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Explaining Government Expenditure and Growth Rate Dynamics in Ghana: A Vector Error Correction Model

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Abstract: This paper examined the Granger-causality relationship between public expenditure and real capita GDP in Ghana, using aggregate data for a sample of 59 years, over the period of 1961–2020. Econometric analyses employed included: The simple Linear Regression Model (SLRM), Augmented Dickey-Fuller (ADF), Granger-causality, and Cointegration Tests (CT). The OLS output reveals that the series has limited ability in predicting each other as indicated by the very low R-square which comes close to zero, the ADF test showed that the series is stationary at the first difference, and The Granger-causality test revealed that there is no causality between the series. That is there is no Granger causal linkage between economic growth and government expenditure. In other words, economic growth and government expenditure are independent of the causal mechanism. The null hypothesis of number co-integration is not rejected since there is no co-integration at the 5% level of significance. This means that there is no long-run relationship between the series. There is a need for policy in public investment to impact growth rates in the future. Government expenditures need to be institutionalized in order to plan public spending over a period so that government expenditure is projected as a stable share of all anticipated flow of future levels of real income.

Keywords: Granger causality, government expenditure, gross domestic product, relationship, cointegration

1. INTRODUCTION

The question about the predictability power of government expenditure on Gross Domestic Product (GDP) or vice versa has been debated and investigated. Scholars who support the public expenditure hypothesis have argued that, government spending contains relevant information about future GDP growth, that is GDP growth is assumed to be linked with government expenditure. For example, if the economy is expected to experience growing phases, then government expenditure has to predict this (Barro, 2003). According to Kunofiwa et al, (2013), the issues about the relationship between government expenditure and economic growth have three dimensions: firstly, government expenditure stimulates economic growth, secondly economic growth influences government expenditure and thirdly, both government expenditure and economic growth influence each other. While economic theory has not provided any conclusion about the nature of relationship of government spending on economic growth, the argument has hinged on the ability of governments to sustain the growth of its expenditure in order to stimulate growth. The growth of government spending in developing and developed countries and its

effect on long-run economic growth has been investigated to explain this relationship. The question is "Is there a causal relationship between government expenditure (measured as a share of total expenditure in GNP) that can be determined to Granger-cause the rate of growth or if the rate of economic growth can be determined to Granger cause the size of government expenditure? One study which has explored this phenomenon was "Wagner's Law" (Wagner, 1893).

The empirical test of this hypothesis was formulated in standard regression analysis (Ganti and Kolluri, 1979, Georgakopoulos and Loizides, 1994) and in error-correction regression (Kolluri, et al, 2000) produced results which differ significantly from one country to another. Similarly, another theory which has investigated the impact of the general flow of government services on private decision making and on the impact of government expenditure on economic growth has been Keynesian economic theory- which posited that government spending determines long-run economic growth and hence government spending has to be treated as an exogeneous variable. The empirical evaluation is to determine whether in the standard regression specification (Landau, 1983) or the error-correction model (Ghali, 1998) have generated different results. In Ghana, the growth in government expenditure over the years has been to raise the prosperity for all, but unfortunately, the rising public spending has not resulted in any significant rise in economic growth. The economy, since 1961 continues to experience some fluctuations in economic growth figures except for 2011 (Aryeetey and Baah-Boateng, 2016) mainly as a result of discovery of oil and gas. It appears the impact of public spending on economic growth remained unclear and quite diverse. It is important that the knowledge of the true nature of the causative process between government spending and GDP is examined to guides government macroeconomic policy decisions and planning horizons.

The significance of doing this paper is in three folds: firstly, understanding the knowledge of the nature of the causative process would help government identify the potential predictability power of one indicator for the other, secondly, the results would inform government whether its rising public expenditures over the years are productive enough to impact and influence the direction of economic growth, and thirdly, the results would provide government with information whether its macroeconomic decisions follow the existence of validity of Keynes Theory-which aims at boosting economic growth by boosting government expenditure through the multiplier effect (King, 2012) or the Wagner Theory-which postulates that economic growth is the determinant of growth public expenditure and hence government intervention (Hossain, 2015). Understanding these hypotheses would ensure effective designing and implementing of macro-economic stabilization policies. The paper seeks to empirically determine the direction of causation between the two series within the context of a bivariate framework using a time series dataset from 1961-2020 and data are analyzed using unit root, Granger-causality and co-integration tests.

