Abstract: This paper attempted to estimate optimal size of public sector that prompts positive output growth in Nigeria based on Monte Carlo simulation of estimated parameters of an error correction model having controlled for regime effect. Our motivation derives from economic theory that absence of government could be injurious to output growth culminating in unavailability of contracts and public goods. Using different policy scenarios of public sector share in GDP, the study validates and supports the tenets of Rahn Curve that economy shrinks when government grows enormous as we found 40% public sector spending as proportion of GDP as optimal public sector size that stimulates positive growth rate of about 0.095% having controlled for regime effect. By implication, our original contribution in this study is amplified on our empirics that public sector role in Nigerian economy is less than or equal to 40%. Consequently, any size of public sector beyond forty percent is economically destructive as it capable of stimulating negative spill overs on the economy due to growing taxes and public debt repayment. Hence, public sector spending should be significantly less than forty percent or at most forty percent for purpose of economic growth. This indeed translates to enforcing responsible fiscal policy centred on forty percent public sector size.

Keywords: Optimal Government Size; Output Growth; Simulation Results; Error Correction; Public Sector Spending; Nigeria

Introduction

Performance indicators have shown that total public spending in Nigeria have incessantly increased since 1980 when aggregate government disbursement was N1, 769,800 million and in 1990, it increased to N7, 325,000 million (CBN, 1990). In 2010, aggregate public
spending increased to N121,383,300 million. In percentage terms, growth rate of public sector spending was 23.2 percent in 1980 and 41.2 percent in 1990. For these years, growth rate of GDP declined from 57.2 percent to 2.9 percent (IMF, 1990). This reported a distressing economic state as increasing government spending seems not to have simulated favorably with growing national output in Nigeria.

Comparatively in 2000, government spending was 15.5 percent and growth rate of GDP was 8.79 percent (NBS, 2000). Ten years going forward, growth rate of government spending was 2.2 percent and output growth rate was 1.5 percent respectively. This interprets another contemptible economic situation whereby rising public sector spending do not compare favorably to growing national output in Nigeria. As at December, 2019, total government expenditure in Nigeria was N18,392.991 billion. This marks mammoth increase compared to 2018 budgeted spending of N16,828.759 billion. According to estimates of IMF (2020), total government spending in Nigeria is estimated to stand at N30,277.552 billion by December 2024.

Following above background, whether or not increasing public sector spending is growth enhancing is another concern in itself considering poor state of macroeconomic indicators for the period of rising public sector spending in Nigeria. This indeed goes to show that the task confronting Nigerian government with regards to fostering economic growth process cannot be overstated. Public expenditure is reputed to be a real growth device as rooted on Keynesian doctrine (Afonso, Antonio, & DavideFurceri, 2010; Nworji, Okwu, Obiwuru, & Nworji, 2012). In effect, public spending is an exogenous variable which can be applied as policy instrument to stimulate growth.

Nonetheless, the theory of optimality in economics demands for optimal public spending (Olorunfemi, 2008; Oteng-Abayie & Frimpong, 2009; Afonso & Jalles, 2011). So, there is need to anticipate that the size of public spending relative to GDP can be excessively lesser or excessively enormous. Numerous studies postulate that countries with more growth had large size of public spending while those with less growth had smaller public sector size (Brady, 2007; Tajudeen & Fasanya, 2013).

When market fails, government intervention would seem to be the panacea. Also, since government provides security and public goods and services to balance private sector provision, increasing the size of government from lesser or insignificant level must increase productivity and hence employment.

With regards to economic theory, zero government disbursements could adversely affect growth climaxing in absence of contracts and public goods (De Witte & Moesen, 2010; Rebelo, 2011). Nevertheless, as with any other dynamic supply, there will be diminishing returns to additional public sector, so a point must also be reached where increases in public spending will be less creative than if those same supply were allocated through the private sector.

More so, mismatch between economic growth and gargantuan budgetary allocations to public expenditure in Nigeria has raised major concerns and hence needs to occupy the centre of economic studies in Nigeria. In fact, Nigeria is currently suffering from substantial macroeconomic imbalances and yet how components of public sector spending influences these imbalances is imprecise.
Accordingly, there ought to be an optimal size of public sector that stimulates growth of national output. The question is, what is the optimal size of government in Nigeria? Most studies (Nworji, Okwu, Obiwuru, & Nworji, 2012; Mutiu, & Olusijibomi, 2013; Awomuse, Olorunleke, & Alimi, 2013; Ekesiobi, Dimnwobi, Ifebi, & Ibekilo, 2016; Adigun, 2017; Ozigbu, Ezekwe, & Morris, 2018) that reported significant positive growth effect of government spending advocated increase in government spending without empirically stipulating size of government. A small government is could be associated with economic growth benefits by circumventing extreme crowding-out effect.

