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An assessment of alternative fiscal stimulus instruments in Nigeria: A DSGE analysis

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Abstract

This paper sets out to ascertain the optimal fiscal stimulus instrument in Nigeria, based on its fiscal multiplier effect on key macroeconomic variables. This is done using a calibrated small open-economy New Keynesian DSGE model of the Nigerian economy augmented by rich fiscal sector incorporating government expenditure. Within this framework, the multiplier effects of three alternative fiscal stimulus instruments in the form of Government transfers, Government consumption expenditure, and Government investment are analysed. The main findings of this paper are; within the short-term period, government transfer shock is found to be more effective in stimulating the economy while, government investment shock has a larger impact in the long term. Therefore, the result suggests that the fiscal authority should spell out its priority clearly before selecting any fiscal instrument.

Keywords: Fiscal multipliers, expenditure components, DSGE simulation.

Introduction

The 2016 recession in Nigeria was to a very large extent caused by poor economic planning and no concrete implementation, high inflation rate, high interest rate, high taxation and policy conflict[1]. This is in addition to supply-side related shocks and terms of trade shocks[2]. In order, to counter the negative impact of the recession, several fiscal and monetary policies were put forward in 2017. For example, the monetary policy rate has been accommodative from 2017 up to date.

Along the same line, fiscal authority embark upon massive stimulus plan in the form of the budget deficit to stimulate the economy, because fiscal policy is regarded as the sole tool available to domestic authority to use in smoothing adverse idiosyncratic shocks in the economy[3].

As a result of the such plans, monetary and fiscal policies actions are placed at the centre stage of an intense debate as per their performances in the management of the 2016 recession. This work intends to contribute to the debate by assessing the fiscal side of government stimulus plans in the macroeconomic space of Nigeria particularly in taming the 2016 recession in Nigeria.

Presently, structural DSGE models have gained prominence as they are widely used by policymaking institutions around the world to investigate the impact of discretionary fiscal stimulus on the economy. This may have motivated the work of Furceri D. et al.[4] as the study applied a DSGE model to examine the impact of different fiscal policy shocks on output in the eurozone. The study reveals that public investment and consumption are effective in increasing output in the short-term because they were found to have larger multiplier effects than other fiscal shocks. Although the study of Coenen G. et al.[5] followed a similar fashion as that of Furceri D. et al.[4] by employing a structural DSGE model involving seven fiscal shocks, the study, however, report a contrasting fact; government spending and transfers have the highest multiplier effect among seven fiscal shocks.

Similarly[6], established that Australian government transfers were effective in combating the economic downturn caused by the Global Financial Crisis (GFC), by applying a small open economy New Keynesian model. Bhattarai K. et al.[7] applied a new-Keynesian DSGE model to analyse the effectiveness of the UK fiscal stimulus package. The study concludes that government consumption and investment are effective in improving the UK macroeconomic in the short-run because they yield the highest GDP multipliers. A similar work was also conducted on the US data by Kara E. et al.[8], by applying a liquidity-constrained New Keynesian model. The study investigates the effectiveness of fiscal instruments shocks on outpour, consumption and investment. The study unearthed the fact that, government spending has the largest fiscal multiplier, thus it contributed positively to an increase in private investment, consumption, and output.

Summarily, literature so far reviewed underscores the macroeconomic impacts of fiscal stimulus instruments in protracting the unpredictably large negative shocks caused mainly by the 2008-2009 GFC in the most advanced economies.

Let alone in Nigeria, where internal factors are the major cause of the 2016 recession[1] with the exception of terms of trade shock. It is, therefore against this background that this work seeks to explicate the fiscal multiplier effects for three fiscal instruments (government transfer, government consumption expenditure, and government investment) on real output, private consumption and investment in Nigeria, by comparing as well as quantifying their macroeconomic effects using an estimated DSGE model.

Following the background, this paper has the following structure. In section 2 the adapted model structure is summarized and described including its calibrated parameters. Section 3 describes the simulation design and compares multipliers of the three fiscal instruments in the short and long run. Section 4 summarizes the main results and concludes.

