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Separating Monetary and Structural Causes of Inflation

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Abstract

The paper employs a structural vector autoregression (SVAR) to model inflation so as to identify the relative importance of shocks to real output growth, monetary growth and exchange rate depreciation in inflation dynamics in developing countries using data from Ghana. The results show that either monetary growth or structural factors alone do not explain the inflation experience and that the structural factors dominate monetary growth in the inflation dynamics. There is a fairly strong feedback between inflation and exchange rate depreciation both of which have weak relationship with monetary growth. These suggest that policies that boost domestic supply and therefore reduce import demand will be more potent than direct monetary management to curb inflation in Ghana.

JEL Classifications: E52, E31

Keywords: monetary, structural, inflation

1. Introduction and Theoretical Framework

There are two schools of thought on what explains inflation; monetarist school and structuralist school. The monetarist school argues that money is all that matters in explaining inflation. This forms the basis of the monetarist statement that "inflation is always and everywhere a monetary phenomenon". The structuralist school, on the other hand, argues that structural and institutional factors play a more prominent role in inflation dynamics. The structuralists' argue that inelastic food supply, infrastructural inadequacies that pose problems for distribution of output, lack of financial resources and low export receipts leading to foreign exchange shortages in developing countries put pressure on domestic prices (London, 1989). "The nominal exchange rate pass-through to domestic price inflation depends on how the changes in the exchange rates are passed through to import prices and therefore to domestic consumer prices" (Mishkin, 2008). It is also argued that the lack of financial resources coupled with a limited tax base cause these less developed countries to resort to deficit financing through the central banks, that lead to inflationary pressures.

This study uses a structural vector autoregression (SVAR) to model inflation so as to identify the relative importance of monetary and structural factors in explaining inflation in developing countries by using data from Ghana. The objectives of this paper are three fold; first, the paper identifies the relative importance of output supply shocks, monetary growth shocks and exchange rate depreciation shocks in inflation dynamics by analyzing the variance decomposition of the

forecast error variance of inflation. Secondly, the paper analyzes how shocks to real output growth, monetary growth and exchange depreciation transmit through to price developments and how fast these shocks dissipate. Lastly, the paper identifies what other channels of monetary policy transmission mechanisms exist in Ghana's monetary policy framework over the years. These help identify which of the variables has more information in better management of inflation in Ghana.

In 2002, Ghana adopted inflation targeting as its monetary policy framework, which requires appropriate target setting for inflation. The adoption of the inflation-targeting framework has certain prerequisites and technical issues as outlined in Blejer and Leone (2000). Among these prerequisites and technical issues are a clear understanding of the monetary policy transmission mechanism and reliable forecasts of inflation. This shows that setting appropriate inflation targets require not only accurate forecast but also knowledge of the channels through which policy variables affect inflation. The knowledge of the impact of these policy variables on inflation also helps in the efficient policy formulation to achieve the target. Also, "a successful implementation of any monetary policy regime requires an accurate and informed assessment of how fast the effects of policy changes propagate to other parts of the economy and how large these effects are. This requires a thorough understanding of the mechanism through which monetary policy actions and other forms of shocks affect economic activity" (Abradu-Otoo, Amoah, & Bawumia, 2003). So knowing the forecast values from the univariate time series models is necessary but not sufficient for the inflation targeting monetary policy framework adopted by the Bank of Ghana.

The rest of this paper is organized as follows: section 2 reviews relevant literature on inflation in Africa. Section 3 discusses the inflationary and monetary developments in Ghana. The methodology of the paper is discussed in section 4 while sections 5 and 6 discuss the empirical results and the conclusions respectively.

2. Literature on Inflation in Africa

The monetarists-structuralists debate makes it hard to determine what actually causes inflation, especially in Africa where structural factors are more highlighted. Some studies find that neither monetary nor structural factors alone explain inflation completely especially in Africa. Among the most relevant studies on monetary growth, exchange rate and inflation nexus in Africa are Chhibber, Cottani, Firuzabadi, and Walton (1989), London (1989), Tegene (1989), Canetti and Greene (1991) and Imimole and Enoma (2011). Chhibber *et al*. (1989) observe that inflationary process goes beyond simple monetary explanation and identify three transmission mechanisms for the inflationary dynamics in Zimbabwe. First, cost-push factors such as nominal wage changes, pass-through effect of import prices and government price controls impact domestic prices directly. Secondly, excess money supply interactions with modes of deficit financing translate into pressure on prices and finally, unfavorable supply conditions pressure prices. London (1989) uses both cross-section data over several African countries and time series data for individual countries and finds that monetarists view on inflation holds in the cross-section equations but not in the individual time series models for all the countries. London (1989) suggests that there are other factors other than monetary growth that explain inflation dynamics in Africa. Some of these factors may be output shocks that arise from supply bottlenecks and exchange rate depreciation. Tegene (1989) identifies monetary growth and changes in real income as the soles sources of domestic inflation in six African countries including Ghana. He, however, argues that the monetary single equation adequately explains the inflation dynamics in these countries with only domestic factors explaining the inflation dynamics in Ghana. Canetti and Greene (1991) use VAR to separate the influence of monetary growth and exchange rate depreciation in explaining inflation in ten African countries and find that monetary dynamics dominate inflation levels in four of the countries, including Ghana, while exchange rates dynamics dominate in three of them. Imimole and Enoma (2011) studying the

causes of inflation in Nigerian using an Autoregressive Distributed Lag model concludes that exchange rate depreciation, monetary growth and real output constraints are the main explanatory factors for the behavior of inflation in that country.

