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Determinants of Inflation in Ghana: A re-examination of the evidence

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Abstract

What are the long-term effects of output growth, broad money supply, government bond rates and fiscal deficits on inflation in Ghana? What is the evolution of orthogonalized shocks to Ghana's inflation? How do we account for structural shifts of inflation along the economic and political cycles? Answers to these questions are critical for development and proper planning to mitigate the risks associated with economic uncertainty, yet previous research has not provided adequate answers to aid economic planners. This study is a re-examination of the evidence, as well as a discovery of fresh insights about persistent price level increases which have so far defied policy interventions. Among others, the study found inflation inertia to be the dominant factor, followed by output and broad money growth, attenuated by treasury bill rate in different regimes. Shocks emanating from output growth appear to have a more lasting impact on inflation while fiscal deficits produce indirect effects. Easing the supply-side constraints that bedevils the Ghanaian economy, prudent economic and sound financial management is one lever that can tackle the inflation problem. Another lever is high level of credibility of central bank operations that should ideally keep inflation expectations anchored.

KEYWORDS:
Inflation; Markov-Switching VAR; Inflation Inertia; Variance Decomposition; Impulse Response Functions.

1 | INTRODUCTION

The study of the origins of inflation is one of the most remarkable macroeconomic disputes in history. The divergence between the developed and developing economies as well as differences in the views on the appropriate measures to control inflation formed suitable bases for this debate. In the advanced economies, the consensus on inflation is that it is purely a consequence of growth in money supply. According to Kiguel (2011), the inflationary spikes in the 1970s which were triggered from oil price shocks proved significant, posing a new and important policy dilemma: whether to accept and validate higher rates of inflation through accommodating monetary policy, or to fight them and try to bring them down through tightening macroeconomic policies. The solution to the final question is well-known. The surge in prices was tolerated by central banks, and most industrialized nations ended up with double-digit inflation rates. Contrary to that assertion, Loungani & Swagel (2001) argued that inflation in developing countries is dependent on sources other than those for the advanced economies. The study argued that inflation in developing economies can be accounted for by four major sources namely: Inflation Inertia, fiscal imbalances, overheating of the economy because of surges in output and "supply-side" cost changes. In recent decades, the persistence of inflation in

some developing economies has raised concerns among policymakers and economists about the harmful impacts of inflation on these countries. During periods of significant inflationary pressures, developing countries face difficulties such as democratic instability, fiscal restraint, and structural restructuring.

In most of its history, Ghana's economy has been characterized by macroeconomic volatility. This is seen in the persistent inflation that has plagued and hampered Ghana's economic growth and development since its independence in 1957. With each stage of macroeconomic instability, there has been a significant unpredictability in the prices of products and services, as well as factors of production, distorting the planning horizon.

Even though inflation continues to afflict the Ghanaian economy and thus takes center stage in economic policy, no single consensus explanation of inflation has developed. Several policies have been implemented to reduce inflation in Ghana, but it persists. For instance, the Structural Adjustment Program (SAP), the Economic Recovery Programme (ERP), IMF bailouts, Monetary aggregates targeting as well as Inflation targeting (IT) frameworks have all been adopted to combat inflation. However, these policies and programs have failed. The persistence of inflation poses the need to re-examine the variables that have been identified to contribute to inflationary spells as well as determine how shocks to these variables transmit to inflation. Inflation policy requires a thorough understanding of these determinants and their impact. Many empirical studies (Adu & Marbuah, 2011a; Ocran, 2007) have linked inflation to various causes.

This research fills the inherent gap by laying emphasis on using time series analysis to analyze inflation dynamics in Ghana whiles accounting for time variations as well as regime changes. Secondly, an analysis was performed to determine the causal impact of these macroeconomic determinants on inflation as well as determine how they have evolved over time; and to determine whether there have been regime changes that could explain inflation dynamics in Ghana. This research will assist policy makers as well as contribute to the literature about the drivers that mostly impact inflation and the extent to which shocks to these macroeconomic variables transmit from one equilibrium state to the other. This information allows the necessary stakeholders make better decisions on policies pertaining to inflation.

The next section presents an overview of literature on inflationary trends in Ghana. Subsequently, we proceed with the data collection techniques and discuss the methodology adopted. Next, we analyze the results and discuss its implications for policy as well as provide recommendations.

2 | INFLATIONARY TRENDS IN GHANA: A REVIEW (1960-2019)

2.1 | Trends in Inflation

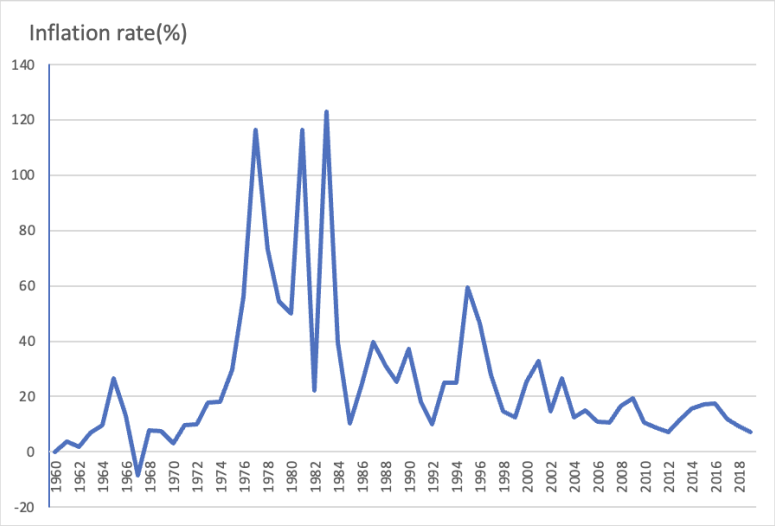
The period immediately after independence was characterized by impressive macroeconomic stability. The country was experiencing the lowest ever inflation rates. Inflation was found to be in its single digits.

Ocran (2007) defined four distinct inflationary episodes in Ghana for the period from 1960 to 2003. They were immediate post-independence, immediate post Nkrumah, the deterioration phase and the stabilization phase which corresponded to 1960-1966, 1966-1972, 1972-1982 and 1982-2003 respectively.

Alagidede et al. (2014) also introduced an additional phase which was termed as the relatively creeping phase which spanned from 2003 to 2013. We extend the relatively creeping phase to include the period from 2013 to 2019. Like the period from 2003 to 2013, the time period from 2013 to 2019 was also heavily characterized by debt relief as well as IMF bailouts. Ghana approached the IMF in early 2015 for a $918 million loan to assist in stabilizing the economy. Working with the Ghanaian government, IMF experts devised a three-part scheme to restore debt sustainability, strengthen monetary policy and clean up the banking system. This saw inflation reducing further to a single digit from about 19 percent to almost 8 percent. In the period from 2020 to date, we have observed a surge in inflation reaching about 50 percent in January 2023. Factors influencing this phase is a mixed of fiscal, money growth, supply shocks (energy shocks, international spillage etc.) and expectations fueling inflation inertia.

