Advances in Social Sciences Research Journal – Vol. 8, No. 2
Publication Date: February 25, 2021
DOI:10.14738/assrj.82.9406.
Adeleke, O. K., & Oyeleke, O. J. (2021). Asymmetric Effect of Fiscal and Monetary Policies on The Stock Market Performance In Nigeria Advances in Social Sciences Research Journal, 8(2) 39-53

Asymmetric Effect of Fiscal and Monetary Policies on The Stock Market Performance In Nigeria

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ABSTRACT

This study investigated the asymmetric effect of fiscal and monetary policies on stock market performance from 2000:q1-2018q3 in Nigeria. The study used Auto Regressive Distributed Lag (ARDL) Bounds Test technique of cointegration to determine the equilibrium relationship among the series. After the long run relationship has been established, Vector Error Correction Model was used to analyse the data. The results showed that only anticipated fiscal policy had a negative and significant effect on the stock market performance in the third and fourth quarters of the year. In contrast, anticipated and unanticipated monetary policy as well as unanticipated fiscal policy did not exert effect on stock market performance in Nigeria. Government in Nigeria should reduce its expenditure which has the capacity to negatively influence the performance of stock market in Nigeria.

Keywords: asymmetry, fiscal policy, monetary policy, performance

INTRODUCTION

Stock market is a distribution vehicle and also acts as an intermediary between the savers and users of funds in an economy. Stock market basically aids the transfer of funds from surplus units to deficit units to ensure the effective and efficient allocation of scarce financial resources, thereby creating an avenue for investors to participate in the economy for investment purposes (Osahon & Oriakhi, 2013). Therefore, stock market performance gauged by volume of transactions (VOT) executes key roles in the growth and development of an economy, and, therefore, cannot be ignored. Stock market performance also plays central roles across the economies of the world by acting as transmission mechanism in facilitating the mobilisation of savings from developed economies to underdeveloped countries (Joshi & Giri, 2015).

However, fluctuations in the VOT through stock prices have significant effects on macroeconomic variables as they affect investment and consumption decisions of both firms and households (Faiza, Yasir, Farhan, Kamran & Saba, 2012). In the literature, there are three identified ways

shocks to stock prices affect the economy; first, shocks to stock prices are responsible for variations to private investment in an economy because firms find it difficult to raise finance on the stock market. Second, shocks to share prices cause deviations to firms' balance sheets. Lastly, variations to stock prices affect household's wealth which have implications on household consumption. This equally affects the liquidity demand of the household, being directly related to the amount of financial wealth that the household holds (Joshi & Giri, 2015; Mbanga & Darrat, 2016). Therefore, an efficient stock market with relatively stable VOT via stock prices enhances the wealth of investors and grows the economic activities of a nation while inefficient stock market hinders the growth and development of an economy (Mishkin, 2001).

Specifically, in Nigeria, the spiral effects of shocks to the stock prices can be seen in the case of the Nigerian Stock Exchange (NSE) which had been experiencing steady growth prior to the global financial recession between 2008/2009. During this financial recession, NSE witnessed a downturn in VOT, a development that had spill over effects on all sectors of the Nigerian economy. For instance, the growth rate of the NSE all-share index in Nigeria in 2006 was 37.8% and there was upward movement to 73.56% in 2007, making the NSE one of the most performing stock exchanges in Africa (NSE, 2007). During the global financial crisis which started early 2008 and was already at its peak in the month of April the same year, the Nigerian stock market witnessed a sharp drop as the growth rate of the all share index declined to 45.8% from 73.56% (Lawal et al 2017). The crisis led to dumping of shares by foreign and domestic investors which further depressed the stock market. As a result of shortage in capital inflow and foreign portfolio investment withdrawal, financial withholdings became the norm. In spite of several reforms by the regulatory authority, stock market performance has still been sub-optimal compared to its pre-2008 level.

After 2008/2009 financial recession, while stock markets in developed economies such as UK and US have shown an impressive recovery, Nigerian stock market's performance has not been remarkable. Although, the development has been blamed on a combination of regulatory weaknesses, political meddling and capacity inadequacy amongst operators. Therefore, from 2008 till date authorities (both monetary and fiscal) in Nigeria have employed mixed of fiscal and monetary policies to ensure incredible stock market performance. Several policies which have been implemented to revamp the stock market, among others, include the frequent reviewing of the monetary policy rate[24], disbursement of bailout to the states of the federation, direct intervention in the banking sector[25] and risk management principles. However, it is pertinent to note that while some of these policies are anticipated, some are not. On this ground, this study intends to investigate which of the policies (anticipated versus unanticipated) implemented by the government has impacted on the performance of the Nigerian stock market.