On the relationship between inflation and money supply in Ghana, Chhibber and Shafik (1990) find that monetary growth was the main force driving inflation in Ghana. They trace the source of the monetary expansion to the large inflow of external resources during the Economic Recovery Program (ERP) of the early 1980s, which in turn generated strong inflationary pressures. Sowa and Kwakye (1993) add that the foreign inflows also led to the rehabilitation of factories and the import of final goods, which eased the supply pressures as well. They thus argue that the influence of money was not that strong as suggested by Chhibber and Shafik (1990) but rather other structural factors might account for Ghana's inflation experience. Sowa (1996) notes that inflation in Ghana, in either the long run or the short run, is influenced more by output volatility than monetary factors.

Ocran (2007) uses an error correction model to model inflation in Ghana and identifies inflation inertia, changes in money and changes in Government of Ghana treasury bill rates, as well as changes in the exchange rate, as determinants of inflation in Ghana. This study is similar to an earlier study by Bawumia and Abradu-Otoo (2003) who also uses an error correction model to analyze the relationship among monetary growth, exchange rates and inflation and confirm the existence of a relationship between inflation, money supply, the exchange rate, and real income. Donyina-Ameyaw (2004) and Acheampong (2005) also find empirical links between inflation and exchange rates in Ghana.

The major weakness of the studies on Ghana, in the context of monetary policy formulation and implementation is that their orientations are to measure the impact of individual variables on inflation in Ghana rather than identifying the transmission mechanisms through which shocks to monetary policy variables have their impacts on inflation in Ghana. They also did not measure the relative strength of these variables in explaining inflation in Ghana. The later questions are more relevant for monetary policy. In an earlier attempt to fill this vacuum Abradu-Otoo *et al*. (2003) uses a seven-variable structural VECM to identify the mechanism through which monetary policy instruments affect inflation in Ghana. They conclude that monetary policy instruments affect inflation and output in Ghana in the long run through exchange rates. The endogenous variables they include in their model are inflation, real GDP, credit to the private sector, 91-day treasury bill rate, real exchange, m2+ a broader definition of money supply and price of crude oil. This, more monetary policy relevant study, suffers from degrees of freedom, given the large number of variables relative to the sample size, which brings the reliability of the results into question.

3. Inflation and Monetary Policy Developments in Ghana

As acknowledged by Canetti and Greene (1991), inflation management is a significant problem in sub-Saharan Africa in the past several decades. Ghana's inflation averaged 49.5 percent in the 1980s, 27.8 in the 1990s and 18.6 percent in the 2000s and as shown in Figure 1 the rates were very high in the 1980s, especially between April 1983 and February 1983 where the rates are above 100 percent. This period marks the start of Economic Recovery Program (ERP) which includes the financial sector reforms, where the inflow of resources led to more imbalances at the beginning.

The high and persistent inflationary pressures led to several monetary policy experiments by the Bank of Ghana over the years. Most of these policy experiments were as a result of controversies over what causes inflation in general and in Africa in particular. The old time monetarist argument is that excessive monetary growth is the sole cause of inflation. There are other arguments for causes of inflation in Africa as reviewed in the previous section. United Nations' Economic Commission for Africa, for example, in its 1989 African Alternative Framework for Structural

Adjustment Programs for Socio-Economic Recovery and Transformation identified exchange rate depreciation as the major cause of inflation in Africa.