Prior to independence, Ghana's inflation was very low and estimated at 1 percent. This is because, Ghana was a member of the West Africa Currency Board (WACB) which prevented the government from any option of restoring to seignories to finance its spending. However, immediately after independence, which saw Ghana opt out of the WACB, inflation began to increase. This is attributed to the industrialization drive by the government at the time which led to increased government spending, consequently resulting in massive fiscal deficit. The government then resorted to seignorage to finance its fiscal deficits. The printing of money translated into higher inflationary pressures with the country experiencing a high double digit inflation rate of 26.4 percent in 1965. As shown in Figure 1, inflation averaged around 5.43 percent per annum for the period from 1961 to 1964. Inflation averaged around 19.84 percent from 1965-1966. The period from 1960-1966 marked the first inflationary episode in

FIGURE 1 Inflationary Trends in Ghana, 1960-2019



Source: Data from Ghana Statistical service

Ghana. In summary, the surge in inflation from 1960 to 1966 could mainly be attributed to massive infrastructural development as well as government's financing of its fiscal deficit through the central bank as well as the commercial banks.

The second inflationary episode dubbed the immediate post-Nkrumah episode occurred from 1966-1972 and was characterized by low inflation rates. In this period, government ventured into an IMF programme to restore the economy after periods of high inflation. There was a massive institution of both fiscal and monetary policies. This led to a major reduction in infrastructural development. External Trade liberalization policies such as the massive devaluation of the local currency by about 30 percent as compared to the United States dollar were pursued in conjunction with stringent fiscal (expenditure cuts and major downsizing in the public sector) and monetary policies which brought about the first ever deflation of 8.42 percent in 1977. Within the period from 1967 to 1969, inflation averaged about 2.26 percent per annum and an overall average of 4.91 percent per annum for the period from 1967-1972.

The third inflationary episode occurred during the period from 1972 to 1982. The previous military government was overthrown by the Acheampong administration. Previous economic policies that were being undertaken were halted. A complete reversal of economic policies was undertaken. Firstly, there was a sudden revaluation of the cedi by 42 percent, a reversal of the previous devaluation of 40 percent by the previous regime. Economic measures initiated by the previous regime which were considered harsh were relaxed.

Secondly, benefits and allowances for civil servants that were scrapped by the previous government were reinstituted and the development levy tax of 7 percent which was imposed to generate revenue by the previous regime was erased. All these reversals worsened the improved balance of payments which resulted from surges in commodity prices back in 1971. The oil price shock also further contributed to the worsening balance of payment (BOP) positions in 1973. The government decided to resort to seignorage to finance its increasing deficit. This translated to major surges in inflation. According to Hutchful (2002), budget deficit in 1977 was around ¢781 million as compared to ¢17 million in 1971 whiles total money supply cumulatively surged to 500% within the said period. The surge in money supply coupled with higher fiscal imbalances led to a surge in inflation allowing it to reach an enormous rate of 116.45 percent by the end of 1977. The Acheampong government was also overthrown by the Akuffo regime. The Akuffo regime started with a devaluation of the cedi by 58 percent in a bid to keep inflation at desired levels. The incumbent regime also failed to stabilize the economy, and this translated into another coup by Rawlings in 1979. Rawlings however handed over power to a civilian government. The civilian government further undertook massive expansionary economic policies. Notable of these policies was the overnight tripling of public sector wages. The producer price of cocoa was also doubled which further worsened the already dilapidating state of the Ghanaian economy. The average inflation during the period from 1972 to 1982 was about 51.33 percent per annum.

In summary, the third inflationary episode was heavily characterized by a blend of both military and civilian rule. This episode also witnessed massive expansionary fiscal policies coupled with weak monetary policies. The impact of the surges in world commodity prices coupled with low production and output can be said to have accounted for the increasing inflationary trend during this episode.

The fourth inflationary episode occurred within the period from 1982 to 2003. This inflationary episode was plagued with unfavorable economic conditions. Firstly, several fluctuations in prices as well as a nonperforming economy forced the government into an IMF bailout as well as support programmes by the World Bank. In the year 1983 there was a massive deportation of about 1 million Ghanaians from Nigeria coupled with the supply cut of crude oil from Nigeria. The drastic drought coupled with several bushfires which significantly reduced food production also contributed to inflation surging to an unprecedented rate of 123% in 1983. The government in order to restore balance within the economy adopted the Economic Recovery Program (ERP) in 1983 and subsequently the Structural Adjustment Program (SAP) which occurred in 1986. The ERP was adopted to curtail inflation as well as improve our trade balance with the external economies. Boosting production through stimulating and incentivizing the various stakeholders as well as improving both economic and social infrastructures were embedded in the program or was the sole aim of the program. The Structural Adjustment Program was instituted to strengthen the already existing reforms as well as bolster their economy. These reforms saw inflation reducing to about 39.64 percent in 1984 which further dropped by 29.36 percent to about 10.31 percent in 1985. Inflation was extremely low from the period from 1986 to 2000 even though it remained above government's set target of 25 percent. The significantly low levels of inflation within this period were attributed mainly to the abundance of food supplies as well as the prudent contractionary monetary and fiscal policies. According to CEPA (1996), the highest possible inflation rate of 59.46 percent which occurred in 1995 was merely as a result of the introduction of a Value Added Tax (VAT) which proved higher in comparison to the sales tax rate at that time. Inflation began to spiral upwards by the end of 2000 after it was kept at significantly lower levels in the previous periods. It argued that the reasons for the surges in inflation was as a result of excessive borrowing by the government to fund the ongoing general elections as well as a depreciation of the cedi. By the end of December 2002, the inflation rate had fallen to 14.82 percent, much below the established target of 25 percent. Prudent fiscal management, tight monetary policies, and a relatively stable currency all contributed to this decline. Even though the inflation targets for 2003 was set at 9%, inflation reached 26.67 percent by the end of the year. This was due to adjustments and corrective measures implemented in the petroleum industry. Inflation averaged 33.83 percent per annum for the period from 1983 to 2003.