Relatively, large government size could be argued to create large scale economies that obliges infrastructural development required for output growth. So, appropriate size of public sector spending essential to stimulate output growth had cyclically generate series of debatable isometrics amongst policy analysts in Nigeria following annual budget release. These jointly motivates our research interest and here lies our task to estimate a threshold of public spending that induces positive output growth in Nigeria.

Furthermore, empirical estimate of appropriate size of government for stimulating Nigeria’s growth is germane to policy makers because it makes contribution to both theoretical and empirical literature regarding effect of public sector size on economic growth. The study utilizes the error correction techniques and also carried out a Monte Carlo simulation isometrics to determine the optimal size of government in Nigeria. Next, literature that reviews both theoretical and empirical channels of relation between government size and economic growth. Theoretical framework and model follows. Results and discussion of same follows and lastly, is conclusion and recommendations of the study.

Literature Review

Theoretical Review

The channels of relation between government size and economic growth has not gain considerable unanimity with regards to exact direction of causality between the two as we have public sector size-led growing national output, growing national output-led public sector size, and feedback channel of effect between Keynesian and Wagner’s arrows of causation. The first channel which is basically Keynesian arrow of causation epitomizes role of government in advancing output growth via regulations, production, consumption, tax revenue generation, allocations and redistributions of national resources (Häge, 2003).

Theory therefore upholds that rise in public sector spending and borrowing crowd out private spending and borrowing by equivalent proportion. In effect, smaller size of government is a reflection of strategic benefits given that governments spend tax revenues or finance spending on basis of borrowing. So, a rise in tax revenue equates reduction in private consumption by equivalent proportion of rise in taxes leaving aggregated demand unaffected and with zero wealth creation (Nyasha, & Odhiambo, 2019). However, large government sizes have been observed to generate larger scale economies with attendant provision of infrastructural development required for private sector investment.

According to new growth theorists as found in works of Lucas (1988) and Romer (1986), short-run effect as well as long-run effect of government fiscal stimulation advances
economic growth in course of national development (Nyasha, & Odhiambo, 2019). Hence, Keynesian causality runs from government disbursement to economic growth via expansionary fiscal policy.

To theorists of classical and neoclassical economics, government size (small or large) impact negatively on economic growth due to crowding-out effect such that weighty rise in government intervention is a replacement of private goods/spending. This indirectly has a way of making interest rates to rise above limit and so subdue private investment. Furthermore, increase in taxes could serve to distort market prices and resource allocation.

Consequently, these class of theorists supported second channel of growing national output-led government size which is Wagner’s rule (Wagner, 1958) of Sate size expansion that centers on exceedingly elastic increase of total government activities in relation to changes in national income and so advocates a state of economic development driving government size. Florio & Colautti (2005) though rejects Wagner’s law of expansion in total State spending in Germany, US, UK, Italy and France and found logistic S-shaped curve of growth of public spending. Thus, suggesting possibility of State size convergence to a steady state.

In addition to the traditional law by Wagner, there is also Peacock & Wiseman’s theory of displacement effect that provides channel of relation between government size and GDP growth. According to Peacock and Wiseman (1961), State size measured by total public spending rises increasingly during periods of social disorders exclusively war time. Legrenzi (2004) researched on Italian economy with aim of validating Peacock-Wiseman theory and found public spending was significantly determined by GDP and it was devoid of displacement influences appraised by shifts in regression intercept. Barro (1989) and Easterly (1999) found feedback response between public sector size-led growth and growth-led public sector size to the effect that government size and economic growth are reciprocally determined.

Empirical Review

In this section, we review empirical channels of relation between government size and economic growth with emphasizes on developing countries given Nigeria the country of focus is a developing nation. Nevertheless, prominent studies in Nigeria have researched on impact rather than size of government spending on economic growth and found a significant positive relationship between public expenditure and output growth in Nigeria (Emori, Duke, & Nneji, 2015; Udoka, & Anyingang, 2015; Iheanacho, 2016; and Ebong, Ogwunike, Udongwo, & Ayodele, 2016; Chinedu, Daniel, & Ezekwe, 2018).

For the period, 1977-2006, Adesoye, Maku & Atanda (2010) found long-term growth effect of rising government spending in Nigeria. Ebiringa & Charles-Anyaogu (2012) engaged in a sectorial analysis using Bound test co-integration method and reported growth effect of disaggregated government spending in Nigeria. Chude & Chude (2013) evaluated effects of public expenditure in education on growth in Nigeria from 1977 to 2012, and found significant positive effect on long-run economic growth in Nigeria.