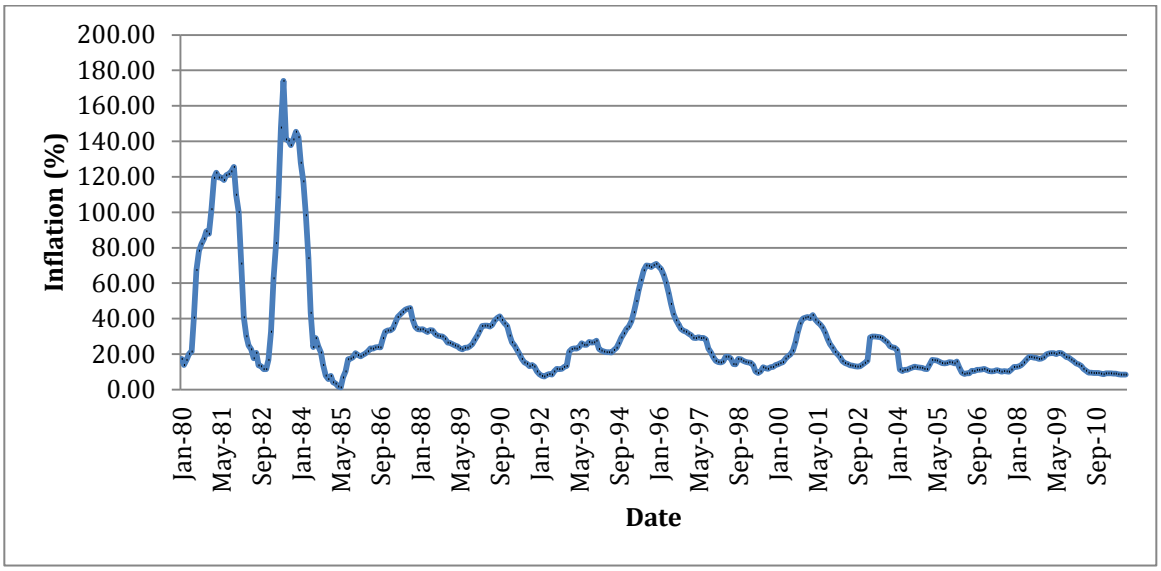

Figure 1. Year-on-year monthly Inflation in Ghana

According to Abradu-Otoo *et al*. (2003), monetary management in Ghana has two phases; pre-1983 reform phase and post-1983 reform phase. In phase I, bank of Ghana implemented both global and sectoral credit controls by implementing different credit ceilings in different sectors in as it deemed it fit for the growth and stabilization goals of the country. The inefficiencies associated with these direct controls necessitate the 1983 financial sector reforms that led to the institution of market-based instruments of monetary policy in 1992, which constitute phase II of Ghana's monetary management. In the financial programming model introduced in collaboration with the IMF in this phase, there were basically three targets: the operating target (reserve money), the intermediate target (money supply) and the ultimate or final target (the general price level). The mechanics of the targeting process is based on the strong view that inflation is predominantly a monetary phenomenon (Abradu-Otoo *et al*., 2003).

In 2001, Bank of Ghana became an independent institution by an act of parliament, free to perform its main function of ensuring stable prices and economic stability. Monetary policy committee was formed in 2002 and charged with the responsibility of those functions. According to Amoah and Mumuni (2008) Ghana adopted the inflation-targeting framework since the latter part of 2002 and the formal announcement was made in May 2007. I designate the start of inflation-targeting framework as the beginning of phase III of the monetary management phases in Ghana.

The behavior of monetary growth through the phases as shown in Figure 2, relative to the inflation series in Figure 1 shows lack of any significant causation from monetary growth to inflation and therefore suggests that monetary growth alone does not explain the variability in inflation in Ghana. The monetary growth series is noisier than the inflation series. Theoretically, if the monetarists' view of inflation holds, we expect high monetary growth to lead to high rates of inflation but that is not generally the case by looking at the two figures. The high monetary growth in the late 1980s did not translate into inflation and the high inflation in the early 1980s cannot be accounted for by high monetary growth as found by Sowa (1996). The later years also seem to have more stable inflation rates that could not be explained by the variable monetary growth over the period.

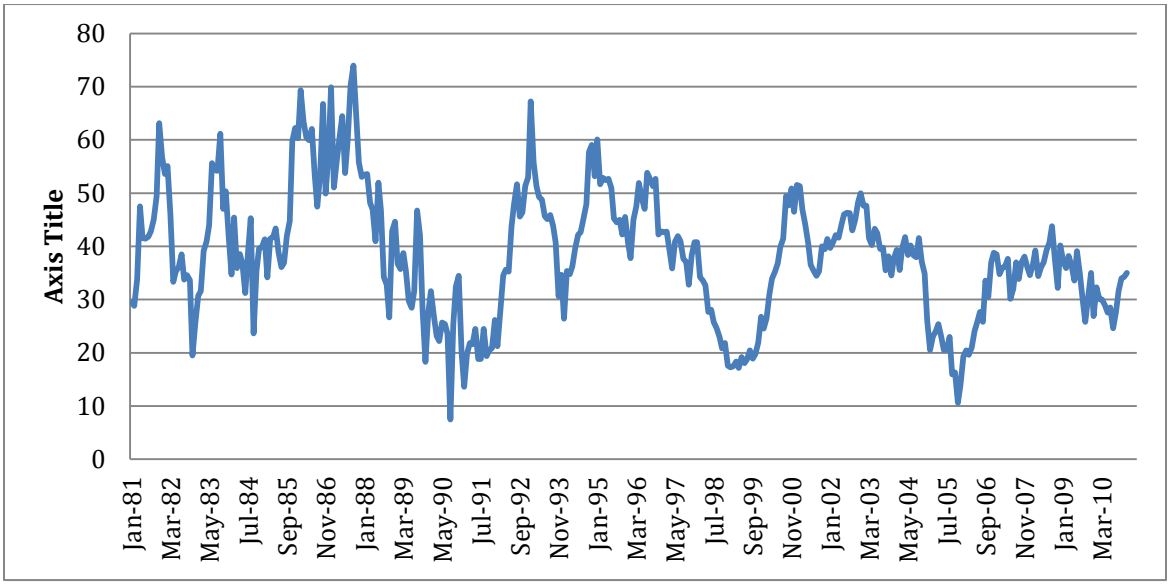

Figure 2. Year-on-year monthly monetary (M2+) growth in Ghana

4. Methodology

As has been discussed in the literature, neither monetary growth nor structural factors alone can explain the inflation experience in an African country like Ghana. "Although monetary developments are an important determinant of price movements in Ghana, a number of other factors are also important. These include exchange rate depreciation, wages, exogenous shocks in the domestic food supply, petroleum prices, and government fiscal policy among others" (Bawumia & Abradu-Otoo, 2003). These other factors, which are exogenous to the following model, are classified into three namely, supply shocks, demand shocks, monetary shocks and direct price shocks, to the system. And the model below is set up to identify relative contribution of these shocks to inflationary developments in Ghana and trace their transmission mechanisms.