[24] The Monetary Policy Rate (MPR) affects both the banking public as interest rates on deposits and loans affect the cost of money and the economy because it naturally affects interest rates on both sides which has a spill over effect on the stock market.

[25] Direct intervention by the Central Bank of Nigeria to support the liquidity of banks in Nigeria.

LITERATURE REVIEW

Studies have not considered investigating the effect of anticipated and unanticipated of monetary and fiscal policies on stock market performance so important. Therefore, more attentions are diverted to examining the relationship between government policies (both monetary and fiscal) and stock market performance in economies around the world, dwelling majorly on causal-effect nexus. For instance, Anghelache, Jakova and Oanea (2016) analysed the causality between fiscal policy and capital market performance in six European countries, using quarterly data from 2004 to 2015. The study found bidirectional causality for Czech Republic and Slovakia, unidirectional for Bulgaria and Poland and indecisive for Hungary and Romania. Abakah and Poku (2016) explored the causality between real budget deficits and the real stock market returns in Ghana using monthly data from 2008 to 2015. In a VAR framework, the results showed that causality ran from budget deficit to stock market in the economy of Ghana. Onyema (2017) investigated the stock market reaction to fiscal policy shocks in Nigeria using the SVAR method. The study found that stock prices insignificantly responded positively to fiscal policy shocks in Nigeria.

Similarly, Joshi and Giri (2015) examined the impact of fiscal deficits on the performance of stock market in India, using annual data from 1988-2012. Using ARDL bounds test and VECM, the results showed a long run relationship between budget deficit and stock prices but no substantial effect in the short run. In another development, Rangan, Charl & Kanyane (2013) surveyed the interplay of fiscal policy and asset prices with quarterly data from 1966 to 2012. Using time varying parameter VAR, the study found that fiscal shocks were associated with increase in stock prices. Osahon & Oriakhi (2013) investigated the effects of fiscal deficits on stock prices in Nigeria using annual data from 1984-2010. Error correction technique of estimation provided the results that fiscal deficit had a negative relation with stock prices. Using South Africa quarterly dataset from 1966-2011 with Bayesian VAR, Goodness *et al* (2012) explored the association between fiscal policy and asset prices. The outcomes showed that deficit exerted positive effects on stock prices, particularly in the short-term.

Lawal et al (2017) examined the relations between monetary and fiscal policies on stock market performance as well as the effect of volatility on the Nigerian stock market using the EGARCH and ARDL methods. The study found that association between the two policies influenced stock market returns in Nigeria. Nwaogwugwa (2018) investigated the linkage between macroeconomic policy and stock market behaviour in Nigeria, using the ARDL bounds testing approach. The outcomes showed that, both in the long-term and short-term, interest rate, money supply, public spending and revenue influenced stock market. Hu et al (2018) probed the effect of Chinese fiscal and monetary policy shocks on stock markets. The study discovered that both policies have positive significant effect on stock market development. Mbanga and Darrat (2016) explored the long and short run effects of fiscal and monetary policies on US stock returns using ECM. The outcomes showed that fiscal policy was a major driver, both in the long and short run, stock market.

In another development, Faiza, Yasir, Farhan, Kamran and Saba (2012) examine the relationship between budget deficits and stock prices in Pakistan using yearly data from 1990 to 2010. The results indicated that high developmental expenditure in Pakistan was the reason for long term positive causal relationship between budget deficit and stock prices and in India a long term negative relationship was observed due to high recurrent expenditure. Agnello and Sousa (2011)

examined the effect of fiscal policy on asset prices by using a Panel Vector Autoregressive model (PVAR) of ten developed countries using quarterly data. They found that a contractionary effect of fiscal policy leads to a crowding out effect and that there is an immediate temporary negative response of stock markets performance to fiscal policy shocks.