The fifth inflationary episode, known as the moderation phase, lasts from 2004 to the present. This period was distinguished by periods of single-digit inflation, which was the first of its kind in four decades. In 2006, inflation rates fell to about 10.92% and remained stable until late 2007. According to Alagidede et al., (2014), the use of debt relief and debt cancellation resources from the heavily indebted poor countries (HIPC) and the Multilateral Debt Relief Initiative (MDRI), new aid flows and externals and inward private central bank transfers to "complete" the otherwise accelerated rates of inflation in the economy, all contributed to this downward trend (CEPA, 2010). The development could also be ascribed to the inflation targeting framework introduced by the Bank of Ghana, which in its new monetary policy agenda for preserving price stability after the 2nd quarter of 2008 well anchored inflation expectations (Adu & Marbuah, 2011b). After 2007, moderation was cut off by external shocks following the global financial crisis and high food prices. Given Ghana's vulnerability to external shocks, the crisis resulted in a fiscal deficit of 13.9 percent of GDP, growing currency rate depreciation, and an election year in 2008. Following a change in government in January 2009, and with the repercussions of the global financial crisis, the economy has had a continuous downward trend in inflation for eighteen months in a row, beginning in June 2009. With a rate of 20.7 percent in June 2009, downward inflationary trends continued into the single digits until 2012, when they reversed. A single-digit inflation rate of 8.73 percent was recorded by the end of 2011 with it dropping further down to 7.13 percent in 2012. Inflation rose to 11.67 percent in 2013, owing mostly to the termination of subsidies on fuel prices and utility tariffs, as well as the pass-through impacts of currency rate depreciation, which indicated a general weakness in external sector developments in 2013. This upward trend in inflation continued till inflation rose to about 17.45 percent in 2016. Ghana approached the IMF in early 2015 for a $918 million loan to assist stabilize the economy. Working with the Ghanaian government, IMF experts devised a three-part scheme to restore debt sustainability, strengthen monetary policy and clean up the banking system. This saw inflation reducing further to a single digit from about 19 percent to almost 8 percent. The inflationary surges in 2016 can be attributed to the general election campaign activities that were being embarked on. Major infrastructural developments were also being undertaken by the government in power to secure another term of office. The period after the 2016 general elections saw inflation exhibiting downward trends. This can also be attributed to the stringent fiscal and monetary policies that were instituted right after the election period. Notable among them was the financial sector reform that was instituted which bolstered the financial and banking sector of the economy.

To summarize, Ghana's economy has grown through multiple episodes of inflation, and so concern with inflation stems not just from the need to maintain macroeconomic stability, but also from the fact that inflation disproportionately impacts the poor, who lack effective inflation hedges (Alagidede et al., 2014).

3 | METHODOLOGY AND DATA SOURCES

This section presents a theoretical model on inflation as well as a description of the methodology utilized in estimating the regression. The sources from which data was obtained as well as several pre-estimation requirements are presented in this section.

3.1 | Theoretical model

We obtain a theoretical inflation model which depicts that of a small open economy as well as data and data issues concerning the conduct of this research. The model in conjunction with the preferred methodology will help achieve the purpose of our research.

The small open economy assumes that the general price level is obtained from the weighted average of prices of Tradable $\left(\mathrm{P^T}\right)$ and Non-Tradable goods $\left(\mathrm{P^N}\right)$. This implies that $\boldsymbol{P_t} = \left(P^t\right)^{\alpha}\left(\boldsymbol{P^N}\right)^{1-\alpha}$ which transforms to

$$\ln P_t = \alpha \ln P^T + (1-\alpha)\ln P^N \tag{1}$$

Where $o < \alpha < 1$ corresponds to the weight of the price of tradable goods. Ghana is a small open economy which is heavily import dependent. As such, most of the prices of tradable goods are dependent on foreign prices $\boldsymbol{P}^f$ as well as the exchange rate E. From the Purchasing Power Parity assumption, we obtain that $\frac{P^T}{\boldsymbol{P}^f} = E \quad \Rightarrow$

$$\ln\left(\boldsymbol{P}^T\right) - \ln\left(\boldsymbol{P}^f\right) = \ln E \tag{2}$$

Since the domestic economy has no influence on the international market, we take the prices of foreign goods as given. Without loss of generality, we proceed to normalize the foreign prices to a unit. Equation (2) becomes;

$$\ln \boldsymbol{P}^T = \ln E \tag{3}$$

It can be seen from (3) that surges in the price level result partially from a depreciation of the local currency. We posit further that, the price of non-tradables is obtained in the domestic market. The price of non-Tradable commodities is assumed to be determined by the equilibrium in the money market. That is

$$\boldsymbol{P}^N = \boldsymbol{\beta}\left(\ln M^s - \ln M^d\right) \tag{4}$$

Where $\boldsymbol{\beta}$ is the scalar proportion representing the relationship between the demand for nontradable goods and overall demand in the economy. Conventionally, the demand for money is determined by real income and interest rates. We specify the money demand function by

$$m^d = g(y, r) \tag{5}$$

Where $\boldsymbol{y}$ represents real income and $\boldsymbol{r}$ is the nominal interest rate on assets. Based on economic theory, the demand for money balances is negatively dependent on interest rates. This is because higher interest rates make it more lucrative to hold other assets other than money so the less amount of money will be demanded if interest rates are very high. Also, real income is expected to have a positive relationship with the demand for real money balances. Substituting (5) into (4) and further substituting its result in conjunction with (3) into (1), we obtain that the general price level can be written generally as

$$P_t = h\left(y_t, E_t, \boldsymbol{r}_t, M_t\right) \tag{6}$$

Recent inflation studies on Ghana have identified fiscal deficits and its mode of financing to be a major determinant of inflation. Studies conducted by Dadson (2015) and Ahiakpor (2014) have found fiscal deficit to have contributed significantly to inflationary pressures in Ghana. Fiscal deficit and its mode of financing has played significant roles in contributing to price surges. Fiscal deficit can either be financed through seignorage or by the transmission of funds from the private sector to the public sector through influencing the lending rate or by selling securities. The influence of fiscal deficit on inflation cannot be ignored so we proceed to augment equation (6) with fiscal deficit to obtain

$$P_t = Z\left(y_t, E_t, r_t, M_t, FD_t\right) \tag{7}$$

Using equation (7), the study uses a Structural VAR to analyze both the contemporaneous and long-term relationship between price and these macroeconomic variables. The SVAR model is ideal compared to single equation models in estimation because it provides a causal relationship between the variables as this is one of the main objectives of the study. Using the SVAR allows for the imposition of restrictions that go beyond those that can easily be identified with standard VARs thereby helping compute and forecast the impact of individual shocks.

3.2 | Data Sources

Annual data on GDP, Fiscal Deficits, Broad Money growth, Headline Inflation, 91-day treasury bill rate and Nominal Exchange rate ranging from 1971 to 2019 are collected from different sources. The variables as well as their data sources are displayed in table 1 below.

TABLE 1 Variable and Data Sources

Variable	Proxy	Sources
Inflation	CPI - based	Bank of Ghana (BOG)
Real Output growth	GDP	WDI (World Bank)
Broad Money Growth	M2+	Bank of Ghana
Treasury Bill rate	90 -day	Bank of Ghana
Fiscal Deficit		International Financial Statistics (IMF)
Exchange Rate	USD-GH	WDI (World Bank)

3.3 | SVAR and MSVAR methodology

The study adopted two estimation techniques. Firstly, the Structural Vector Autoregression Technique (SVAR) which was first introduced by (Sims, 1991) and has been in several seminal works (Amisano Giannini, 1997; Kilian & Lütkepohl, 2017; Sims, 2002; Sims, 1991), is used to ascertain the kind of causality and relationship that exists among the variables under consideration as well as identify the extent to which shocks to these variables transmit to one another. Secondly, a Markov Switching Var (MSVAR) is adopted to capture the regime changing effects of these variables on inflation (Krolzig, 1997a).