4.1 The Model

The approach to modeling inflation in this paper is to identify the variables that are found to explain inflation dynamics in Africa, from the literature, and analyze these variables in a Structural Vector Autoregression by imposing appropriate economic theory on their dynamic relationship. Monetary growth and exchange rate depreciation have a significant positive relationship with inflation in African countries (Canetti & Greene, 1991), and from the structuralist argument, supply factors are more responsible for inflation dynamics in developing countries. So in modeling inflation and monetary policy transmissions to inflation in Ghana, we consider the behavior of changes in four endogenous variables, real GDP x_1, monetary growth x_2, inflation x_3 and nominal exchange rate of the Ghanaian cedi against the US dollar x_4 in a VAR. The changes in these variables are measured as the log-difference of quarterly levels of the variables so that they the quarterly growth rates.

Let $y_t = \left(x_{1t}\, x_{2t}\, x_{3t}\, x_{4t}\right)'$ be a 4-dimensional vector of endogenous variable in the VAR where x_{1t} is real GDP growth, x_{2t} is monetary growth x_{3t} is inflation, and x_{4t} is changes in the nominal exchange rates of the cedi against the US dollar. The structural representation of the model is

$$\Gamma y_t = \mu + \sum_{j=1}^{p} B_j y_{t-j} + v_t \tag{1}$$

where Γ is a 4×4 matrix of contemporaneous coefficients among the endogenous variables, μ is a vector of constants, B_j is a 4×4 matrix of structural coefficients, v_t is a vector of orthogonal structural shocks to the system so that $\Sigma_v = E\left(v_t v_t'\right) = I$. The reduced form of equation (1) is

$$y_t = \Gamma^{-1}\mu + \sum_{j=1}^{p} \Gamma^{-1} B_j y_{t-j} + \Gamma^{-1} v_t \tag{2}$$

this can be written as

$$y_t = \nu + \sum_{j=1}^{p} \Theta_j y_{t-j} + e_t \tag{3}$$

where $\nu = \Gamma^{-1}\mu$, $\Theta_j = \Gamma_j^{-1} B_j$, and $e_t = \Gamma^{-1} v_t$. Equation (3) can also be written as

$$y_t = \nu + \Theta(L) y_t + e_t \tag{4}$$

where $\Theta(L) = L + L^2 + ... + L^p$ and L is a lag operator. Given that the system in equation (4) is stable, we can re-write (4) as a moving average representation, by Wold's decomposition.

$$\left(I - \Theta(L)\right) y_t = \nu + e_t \tag{5}$$

$$y_t = \left(I - \Theta(L)\right)^{-1} \nu + \left(I - \Theta(L)\right)^{-1} e_t \tag{6}$$

$$y_t = \mu_0 + \sum_{j=0}^{\infty} \Phi_j e_{t-j} \tag{7}$$

Now suppose, as in Blanchard and Quah (1989), Clarida and Gali (1994) and Kempa (2002) that the estimated MA representation, based on estimation of the reduced form equation in (4), is given by

$$y_t = e_t + C_1 e_{t-1} + C_2 e_{t-2} + ... \tag{8}$$

and the true MA representation of the data generating process is

$$y_t = A_0 v_t + A_1 v_{t-1} + A_2 v_{t-2} + ... \tag{9}$$

from equation (3)

$$e_t = \Gamma^{-1} v_t \tag{10}$$

substituting equation (11) to equation (8) gives

$$y_t = \Gamma^{-1} v_t + C_1 \Gamma^{-1} v_{t-1} + C_2 \Gamma^{-1} v_{t-2} + ... \tag{11}$$

comparing equation (9) and (11) give us

$$A_0 = \Gamma^{-1}, \qquad e_t = A_0 v_t \ for\ j = 0 \qquad A_j = C_j A_0 \ for\ j > 0 \tag{12}$$

This shows the relationship between the vector of structural shocks $\boldsymbol{v}_t$ and the vector of reduced form residuals $\boldsymbol{e}_t$. Therefore by knowing $\boldsymbol{A}_0$, we can recover the structural shocks from the innovations. From equation (12) we can write

$$\Sigma_e = E(\boldsymbol{e}_t\boldsymbol{e}_t') = \boldsymbol{A}_0 E(\boldsymbol{v}_t\boldsymbol{v}_t')\boldsymbol{A}_0' = \boldsymbol{A}_0\boldsymbol{A}_0' \tag{13}$$

This gives a system of 10 equations with 16 unknowns, so for $\boldsymbol{A}_0$ to be identified, that is for the elements to have unique values so that the structural shocks are recovered, it requires 6 restrictions. Also, since $\boldsymbol{C}_j$ is estimated from (3) and (8), we can also identify $\boldsymbol{A}_0$ by imposing restrictions on the elements of $\sum_{j=1}^{\infty}\boldsymbol{A}_j$ in the relationship $\sum_{j=1}^{\infty}\boldsymbol{A}_j = \sum_{j=1}^{\infty}\boldsymbol{C}_j\boldsymbol{A}_0$ which are long run relationships because they imply that the cumulative effect of shocks to certain variables on others is zero.

4.2 Identification

Different types of restrictions have been used to identify VAR as an alternative to the standard Choleski decomposition, which have been criticized for its lack uniqueness because different arrangements of variables in the VAR give different results. Bernanke (1986) and Sims (1986) propose alternatives to the Choleski decomposition by using zero identifying restrictions on the contemporaneous coefficient matrix.

