays ayant bénéficié des initiatives PPTE et IADM



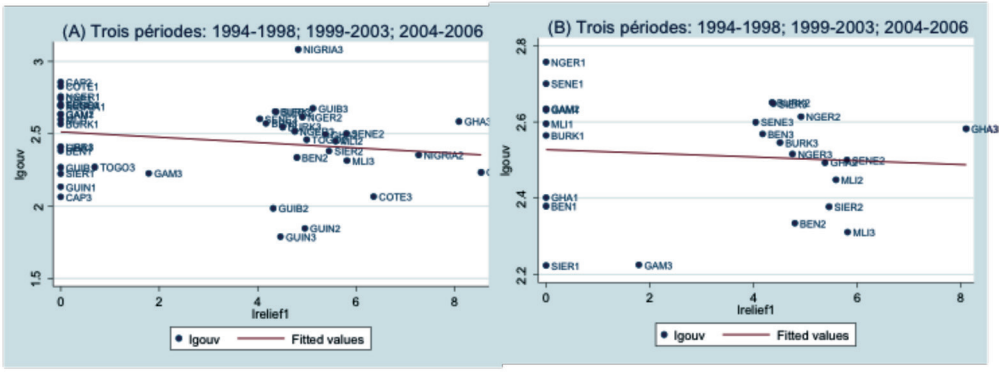
Graphique 8: Allègement de la dette et Investissement Direct Etranger (IDE)

(A) : Tous les pays de la CEDEAO. (B) : pays ayant bénéficié des initiatives PP**TE et IADM**



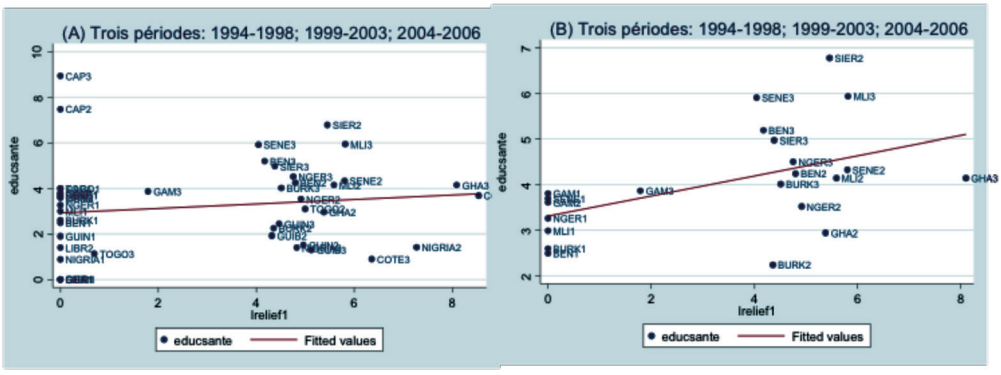
Graphique 9: Allègement de la dette et dépense du Gouv

(A) : Tous les pays de la CEDEAO. (B) : pays ayant bénéficié des initiatives PPTE et IADM



Graphique 10: Allègement de la dette et dépense publique d'éducation et de santé

(A) : Tous les pays de la CEDEAO. (B) : pays ayant bénéficié des initiatives PPTE et IADM



11-13 ECOWAS Street - Sierra Leone P.M.B. 218
Tel: +232 22 22 44 85/86 - Fax: +232 22 22 39 43
www.amao-wama.org
wamao@amao-wama.org

ISSN : 2305-3011