Basing analysis on expost-facto research design, Adewara & Oloni, (2012) established negative impact of sectoral spreads of public sector spending on GDP growth in Nigeria.
On their part, Olulu, Erhieyovwe & Ukavwe (2014) implementing OLS technique found inverse link between public health spending and economic growth in Nigeria. Basing analysis on sample period from 1984 to 2013, Yusuf, Babalola, Aninkan & Salako (2015) adopted ARDL. Bound test co-integration technique in their study and yet found no significant economic growth effect of government spending in short-run, while in long-run, government defence spending was reported to have impedes output growth and government agricultural spending stimulates output growth. Establishing findings on co-integration and ECM, Abu & Abdullahi (2010) found negative effect on economic growth following changes in government spending in Nigeria.

Conspicuous studies seems to find a negative relationship between total government size and economic growth (Davoodi, Clements, Schiff, & Debaere, 2001; Cooray, 2009; Rebero, 2011; Facchini & Melki, 2013; De Witte & Moesen, 2010; Connolly & Li, 2016).

To Fosler & Henrekson (2001), ten percent rise in ratio of State spending to GDP decreases economic growth rate by 0.8 percent and as a result, established that smallest threshold State size favours economic expansion. Blanchard & Perotti (2002) found positive effect on growth of national output in America. According to Brady (2007), there is a link between expansion in size of public sector measured by increase in its public expenditures and decline in economic growth. Romero-Avila & Strauch (2008) found that total State expenditure had negative impact on economic growth rate in fifteen countries of EU from 1960 to 2001.

De Witte & Moesen (2010) established that larger public sector may imply slower economic growth but emphasizes growth was usually not the only goal. Bergh & Karlsson (2010) reported that government size had significant negative effect on GDP growth rates in twenty OECD nations. In a study of one hundred and eight nations, Afonso & Jalles (2011) reported negative contribution of government size on economic growth even in smaller nations as against larger nations.

Di Matteo (2013) finds that, on average, annual per capita GDP growth rate was maximized at 3 percent when public sector expenditure to GDP ratio is 26 percent and that there are few additional benefits once public sector reaches 30 to 35 percent of GDP. Facchini & Melki (2013) finds 30 percent optimal ratio for France with emphasis of a U-shape effect of public sector size on growth, but that the optimum will tend to vary by country. By reducing size of public sector in France from 50 to 30 percent of GDP, their model predicts average growth rate in France would increase from 1.9 to 3.2 percent.

In Malaysia, Tang (2001) utilized Johansen’s multivariate test for co-integration tests and found growth measured by national income was formative factor of size of public spending. Using same method of analysis, study carried out by Abu-Bader & Abu-Qarn (2003) in Egypt showed that economic growth/development determine size of government spending thereby lending credence to demand-following rule of Wagner. In Greece and Turkey, Dritsakis (2004), growing national output-led size of public spending was supported.

In their research of Ireland, Greece, and UK, Loizides & Vamvoukas (2005) implemented error-correction models (ECMs) within a Granger-causality structure and found that government size Granger-causes economic growth in Greece. Implementing same
econometric techniques of analysis, Loizides & Vamvoukas (2005) found that economic growth was significantly responsible for rise in relative size of government in Greece.

In Philippines, work of Dogan & Tang (2006) supported national income effect of public sector size using Granger-causality technique. Also in country of Greece, Sideris (2007) for period of 1833-1938 found significant causal effect from income growth to size of public disbursement. The results of Blankenau, Simpson, & Tomljanovich (2007) supported Keynesian arrow of causation detailing economic growth effect of government size in developed and developing countries. Mohammadi, Cak, & Cak (2008) implementing Granger causality test method, validated Wagner’s arrow of relationship in Turkey.

Correspondingly, in his study for Malaysian economy, Tang (2009) implemented bounds testing for co-integration and Modified Wald (MWALD) causality test and obtained empirical evidence in favor of national income as a stimulant of education, defense and government health spending. To Samudram et al. (2009), it is economic growth that causes significant changes in size of defense and education expenditure in Malaysia and not vice versa. In 2010, Taban (2010) re-visited Turkey implementing econometric methods same as that implemented by Tang (2009) together with quarterly data and found that per capita output growth drives size of public investment spending as ratio of GDP.

In another study conducted for Malaysian economy utilizing ARDL technique, Chandran, Rao, & Anwar (2011) show that aggregate government spending enhances economic growth significantly from 1970 - 2006. In Sudan, Granger-causality test and ECM techniques were utilized by Ebaidalla (2013) and Keynesian public sector size-led growing national output was validated. In long-run econometric analysis, economic growth was reported to be formative factor of size of government expenditure in New Zealand by Kumar, Webber, & Fargher (2012).

Growth-led public sector spending was validated in Indian by Srinivasan (2013) basing techniques of analysis on co-integration and ECM having embraced data from 1973 to 2012. In his study, Akinlo (2013) adopted multivariate structure and reported that national income determines size of government spending in Nigeria. Within a bivariate model of estimation while utilizing JML co-integration and variance decomposition methods, Abu-Bader & Abu-Qarn (2003) found feedback effect between government size and economic growth in Syria and Israel.