Other identifying restrictions have been used in the literature to identify monetary policy shocks to macroeconomic variables. Bernanke and Blinder (1992) show that monetary policy shocks can be identified without necessarily identifying the whole system by assuming that monetary policy shocks do not affect any of macroeconomic variables contemporaneously. This identification restriction implies setting the contemporaneous coefficient of the policy variables to zero. Estimating the resulting system by standard VAR followed by Choleski decomposition of the variance-covariance matrix, with the policy variable coming last in the ordering, gives estimated exogenous monetary policy shocks (Bernanke & Blinder, 1992).

Since the objective of this paper is to identify all the structural shocks, we use the identification restrictions proposed by Gali (1992) who uses a combination of contemporaneous and long run restrictions to identify all the structural shocks. Like Blanchard and Quah (1989), Gali (1992)'s long run restrictions are that only supply shocks affect real GDP growth, making use of the neutrality of the nominal variables in the model. This imposes three long run zero restrictions on the elements of $\sum_{j=1}^{\infty}\boldsymbol{A}_j$ in the four-variable VAR discussed above. In addition to these long run restrictions, Gali (1992) impose five short run restrictions, three of which are relevant for the current paper and are used as the three additional restrictions needed to identify the structural shocks. First, there is no contemporaneous effect of money supply shocks on output, which imposes one zero restriction on $\boldsymbol{A}_0$. Secondly, shocks to inflation do not affect money supply contemporaneously, which imposes another zero restriction on $\boldsymbol{A}_0$. Finally, contemporaneous real output changes do not enter the money supply rule, which implies that the coefficient of real output changes in the money supply function is zero in the current period which is a zero restriction on Γ. The last two restrictions are based on the fact that monetary authorities are unable to measure the real GDP and price variables contemporaneously, which is true because real GDP is measured quarterly at best while price is measured monthly with a lag.

The first set of Gali (1992) identification restrictions imply which, this model setting that

$$\sum_{i=0}^{\infty} a_{21i} = \sum_{i=0}^{\infty} a_{31i} = \sum_{i=0}^{\infty} a_{41i} = 0$$

The first and the second short run assumptions imply that

$$a_{210} = a_{310} = 0$$

The third restrictions also imply that

$$\gamma_{21} = 0$$

The last restriction is a non-linear restriction because it is imposed on contemporaneous relationships among the variables but not on the relationships among the shocks. That is, this restriction is on Γ and since $A_0 = \Gamma^{-1}$ it is non-linear in terms of the shocks. Putting all the restrictions together gives the

$$\sum_{j=1}^{\infty} A_j = \sum_{j=1}^{\infty} C_j A_0 = \begin{pmatrix} * & 0 & 0 & 0 \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix}, \quad A_0 = \begin{pmatrix} * & 0 & 0 & * \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix} \text{ and } \Gamma = \begin{pmatrix} * & * & * & * \\ 0 & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix}$$

where *'s are values to be estimated and the 0's are the identifying restrictions. These together identify the structural shocks v_t.

4.3 Data Sources and Description

Three main sources of data are used for this study, International Financial Statistics (IFS), Statistical Bulletin of Bank of Ghana and National Accounts Statistics of Ghana Statistical Service. Real GDP and exchange rate data are obtained from International Financial Statistics (IFS) of IMF, money supply data from Statistical Bulletin of Bank of Ghana and inflation data from Ghana Statistical Service.

Quarterly data covering the period 1980 to 2010 are used to estimate the models in the study. The period of the data is chosen for convenience so that all the variables in the model have data. Though data for all the variables, except real GDP, are available monthly, quarterly data are used in estimating the model because of real GDP data, which is available quarterly. Monthly data are aggregated into quarterly data depending on the type of data; quarterly exchange rates, CPI and money supply are period quarterly averages of the monthly data. Annual real GDP data for the period preceding 2006 are interpolated using COTRIM 1.01 Disaggregation Software which is based on Boot, Feibes, and Lisman (1967). Changes in these variables are calculated as quarterly changes.

5. Empirical Results

This section presents the results of the study. First, we present time series characteristics of the data, including the graphs and Augmented Dickey-Fuller test for stationarity, are discussed followed by variance decomposition of inflation and impulse response functions of the variables in the model conclude this section.

5.1 Characteristics of the Data

The graphs of the variables in Figure 3 show that they are stationary at their levels and these are confirmed by the Augmented Dickey-Fuller tests presented in Table 1. The optimum lag selection

for the VAR is based on Akaike Information Criteria and two lags are found to be optimal for the final models.