METHODOLOGY

Model Specification

The purpose of this study is to empirically investigate the asymmetric (anticipated and unanticipated) effect of fiscal and monetary policies on stock prices from 2000-2018 in Nigeria. Therefore, the study adopts Michael, Douglas, Dirk and Susanna (2010)'s model of The Global Integrated Monetary and Fiscal Model (GIMF) as its framework. GIMF is a 'dynamic general equilibrium model that is used for a variety of tasks including policy analysis, risk analysis, and surveillance'. To capture the asymmetric effect of fiscal and monetary policies, equation (1) is developed (see appendix). Therefore, we estimate dynamic models of monetary and fiscal policy reaction function as specified in equations 1;

$$Y_t^{GD} = h_i\left(FP, MP, W_t\right) \tag{1}$$

$Y_t^{GD} = Government\ output$

$FP = Fiscal\ Policy\ Measure$

$MP = Monetary\ Policy\ Measure$

$W_t = Shocks\ Embedded$

Model Estimation

Following Joshi and Giri (2015)'s model, Vector Error Correction Method (VECM) is employed to determine the asymmetric effect of monetary and fiscal policy on stock market performance in Nigeria from 2000:q1-2018:q3. Therefore, equations (1) is specified to follow Vector Error Correction Model (VECM) framework. The functional model is, therefore, transformed into an econometric model as shown below;

$$\Delta Y_{it} = \prod Y_{t-1} + \sum_{i=1}^{p-1} \phi^*{}_i \Delta Y_{it-j} + \varepsilon_t \tag{2}$$

Where Π and ϕ_i^* are functions of the ϕ_i^* specified. However specifically,

$$\phi_i^* = -\sum_{i=j+1}^{p} \phi_i, \qquad \Pi = -\left(1 - \phi_1 - \cdots - \phi_p\right) = -\phi(1)$$

J=1,…,p-1

The characteristic polynomial is $1 - \phi_i z - \ldots - \phi_p z^p = \phi(z)$

Y is the vector of variables considered for the analyses in equ. (2). If $\Pi = 0$, then there is no co-integration. The structural VECM is specified as the anticipated and unanticipated models below;

$$\Delta lnVOT_t = \alpha_0 + \theta_i \sum_{i=1}^{p} \Delta lnVOT_{t-i} + \beta_i \sum_{i=0}^{n} \Delta lnCGEXP_{t-i} + \delta_i \sum_{i=0}^{m} \Delta lnCMSv_{t-i} + \Psi_i \sum_{i=0}^{y} \Delta INT_{t-i} + \rho_i ECM_{(-1)} + \varepsilon_t \quad (3)$$

$$\Delta lnVOT_t = \phi_0 + \Gamma_i \sum_{i=1}^{p} \Delta lnVOT_{t-i} + \psi_i \sum_{i=0}^{n} \Delta lnGEXPv_{t-i} + \gamma_i \sum_{i=0}^{m} \Delta lnMSv_{t-i} + \Psi_i \sum_{i=0}^{y} \Delta INT_{t-i} + \Lambda_i ECM_{(-1)} + \varepsilon_t \quad (4)$$

Where VOT is the value of transactions at the stock market, CGEXP equals anticipated fiscal policy measured as change in government expenditure, CMS represents anticipated monetary policy measured as change in money supply, GEXPv stands for unanticipated fiscal policy calculated as variance of government expenditure and MSv denotes unanticipated money policy calculated as variance money supply. VECM is a full information maximum likelihood estimation model because it yields more efficient estimators of the cointegrating vectors. The method also permits testing for cointegration in a whole system of equation in one step without requiring a specific variable to be normalized. It also means that all the variables can be solved simultaneously (Koh & Maysami (1997). It allows for the non-requirement for a prior assumption of endogeneity or exogeneity of the variables. For estimation purposes, the anticipated and unanticipated fiscal policy and monetary policy series are deduced from the fitted and residual values from the OLS.

Data Source and Measurement

In order to achieve the objective of this study i.e. the asymmetric effect of fiscal and monetary policies on stock market performance, the study employs quarterly time series data on Nigeria covering first quarter 2000:q1-2018:q3. The data are obtained from the Central Bank of Nigeria Statistical Bulletin, 2019. The data include government expenditure which represents fiscal policy, value of transactions in the stock market is used for stock market performance, while money supply captures monetary policy. The value of transactions is chosen as a tool to measure the stock market performance since it encompasses both the value and volume of transaction in the stock market. It also captures daily movements of equities, thereby showing the stock market's movement.