The SVAR model can be defined as:

$$C_0 Y_t = \sum_{j=0}^{p} C_t Y_{t-j} + \varepsilon_t \tag{8}$$

Where $\boldsymbol{Y_t}$ is a $\boldsymbol{k}\times\boldsymbol{1}$ vector of endogenous variables at time t and $\boldsymbol{C_i}$ is a $\boldsymbol{k}\times\boldsymbol{k}$ matrix of unidentified parameters for $\boldsymbol{i = 0, 1 \ldots, p}$. $\boldsymbol{\varepsilon_t}$ is a $\boldsymbol{k \times 1}$ vector of white noise error processes with $E\left(\varepsilon_t\right) = 0$ and $\boldsymbol{E}\left(\varepsilon_t \varepsilon_t^1\right) = \Sigma_\varepsilon$.

The major assumption of the Structural Vector Autoregressive approach is that the error terms $\boldsymbol{\varepsilon_t}$ are uncorrelated orthogonal structural shocks that have a constant variance-covariance matrix $\boldsymbol{\Sigma_\varepsilon}$ which is also diagonal. The structural variances are usually normalized. As a result, we have that $\boldsymbol{E}\left(\varepsilon_t \varepsilon_t^1\right) = \boldsymbol{\Sigma_\varepsilon} = \boldsymbol{I_k}$

To obtain a single dependent variable for each equation, we normalise the contemporaneous matrix $\boldsymbol{C_0}$ across the leading diagonal. One major problem associated with (8) is that it is difficult to estimate the coefficients of the matrices $\boldsymbol{C_0, C_1, \ldots, C_p}$ as well as the values of $\boldsymbol{\varepsilon_t}$. We then proceed to estimating model (8) in two stages. Firstly, we obtain the reduced form equation for model (8) and then we proceed to estimating each equation using the method of Ordinary Least Squares (OLS). The reduced form VAR associated with model (1) is given by

$$Y_t = \sum_{j=1}^{p} C_0^{-1} C_j Y_{t-j} + C_0^{-1} \varepsilon_t \tag{9}$$

Which can further be written as $Y_t = \sum_{j=1}^{p} A_j Y_{t-j} + e_t$ where $A_i = C_0^{-1} C_i \quad i = 1, \ldots, p$ and $e_t = C_0^{-1}\varepsilon_t$ and $e_t \sim N\left(0, \Sigma_e\right)$. We can then proceed to estimate model (9) equation by equation using OLS. The relation between the reduced form VAR innovations and the SVAR innovations is given by

$$\boldsymbol{\Sigma}_e = E\left(e_t e_t'\right) = E\left(\left(C_0\varepsilon_t\right)\left(C_0^{-1}\varepsilon_t\right)'\right) = C_0^{-1}\Sigma_\varepsilon\left(C_0^{-1}\right)'$$

Secondly, we try to identify the contemporaneous matrix $\boldsymbol{C_0}$ by using economic theory to impose appropriate restrictions. We then proceed to estimate the variance - covariance matrix $\boldsymbol{\Sigma_\epsilon}$ by maximizing the likelihood function which is based on the parameter estimates of model (9).

In analyzing the SVAR equation, the contemporaneous matrix $\boldsymbol{C_0}$ has $\boldsymbol{k^2}$ parameters while the reduced form innovations have $\frac{\boldsymbol{k(k+1)}}{2}$ distinct values. As a result, in order to identify the structural shocks $\boldsymbol{\epsilon_t}$, the number of unknown structural parameters in $\boldsymbol{C_0}$ must be less than or equal to the number of estimated parameters in the reduced form variance-covariance Matrix. As a result, we need to impose at least $\boldsymbol{k}^2 - \frac{\boldsymbol{k(k+1)}}{2} = \frac{\boldsymbol{k(k-1)}}{2}$ restrictions on $\boldsymbol{C_0}$.

The Markov Switching Vector Autoregressive model (MSVAR) is defined below. Consider a standard VAR equation of the form;

$$y_t = \sum_i A_i y_{t-i} + \mu_t + \epsilon_t \tag{10}$$

where y_t is a $kx1$ vector of endogenous variables, A_i is a kxk matrix of lag coefficients, μ_t is a $kx1$ vector of intercepts and ϵ_t is a $kx1$ vector of white noise processes with $\boldsymbol{E}\left(\boldsymbol{\epsilon_t}\right) = 0, E\left(\epsilon_t\epsilon_t'\right) = \sum_\epsilon$, and $\quad E\left(\epsilon_t\epsilon_s'\right) = 0 \quad \forall t \neq s$.

Following Krolzig(1997), we alter equation 10 by accounting for regime changes so that the dependent variables $\boldsymbol{y_t}$ follows a Vector Autoregressive process which is dependent on the value of a state $\left(s_t\right)$ which is unobserved as well as discrete. Suppose there are $m = 1, 2, \ldots, \boldsymbol{M}$ possible regimes. We can say we are in regime m in time period t when $m = s_t$. In accounting for the regime dependent probabilities, we obtain

$$\boldsymbol{y}_t = \sum_{i=0} \boldsymbol{A}_i\left(s_t\right)\boldsymbol{y}_{t-i} + \mu_t\left(s_t\right) + \boldsymbol{\epsilon_t} \tag{11}$$

Or

$$y_t - \mu_t\left(s_t\right) = \sum_j A_i\left(s_t\right)\left(y_{t-j} - \mu_t\left(s_t\right)\right) + \epsilon_t \tag{12}$$

These two equations correspond to the switching intercepts and switching means respectively. We further assume that the error terms are normally distributed with mean zero and variance $\sum_{\epsilon_t}\left(s_t\right)$. That is $\boldsymbol{\epsilon_t} \sim \boldsymbol{N}\left(0, \sum_{\epsilon_t}\left(\boldsymbol{s_t}\right)\right)$ for $\boldsymbol{s_t} = 1, \ldots, \boldsymbol{M}$. The error variable has a probability density function given as

$$f\left(\epsilon \mid \sum\right) = \frac{1}{(2\pi)^{\frac{k}{2}} \mid \Sigma^{\frac{1}{2}}} \exp\left(-\frac{1}{2}\epsilon' \sum^{-1} \epsilon\right) \tag{13}$$

4 | RESULTS AND DISCUSSIONS

We present the results from the study and discuss the empirical findings. We start by the understanding the generation processes of the data to help with selecting the appropriate modeling technique. Accordingly, we present the stationarity results, lag order selection results, Granger causality test results, then the SVAR and MSVAR.

4.1 | Stationarity Test Results

The stationarity results of the various variables are displayed in table 3 below. To account for structural changes in the data, a unit root test with structural break proposed by Zivot & Andrews (1992) is estimated. The results of the tests conducted using the method proposed by Zivot & Andrews (1992) is depicted in table 2 below.