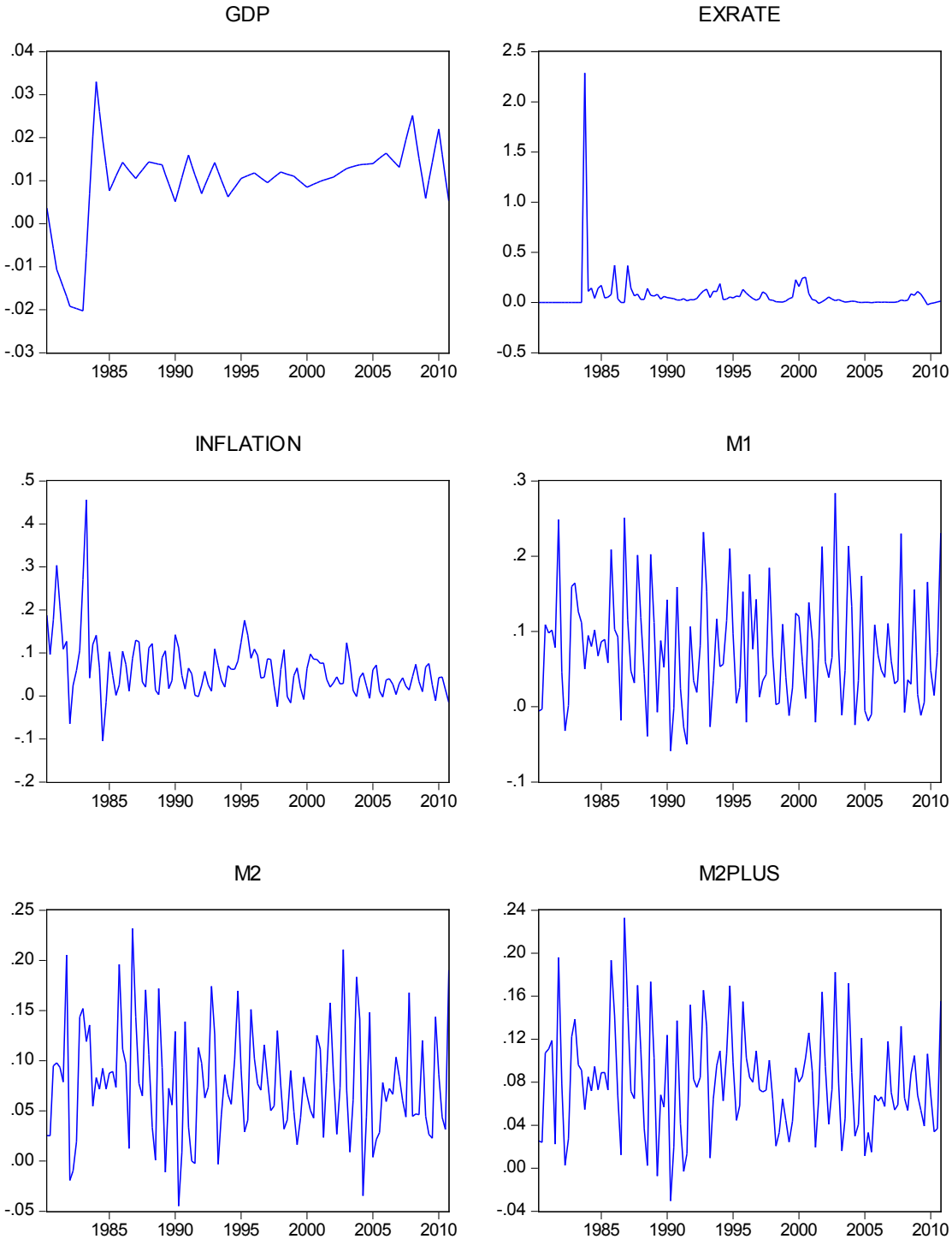

Figure 3. Graphs of the variables in the models

Table 1. Augmented Dickey-Fuller tests

Variable	lags	p-value
Real GDP growth	9	0.0001
Exchange rate	0	0.0000
Inflation	5	0.0000
M1	3	0.0024
M2	5	0.0008
M2+	3	0.0308

5.2 Variance Decomposition and Monetary Policy Transmission

The variance decomposition of inflation shows the relative importance of the monetary and structural shocks in explaining the forecast error variance of inflation at various forecast horizons. Three monetary aggregates are used in the VARs but only the results of the VAR including M2+ monetary aggregate is reported since the results are not sensitive to the type of aggregate used. The variance decomposition for the horizons 1, 6, 12, 24, 36 and 40 are reported in Table 2 to Table 5.

Table 2. Variance decomposition of real output growth

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	47.074	0.000	0.000	52.926
3	72.656	0.127	0.066	27.151
6	87.753	0.067	0.258	11.922
12	93.073	0.040	0.157	6.730
24	94.820	0.031	0.119	5.029
36	95.216	0.029	0.111	4.644
40	95.272	0.028	0.109	4.591

The variance decomposition for real output growth in Table 2 shows that exchange rate depreciation explains a significant percentage (52 percent) of variability in real output growth in the first round. This falls quickly to 27 percent in the third round and to about 5 percent after the results stabilize in the 24^{th} round. Monetary growth and inflation account for less than one percent of the variability in real output growth. Over the longer horizon, real output growth explains the variability in itself, which is consistent with the argument that nominal variables do not explain real output growth in the long run.

Table 3. Variance decomposition of inflation

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	26.648	56.149	4.748	12.455
3	45.460	29.442	4.317	20.782
6	47.434	28.924	5.168	18.474
12	55.417	24.749	4.491	15.342
24	61.338	21.433	3.891	13.338
36	63.015	20.488	3.720	12.777
40	63.262	20.349	3.695	12.694

The result for inflation in Table 3 stabilized after 12 rounds and as shown in the table, most of the variability in inflation is explained by real output growth in the long run. At 1-period-ahead forecast, monetary shocks explain 56.15 percent while real output shocks explain 26.6 percent. The percentage variability explained by monetary growth reduces quickly over the forecast horizons to about 20 percent while real output growth, exchange rate depreciation and inflation itself explains about 80 percent.