ESTIMATION RESULTS

Unit Root Test

The stationarity test is done to detect the presence of unit root in the variables. To avoid the problem of spurious regression, it is required that all variables must be stationary either at level or at first difference. The results of stationarity test is pasted in Table 1. As indicated in the Table 1, all the series are stationary at levels but some at first difference. Therefore, the series are of different orders of integration i.e. I(0) and I(1).

Table 1: Unit Root Test.

Variables	ADF		
	Level	**First Difference**	**Decision**
GEXPv	-2.586385	-9.567882*	I(1)
MSv	-2.537982	-9.147639*	I(1)
CGEXP	-10.78503*		I(0)
CMS	-15.00819*		I(0)
VOT	-1.471379	-6.274715*	I(1)
INT	-2.026019	-9.570650*	I(1)

*** indicated 1% significant levels.**

Cointegration Test

Stationarity test results show that there are mix of I(0) and I(1) series, thus, ARDL Bounds Testing method of cointegration may be applied. This method is launched by Pesaran, Shin and Smith (2001) to address cointegration of series with different orders of integration. The results of ARDL Bounds Testing cointegation are presented in Table 2a &b. While section 2a contains results for anticipated series, 2b contains results of unanticipated series. The results reveal that the series tested for equilibrium have a long run relationship as computed *F-statistic* is greater than Critical *F-statistics* at 5% level of significance. We, therefore, reject null hypothesis of no long run relationship among the series.

Table 1a. ADRL Bounds Testing Cointegration Results for Anticipated policies

	Computed F-statistic* =** 3.622895	**K**	**Observation**
	Asymptotic Critical Values	4	76
	Lower Bounds: I(0)	Upper Bounds: I(1)	
10%	2.2	3.09	
5%	2.56	3.49	
2.5%	2.88	3.89	
1%	3.29	4.37	

***indicated 10% significant levels.

Table 2b. ADRL Bounds Testing Cointegration Results for Unanticipated policies

	Computed F-statistic* =** 7.982895	**K**	**Observation**
	Asymptotic Critical Values	4	76
	Lower Bounds: I(0)	Upper Bounds: I(1)	
10%	2.2	3.09	
5%	2.56	3.49	
2.5%	2.88	3.89	
1%	3.29	4.37	

***indicated 10% significant level.

Lag Selection Test

Akaike Information Criterion (AIC), Schwartz Bayesian information Criteria (SIC) and the Hannan-Quinn information criterion (HQ) are identified in literature as appropriate in selecting optimal lag lengths that produce errors that approach a white noise process, subject to the constraint that the smallest number of lag terms was selected for parsimony. However, for this study, the Akaike

Information Criterion is used to determine the lag length chosen in the regression models. While four lags are chosen for anticipated policy effect on stock market regression, only one lag length is chosen for unanticipated policy effect. The decision is based on AIC and SIC lag length selection criterial. The results of the lag length selection tests are pasted in the appendix.

Discussion of Results

Table 3a presents the results of anticipated monetary and fiscal policies. The results shows the effects of anticipated fiscal and monetary policies from the first quarter to the fourth quarter as chosen by the lag length selection orders. The coefficient of the anticipated fiscal policy at third quarter was (0.484) and its t-statistic value was (-3.872) which is statistically significant 1% level of significance. In other words, the outcomes show that 1% change in anticipated fiscal policy caused stock market performance to decrease by 48% at every third quarter of the year. Also, the coefficient of the anticipated fiscal policy at fourth quarter was (-1.750) and its t-statistic value was (-6.386) which is equally statistically significant 1% level of significance. This implies that 1% change in the anticipated fiscal policy also caused reduction on stock market performance by more 170% in the fourth quarter of every year. This results support the evidence provided by Osahon and Oriakhi (2013) but not consistent with Onyema (2017) for Nigeria. This implies that anticipated fiscal policy has a long term negative effect on the performance of the stock market.

On the other hand, neither negative nor positive effect of anticipated monetary policy (CMS) is observed on the performance of the stock market from the first quarter to the fourth quarter of analysis. Interest rate is also seen to have effect on stock market negatively in all the four quarters and the effects are statistically significant in the first to the third quarters while the fourth quarter is not significant. This is in line with interest rate theory which says a rise in interest rate is expected to impact negatively on stock market performance. Although, some studies are of the opinion that short term interest rate affects the stock market positively (Chakradhara, 2008). Furthermore, stock market in the second quarter has negative impact on anticipated monetary policy in the third quarter at the 10% level of significance. However, it is evident from results in Table 3b that neither unanticipated fiscal policy nor unanticipated monetary policy has impact on stock market performance in Nigeria during the period under review. Therefore, we conclude that unanticipated policies do not influence the variations to share prices in Nigeria.