The results from table 2 above show that INFL, GDP growth, M2 growth exhibited stationarity at the 1 percent, 5 percent and 10 percent significant values. These variables were stationarity at either their intercepts or trends as well as a combination of both. However, the Treasury bill rate and FD were not stationarity at all their specification points. For instance, FD was stationary at the critical values of 10 percent at both its trend as well as intercept specification. Looking at both the trend and

TABLE 2 Result from Zivot Andrews test for Stationarity

Variables	Break Date	t-statistic	Prob*
INFL:			
Intercept	1983	-6.258633	< 0.01
Trend	1978	-6.980197	< 0.01
Trend and Intercept	1979	-7.220272	< 0.01
GDP Growth:			
Intercept	1983	-6.964334	< 0.01
Trend	2012	-6.048756	< 0.01
Trend and Intercept	1983	-7.035634	< 0.01
M2 Growth:			
Intercept	2001	-6.798036	< 0.01
Trend	1985	-6.912131	< 0.01
Trend and Intercept	1978	-7.091948	< 0.01
Tbill:			
Intercept	1983	-2.598106	0.8694
Trend	1997	-3.833696	0.2424
Trend and Intercept	2001	-5.287934	0.0373
FD:			
Intercept	2000	-4.772255	0.0638
Trend	1992	-4.520731	0.0506
Trend and Intercept	2000	-5.673082	0.0122

intercept specification for FD, FD is stationary at the 5 percent significant level. Tbill on the other hand was not stationary at any of the critical values using its trend or intercept specifications. However, Tbill was found to be stationary at 5 percent when considering its trend and intercept specification. There were structural breaks in the variables using different specifications. The structural breaks exhibited in the variables can explain why different results are being obtained for the determinants of inflation during different inflationary regimes by previous researchers.

4.2 | Granger causality test results

VAR modelling operate under the assumption of bi-directional causality. Therefore, we test the causality using the Granger causality test. The test helps to determine the kind of interrelationship that exists among the various variables under study. The Engle Granger causality test result for inflation is displayed in table 3 below. The results indicate that GDP growth, M2 growth, and Fiscal deficit are major factors that explain the dynamics of inflation in the short to medium run. The T-bill rate based on the results does not explain the dynamics of inflation in the short to medium run. In the long run, however, all the variables jointly explain the dynamics of inflation. The results are indicative of the fact that inflation is caused by both structural and monetary factors.

4.3 | SVAR results

Using a lag length of one following the H-Q, Akaike, and Schwartz Bayesian information criteria, we estimated the SVAR to generate the impulse responses. The identification strategy follows that of a recursive block structure utilized in the seminal works of Dungey & Pagan (2000), Eichenbaum & Evans (1995) and Christiano et al., (1999). We impose a recursive restriction on the parameters of the model. The recursive assumption of the structure is based on 'successively related' variables and suggests that monetary policy shocks orthogonally correspond to the monetary authority information set. These distinguishing assumptions correspond to the idea that economic variables are determined in a block recursive manner. The nonpolicy variables (prices and output) are decided first, then the Central Bank's policy instrument (money supply and tbill rate), and finally the remaining variables known as information variables (Fiscal Deficit and exchange rate). This arrangement accounts for the targeting regimes

TABLE 3 Granger causality results for inflation

Variable: **INFL**			
Excluded	**Chi-Sq**	**df**	**Prob**
GDP Growth	20.27871	2	0.0000
M2 Growth	12.30716	2	0.0021
FD	7.228660	2	0.0269
T-bill	1.052869	2	0.5907
All	26.33720	8	0.0009

Source: Computations from EViews 11

adopted within the Ghanaian economy so far. During the period of Broad Money aggregates, inflation is determined followed by output growth. The central bank then determines the amount of money to supply which in turn influences the interest rate. Fiscal Deficit follows and then the exchange rate. We obtain a Cholesky ordering of Inflation, GDP growth, broad money growth, Treasury bill rate, fiscal deficit and Exchange rate (Infl, GDP growth, m2 growth, tbill, fd, exr). The inflation targeting regime also presents us with a similar ordering. We present the variance decomposition for inflation in Table 4 to determine the contributors to inflation variations.

The result reveals that inflation shocks account for 100 percent of inflation variations in the first forecast horizon. Money growth accounted for about 22.03 percent of the variability in inflation after 3 forecast horizons. This increased to 26.94 percent after 12 forecast horizons. Output growth also contributed about 15.26 percent to the variability in inflation after 3 forecast periods. This contribution continued to dwindle even up to the twelfth forecast horizon where it contributes about 11.76 percent to the variability in inflation. T-bill and fiscal deficit jointly contributed about 6.7 percent to the variability in inflation in the twelfth forecast period. An improvement from the 0 percent they jointly contributed during the first horizon. Jointly, real output growth, money growth, T-bill, and fiscal deficit jointly about 45.41 percent to the variability in inflation in the twelfth forecast horizon, an increase from the 34.87 percent they jointly contributed initially within the third forecast period. The results from the variance decomposition goes to assert that inflation in Ghana is not solely a monetary phenomenon but also structural factors contribute to inflationary pressures in Ghana. However, inflation inertia dominates inflation variations in Ghana.

TABLE 4 Variance decomposition of Inflation

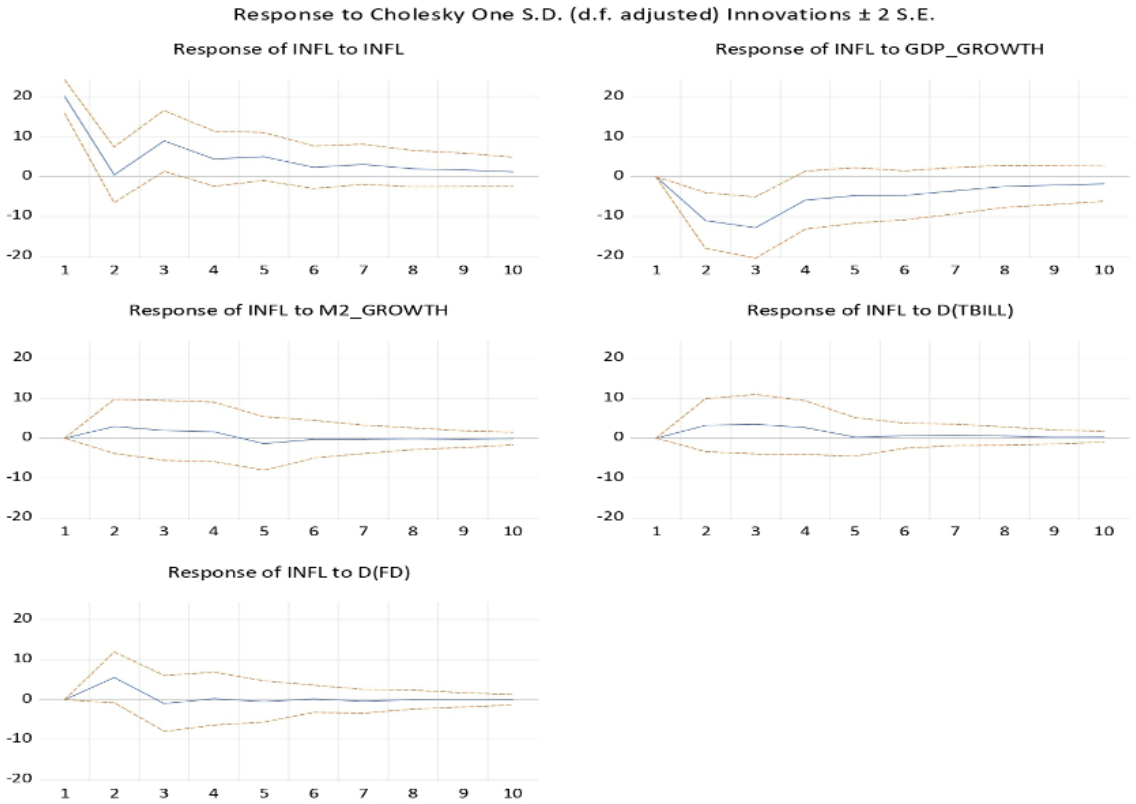
Inflation					
Period	**INFL**	**GDP Growth**	**M2 Growth**	**T-Bill**	**FD**
1	100	0.00	0.00	0.00	0.00
3	65.13	15.26	15.39	1.52	2.70
6	58.72	13.61	22.03	3.51	2.16
9	56.17	12.56	25.15	4.13	1.99
12	54.59	11.76	26.94	4.67	2.03