Other studies that reported feedback effect between government size and economic growth include, Samudram et al. (2009) for Malaysia from 1970 to 2004, via ARDL bounds testing approach, Abu-Eideh (2015) in the Palestine from 1994 to 2013 via Granger-causality tests. Researching on thirty OECD nations, Olugbenga & Owoye (2007) reported results in favour of government size-led growth for sixteen nations, growing output-led government size for ten countries and feedback channel of relation between size of public spending and economic growth for four nations. Concisely, it suffixes to deduce from reviewed literature that channel of effect between government and economic growth depends on the nationality for which analysis is carried out.

Methods
Given that study was set out to estimate trivariate parsimonious error-correction equation within Granger-causality framework, we proceeded as follows to derive parsimonious ECT equation. The error correction application directly inferred by Granger theorem encompasses an ADL(1,1) model of this specification:

\[ S_t = \delta_0 + \delta_1 S_{t-1} + \alpha_0 W_t + \alpha_1 W_{t-1} + \epsilon_t \]  
\[ S_t = \delta_0 + \delta_1 S_{t-1} + \alpha_0 W_t + \alpha_1 W_{t-1} + \epsilon_t + S_{t-1} - S_{t-1} + W_{t-1} - W_{t-1} + \alpha_0 W_{t-1} - \alpha_0 W_{t-1} + \alpha_1 W_{t-1} - \alpha_1 W_{t-1} \]  

[1]

[2]

Repositioning relations, we obtain the error correction model:

\[ \Delta S_t = (\alpha_1 - 1) \left[ U_{t-1} - \frac{\delta_0}{1 - \delta_1} - \frac{\alpha_0 + \alpha_1}{1 - \delta_1} W_{t-1} \right] + \alpha_0 \Delta W_t + \epsilon_t \]

\[ \text{where } \epsilon_{t-1} = \left[ U_{t-1} - \frac{\delta_0}{1 - \delta_1} - \frac{\alpha_0 + \alpha_1}{1 - \delta_1} W_{t-1} \right] = ECT \]  

[3]

Theoretically, procedure involves estimating co-integrating link, and ECM using differenced variables and lagged residuals from co-integrating relationship. In effect, variables are co-integrated when \((\alpha_1 - 1) < 0\), when \((\alpha_1 - 1) > 0\) disequilibrium expands, when \((\alpha_1 - 1) = 0\), no error correction. Thus, \(-1\) indicates complete error correction in 1 period while \(<-1\) indicates overshooting and oscillatory adjustment. If \(\eta_t = \eta_0 + \eta_t\) is a linear trend, we have \(\Delta W_t = \Delta z_t = \eta_0 - \eta_t\) and \(\Delta W_t = \Delta z_t - \eta_t\). Thus, \(\Delta S_t = \alpha \beta' [S_{t-1} - \eta_0 - \eta_t(t-1)] + \Gamma_1 [\Delta S_{t-1} - \eta_1] + \ldots + \Gamma_{p-1} [\Delta S_{t-p+1} - \eta_1] + \epsilon_t\)

Rearranging the deterministic terms we have,

\[ \Delta S_t = \phi + \alpha (\beta' \gamma') \left[ \frac{S_{t-1}}{t-1} \right] + \Gamma_1 \Delta S_{t-1} + \ldots + \Gamma_{p-1} \Delta S_{t-p+1} + \epsilon_t \]

\[ \Rightarrow \phi + \Pi^* S_{t-1}^* + \Gamma_1 \Delta S_{t-1} + \ldots + \Gamma_{p-1} \Delta S_{t-p+1} + \epsilon_t \]

\[ \gamma' = -\beta' \eta_t, \quad \Pi^* = \alpha (\beta' \gamma') \]

\[ S_{t-1}^* = \begin{bmatrix} S_{t-1} \\ t-1 \end{bmatrix} \]

is a \(K \times (K+1)\) matrix and \(\phi\) is unrestricted, while linear trend term can be absorbed into the co-integration link such that,
Basically therefore, the trend slope parameter $\eta_i$ is orthogonal to co-integration matrix such that $\beta' \eta_i = 0$ such that $\gamma = 0$. The model is thus specified:

$$\Delta S_t = \phi_0 + \phi t + \Pi S_{t-1} + \Gamma_1 \Delta S_{t-1} + \ldots + \Gamma_{p-1} \Delta S_{t-p+1} + \epsilon_t$$

$$\Rightarrow \phi_0 + \Pi S_{t-1} + \Gamma_1 \Delta S_{t-1} + \ldots + \Gamma_{p-1} \Delta S_{t-p+1} + \epsilon_t$$

The data sources include IMF, World Economic Outlook database (http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/index.aspx), Economic Freedom of the World, Fraser Institute (http://www.freetheworld.com/release.html) and Worldwide Governance Indicators (http://www.govindicators.org).

