Testing the Validity of Wagner's Law in Nigeria: Evidence from Nonlinear Causality

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Abstract

The study investigates the linear and nonlinear causal linkages between government expenditure and output nexus in Nigeria for the period 1961-2013. Employing a nonparametric causality test of Diks and Panchenko (2006) as well as the Hacker and Hatemi-J bootstrap parametric causality test using the VAR model, results show that there is evidence of unidirectional linear and nonlinear causality from national income to government expenditure. This result points to the validity of the Wagner's hypothesis in Nigeria. The policy implication of this result is that government should be careful of the danger involved in increased public sector participation arising from the uncertainty in oil prices which generates about 80 per cent of government revenue.Thus, government should intensify efforts to improve her revenue by diversifying into other sectors of the economy.

Key Words: Expenditure, GDP, nonlinear causality, Nigeria
JEL Classification: E62, H6, C22

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1 Introduction

One of the main questions debated by policy makers and researchers is whether public sector spending alleviates poverty in developing countries Nigeria inclusive, thereby increasing economic growth. This is because while public sector spending may be considered a factor input that contributes positively to economic growth, the way public investment is financed may crowd out private investment, as argued by Mittnik and Neumann (2001). The main criticism of government intervention is that it is not as effective as market forces in allocating resources. However, the rationale for intervention is based on the conventional public goods argument that the private sector fails- or is unable- to provide public goods, internalize externalities and fairly and equitable redistribute income. Over the past two decades, most African countries have witnessed low growth production capacity, output, and a sustained high level of unemployment; all this may be traced to excessive government spending to un-productive sectors of the economy as well as unstable polity, and this call for the need to assess the empirical relationship between the government expenditure and output.

In view of the recent growth in Nigeria's expenditure and GDP, this study will provide answers to the following questions concerning the government spending and output relationship; (i) Is there a long-run relationship between government expenditures and GDP? (ii) Do asymmetries causality exist between government expenditure and output? To the best of our knowledge, the existing research on the government expenditure and GDP nexus has, to date, focused mainly on a linear causal relationship and has ignored the possibility of a nonlinear causal relationship. This remains a major gap to be filled in the government expenditure and GDP debate literature. In view of this, the main contributions of this paper are; first, the study examine a bootstrap causality test advocated by Hacker and Hatemi-J (2006) which overcame the over-rejection issue associated with the Granger and Toda and Yamamoto causality test. Second, the study examine nonlinear causality between government expenditure and GDP in Nigeria. In particular we used a new nonparametric methodology by Diks and Panchenko (2006), which overcame the potential over-rejection issue that flawed the famous non-linear Granger causality of Hiemstra and Jones (1994). The justification for this approach in Nigeria is that there exist an imperfect and underdeveloped market system and adjustment may be irregular and uncertain, therefore, previous studies have been misspecified.

The remainder of the paper is organized as follows. Section 2 provides the theoretical linkages and the empirical evidence on government spending and GDP debates in Nigeria. Section 3 provides a description of the Diks and Panchenko nonparametric test for nonlinear Granger causality. Section 4 is devoted to data and results. Section 5 concludes.

2 Wagner's hypothesis and literature for Nigeria

The Wagner's law of public expenditure was offered in the 19th century and it states that "the share of government expenditure increase as the economic activities of the economy increases". Wagner observed a positive correlation between economic growth and the growth of government activities. He argued that during the process of economic development, the involvement of government in economic acitivities is greater than the private sector. Thus, higher growth requires higher government expenditure. Henrekson (1993) pointed out that Wagner saw three main reasons for the increase in the government's role. First, industrialization and modernization would lead to a substitution of public for private activities. Expenditures on law and order as well as on contractual enforcement would have to be increased. Second, an increase in real income would lead to an expansion of the income elastic "cultural and welfare" expenditures. Wagner cited education and culture to be two areas in which the government could be a better provider than the private sector. Thus, the public sector would grow after basic needs of the people are satisfied and consumption pattern of people expands towards activities such as education and culture. Third, natural monopolies such as the railroads had to be taken over by the government because private companies would be unable to run these undertakings efficiently because it would be impossible to raise such huge finance that are needed for the development of these natural monopolies.

Peacock and Scott (2000) suggested that the directions of causal relationship between public spending and output could be categorized into four types and they are; the neutrality hypothesis, the Wagnerian hypothesis, the Keynesian hypothesis and the feedback hypothesis. The neutrality hypothesis occurs if there is no causal relationship between GDP and public spending, this implies that the two variables are distant cousins. The Wagnerian hypothesis suggests that the direction of causality is from output to government expenditure. This implies that an increase in government expenditure is influenced by increases in output. The Keynesian hypothesis suggests that the direction of causality is from government expenditure to output. The feedback hypothesis exists when there is a bi-directional causal relationship between government expenditure and GDP.