4.4 | Impulse Response Results

The resulting Impulse Response Function (IRF) from the variance decomposition generated from the structural VAR is presented in figure 2 below. The IRF shows how a shock in a current time affects a particular variable in future and track the dynamic influence of those shocks.

The impulse response of inflation to shocks from the other variables show that these shocks have only transitory effects on inflation. Shocks from inflation causes inflation to drop sharply within the first period. It then rises from the second to third horizon and eventually assumes a downward trend over time. Over the longer time period, shocks from inflation have no significant effect on inflation. Shocks emanating from GDP growth, causes inflation to drop within the first few horizons, eventually dissipating over time. A positive shock to GDP growth in the form of lower input and production costs causes firms

FIGURE 2 Impulse response Graph of inflation



Source: Authors' Computations

to increase investment which in turn causes output to increase. An increase in output causes the price level to fall in the short run. The lower price level in the short run causes an increase in aggregate demand over time which eventually causes prices to adjust back to equilibrium level in the long run. Positive shocks to money growth causes an increase in the supply of money which in turn lowers the cost of borrowing in the economy. This eventually triggers an increase in aggregate demand thereby leading to a rise in the price level. In order to keep inflation at significantly lower levels, the monetary authorities should target both monetary and structural factors as these factors perform exceedingly in keeping inflation at targeted levels. Shocks from inflation performs better in keeping inflation at lower levels in the long run. This is indicative of the fact that inflation targeting has performed much better for the Ghanaian economy.

4.5 | Markov Switching VAR Results

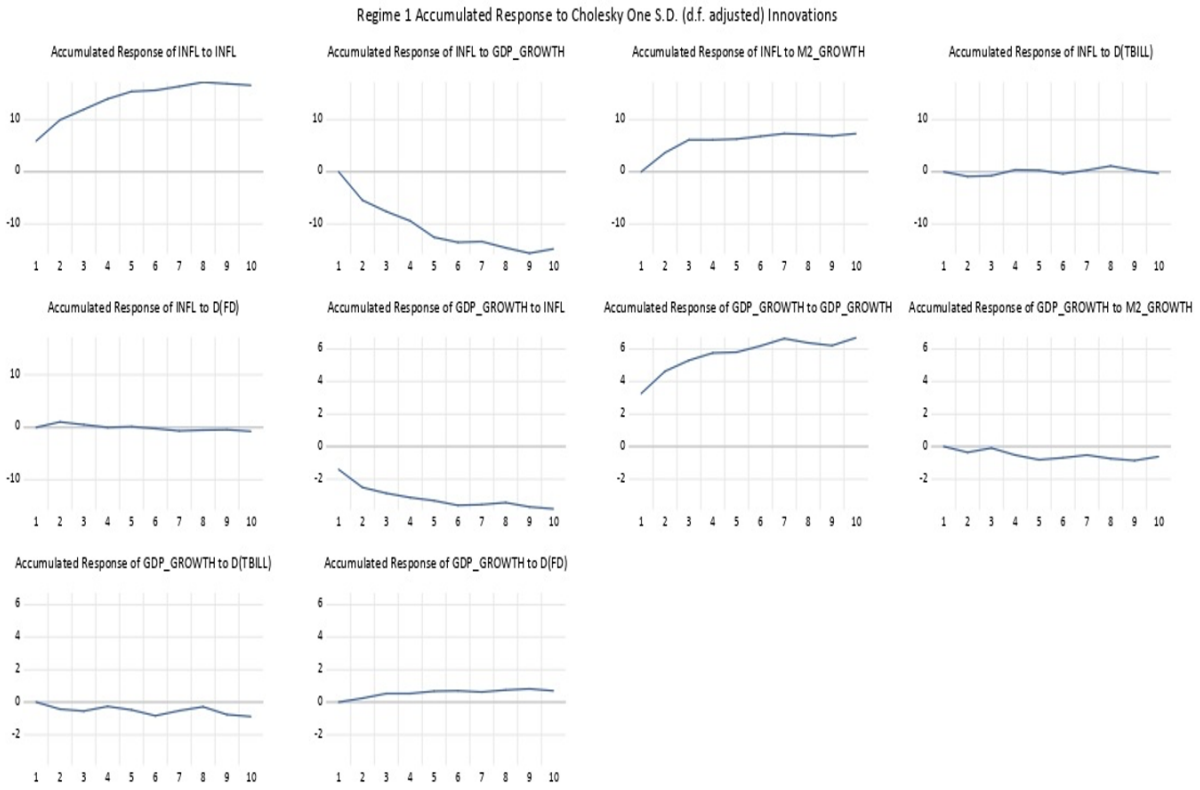
To determine whether each of the variables explain inflation differently for each regime, a Markov Switching Vector Auto Regression (MS-VAR) Model was analysed and the results discussed below.

The results from both regimes indicate that inflation is not only caused by monetary factors but by a combination of both monetary and output growth. For instance, within the first regime which is considered as a regime characterized by high inflation, money growth was found to have a significant and positive relationship with inflation. This is indicative of the notion that when there is an increase in money supply, people begin to increase the demand for goods and services as there is more money chasing fewer goods. This causes a surge in the general price level. Output growth was found to have an inverse and significant relationship with inflation. An increase in output growth was found to reduce inflationary pressures during high inflationary

regimes. One other variable that proved its significance as a major determinant of inflation was fiscal deficit. Higher fiscal deficits as a result of government spending were found to be inflationary. In conclusion, inflation in high inflationary regimes were caused by monetary growth, output growth and fiscal deficit. The results from the equation representing output growth shows that all the nominal variables in the equation were not significant in determining output growth. This conforms to theory that nominal variables do not have any influence on real variables over time especially in the long run.