The variables used comprise, total government spending as share of GDP was used to measure government size (in terms of resources spent, public goods and services delivered as well as social protection provided), growth rate of GDP adjusted for variations in price level (proxy for economic growth), and institutional index as measured by regime stability.

Variables are in log values. We estimated our models with different sub-periods given the resolve to control for regime effect and hence check how comparable our government size coefficient estimates are for different sub-periods of time.

Findings

Given that we estimated trivariate error correction equation, we needed application of Johansen co-integration test method that certifies more than one co-integrating relations if it exits unlike Engle-Granger method that is based on stationary test of unit roots in residuals from single co-integrating equation. Table I reports the co-integration test results before structural adjustment. The Trace tests indicate three co-integrating relationships or vectors at 5% level of significance.

| Null | Alternative | Statistic | 95% Critical Value |
|------|-------------|-----------|--------------------|
| r = 0 | r >= 1      | 172.5291  | 153.4200           |
| r <= 1 | r >= 2     | 152.7641  | 148.8600           |
| r <= 2 | r >= 3     | 97.1268   | 92.5300            |

Table 1. Co-integrating vector for complete sample, 1970Q1 – 2017Q4
| $r \leq 3$ | $r = 4$ | 51.2539 | 67.8900 |
| $r \leq 4$ | $r = 5$ | 7.38437 | 9.0200 |

Conclusion $r = 3$

Table II reports the co-integration test results before structural adjustment. The Trace test indicate one co-integrating vector at the 5% level of significance.

**Table 2. Co-integrating vector before structural adjustment, 1970Q1-1985Q4**

Co-integration with unrestricted intercepts and trends in the VAR

Co-integration LR test based on trace of the stochastic matrix

| List of variables included in the co-integrating vector: | lngdp   | lngsz   | lnrgm |
|--------------------------------------------------------|---------|---------|-------|
| List of eigenvalues in descending order:               | 0.01486 | 0.32156 | 0.72392 |

**Null** Alternative Statistic 95% Critical Value

| $r = 0$ | $r = 1$ | $r = 2$ | $r = 3$ | $r = 4$ | $r = 5$ |
|---------|---------|---------|---------|---------|---------|
| $r \geq 1$ | 69.3892 | 42.7439 | 24.1162 | 5.7923  | 1.3982  |
| $r \geq 2$ | 48.5321 | 27.9642 | 8.3791  | 5.2576  |         |
| $r \geq 3$ | 27.9642 | 8.3791  |         |         |         |
| $r \geq 4$ | 5.2576  |         |         |         |         |

Conclusion $r = 1$

Table III reports the co-integration test results after the structural break. Two long term relations are reported at 5% level. The trace statistics value tests indicate 2 co-integrating relationship or vectors at 5% level of significance. The presence of co-integrating vector shows existence of long-run association amongst, growth of output, government size, and regime stability.

**Table 3. Co-integrating vector after structural adjustment, 1986Q1-2017Q4**

Co-integration with unrestricted intercepts and no trends in the VAR

Co-integration LR test based on trace of the stochastic matrix

| List of variables included in the co-integrating vector: | lngdp   | lngsz   | lnrgm |
|--------------------------------------------------------|---------|---------|-------|
| List of eigenvalues in descending order:               | 0.13523 | 0.13697 | 0.08634 |

**Null** Alternative Statistic 95% Critical Value

| $r = 0$ | $r = 1$ | $r = 2$ | $r = 3$ | $r = 4$ | $r = 5$ |
|---------|---------|---------|---------|---------|---------|
| $r \geq 1$ | 113.2543* | 79.4678* | 35.9256 | 23.8732 | 1.2613  |
| $r \geq 2$ | 102.2581 | 69.5273 | 37.3590 | 26.5820 | 4.3296  |

Conclusion $r = 2$
In terms of short run dynamics of response of output growth to changes in public sector size in Nigeria, estimates of the short-run dynamics for complete sample, before structural adjustment and after structural adjustment are shown in Table IV, V and VI respectively. In the results of short-run dynamics without structural break and before structural break, the coefficient of public sector size is statistically insignificant at all lags with p-values of 0.520, 0.903 and 0.826. Though, all coefficients of public sector size are positively sign in conformity with apriori expectation but are failed significance test as revealed from the p-value.

Nevertheless, coefficients of government size in estimates of short-run dynamics after structural adjustment as in Table IV are all significant indicating a potential temporary positive impact on growth rate of increasing public sector size. The error correction term is significant with a t-ratio of -2.956 and an economic coefficient of 0.497 indicating that 49.7 percent disequilibrium in economic growth is corrected annually given changes in public sector size and regime stability. In sum, the short-run relationship of public sector share with output growth is positively significant.