Table 3a. VEC Model 1 on anticipated policies

	Dep(Variables)			
Ind(Variables)	**D(VOT)**	**D(CGEXP)**	**D(CMS)**	**D(INT)**
C	0.106 [1.875]	0.028 [0.433]	0.052 [1.675]	-0.938 [-1.155]
D(VOT(-1))	0.252 [3.959]*	-0.112 [-0.762]	0.001 [0.020]	-0.979 [-0.528]
D(VOT(-2))	0.074 [0.518]	-0.127 [-0.775]	-0.134 [-3.688]*	-1.752 [-0.850]
D(VOT(-3))	0.331 [2.094]*	0.133 [0.735]	0.109 [1.242]	0.891 [0.391]
D(VOT (-4))	0.082 [0.668]	0.105 [0.747]	-0.094 [-1.374]	2.228 [1.255]
D(CGEXP(-1))	-0.273 [-1.253]	0.245 [0.984]	0.014 [0.112]	-3.949 [-1.256]

D(CGEXP(-2))	-0.140 [-0.635]	0.517 [2.048]***	0.155 [1.265]	-0.264 [-0.083]
D(CGEXP(-3))	-0.484 [-3.872]*	-0.206 [-0.698]	-0.215 [-4.501]*	1.093 [0.294]
D(CGEXP(-4))	-1.750 [-6.386]*	-0.695 [-2.221]**	0.111 [0.727]	5.488 [1.389]
D(CMS(-1))	0.232 [0.812]	0.055 [0.167]	0.031 [0.196]	2.077 [0.534]
D(CMS(-2))	0.057 [0.202]	0.065 [0.200]	-0.338 [-2.155]**	2.602 [0.638]
D(CMS(-3))	-0.236 [-0.851]	-0.026 [-0.082]	-0.027 [-0.177]	3.101 [0.777]
D(CMS(-4))	-0.407 [-1.454]	-0.162 [-0.014]	0.664 [4.279]*	2.694 [0.668]
D(INT(-1))	-0.047 [-3.025]*	-0.014 [-0.818]	0.011 [1.295]	-0.193 [-0.870]
D(INT(-2))	-0.022 [-1.634]	-0.006 [-0.392]	-0.003 [-0.395]	-0.118 [-0.607]
D(INT(-3))	-0.030 [-2.206]**	-0.022 [-1.403]	-0.005 [-0.644]	0.319 [1.637]
D(INT(-4))	-0.001 [-0.108]	0.002 [0.150]	-0.009 [-1.215]	-0.124 [-0.660]
ECM(-1)	-0.130778 [-6.68800]*			
't' statistics in parentheses, *p< 0.1,**p<0.05,***p<0.01				

*/**/*** indicate 1%, 5% and 10% significance level respectively

Table 3b. VEC Model 2 on Unanticipated policies

	Dep(Variables)			
Ind(Variables)	**D(VOT)**	**D(GEXPV)**	**D(MSV)**	**D(INT)**
C	0.028 [1.049]	0.002 [0.097]	0.006 [0.297]	0.278 [1.279]
D(VOT(-1))	0.528 [3.170]*	-0.084 [-0.866]	0.064 [0.485]	-3.534 [-2.629]**
D(GEXPV(-1))	0.199 [0.640]	0.184 [1.018]	0.160 [0.652]	-1.177 [-0.469]
D(MSV(-1))	0.000 [0.001]	0.093 [0.891]	-0.126 [-0.889]	0.761 [0.524]
D(INT(-1))	-0.016 [-0.826]	-0.003 [-0.278]	-0.005 [-0.315]	-0.031 [-0199]
ECM(-1)	-0.05419 [-1.73076]			
't' statistics in parentheses, *p< 0.1,**p<0.05,***p<0.01				

*/**/*** indicate 1%, 5% and 10% significance level respectively

The error correction terms have negative sign and they are less than one. The coefficients of error correction represent the speed of adjustment in the stock exchange which are 13% and 5% respectively. While coefficient of error correction for anticipated effect of policies on stock market performance is significant (-6.688) at 1% level of significance, the ECM on unanticipated policy

effect is not statistically significant. The performance of the stock market in the two lagged values have a positive effect on the present performance of the stock market with only the first and third quarters being significant at the 10% and 5% level. It, however, had the highest values in the levels that is significant. This implies that the present performance of the stock market has a short and long term effect.