Concerning the causal relationship between government expenditure and GDP in Nigeria, the results have been mixed, with studies finding support for the four hypotheses. These can be explained by the difference in the choice of methodology and use of different time frame. The neutrality hypothesis has been supported in studies by Essien (1997) and Chimobi (2009). The Wagnerian hypothesis has been supported by Olomola (2004), Aregbenyen (2006), Akinlo (2013) and Dada & Adewale (2013). Also, there is evidence for the Keynesian hypothesis in the study by Babatunde (2011), Clement et al. (2010), Alimi et al (2013) and Akpan (2011). The feedback hypothesis has been supported in studies by Aigboikhan (1996) and Olaiya et al (2012).

3 Methodology: The Diks and Panchenko non-parametric nonlinear causality test

The study used the nonparametric test developed by Diks and Panchenko (2006, hereafter DP test) for testing nonlinear Granger causality. The test is better, because it overcame the over-rejection issue observed in the previously popular test advocated by Hiemstra and Jones (1994, hereafter HJ test).

The general setting for this approach is summarized as follows. The null hypothesis for the Granger test for non-causality from one series (X_t) to another series (Y_t) is that $X_t^{\ell_X}$,does not contain additional information about Y_{t+1}, that is,

$$H_0 : Y_{t+1} \Big| (X_t^{\ell_X}; Y_t^{\ell_Y}) \sim Y_{t+1} \Big| Y_t^{\ell_Y} \tag{1}$$

For a strictly stationary bivariate time series Eq. (3) comes down to a statement about the invariant distribution of the (ℓ_X +ℓ_Y +1)-dimensional vector $\mathbf{W_t}$ =($\mathbf{X}_t^{\ell_X}, \mathbf{Y}_t^{\ell_Y}, Z_t$) where $Z_t = Y_{t+1}$. To keep the notation compact, and to bring about the fact that the null hypothesis is a statement about the invariant distribution of ($X_t^{\ell_X}, Y_t^{\ell_Y}, Z_t$) we drop the time index and also ℓ_X = ℓ_Y =1 is assumed. Hence, under the null, the conditional distribution of Z given (X, Y)=(x, y) is the same as that of Z given $Y = y$. Further, Eq. (3) can be restated in terms of ratios of joint distributions. Specifically, the joint probability density function $f_{X,Y,Z}(x, y, z)$ and its marginals must satisfy the following relationship:

$$\frac{f_{X,Y,Z}(x, y, z)}{f_Y(y)} = \frac{f_{X,Y,}(x, y)}{f_Y(y)} . \frac{f_{Y,Z}(y, z)}{f_Y(y)} \tag{2}$$

This explicitly states that X and Z are independent conditionally on $Y = y$ for each fixed value of y. Diks and Panchenko (2006) show that this reformulated H_0 implies:

$$q = E\left[f_{X,Y,Z}(X, Y, Z)f_Y(Y) - f_{X,Y}(X, Y)f_{Y,Z}(Y, Z)\right] = 0 \tag{3}$$

Let $\hat{f}_W(Wi)$ denote a local density estimator of a d_W-variate random vector $\mathbf{W}$ at W_i defined by $\hat{f}_W(Wi) = (2\varepsilon_n)^{-d_W}(n-1)^{-1}\Sigma jj \neq iIij^W$ where $Iij^W = I(\|W_i - W_j\| < \varepsilon_n)$ with $I(.)$ the indicator function and ε_n the bandwidth, depending on the sample size n. Given this estimator, the test statistic is a scaled sample version of q in Eq. (5):

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} . \sum_i \left(\hat{f}_{X,Z,Y}(X_i, Z_i, Y_i)\hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i, Y_i)\hat{f}_{Y,Z}(Y_i, Z_i)\right) \tag{4}$$

For $\ell_X = \ell_Y$ =1, if $\varepsilon_n = Cn^{-\beta}(C > 0, \frac{1}{4} < \beta < \frac{1}{3})$ then Diks and Panchenko (2006) prove under strong mixing that the test statistic in Eq. (6) satisfies:

$$\sqrt{n}\frac{(T_n(\varepsilon_n) - q)}{S_n} \underrightarrow{D} N(0,1) \tag{5}$$

where $\underrightarrow{D}$ denotes convergence in distribution and S_n is an estimator of the asymptotic variance of $T_n(.)$.

4 Data and Results

In this section, we examine the issue of linear and non-linear Granger causality for the Wagner law hypothesis in Nigeria using the Dicks and Panchenko (2006) approach described in the last section. We use data on total government expenditures, gross domestic product and population, which are denoted by GE, GDP and N, respectively. The annual data on government expenditures, and GDP are from the Nigerian Central Bank statistical bulletin, while the population data is from the World Bank Development Indicators and the sample period is from 1961-2013.