This structure of the variance decomposition of inflation suggests that inflation in Ghana is not necessarily a monetary phenomenon. Structural factors like excess import demand and shortages in export supply that reflect in exchange rate depreciation and local supply shocks in an agriculture led economy that heavily relies on rainfall explain more of the inflationary dynamics in Ghana than monetary growth.

Table 4 indicates that variability in exchange rate depreciation is mainly explained by inflation, real output growth and its own history. This finding, together with that of Table 3 where a significant percentage of variability in inflation is explained by exchange rate deprecation, establishes a fairly strong feedback between inflation and nominal exchange rate depreciation in Ghana. Table 5 also shows that real output growth and exchange rate depreciation are the main explanatory shocks to the variability in monetary growth.

Table 4. Variance decomposition of exchange rate

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	4.570	9.222	81.598	4.611
3	10.758	6.517	67.188	15.537
6	14.202	7.046	64.004	14.749
12	23.968	6.317	56.581	13.134
24	32.193	5.634	50.402	11.771
36	34.547	5.437	48.637	11.380
40	34.898	5.407	48.374	11.321

Table 5. Variance decomposition of money supply (M+)

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	55.387	14.689	1.033	28.891
3	50.276	19.548	6.952	23.224
6	61.058	17.145	5.418	16.379
12	70.250	13.300	4.133	12.317
24	76.045	10.657	3.314	9.985
36	77.504	9.990	3.107	9.398
40	77.714	9.894	3.078	9.314

The fact that the history of inflation explains little of its variability suggests that univariate time series methods will not forecast inflation as accurately as multivariate methods that include GDP growth, monetary growth and exchange rate depreciation.

5.3 Impulse Response of Inflation

In addition to the variance decomposition of the previous section, this section analyzes the impulse response of inflation to the shocks of the other variables in the model. The impulse response

functions, as shown in Appendix, are graphs of the effect of a 1-standard deviation shock to the orthogonal structural shocks on the variables.

At impact, inflation rises in response to real output growth shocks and thereafter falls through various oscillations. The shock decays slowly through time to return to its mean after the 20th period. This shows that real output growth will lead to fall in inflation in the long run. The response of inflation to monetary growth shocks decays quickly within the 6th period from the initial rise. Exchange rate depreciation has an initial effect of lowering inflation, but over 12 periods inflation increase back to it mean. While real output growth shocks have a long lasting effect on inflation, the effect of monetary shocks and exchange rate shocks dissipate quickly over time.

6. Conclusions

This paper separates monetary and structural causes of inflation in Ghana by using variance decomposition and impulse responses from a Vector Autoregression with monetary and structural variables as the endogenous variables. The results indicate that structural factors explain more of the inflation dynamics in Ghana than the monetary factors. While the structural shocks take a longer time to decay, monetary shocks dissipate quickly over a shorter period.

Inflation is found to be explained less by its past rather than the structural and monetary shocks. These results are consistent with other studies on Africa, especially Canetti and Greene (1991) where inflation in ten African countries studied is largely explained by exchange rate depreciations and real incomes. The results, however, contradicts Ocran (2007) where inflation inertia, defined as lags of inflation, which reflects inflationary expectations impacts significantly on the evolution of inflation in Ghana.

The implications of the conclusions from this study are that the monetarist view of inflation that only money matters in inflation dynamics does not seem to hold for Ghana as the structural factors dominate monetary growth over the various lags. Even supply shocks alone explain more of variability in inflation than monetary shocks so inflation in Ghana is more of a structural phenomenon than monetary.

These conclusions show that to attain the goal of low and stable inflation, monetary management alone is not enough in inflation management in Ghana. These should be supported by other policies that may be more effective than monetary management alone. Addressing supply bottlenecks in agriculture and bureaucratic impediments in industry, which together form over 50 percent of the Ghanaian economy will ease aggregate supply problems domestically and reduce the export shortfall that put pressure on exchange rates and pass through to domestic prices.