CONCLUSION

The objective of this study was to determine the asymmetric (anticipated and unanticipated) effects of fiscal and monetary policies on stock market performance in Nigeria. Secondary data on quarterly basis from 2000:q1-2018:q3 were obtained from Central Bank of Nigeria Statistical Bulletin, 2019. To achieve the objective of the study, we partitioned the monetary and fiscal policy into two, namely; anticipated and unanticipated and their effects on stock market performance in Nigeria were investigated. Using Vector error correction method estimation technique was used to analyse the data. The results on anticipated policies showed that while fiscal policy had a negative and significant effect on the stock market performance in the third and fourth quarters of the year, anticipated monetary policy as well as unanticipated fiscal policy did not exert influence on stock market performance in Nigeria. Furthermore, the interest rate exhibited negative but significant effect on stock market performance both in the second and fourth quarters of every year of the period covered by this study.

Similarly, the findings showed there was no effect of both unanticipated fiscal and monetary policies on the performance of the stock market in Nigeria. Again, the results suggested that unanticipated fiscal and monetary policies did not distort interest rate in Nigeria within the period under review. However, interest rate had a negative but not significant impact on the performance of the Nigerian stock market. The study, therefore, concluded that only anticipated fiscal policy has effects on the stock market performance in Nigeria during the period covered by this study. As anticipated fiscal policy, therefore, government in Nigeria should reduce its expenditure which has the capacity to positively influence the performance of stock market.

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APPENDIX

The Global Integrated Monetary And Fiscal (GIMF) Model

This framework is divided into three sections which include; fiscal policy and output, monetary policy and output, and the combination of the two. The model starts as follow;

Fiscal Policy And Output

Considering an economy that uses consumption goods X_t^{CG} and investment goods X_t^{IG} to produce government output Y_t^{GD}. Thus, the equation becomes;

$$Y_t^{GD} = \left[(\beta_{CG})^{1/E_G}\left(X_t^{CG}\right)^{E_G-1/E_G} + (1-\beta_{CG})^{1/E_G}\left(X_t^{IG}\right)^{E_G-1/E_G}\right]^{E_G/E_G-1} \quad (1)$$

The constant elasticity of substitution (CES) production function in equation (1) shows the output function for the hypothetical economy where β_{CG} is the consumption good share factor and E^G an elasticity of substitution. Representing the marginal cost of producing Y^G by P_t^{ZG} and normalising the cost with technology and labour force; the standard input demands becomes:

$$\hat{X}^{CG} = \beta_{CG} Y^{GD}\left(P_t^{ZG}\right)^{EG} \quad (2)$$

$$\hat{X}^{IG} = (1-\beta_{CG}) Y^{GD}\left(P_t^{I} / P_t^{ZG}\right)^{-E_G} \quad (3)$$

If we allow for unit shocks that could influence the relative price of government output, Y_t^{GD} then, the output of government goods Y_t^G can be converted to final output of the government using the technology- leading process, and therefore, the equation becomes:

$$\hat{Z}_t^{GD} = T_t^G\, Y_t^{GD} \quad (4)$$

Where T_t^{GD} is the technology-leading shock with no growth in trends. Moreover, consider the stochastic relative price as;

$$P_t^G = \hat{P}_t^G\, P_t^{ZG} \quad (5)$$

Assume the demand for government output G_t comes from government consumption and investment such that:

$$G_t = G_t^I + G_t^C \quad (6)$$

And that the market clearing condition is given as supply equates demand;

$$G_t = Y_t^{GD}$$

Thus, equation 4 can be rewritten as;

$$Z_t^{GD} = T_t^G\, G_t \quad (7)$$

Furthermore, given the assumption that fiscal policy consists of lump sum taxes and transfers which are represented below;