The Model

The economic model adapted for this work is based on and drawn from the work of Iwata Y.[9], Beltran D. et al.[10] and Almeida V.[3]. The choice of these models is informed by the nature of the study. The redesigned model includes the following characteristic: First, the is augmented by a detail set of distortionary taxes such as taxes on consumer purchases, labour income tax, tax on capital income and profits income and social security contributions by firms, in addition, it features government consumption expenditure, lump sum government transfer to households and government investment. Thus, it provides us with the tools to analyze fiscal policy instruments. Second, it is suitable for quantitative policy analysis, forecasting and assessing macroeconomic impact of the alternative fiscal stimulus approaches. In addition to, the distributional effects of shocks. Third, numerous nominal rigidities, real rigidities and real frictions which are empirically significant in macroeconomic analysis like the habit formation, sticky prices and financial frictions in the form of a fraction of liquidity constrained household are incorporated.

Households: The household sector consists of non-liquidly constrained and liquidity constrained households. The non-liquidly constrained household forms a fraction of $(1-\omega)$ of the total population while Liquidity constrained households form the remaining proportion of the population.

Ricardian Households (Non-liquidity constraint): The non-liquidity constrained household maximizes its intertemporal utility by choosing consumption, investment and leisure. It must also decide on saving instrument i.e. physical capital or government bonds. The non-liquidity constrained household earned income from wages (W); return on capital rent to firms (R) and income from government bonds acquired in the previous period. It also pays consumption tax, personal income tax and capital income tax. The non-liquidity constrained household maximizes its intertemporal utility subject to budget constraint as follows:

$$\left(1+\tau_t^c\right)C_t^R(r)+I_t(r)+\psi(Z_t(r)K_{t-1}(r)+\frac{B_t(r)}{R_tP_t}= \\ \left(1+\tau_t^l\right)W_t(i)L_t^R(r)+\left(1-\tau_t^k\right)r_t^kZ_t(r)K_{t-1}(r)+\left(1-\tau_t^k\right)\frac{D_t(r)}{P_t}+\frac{B_{t-1}(r)}{P_t} \quad (1)$$

Non-Ricardian Households (Liquidity constraint): The Non-Ricardian household has a simpler behaviour i.e. does not maximize its intertemporal utility. The Non-Ricardian household received income from only a source i.e. wage income, at the same time it pays consumption tax and personal income tax on wage income. The non-Ricardian house also received government transfer. Thus, the Non-Ricardian household simply allocates his entire income to consumption under the below hypothesis:

$$\left(1+\tau_c\right)C_t^{NR}(j)=\left(1-\tau_t^l\right)W_t(j)L_t^{NR}(j)+G_t \quad (2)$$

Wage Settings: The Ricardian household is a wage $(W_t^R(i))$ setters for its differentiated labour services $L_t^R(i)$ in a monopolistically competitive labour market while its nominal wage is set in the spirit of Calvo G.A.[11]. The Non-Ricardian household, on the other hand, set its wage $W_t^{NR}(j)$ for its differentiated labour service $L_t^{NR}(j)$ to be equal to its average nominal wage. Within each group of households, wages and labour hours are equal, as households face the same labour demand schedule. I.e. $W_t^R = W_t^{NR} = W_t(n)$ and $L_t^R = L_t^{NR} = L_t(n)$. It is assumed that an independent and perfectly competitive employment agency bundle the differentiated labour services $L_t(n)$ into a single type of effective labour input L_t. The aggregate wage law of motion follows the below process:

$$W_t=\left[(1-\varepsilon_w)\left(W_t^*(n)\right)^{-\frac{1}{\lambda_{w,t}}}+\varepsilon_w\left(\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma_w}W_{t-1}(i)\right)^{-\frac{1}{\lambda_{w,t}}}\right]^{-\lambda_{w,t}} \quad (3)$$

Firms: There are two types of firms in the domestic economy, i.e. perfectly competitive final-good firms and monopolistically competitive intermediate-good firms indexed by $f\epsilon[0,1]$, in addition, to the domestic retail importers.

Intermediate Goods Firms: There is a continuum of intermediate goods-producing firms in the domestic economy; each firm is producing a differentiated good $Y_t(j)$ using increasing-returns-to-scale Cobb-Douglas technology. Intermediate goods firms set prices in a staggered manner as proposed by Calvo[11]. Each intermediate goods producer j maximized profit subject to the given demand for intermediate goods, production technology and capital accumulation. The profit maximization solution of the intermediate good producer becomes.

$$D_t^j = OCF_t - \tau_t^k\left(NOF_t\right) \quad (4)$$

Where: $D_t^J(j)$ is period t dividend and OCF_t is the difference between overall revenue and expenditure.

$$OCF_t = P_t Y_t - \frac{\left(1 - TSP_t W_t^{1-\alpha}\left(K_t^r\right)^{\alpha}\right)}{\varepsilon_t^a \alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}} \quad (5)$$

In 5 $(1 - Tsp_t W_t^{1-\alpha})$ is the cost of labour plus employer's social security contributions, while τ_t^K is tax deductions on dividend and net operating cash flow, which is defined as

$$NOCF_t = P_t Y_t - \frac{\left(1 - TSP_t W_t^{1-\alpha} + Q_t\left(K_t^r\right)^{\alpha}\right)}{\varepsilon_t^{\alpha} \alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}} \quad (6)$$

In the above equation, 6 Q_t isTobin's Q.