Regime stability passed test of significance with a positive sign. For lag 1, the results reported a coefficient of 0.073 with a t-value of 5.098; for lag 2, the results reported a coefficient of 0.023 with a t-value of 1.986; and for lag 3, the results reported a coefficient of 0.054 with a t-value of 2.375. A stable regime contributed significantly to output growth in Nigeria. In all sub-periods of analysis, co-integrating coefficients normalized on growth rate of GDP having been adjusted for changes in price level are 1.629, 1.291 and 1.056 separately. These coefficients are all relatively significant with an elastic degree of responsiveness of output growth rate to changes in government size.

This corroborates previous studies (Maku, 2009; Ighodaro, & Oriakhi, 2010; Awomuse, Olorunleke, & Alimi, 2013; Ekesiobi, Dimnwobi, Ifebi, & Ibekilo, 2016, Adigun, 2017) that government spending stimulates significant positive effect on Nigeria’s GDP growth rate. The inverse root plot of stability is reported for each sub-periods at the bottommost section of Tables 4, 5 & 6 respectively. Explicitly, no roots falls outside unit circle implying stability of estimated results for our parsimonious ECT equations.

The goodness-of-fit statistics are robust and highly plausible as shown in Tables IV, V, and VI. The diagnostic test obtained from the regression is quite impressive. For example, we obtained 56.9%, 53.1% and 79.2% adjusted R² for short-run dynamics for full sample, before structural adjustment and after structural adjustment respectively. Also, the respective F-statistics of 23.791, 25.628 and 29.862 are statistically significant at any conventional level. The standard error of regression estimate are very low indicating absence of heteroscedasticity and serial correlation in the model.

**Table 4. Short run results for complete sample, 1970Q1- 2017Q4**

| Regressor | Coefficient | T-Ratio [Prob] |
|-----------|-------------|----------------|
| Intercept | -.063       | -1.432 [.159]  |
| dLngdp1   | .271        | 3.256 [.002]** |

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Cointegrating coefficients normalized on gdp (standard error in parentheses)

gdp  gsz  rgm
1.000 1.629 0.0832
    (.035) (1.005)

Diagnostics for short run results for complete sample, 1970Q1-2017Q4

R-Squared 0.635
R-Bar-Squared 0.569
DW-statistic 2.000
S.E. of Regression 0.005
F-stat. 23.791 [.000]
Mean of Dependent Variable 6.389

Note. * Significant @ 0.05; ** Significant @ 0.01

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Table 5. Short run results before structural adjustment, 1970Q1-1985Q4

Dependent variable is dlngd1

| Regressor | Coefficient T-Ratio [Prob] |
|-----------|---------------------------|
| Intercept | .349 9.542 [.000]**       |
| dLngdp1   | .268 2.346 [.002]*        |
| dLngsz1   | .024 0.027 [.659]         |
| dLnrgm1   | .129 2.567 [.005]*        |
| dLngdp2   | .047 3.594 [.000]**       |
dLngsz2  .052  .026[.573]
dLnrngm2 .063  3.475[.000]**
DLngdp3  .185  2.962[.003]*
DLngsz3  -.009 -1.369[.920]
DLnrngm3 .053  6.724[.000]**
ecm (-1) -.529 -3.028[.000]**

Cointegrating coefficients normalized on gdp (standard error in parentheses)
gdp           gsz         rgm
1.000         1.291       .063
               (.675)      (.298)

Diagnostics for short run results before structural adjustment 1970Q1-1985Q4
R-Squared     0.600
R-Bar-Squared 0.531
DW-statistic  1.992
S.E. of Regression 0.002
F-stat.        25.628[.000]
Mean of Dependent Variable 9.359
Note. * Significant @ 0.05; ** Significant @ 0.01

Inverse Roots of AR Characteristic Polynomial

Table 6. Short run results after structural adjustment, 1986Q1-2017Q4

Dependent variable is dlngdp

| Regressor     | Coefficient | T-Ratio [Prob] |
|---------------|-------------|----------------|
| Intercept     | -.135       | 1.492[.165]    |
| dLngdp1       | .271        | 4.569[.000]**  |
| dLngsz1       | .064        | 2.573[.012]*   |
| dLnrgm1       | .298        | 1.996[.015]    |
| dLngdp2       | .127        | 2.187[.012]**  |
| dLngsz2       | 0.012       | 7.349[.000]**  |
| dLnrgm2       | .023        | 3.562[.001]**  |
| dLngdp3       | .016        | 3.109[.001]**  |
| dLngsz3       | -.115       | 3.002[.001]**  |
| dLnrgm3       | .002        | 2.594[.003]*   |
ecm (-1) - .793 -6.231 [.000]**
Cointegrating coefficients normalized on gdp (standard error in parentheses)
gdp gsz rgm
1.000 1.056 .092
(.675) (.075)

Diagnostics for short run results after structural adjustment, 1986Q1-2017Q4
R-Squared 0.796
R-Step-Squared 0.792
DW-statistic 2.009
S.E. of Regression 0.000
F-stat. 29.862 [.000]
Mean of Dependent Variable 12.438
Note. * Significant @ 0.05; ** Significant @ 0.01

On Simulation analysis, summary statistics for the historical simulation obtained in the study are presented in Table VII below. The simulation is for the period 2019Q1 to 2024Q4.