In the low inflationary regimes, all the other variables were found to exhibit significant effects on inflation during the second regime. Output growth was found to have a negative relationship with inflation and had its coefficient to be significant at 1 percent. Contrary to theory, money growth was found to be deflationary within the first few periods. This effect changes with inflation rising after four periods. An increase in money growth causes inflation to fall holding all other variables constant. Increases in the tbill rate as well as increases in government spending which leads to massive deficits causes' inflation to rise.

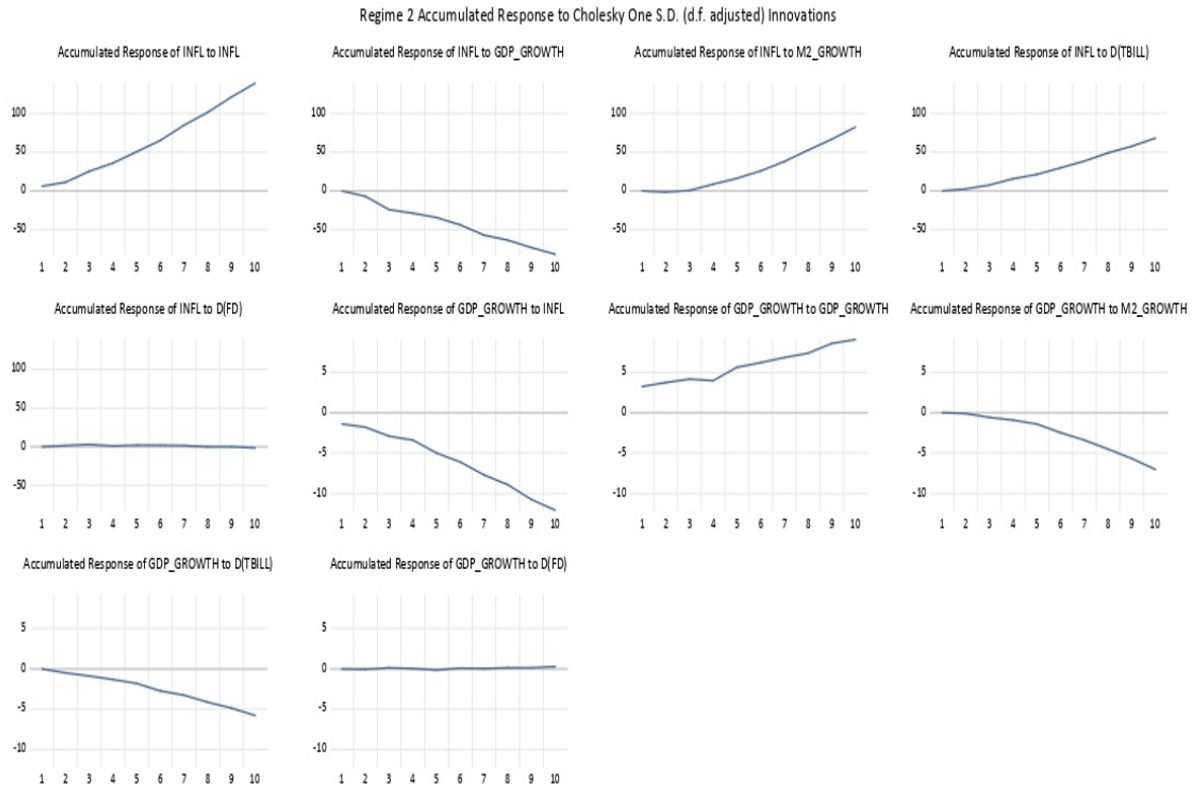
FIGURE 3 Impulse Response Graph for Regime 1



Source: Author's computation using EViews 11.

The accumulated impulse response of inflation to shocks from the other variables vary significantly in each regime. In the first regime, most shocks to inflation seem to have a permanent accumulated effect on inflation. Accumulated shocks to inflation in the first regime cause inflation to rise within the first five horizons. The shocks eventually stabilize after the fifth horizon. This effect does not level out eventually. Shocks to inflation emanating from output growth causes inflation to drop drastically. There is a sudden drop in inflation within the first six periods and after that, inflation seems to be on a steady decline which eventually stabilizes after the tenth horizon. Accumulated shocks emanating from money supply, tbill as well as fiscal deficit does not seem to have any significant impact on inflation. However there seems to be a minimal effect on inflation as a result of a shock from money supply. This causes inflation to rise slightly although the effect does not last after a few periods.

FIGURE 4 Impulse Response Graph for Regime 2



Source: Author's computation using EViews 11.

In the second regime however, most shocks appear to have a permanent effect in nature. Shocks from output growth on inflation causes it to fall drastically. The effect is permanent in nature. Shocks from tbill and money growth however seem to have no effect on inflation within the first three periods. However, inflation seems to rise as a result of these shocks in longer horizons. Shocks from fiscal deficit appear to have no effect on inflation similar to the first regime. Inflationary shocks further worsen inflation within the Ghanaian economy especially within the second inflationary regime.

4.6 | Variance Decomposition

The variance decomposition for the first regime is displayed in table 5 below. The variance decomposition (VD) for inflation asserts that within the first period, all the variability in inflation is explained by inflation itself. After the first period, output growth accounts for about 30.5 percent of the variability in inflation whiles money growth accounts for about 14.15 percent of changes in inflation rate. Within the medium to long term, 36.2 percent of the movement in inflation could be explained by output growth movements whiles the treasury bill rate and fiscal deficit jointly accounts for about 5 percent of the variability in inflation.

Monetary growth seems to contribute greatly to the variability in inflation within the second regime, followed by output growth in the long run and vice versa in the short run. After the second horizon, output growth accounts for about 41.8 percent of the variability in inflation whiles monetary growth accounts for 2 percent. Inflation accounts for about 48 percent of its own variability in the short run. In the longer horizon, output growth accounts for only 18.8 percent of the variability in inflation whiles monetary growth's contribution to inflation variability from 2 percent in the second period to about 22 percent in the tenth period. The treasury bill rate also contributes about 12 percent to the variability in inflation in longer horizons.

TABLE 5 Variance Decomposition for Regime 1

REGIME 1						
Variance Decomposition of Inflation						
Period	**S.E.**	**INFL**	**GDP growth**	**M2 growth**	**D(T-bill)**	**D(FD)**
1	5.932265	100.0000	0.000000	0.000000	0.000000	0.000000
2	9.774963	53.58612	30.49028	14.15262	0.745770	1.025216
3	10.51620	50.02079	30.58502	17.63293	0.662661	1.098595
4	10.93672	49.68642	31.12772	16.30300	1.623803	1.259050
5	11.45859	46.75011	35.73311	14.87043	1.483952	1.162396
6	11.54036	46.12772	35.95022	14.85027	1.837939	1.233854
7	11.60447	46.00485	35.58203	14.90387	2.151131	1.358123
8	11.72810	45.51645	35.87373	14.60755	2.664720	1.337546
9	11.81617	44.90328	36.11888	14.46823	3.180310	1.329295
10	11.87539	44.50892	36.19527	14.51127	3.397643	1.386895

Source: Author's computation using EViews 11.