Distributors: In the domestic economy, there is a continuum of distributors for each type of final goods. As each type of final good is demanded by a unique type of customer: household demands for consumer goods (C), firms demand for new capital goods (I) while government demanded government consumption goods (G). Distributors sell their goods at a price plus a markup over the marginal costs $P_t^f(f)$. Domestic distributors set prices in a similar fashion with domestic intermediate goods producers.

Domestic Retail Importers: In the domestic economy, there is a continuum of retails importers distributing differentiated goods. Importers pay the world-market price in terms of the domestic currency for the imported goods, i.e. the law of one price still holds. To set prices in local currency optimally, the retail importers must solve an optimal markup problem. Thus, deviation from the law of one price becomes obvious. Import retailers like the domestic producers set price $\dot{P}_f^I(f)$ in Calvo style, in order to maximize profit. His mark up solution becomes:

$$\sum_{k=0}^{\infty}\left(\theta_f \beta\right)^k \nu_{t,t+k} C_{f,t+k}(j)\left[P_f, t(j) - \left(1+u_t^f\right)\varepsilon_{t+k} P_{t+k}^*\right] = 0 \quad (7)$$

Monetary and Fiscal Authorities: Monetary Policy: The monetary authority sets nominal interest rates according to a modified Taylor rule following[12] in the form of

$$i_t = \left[\rho_i i_{t-1} + \left(1-\rho_i\right)\right]\left(\varphi_\pi \pi + \varphi_x \ddot{x} + \varphi_e\left(e_t - e_{t-1}\right)\right) + \varepsilon_t \quad (8)$$

Fiscal Authority: The fiscal authority earned revenue through a consumption tax, labour income tax, capital income tax and social security contributions on firms' payroll τ_t^c, τ_t^l τ_t^k and f TSP_t respectively. In addition, the fiscal authority issues bonds B_t which pay debt interest outlays $(i_{t-1} - 1)B_{t-1}$. The fiscal authority spent the earned revenue on government consumption G_t, government investment G_{it} and performs lump-sum transfers to households TRG_t. Thus, the fiscal authority has the below budget constraint:

$$G_t + \frac{B_{t-1}}{P_t} + TRG_t + GI_t = C_t\tau_t^c + W_t L_t \tau_t^l + \tau_t^k r_t^k Z_t K_{t-1} + r_t^k \frac{D_t}{P_t} + \frac{1}{R_t}\frac{B_t}{P_t} \quad (9)$$

Based on the above budget constraint the following fiscal rules are adopted from[9].

$$\hat{\tau}_t^c = \rho_{tc}\hat{\tau}_{t-1} + \left(1-\rho_{tc}\right)\varphi_{tc}\left(\hat{b}_{t-1} - \hat{Y}_{t-1}\right) + \eta_t^{tc} \quad (10)$$

$$\hat{\tau}_t^l = \rho_{tl}\hat{\tau}_{t-1} + \left(1-\rho_{tl}\right)\varphi_{tl}\left(\hat{b}_{t-1} - \hat{Y}_{t-1}\right) + \eta_t^{tl} \quad (11)$$

$$\hat{\tau}_t^k = \rho_{tk}\hat{\tau}_{t-1} + \left(1-\rho_{tk}\right)\varphi_{tk}\left(\hat{b}_{t-1} - \hat{Y}_{t-1}\right) + \eta_t^{tk} \quad (12)$$

$$\hat{G}_t = \rho_g \hat{G}_{t-1} + \left(1-\rho_g\right)\phi_{gy}\hat{Y}_{t-1} + \eta_t^g \quad (13)$$

$$\hat{GI}_t = \rho_{gi}\hat{GI}_{t-1} + \left(1-\rho_{gi}\right)\phi_{gi}\hat{Y}_{t-1} + \eta_t^i \quad (14)$$

$$\hat{TRG}_t = \rho_{trg}\hat{TRG}_{t-1} + \left(1-\rho_{trg}\right)\phi_{gty}\hat{Y}_{t-1} + \eta_t^{tg} \quad (15)$$

Rest of the World: We adopted [10] to modelled the rest of the world economy as a closed economy.