Table 7. Historical simulation results

| Endogenous Variable | Theil’s Inequality Coefficient | Decomposition of Theil’s Inequality | Root Mean Squared Error (%) | Correlation Coefficient |
|---------------------|----------------------------------|-------------------------------------|----------------------------|-------------------------|
| lngdp               | 0.013                            | 0.000                               | 0.128                      | 0.761                   |
| lngsz               | 0.057                            | 0.000                               | 0.062                      | 0.692                   |
| lnrpm               | 0.089                            | 0.000                               | 0.005                      | 0.869                   |

Table VII shows correlation coefficient of 0.761 between actual and simulated series for output equation while the root-mean-square simulated error is 12.8 percent. The Theil’s inequality coefficient between actual and simulated output series is 0.013 which lies between 0 and 1. Given that the coefficient is close to zero, it thus signifies that the simulated output series tracks the actual output series.

Tables VIII, IX and X reports policy simulation results for 40%, 50% and 60% policy scenario namely, changes in public sector share of output. The results of the controlled solution, that is, base line are without changes in exogenous policy variable, (gsz) while disturbed solution encompasses solution with changes in policy variables on output.
growth. In effect, we examined how changes in public sector share of GDP affect economic growth.

| Endogenous Variable | Years | Controlled Solution | Disturbed Solution |
|---------------------|-------|---------------------|--------------------|
| lngdp               | 2019Q1| 0.2375              | 0.2337             |
|                     | 2019Q2| 0.3409              | 0.3429             |
|                     | 2019Q3| 0.3522              | 0.3562             |
|                     | 2019Q4| 0.3556              | 0.3591             |
|                     | 2020Q1| 0.3791              | 0.4123             |
|                     | 2020Q2| 0.3921              | 0.4230             |
|                     | 2020Q3| 0.4511              | 0.4533             |
|                     | 2020Q4| 0.4026              | 0.4421             |
|                     | 2021Q1| 0.3721              | 0.3839             |
|                     | 2021Q2| 0.3815              | 0.3912             |
|                     | 2021Q3| 0.4123              | 0.4233             |
|                     | 2021Q4| 0.4556              | 0.4025             |
|                     | 2022Q1| 0.3627              | 0.4637             |
|                     | 2022Q2| 0.3556              | 0.4837             |
|                     | 2022Q3| 0.3522              | 0.3725             |
|                     | 2022Q4| 0.3556              | 0.3856             |
|                     | 2023Q1| 0.3627              | 0.3917             |
|                     | 2023Q2| 0.3615              | 0.4215             |
|                     | 2023Q3| 0.3522              | 0.4138             |
|                     | 2023Q4| 0.3556              | 0.4381             |
|                     | 2024Q1| 0.3627              | 0.3972             |
|                     | 2024Q2| 0.3615              | 0.4253             |
|                     | 2024Q3| 0.3522              | 0.4361             |
|                     | 2024Q4| 0.3615              | 0.4918             |

| Endogenous Variable | Years | Controlled Solution | Disturbed Solution |
|---------------------|-------|---------------------|--------------------|
| lngdp               | 2019Q1| 0.2562              | 0.2511             |
|                     | 2019Q2| 0.2543              | 0.2423             |
|                     | 2019Q3| 0.2568              | 0.2843             |
|                     | 2019Q4| 0.2637              | 0.2569             |
|                     | 2020Q1| 0.2589              | 0.2537             |
|                     | 2020Q2| 0.2594              | 0.2541             |
|                     | 2020Q3| 0.2543              | 0.2543             |
|                     | 2020Q4| 0.2568              | 0.2569             |
|                     | 2021Q1| 0.2637              | 0.2537             |
|                     | 2021Q2| 0.2589              | 0.2541             |
|                     | 2021Q3| 0.2594              | 0.2643             |
|                     | 2021Q4| 0.2543              | 0.2769             |
|                     | 2022Q1| 0.2568              | 0.2537             |
|                     | 2022Q2| 0.2637              | 0.2641             |
|                     | 2022Q3| 0.2589              | 0.2543             |
Table XI shows negative multiplier effects of public sector size for most part of the period of analysis for 50% and 60% policy scenarios. These indeed indicate negative growth effect. For the 40% policy scenario, the dynamic multiplier of increase in public sector size at first quarter of 2019 is -0.0095. For the remaining most period, the dynamic effect became positive. In fourth quarter of 2024, the dynamic output multiplier grew to 0.3258. In fact, the policy simulation results indicate forty percent as optimal size of public sector spending required for inducing growth of national output in Nigeria. So, constantly maintaining 40% of GDP as public sector spending over the period of 2019Q1 to 2024Q4, economy grows by 0.095% on average as against growth decline of 0.00065% for 50% and 0.01123% growth for 60% public sector sizes respectively. Policy
Implication is that forty percent public sector spending as a share of national economic output is the optimal public sector size in stimulating output growth in Nigeria.