Lump Sum Taxes;

$$t_{ls,t} = t_t^{lsG} + t_t^{lsQ} \tag{8}$$

Lump Sum Transfer;

$$T_{ls.t} = T_t^{lsG} + T_t^{lsQ} \tag{8}$$

Moreover, assuming that both types of government spending are exogenous and stochastic and government investment spending is an important function in this economy, the stock of publicly provided infrastructure capital is given as;

$$K_{t+1}^{GI} = \left(1 - \delta_{GI}\right) K_t^{GI} + G_t^{In} \tag{9}$$

Where:

δ_{GI} is the depreciation rate of public capital. Similarly, a representative of the government consumption spending can be modeled as follows:

$$K_{t+1}^{GC} = (1 - \delta_{GC})\, K_t^{GC} + G_t^{C} \tag{10}$$

Assuming that the government lump sum transfers and taxes are received and paid by individuals in proportion to their share in aggregate consumption; rescaling by technology, we therefore have the lump sum taxes restructured as follows:

$$t_{ls,T} = \gamma_i \left(d_t^N + d_t^T + d_t^D + d_t^C + d_t^I + d_t^M + d_t^X + d_t^F + d_t^K + d_t^{EP}\right) + C_t^I / C_t \left(d_t^R + T_t - t_{ls.t}\right) + l_t^I / L_t\, d_t^U \tag{11}$$

The sources of nominal tax revenue are labour income taxes, $t_{l,t} W_t L_t$, consumption taxes, t $t_{c,t} P_t^c C_t$, taxes on return to capital $t_{k,t} \sum_j = \gamma_j \left[R_{k,t}^j - \delta_{k,t}^J P_t Q_t^J \right] \bar{K}_t^J$ and lump sum taxes P $^{P_t t_{ls,t}}$, thus, the aggregate real tax variable as:

$$t_t = t_{l,t} W_t L_t + t_{c,t} P_t^c C_t + t_{ls,t} + t_{k,t} \sum_j \tag{12}$$

$$t_t = t_{l,t} W_t L_t + t_{c,t} p_t^c c_t + t_{ls,t} + \left[\gamma_j R_{k,t}^J - \gamma_j \delta_{k,t}^J p_t Q_t^J\right] \bar{K}_t^J$$

$$t_t = t_{l,t} W_t L_t + t_{c,t} p_t^c c_t + t_{ls,t} + \gamma_j \bar{k}_t^j R_{k,t}^j - \gamma_j \bar{k}_t^j \delta_{k,t}^j p_t Q_t^j \tag{13}$$

Furthermore, if the real government budget constraint involves one period nominal debt, B_t at the gross nominal interest rate i_t.

$$b_t + t_t + g_t^x = i_{t-1} / \pi_t g_n b_{t-1} + p_t^c G_t + T_t \tag{14}$$

We further consider two major economic concerns: (1) dynamic stability and (2) stabilization of the business cycle. First, fiscal policy ensures a non-explosive government debt to GDP ratio by

adjusting tax rates to generate sufficient revenue, or by reducing expenditure, in order to stabilize the overall interest inclusive government surplus to GDP ratio, g_t^{rat} at a long run level of $g_{t,LR}^{rat}$;

$$g_t^{rat} = t_t + g_t^x - p_t^G G_t - T_t - i_{t-1} - 1/\pi_t g_n (b_{t-1)} \quad (15)$$

Satisfying its long run target of g_t^{rat} and flexibly responding to the business cycle, specifically, we have the following structural fiscal surplus rule;

$$g_t^{rat} = g_{t,LR}^{rat} + d^{debt}\left(b_t^{rat} - b_{t,LR}^{rat}\right) + d^{gdp} In\left(gdp_t^{Fisher} / gdp_t^{pot}\right) + d^{tax}\left(t_t - t_t^{pot} / gdp_t\right) + d^{transfer}\left(g_t^x - g_{x,t}^{pot} / gdp_t\right) \quad (16)$$

The relationship in equation (15) implies that even with $d^{debt} = 0$. The rule in equation (16) automatically ensures a non-explosive government debt to GDP ratio of b_t^{rat}, but the long run autoregressive coefficient on debt in that case at $1/(\pi_t g_n)$ is very close to one. Setting $d^{debt} \succ 0$ ensures faster convergence of debt at the expense of more volatile government surpluses. The remaining terms in equation (16) represent responses to the state of business cycle. The d^{gdp} is the output gap; this uses current and potential Fischer weighted GDP; $gdp_t^{fischer}$ and gdp_t^{pot} as the relevant measures. Other terms remain as earlier defined.