Calibration

Accordingly, the parameters of this model are calibrated, so as to simulate the model and then compare the performance of alternative fiscal stimulus instruments in Nigeria. In line with the New Keynesian DSGE model's tradition, parameters are borrowed from the literature on the economies of similar structure, or estimate from actual data for the Nigerian economy. Table-1 present the calibrated parameters of the model.

The model steady-state parameters are estimated on the Nigerian data for the period starting from 2007:Q1 to 2016:Q3. We followed Iwata Y.[9] and Li S.M. et al.[6], by taking the sample period averages, as reported in Table-1. For other steady-state parameters like the inverse adjustment, capital utilization, depreciation cost, labour-output ratio, steady-state wage increment etc, we set their values to be consistent with the steady-state conditions implied by the model, as reported in Table-1.

A Bayesian approach is used in estimating the model, using pre-recession Nigerian data (2007-2016). The estimated model implies impulse response functions to the three exogenous shocks that are consistent with economic intuition.

Macroeconomic Impact of Fiscal Stimulus

In this section, we assess the macroeconomic impact of different fiscal stimulus instruments in Nigeria within the context of a

small open economy model. We implemented a set of fiscal policy simulation using the model described in section 2, in order to study the cost and benefits of several fiscal stimulus instruments. The analysis is achieved by presenting three simulations, where the impact of each fiscal stimulus instrument on the main macroeconomic variables is analysed in isolation.

Impact of Alternative Fiscal Stimulus Instruments in Nigeria: Government Transfer: Figure-1 presents the results of a 1 percent point (1pp) increase in government transfer as an alternative fiscal stimulus instrument. In this simulation, other tax rates and expenditure components are held constant. Consumption/leisure allocation is positively affected by an increase in government transfer, leading to a decrease in labour supply and hours worked. Such a decrease in labour supply forces the marginal cost to rise, which in turn lead to an increase in domestic prices.

A 1pp increase in government transfers has a significant positive effect on real output and household welfare in Nigeria but has a negative effect on private investment because of the crowding out effect.

Table-1: Calibrated Parameters and Steady-state Ratios.

Calibrated parameter			
Parameter Descriptions	Parameters	Values	Source
Calvo parameter for domestic producers	θ_h	0.64	[12]
Calvo parameter for domestic wage	γ_w	0.6	Authors
Calvo wage indexation	ξ_w	0.5	Authors
Calvo parameter for retail importers	θ_f	0.64	Authors
Calvo parameter for foreign producers	θ_h	0.75	[13]
AR (1) persistence shock for domestic producers	ρ_{pih}	0.2	[13]
Government exp. AR coefficient	ρ_g	0.80	[9]
Con tax. AR coefficient	ρ_c	0.75	[9]
Labour tax. AR coefficient	ρ_l	0.50	[9]
Capital tax. AR coefficient	ρ_k	0.75	[9]
persistence of preference shock	ρ_{sc}	0.50	[9]
persistence of labour supply shock	ρ_{sl}	0.75	[9]
persistence of inv.adj cost shock	ρ_k	0.75	[9]
Inflation	ϕ_π	1.45	[14, 15]
Output	ϕ_x	0.53	[12]
Nominal Exchange	ϕ_e	0.28	[12]
Government. exp. output gap coefficient	ϕ_{gy}	0.1	[9]
Consumption tax debt coefficient	ϕ_c	0.1	[9]
Labour tax debt coefficient	ϕ_l	0.1	[9]
Capital tax debt coefficient	ϕ_k	0.1	[9]
i.i.d shock: productivity	η_a	0.4	[9]
i.i.d shock: preference	η_{sc}	0.1	Authors
i.i.d shock: labour supply	η_{sl}	0.2	Authors
i.i.d shock: wage markup	η_l	0.1	Authors
i.i.d shock: price markup	η_p	0.15	[9]
i.i.d shock: interest rate	η_r	0.1	[9]
i.i.d shock: government spending	η_g	0.3	[9]
i.i.d shock: consumption tax	η_c	0.2	Authors
i.i.d shock: labour tax	η_l	0.1	[9]
i.i.d shock: capital tax	η_k	0.3	Authors
Fiscal steady-state parameters			
Consumption tax	τ_c	0.05	[16]
Personal income tax	τ_l	0.24	[16]
Capital income tax	τ_k	0.30	[16]
Dividend income tax	γ_d	0.25	Model
Depreciation rate	δ	0.25	Model
Wage increment	γ_{wl}	0.1	Model
Level of gov transfer	γ_t	0.4	Model
Employer social contributions	τ_{cc}	0.19	[17]
Steady-state ratios parameters			
Debt to GDP	γ_b	0.42	Data
wage to GDP	γ_l	0.27	Data
Consumption to GDP	γ_c	0.62	Data
Gov consumption to GDP	γ_g	0.07	Data
Investment to GDP	γ_b	0.15	Data
Capital to GDP	γ_b	0.15	Model