2. LITERATURE REVIEW

Garba and Abdullahi (2013) examined the relationship between public expenditure and economic growth in Nigeria. They applied the Johansen co-integration approach and the Granger causality test using time series aggregate data for a sample of 39 years, over the period of 1970–2008. The result revealed that public expenditure and economic growth are co-integrated in the long run. Furthermore, the results of the Granger causality test indicated a bidirectional causality running from public expenditure to economic growth and, in turn, from economic growth to public expenditure instead of being unidirectional. Dogan & Tang (2011) determined the direction of causality between public expenditure and economic growth for Indonesia, Malaysia, Philippines, Singapore, and Thailand, by using Johansen co-integrated methods and the Granger causality test, the result showed that causality ran from public expenditure to national income only for the Philippine's data. The result revealed that the Keynesian hypothesis was supported by data. Abubakar (2016) examined the association between public expenditure and economic growth in Nigeria by employing the Johansen co-integration test and the Vector Error Correction Model (VECM) to examine the short-run and long-run impacts of components from public spending on economic growth.

Findings showed a mixed impact of components of public expenditure on GDP in short-run and long run. Cosimo (2011) analyzed the relationship between public expenditure and economic growth for Italy. A Granger causality test was employed for the period 1960–2008. The results supported the Keynesian hypothesis for public investment in Italy. Salih (2012) used co-integration, causality and an error correction model (ECM) for Sudan, using time series data for the period 1970–2010. The result also revealed that real GDP growth per capita positively impacted the growth of general public expenditure as part of the GDP. The result supported Wagner' hypothesis for Sudan's economy. Wang, Peculea, and Xu, (2016) applied the Auto Regression Distributed Lag and the Bounds Test, based on Unrestricted Error Correction Model, to test five different representations of Wagner's hypothesis using annual data for the period 1991– 2014 for Romania. Empirical results showed that there is a long-term relationship between public spending and economic growth, which is unidirectional from economic growth to government expenditure. Leke and Alban (2017) investigated the relationship between public expenditure and economic growth in Kosovo. The primary objective was to test the views of Keynes's versus Wagner's hypothesis for Kosovo, using public expenditure, gross domestic product and three other components of GDP: Foreign Direct Investment, Export and Total Budget Revenue, using quarterly time series data from 2004–2016. The results showed that there is a unidirectional causality between government expenditure and economic growth, a bidirectional causality between total budget revenue and public expenditure and a bidirectional causality between export and economic growth. The result supported the Keynesian view. Paparas & Stoian (2016) applied the Johansen co-integration and the Granger causality tests to investigate the relationship between economic growths and government expenditure in Romania using annual data from 1995 to 2015. The results were consistent with Wagner's hypothesis in the long but nonexistence of the Wagner's Law in three out of five versions in the short run.

3. MATERIALS AND METHODS

Granger (1969) proposed a time-series data based to determine causality. In the Granger-series, the variable x is a cause of y, if it is useful forecasting y, that is x is able to increase the accuracy of the prediction of y, with respect to forecast, accounting for only past values of y. For example, if there is an information set θ_t in the form $\{x_t, \ldots . x_{t-j}, y_t, \ldots . y_{t-i}\}$, then it can be concluded that the variable x_t is Granger causal for y_t with respect to θ_t, given that, the variance of the optimal linear predictor of y_{t+h} based on θ_t, is assumed to have smaller variance compared with the optimal linear predictor of y_{t+h} based on only the lagged values of y_t for any h. Given this series, the variable x Granger-causes y if and only if $\sigma_1^2(y_t : y_{t-j}, x_{t-i}) < \sigma_2^2(y_t : y_{t-i})$ with respect to j and $i = 1,2,3, \ldots . n$, where σ^2 is the variance of the forecast error (Foresti, 2006). Granger (1969) identified three different scenarios in which Granger-causality can be applied:

(i) A bivariate Granger-causality test where there are two time series and their lagged series.
(ii) A multivariate Granger-causality test where there are more than two series are included and finally
(iii) Granger-causality that can be tested using the VAR principle to test for simultaneity of all included series.