Monetary Policy and Output

Introducing the effect of monetary policy by assuming that monetary policy uses an interest rate rule that features interest rate smoothing and which responds to:

i. Deviations of one-year a-head year on year inflation π_{t+1} from possibly time varying inflation target π_t.

ii. The output gap;

iii. The year-on year growth rate of Fischer weighted GDP;

iv. Deviation of current exchange rate depreciation value exh_t.

Furthermore, allowing for autocorrelated monetary policy shocks, S_t^{int} if the notation below is employed and the model allows for inflation rate targeting by monetary policy; then the complete monetary rule is given by;

$$i_t = E_t\left(i_{t-1}\right)^{\delta_i}\left(r_t \bar{\pi}_t\right)^{1-\delta_i}\left(\pi_t / \bar{\pi}_t\right)^{(1-\delta_i)\delta_\pi}\left(gdp_t^{fish} / gdp_t^{pot}\right)^{(1-\delta_i)\delta_y}\left[\left(gdp_t^{fischer} / gdp_{t-4}^{fischer}\right)\right]^{(1-\delta_i)\delta_{yg}} \left(EXH_t / EXH_t\right)^{\delta_e} S_t^{\text{int}} \quad (17)$$

Where:

$$\bar{\pi}_t = \pi_t^{\delta\pi} \pi_{t+1}^{1-\delta\pi}$$

$$r_t = r_t^{world} EXH_t$$

$$r_t^{world} = \pi_{j=1}^{N} \left(r_t^j\right) gdp_i / \sum gdp$$

$$r_t^j = \left(r_t^j \left(r_{t-1}^{ma(j)}\right)^k\right)^{1/1+k}$$

Incorporating shocks into equations (1) and (16) and assuming that the shocks are denoted by w_t; which is modeled as follows;

$$w_t = (1-\rho_i)\bar{w}_t + \rho_i w_{t-1} + \mu_t^w \bar{w}_t \quad (18a)$$

$$In\left(\bar{w}_t\right) = In\left(\bar{w}_{t-1}\right) + \mu_t^w \quad (18b)$$

Recall equations (1), (17) and (18a);

$$Y_t^{GD} = \left[(\beta_{CG})^{1/E_G} \left(X_t^{CG}\right)^{E_{G-1}/E_G} + (1-\beta_{CG})^{1/E_G} \left(X_t^{IG}\right)^{E_G-1/E_G}\right]^{E_G/E_G-1}$$

Fiscal Policy, Monetary Policy and Output

From the equation above, the variables for both monetary policy and fiscal policy were extracted to give us equation 19 below.

$$FP = f_i\left(t_{ls,t}, k_{t+1}^{GI}, b_t, g_t^{rat}\right)$$
$$MP = g_i\left(i_t, r_t^j, EXH_t^{ki}\right) \quad (19)$$

Modifying equation (1);

$$Y_t^{GD} = h_i\left(FP, MP, W_t\right) \quad (20)$$

$Y_t^{GD} = Government\ output$
$FP = Fiscal\ Policy\ Measure$
$MP = Monetary\ Policy\ Measure$
$W_t = Shocks\ Embedded$

Equation 20 represents fiscal and monetary policies as they affect aggregate output and, the equation is estimated.

VAR Lag Selection Test (Anticipated Policies)

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-90.4854	NA	3.68E-05	3.9786	4.1735	4.0522
1	189.5589	490.078	8.98E-10	-6.6483	-5.478*	-6.2063
2	215.0649	39.322	9.10E-10	-6.6694	-4.5253	-5.8591
3	256.8275	55.683	4.96E-10	-7.3678	-4.2491	-6.1893
4	291.5493	39.0621*	3.97e-10*	-7.772*	-3.6796	-6.226*
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

VAR Lag Selection Test (Unanticipated Policies)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-43.0304	NA	5.09E-06	2.0013	2.1962	2.0749
1	185.4081	399.767*	1.07e-09*	-6.475*	-5.305*	-6.033*
2	206.6423	32.7361	1.29E-09	-6.3184	-4.1743	-5.5082
3	224.9809	24.4515	1.87E-09	-6.0409	-2.9222	-4.8623
4	252.8943	31.4026	1.99E-09	-6.1623	-2.0690	-4.6154
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						