Government Consumption Expenditure: Figure-2 presents the results of a 1pp increase in government consumption expenditure as an alternative fiscal stimulus instrument. In this simulation, other tax rates and expenditure components are held constant. Consumption/leisure allocation is distorted by an increase in government consumption spending in Nigeria. Government consumption expenditure in Nigeria is mostly input such as petroleum products, fertilizer etc, which implies an increase in the cost of production. Changes in government consumption spending affect the economy through the price transmission channel (see the rise in CPI inflation above the steady-state in Figure-2). Consequently, real wages and household's consumption and welfare increase. It can be observed from Figure-4, that real output is above its steady-state level while government consumption expenditure crowd out private investment (private investment is below its steady-state level).

Government Investment Spending: Figure-3 presents the results of a 1pp increase in government investment as an alternative fiscal stimulus instrument. In this simulation, other tax rates and expenditure components are held constant. Consumption/leisure allocation is distorted by an increase in government investment in Nigeria. Government investment in Nigeria is mostly in the areas of infrastructure, which normally has a long built-up time, implying an increase in the cost of production. Changes in government investment affect the economy through the price transmission channel (see the rise in CPI inflation above the steady-state in Figure-3). As a consequence, real output and real wages increase. It can be observed from Figure-3, that an increase in government investment has an insignificant effect on household consumption and welfare. In addition, government investment expenditure crowds out private investment (private investment is below its steady-state level).

Fiscal multipliers: We follow Iwata[9] definition of the fiscal multiplier. We use traditional fiscal multiplier to evaluate the effects of alternative fiscal stimulus strategies quantitatively. We examined and compared the short run (quarter 1) and the long run (quarter 40) fiscal multiplier effects following three fiscal stimulus shocks. For the sake of simplicity, shocks are assumed to be permanent while the model is assumed to be at its steady-state before shocks' impact.

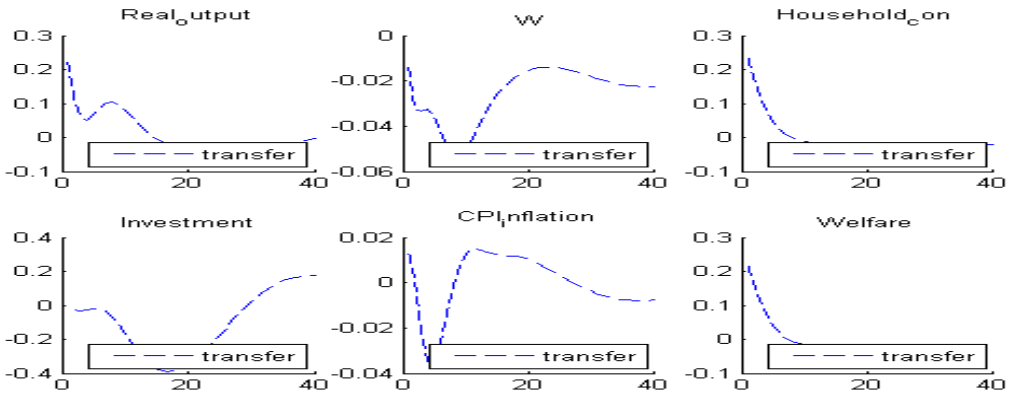

Figure-1: 1pp Increase in Government Transfer.