In testing the Wagner's law in Nigeria, five specifications dominant in the literature were examined, and they are expressed mathematically in a log-linear functional form below;

(1) Peacock and Wiseman (1967): $GE = \alpha + \beta(GDP)$

(2) Goffman (1968): $GE = \alpha + \beta(\frac{GDP}{N})$

(3) Gupta (1967): $\frac{GE}{N} = \alpha + \beta(\frac{GDP}{N})$

(4) Musgrave (1969): $\frac{GE}{GDP} = \alpha + \beta(\frac{GDP}{N})$

(5) Mann (1980): $\frac{GE}{GDP} = \alpha + \beta(GDP)$

where GE is total government expenditures, GDP is the gross domestic product, N is population, GDP/N is the GDP per capita, GE/N is the total government expenditures per capita and GE/GDP is the ratio of total government expenditures to GDP. All variables are expressed in logarithm terms. For the validity of the Wagner's law, $\beta > 1$ for the first three specifications, and $\beta > 0$ for the last two specifications. The direction of causality must be from gross domestic product to government expenditure. Also, the existence of a long-run relation from the specified model is an indication of the Wagner's law.

The study begins the analysis, by testing for the order of integration of the series. The augmented Dickey Fuller (ADF), Phillip-Perron (PP) and the Ng-Perron (NP) suggests that government expenditures, gross domestic product, the GDP per capita, the total government expenditures per capita and the ratio of total government expenditures to GDP were stationary in their first differences. The results show that the variables follow a unit root process, thus gives way for testing for possible long-run co-integrating relationship among the variables. Thus, we estimate the Engle-Granger and the Johansen cointegration tests.

Table 2 reports the two stage procedure advocated by Engle and Granger (1987). In the first stage we estimate the dynamic OLS and in the second stage we examine the unit root of residuals using the ADF statistic. The results indicates that the residuals are stationary at the 5 per cent level of significance.

This shows that there is a long run relationship among the variables. As regards, the signs and magnitude of β from the five specifications of the Wagner's law, we found that $\beta > 1$ for specifications (1-3) and that $\beta > 0$ for specifications 4 and 5. These results support the validity of the Wagner's law in Nigeria. Also, the Johansen cointegration test reject the null of no cointegration in all the five specifications of the Wagner's law. The results also reaffirms the existence of a long-run relation among the variables.

4.1 Linear Causality

Next, we estimate the parametric linear causality testing using the Hacker and Hatemi-J (2006) bootstrap procedure. Based on the results reported in Table 3, there is evidence of unidirectional causality from the gross domestic product to total government expenditure in Nigeria. There is also evidence that the per capita GDP Granger cause total government expenditure and total government expenditure per capital. This further reaffirms the validity of the Wagner's law in Nigeria.

4.2 NonLinear Causality

To implement the nonparametric causality test of DP, the study deals with cases where $\ell_X = \ell_Y$ =1, considering the fact that we have a small sample size of 49 observations and following the suggestion of Diks and Panchenko (2006) the bandwidth was set to 0.5. Based on the results presented in Table 4, we were able to make the following remarks. The DP nonlinear causality test revealed a uni-directional nonlinear causality from the gross domestic product to total government expenditure in Nigeria. We also found evidence of unidirectional causality from per capita GDP to total government expenditure and total government expenditure per capital. However, we also found evidence of bidirectional causality between the ratio of government expenditure and GDP to per capital GDP, and the ratio of government expenditure and GDP to the GDP. In sum, the results show that Wagner's law holds in Nigeria.

5 Conclusion

This paper investigates the existence of linear and nonlinear causal relations between government expenditure and output in Nigeria. This study contributed to the Wagner's law literature in several ways. First, we examine the government expenditure and output causal relationship using the Hacker and Hatemi-J (2006) bootstrap causality test. Second, we employed a new nonparametric nonlinear Granger causality. In sum, results show evidence of uni-directional nonlinear causality from output to government expenditure in Nigeria.These conclusions, apart from offering a much better understanding of the dynamic linear and nonlinear relationships underlying the Wagner's hypothesis nexus, may have important implications for government fiscal policy in Nigeria. The policy implication of this result is that government should be careful of the danger involved in increased public sector participation arising from the uncertainty in oil prices which generates about 80 per cent of government revenue.Thus, government should intensify efforts to improve her revenue by diversifying into other sectors of the economy.