TABLE 6 Variance Decomposition for Regime 2

REGIME 2						
Period	**S.E.**	**INFL**	**GDP growth**	**M2 growth**	**D(T-bill)**	**D(FD)**
1	5.932265	100.0000	0.000000	0.000000	0.000000	0.000000
2	11.17625	48.33898	41.83408	2.042876	5.431490	2.352571
3	25.46520	39.46438	53.91581	1.101812	4.859133	0.658865
4	30.15679	40.74221	40.61608	7.507772	10.34273	0.791208
5	35.29593	47.01592	32.22516	9.982742	10.12174	0.654432
6	41.56244	46.49510	28.37238	12.98488	11.67072	0.476913
7	49.92216	47.35275	26.38388	14.85447	11.07634	0.332568
8	55.90461	46.65764	22.44274	18.43070	12.14136	0.327562
9	62.35605	47.50331	20.43425	19.99407	11.80316	0.265209
10	68.17370	46.78564	18.82353	21.89134	12.24683	0.252663

Source: Author's computation using EViews 11.

5 | CONCLUSIONS AND RECOMMENDATIONS

The research aimed to emphasize and investigate the long-term effects of output growth, broad money growth, Treasury bill rates, and fiscal deficits on inflation in Ghana. In addition, the study wanted to see what kind of link existed between these factors and inflation in Ghana. Finally, the study attempted to account for regime shifts and determine the nature of these variables' impacts on inflation in various regimes, as well as examine the effects of orthogonalized shocks on the inflation variable.

The Granger causality results indicated a unidirectional causation link between broad money growth, output growth, and inflation. A bidirectional relationship between inflation and output growth was discovered. All the factors were discovered to jointly Granger cause inflation. The forecast error variance decomposition for inflation computed from the SVAR indicates that in the short run, inflationary surges are caused by inflation inertia. That is, current inflationary episodes are triggered by price surges from previous periods. It was identified however that; inflation is triggered by both broad money growth and output in the medium run as well as the long run. Fiscal deficit and the Treasury bill rate were found not to influence inflation in the short run. In the long run however, they were both found to influence inflation to a little extent. From the SVAR results, inflation is caused by both monetary and structural factors.

After accounting for regime changes, the results from the MS- VAR indicated that inflation in Ghana is highly influenced by output growth than broad money growth in both regimes. This finding is in line with the findings of Adu & Marbuah (2011b). Inflation inertia was found to be the most significant factor that accounted for the high inflationary surges within the economy,

a finding consistent with that of Ocran (2007). The Treasury bill rate was found to also contribute to inflation in the long run, a finding similar to that of the SVAR. In a high inflationary regime, it was found that inflation inertia as well as output growth were the main causes of inflation within that period. The exchange rate was also found to have a negative effect on the price level. A devaluation in the local currency causes inflation even though this finding was not significant. Broad money growth and the Treasury bill rate together with past inflation were found to have caused inflation in a low inflationary period. Contrary to some studies such as Ahiakpor (2014); Dadson (2015), fiscal deficit had no significant influence on inflation.

The Impulse response graphs showed that most of the shocks to inflation were temporary in nature. The SVAR results indicate that shocks emanating from fiscal deficit as well as the Treasury bill rate had no significant effect on inflation. Shocks from these variables causes inflation to return to equilibrium after two to three periods. Shocks from broad money growth on inflation eases out after four periods. Shocks emanating from output growth have a more lasting effect on inflation compared to the other variables.

After accounting for regime changes, shocks from output growth and inflation were found to have a more lasting effect on inflation in both regimes. Shocks emanating from inflation causes inflation to surge upwards in subsequent periods within the first regime. Inflation increases until it reaches a new equilibrium level. Shocks from output growth causes inflation to fall in both short and long run periods until it reaches a new equilibrium level. The accumulated response of inflation to shocks from broad money growth, causes inflation to rise as well. Shocks from fiscal deficit and the Treasury bill rate have no effect on inflation in the first regime. In the second regime however, shocks emanating from all the variables except for fiscal deficit had any major accumulated effects on inflation.

5.1 | Implication and Policy Recommendations

This research is insightful because it sheds more light on how some of the variables considered influence inflation dynamics in both short and long run periods using FEVD analysis. It also provides policy makers with a thorough analysis on how these variables react to inflation in all regimes. Some key notes worth taking from this research include the following;

i. Interest rates have a significant role to play in Ghana's economic growth. The impact of interest rate on the GDP growth cannot be overlooked and could be adequately managed to stimulate economic activity within the economy.

ii. Fiscal deficit has no significant and direct influence on inflation but has been determined to influence the Treasury bill rate and broad money supply, both of which affect inflation.

iii. Output growth as well as inflation inertia have been found to contribute greatly to Ghana's inflation dynamics with inflation inertia having a short run effect on inflation.

iv. Shocks emanating from output growth appear to have a more permanent effect on the general price level as compared to the other variables which appear to have temporal effects as a result of shocks.

v. Exchange rate depreciation have a detrimental effect on the price level.

In order to keep inflation at significantly low levels, the following recommendations are vital. Firstly, the Ministry of Finance should understand that prudent economic and financial management is very vital to ensure stability within the economy and tailor government expenditure to that effect. Increased revenue generating activities should be undertaken to commensurate the growing expenditure by Government. The finance ministry can increase its tax revenue generating capability by closing the various leakages in tax collection. This eases pressure on financing the budget deficit through seignorage or issuing securities.

Secondly, barriers to supply side constraints should be eased in order to increase output growth. The ministry of Food and Agriculture should provide incentives aimed at boosting local production within the economy should as it will contribute greatly to the growth in output which is disinflationary in nature. Some of these incentives can include tax subsidies on required inputs for agricultural production. Ensuring that there is a ready market for locally produced goods both internally and externally.

The Central Bank should ensure that there is a high level of credibility in its operations. This ensures that citizens and institutions react appropriately to interest rate policy changes aimed at contributing to the disinflationary process. It should also ensure that it implements serious exchange rate policies to counteract the depreciating nature of the Ghanaian cedi. Inflation expectations should also be critically monitored and anchored.

BIOGRAPHICAL NOTES

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Richard K. Ayisi is an economist with the Department of Economics of the University of Ghana. He has over a decade-long experience in economic policy, providing technical support in the areas of research and policy advice to private enterprises, government, and international organizations. His research focuses on incorporating the idiosyncratic characteristics of developing economics in economic models to develop policies that incorporate the country's specific characteristics. His research interest spans across development macroeconomics, monetary and financial economics, regulatory economics, poverty and inequalities, and adaptation strategies. Richard holds a Ph.D. Economics degree from the University of Milan - Italy, and an MPhil and bachelor's degree from the University of Ghana. .

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How to cite this article: Woblesseh, R. , Alagidede, P. I. Y. & Ayisi, K. R. (2022), Determinants of Inflation in Ghana: A re-examination of the evidence, *Journal of African Political Economy and Development*, *2022;07:38–53*.