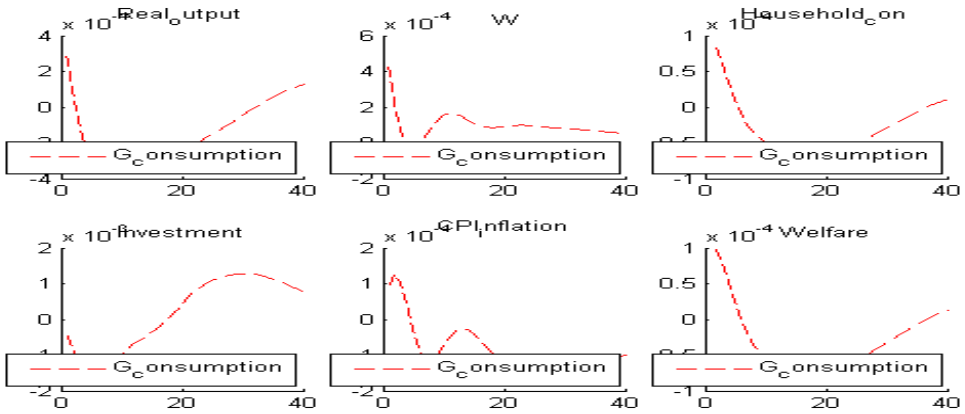

Figure-2: a 1PP Increase in Government Consumption Expenditure.

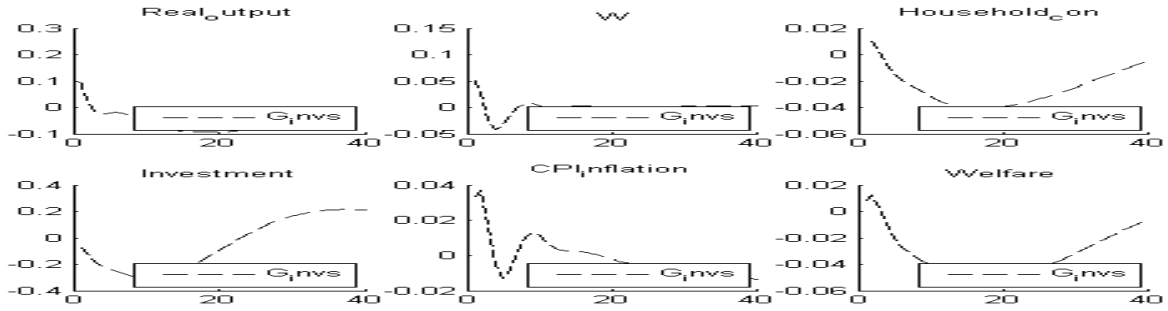

Figure-3: A 1.pp Increase in Government Investment.

Table-2: Fiscal Multipliers of Alternative Fiscal Stimulus Instruments.

Shocks	Real output		Consumption		Investment	
	SR	LR	SR	LR	SR	LR
Govt. Transfer	0.238	-0.003	0.245	-0.021	-0.007	0.172
Govt. Consumption	0.003	0.000	8.768e-005	1.12e-005	-0.002	0.000
Govt. Investment	0.108	-0.017	0.008	-0.004	-0.051	0.213

Table-2 shows the multipliers of three alternative fiscal stimulus instruments in the process of stimulating the economy. A larger multiplier is more desirable as one unit of stimulus provides a higher boost to GDP, consumption and private investment.

Table-2 shows that government transfer has the largest effect on real output and consumption in the short run, followed by government investment while government consumption has the worst effect on GDP and consumption in the short run. On the other hand, government investment has the largest impact on private investment in the long run. From the foregoing, it is therefore concluded that fiscal stimulus instruments in Nigeria have a larger positive effect in the short run on real output and consumption and this positive impact diminishes with time. The same fiscal stimulus instruments have a larger negative effect in the short run on investment and this negative impact diminishes with time.

Conclusion

In this paper, we develop a small open economy DSGE model for the Nigerian economy with a rich fiscal sector in order to assess the impact of various fiscal stimulus instruments on the economic performance of Nigeria during a recession. The set of instruments comprises of government transfer, government consumption expenditure and government investment shocks.

The main conclusion of this paper is that in general, fiscal stimulus in Nigeria is more effective at take-up stage but this positive effect diminishes with time; the least desirable instrument in stimulation the economy is government consumption expenditure.

Therefore, the fiscal authority should be clear about their short run and long run priority. If the fiscal authority is interested in immediate impact, government transfer appears to have the largest impact on output but a lower long term impact on private investment. But if the priority of the fiscal authority is more interested in future impact, then government investment shock appears to be the best instrument because it is found to have the largest positive impact on private investment.

Notwithstanding, it should be noted that the results have some limitations: First, our analysis and conclusion are based on simulation results that are obtained by making some assumptions and simplifications. A second limitation has to do with those aspects that the model omits such as the oil and informal sector. However, the model incorporates elements of the Nigerian economy and its findings are in accordance with its characteristics. Sequel to these, a vacuum for further research in this area still exist. One direction for further research is to examine fiscal consolidation strategies in Nigeria, by examining both the revenue and expenditure side of fiscal instruments.

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