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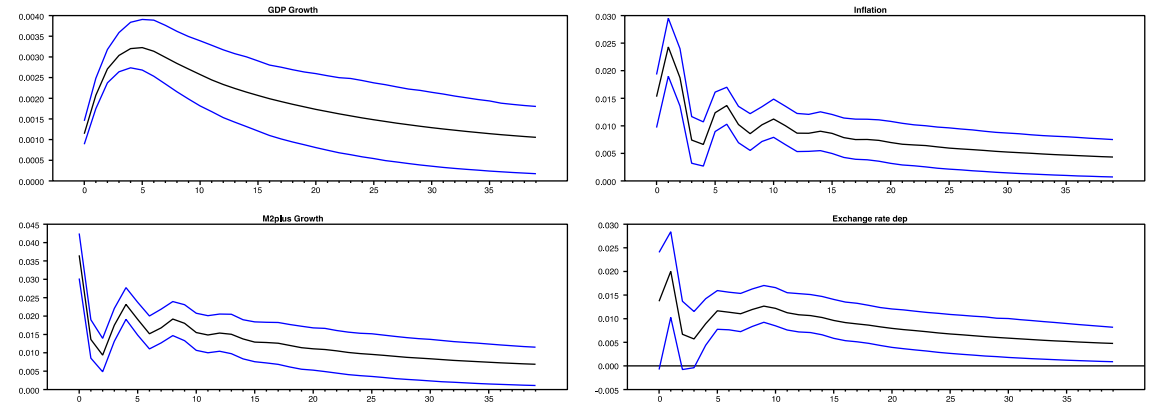
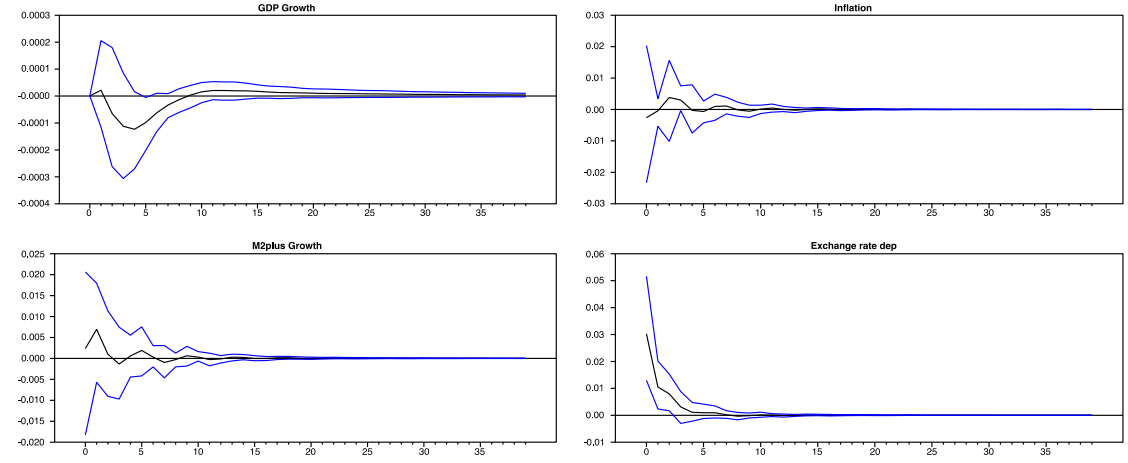
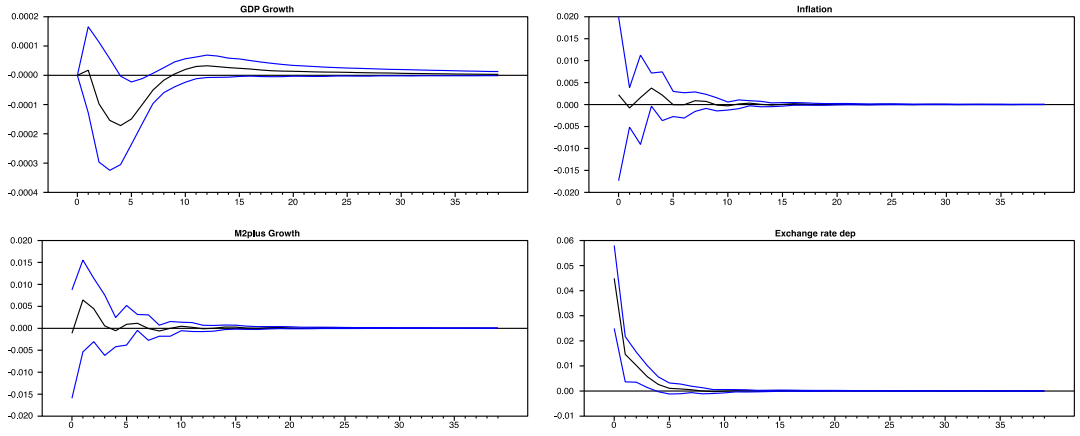
Appendix: Impulse response functions for all the variables to each shock



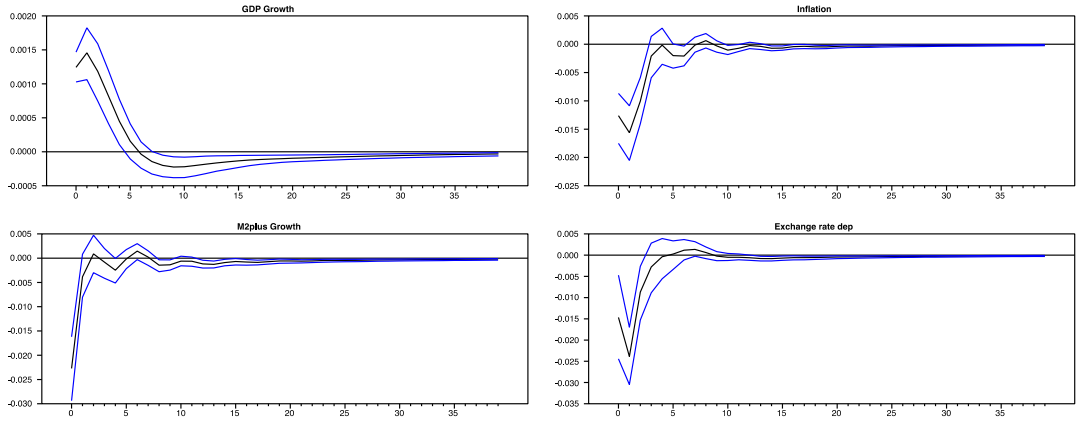
Responses to GDP growth



Responses to Monetary growth



Responses to Inflation



Responses to exch. rate dep

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