| Years   | 40% Dynamic output multiplier | 50% Dynamic output multiplier | 60% Dynamic output multiplier |
|---------|-------------------------------|-------------------------------|-------------------------------|
| 2019Q1  | -0.0095                       | -0.0102                       | -0.0270                       |
| 2019Q2  | 0.0050                        | -0.0240                       | -0.0137                       |
| 2019Q3  | 0.0100                        | 0.0550                        | 0.0420                        |
| 2019Q4  | 0.0087                        | -0.0136                       | -0.0278                       |
| 2020Q1  | 0.0830                        | -0.0104                       | 0.0044                        |
| 2020Q2  | 0.0773                        | -0.0106                       | -0.0209                       |
| 2020Q3  | 0.0055                        | 0.0000                        | 0.0720                        |
| 2020Q4  | 0.0987                        | 0.0002                        | -0.0044                       |
| 2021Q1  | 0.0295                        | -0.0200                       | -0.0606                       |
| 2021Q2  | 0.0243                        | -0.0096                       | -0.0809                       |
| 2021Q3  | 0.0275                        | 0.0098                        | 0.0620                        |
| 2021Q4  | -0.1328                       | 0.0452                        | 0.07060                       |
| 2022Q1  | 0.2525                        | -0.0062                       | -0.0166                       |
| 2022Q2  | 0.3203                        | 0.0008                        | -0.0109                       |
| 2022Q3  | 0.0508                        | -0.0092                       | 0.0220                        |
| 2022Q4  | 0.0750                        | 0.0350                        | -0.0878                       |
| 2023Q1  | 0.0725                        | 0.0008                        | 0.0494                        |
| 2023Q2  | 0.1500                        | 0.0046                        | -0.0209                       |
| 2023Q3  | 0.1540                        | -0.0188                       | 0.0720                        |
| 2023Q4  | 0.2063                        | -0.0040                       | -0.0478                       |
| 2024Q1  | 0.0862                        | -0.0114                       | -0.0706                       |
| 2024Q2  | 0.1595                        | -0.0004                       | -0.0709                       |
| 2024Q3  | 0.2097                        | -0.0050                       | -0.0780                       |
| 2024Q4  | 0.3258                        | -0.0136                       | -0.0250                       |

Conclusion

The study attempted to estimate optimal size of public sector spending that induces growth rate of national output in Nigeria under an economically stable regime using ECM approach together with Monte Carlo simulation. The empirical evidence from the analysis in the study upholds that public sector size of forty percent of GDP is an effective tool in macroeconomic management in Nigeria in presence of a stable regime.

Public sector spending within neighbourhood of forty percent in Nigeria builds positive national output. Such share of public sector spending stimulates further rise in aggregate demand thereby causing an enormous final increase in GDP than the initial injection. This is a plausible reality given the fact that the Nigerian economy is not at full capacity. Hence, multiplier effect of 40 percent public sector size would tend to crowd in the private sector leading to net increase in economic growth. The contribution to knowledge is accentuated.
on our empirics that public sector role in Nigerian economy is less than or equal to 40%. So, any size of public sector beyond forty percent is economically damaging. This could be due to various harmful effects of taxation, costly financing choices, cost of market distortion and public debt repayment.

A case in point is that noted by Adigun (2017) that with huge revenue shortfall, Federal public sector’s borrowing required to fund capital projects was estimated at N1.6 trillion in 2017. Consequently, financing capital budget had always necessitated higher than estimated borrowing with deleterious effects for interest rates and interest costs. So, a growing public sector size above forty percent is contrary to Nigeria’s economic growth either because public sector becomes outsized or because monies are misapplied. In such cases, cost of government exceeds benefit.

Subsequently, public sector spending should not exceed the level which maximizes the rate of real GDP growth rate in Nigeria. Public sector spending should be significantly less than or equal to forty percent for purpose of national growth of output. In effect, Nigerian government should enforce a responsible fiscal policy based on forty percent public sector size. Should the government spends forty percent of GDP in a productive way by enforcing contracts and restructuring economy it spawns rate of return higher than that of the private sector and the Nigerian economy profits.

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