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Table 1: Unit roots, Nigeria, 1961-2013

Variable	ADF	PP	$\bar{M}Z_{\alpha}^{GLS}$	$\bar{M}Z_{t}^{GLS}$
GDP	-2.379	-2.432	-3.308	-1.265
ΔGDP	-5.326***	-5.325***	-21.595***	-3.271***
GE	-2.369	-2.531	-8.889	-2.097
ΔGE	-7.707***	-7.705***	-23.431***	-3.421***
GDP/N	-2.331	-2.388	-3.303	-1.263
$\Delta GDP/N$	-5.335***	-5.334***	-21.656***	-3.276***
GE/N	-2.347	-2.508	-8.833	-2.093
$\Delta GE/N$	-7.703***	-7.700***	-23.434***	-3.421***
GE/GDP	-2.559	-2.271	-7.735	-1.916
$\Delta GE/GDP$	-9.149***	-9.650***	-21.710***	-3.292***

Note: *,** and *** indicate level of significance at 10, 5 and 1 per cent respectively.

Table 2: Engle-Granger cointegration test

Model	Cointegrating Equation						ADF
1	GE =	-0.860	+	1.002GDP	+	ε_t	
		(-5.063)***		(29.858)***			-3.139**
2	GE =	0.648	+	1.135GDP/N	+	ε_t	
		(4.694)***		(27.083)***			-3.086**
3	GE/N =	-0.843	+	1.001GDP/N	+	ε_t	
		(-6.684)***		(26.126)***			-3.130**
4	GE/GDP =	- 0.844	+	0.001GDP/N	+	ε_t	
		(-6.684)***		(0.025)			-3.131**
5	GE/GDP =	-0.861	+	0.002GDP	+	ε_t	
		(-5.063)***		(0.046)			-3.146**

Note: *,** and *** indicate level of significance at 10, 5 and 1 per cent respectively.

Table 3: Johansen cointegration test

Model	Null Hypothesis	Alternative Hypothesis	Trace test Statistics	Trace test 0.05 Level critical value	Eigen-value test Statistics	Eigen-value test 0.05 Level critical value
1	r = 0	r = 1	17.159**	12.321	17.046**	11.225
	r ≤ 1	r = 2	0.113	4.129	0.113	4.129
2	r = 0	r = 1	17.159**	12.321	17.046**	11.225
	r ≤ 1	r = 2	0.113	4.129	0.113	4.129
3	r = 0	r = 1	17.511**	12.321	11.533**	11.225
	r ≤ 1	r = 2	5.978**	4.129	5.979**	4.129
4	r = 0	r = 1	17.511**	12.321	11.533**	11.225
	r ≤ 1	r = 2	5.978**	4.129	5.979**	4.129
5	r = 0	r = 1	20.091**	12.321	12.979**	11.225
	r ≤ 1	r = 2	7.115**	4.129	7.115**	4.129

Note: 'r' shows the number of cointegrating vectors and critical values are from the MacKinnon-Haug-Michelis table (1999)

*,** and *** indicate level of significance at 10, 5 and 1 per cent respectively.

Table 4: Hacker and Hatemi-J Bootstrap causality test

Model	d	Null Hypothesis	T-test	1%Bootstrap CV	5%Bootstrap CV	10%Bootstrap CV
1	1	$GDP \nRightarrow GE$	10.586***	8.442	4.099	2.949
	1	$GE \nRightarrow GDP$	0.469	7.489	3.959	2.776
2	1	$GDP/N \nRightarrow GE$	10.114***	8.558	4.111	2.900
	1	$GE \nRightarrow GDP/N$	0.432	7.953	4.001	2.808
3	1	$GDP/N \nRightarrow GE/N$	10.732***	8.409	4.153	2.950
	1	$GE/N \nRightarrow GDP/N$	0.452	7.471	3.931	2.763
4	1	$GDP/N \nRightarrow GE/GDP$	0.962	8.476	4.436	2.980
	1	$GE/GNP \nRightarrow GDP/N$	0.452	7.604	4.105	2.651
5	1	$GDP \nRightarrow GE/GDP$	0.996	8.501	4.369	2.947
	1	$GE/GDP \nRightarrow GDP$	0.469	7.659	4.101	2.676

Note: *,** and *** indicate level of significance at 10, 5 and 1 per cent respectively.

Table 5: Diks and Panchenko Nonlinear causality test

Model	Null Hypothesis	T-test
1	GDP$\nRightarrow GE$	1.656**
	GE$\nRightarrow GDP$	1.104
2	GDP/N$\nRightarrow GE$	1.738**
	GE$\nRightarrow GDP/N$	0.930
3	GDP/N$\nRightarrow GE/N$	1.586*
	GE/N$\nRightarrow GDP/N$	1.082
4	GDP/N$\nRightarrow GE/GDP$	1.417*
	GE/GNP$\nRightarrow GDP/N$	1.487*
5	GDP$\nRightarrow GE/GDP$	1.449*
	GE/GDP$\nRightarrow GDP$	1.689**

Note: *,** and *** indicate level of significance at 10, 5 and 1 per cent respectively.