3.1 DEPENDENCE RELATIONSHIP

This paper followed the two steps procedure in testing whether Gross Domestic Product (GDP) influences government expenditure (GVT) or GVT influences GDP, using a simple linear regression model. In the first step, GDP was regressed on all GVT series and secondly GVT was regressed on all GDP series using the equations below.

$$GDP_t = \beta_0 + \beta_1 GVT_t + u_{1t}$$
$$GVT_t = \alpha_0 + \alpha_1 GDP_t + v_{1t}$$

where u_{1t} and v_t are the disturbance terms

3.2 GRANGER-CAUSALITY TEST

Granger (1969) causality offered an important methodology for characterizing the dependence relationship between time series dataset in econometrics in testing whether GDP is Granger-caused by government expenditure or whether government expenditure is Granger-caused by GDP. The paper assumed that there is no claim that these models are of a particular structural type, that is there is no assumption about a particular underlying econometric model here, but one underlying assumption is that there is unit roots or stationarity of variables in order to run the VAR models and conduct the Granger test. The test is based on a standard F-test which seeks to determine if any development in one series causes development in another series (Paparas & Stoian, 2016). The test is applied to determine the existence of the Keynesian or Wagner hypotheses in estimating the following equations.

$$InGDP_t = \alpha + \sum_{i=1}^{m} \beta_i (InGDP)_{t-1} + \sum_{j=1}^{n} \varphi_j (InGVT)_{t-j} + \mu_t$$

$$InGVT_t = \theta + \sum_{i=1}^{p} \phi_i (InGVT)_{t-1} + \sum_{j=1}^{q} \omega_j (InGDP)_{t-j} + \eta_t$$

where $InGDP$ and $InGVT$ are natural logarithms of Gross Domestic Product growth rate and government expenditure respectively. μ_t and η_t are the white error terms. The null hypothesis for first equation is that $(InGVT)$ does not Granger cause $InGDP_t$. This hypothesis would be rejected if the coefficients of the lagged GVT (summation of $\varphi_j s$ as a group) are found to be jointly significant. The null hypothesis for the second equation is that $InGDP$ does not Granger cause $InGVT_t$. This hypothesis would be rejected if the coefficients of the lagged GDP(summation of ω_j as a group) are found to be jointly significant. Given that there is no long run relationship between GDP and GVT, the Granger test is performed using first difference of variables and the optimal lag length for the causality test is then determined by a vector introgressive (VAR) form. Based on this specifications, four different hypotheses about the nature of relationship between GDP and GVT can be formulated.

1. Unidirectional Granger-causality from GVT to GDP, such that GVT increases predictability of GDP, but not vice versa, thus
$$\sum_{j=1}^{n} \varphi_j \neq 0 \ and \ \sum_{j=1}^{q} \omega_j = 0$$
2. Unidirectional Granger-causality from GDP to GVT, such that GDP increases prediction of GVT, but not vice versa, thus
$$\sum_{j=1}^{n} \varphi_j = 0 \ and \ \sum_{j=1}^{q} \omega_j \neq 0$$
3. Bidirectional(feedback) Granger-causality such that GDP, increase the prediction of GVT and vice versa such that
$$\sum_{j=1}^{n} \varphi_j \neq 0 \ and \ \sum_{j=1}^{q} \omega_j \neq 0$$
4. Independence between GDP and GVT, that is no Granger-causality in any direction, where
$$\sum_{j=1}^{n} \varphi_j = 0 \ and \ \sum_{j=1}^{q} \omega_j = 0$$

By obtaining one of these hypotheses, it is possible to identify the nature of causal relationship between GDP and GVT of Ghana. A series is stationary if it has a tendency to move to a fixed mean overtime. Given that the series are cointegrated, error correction model would be applied to test for the causality

instead of the standard Granger test. In the error correction model, the appropriate error correction term EC_{t-1} are included in the standard Granger causality process after all variables have been made stationary by differencing. The following equations describe the process

$$\Delta InGDP_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta(InGDP)_{t-1} + \sum_{j=1}^{n} \varphi_j \Delta(InGVT)_{t-j} - \tau_i EC_{t-1} + \mu_t^*$$

$$\Delta InGVT_t = \theta + \sum_{i=1}^{p} \phi_i \Delta(InGVT)_{t-1} + \sum_{j=1}^{q} \omega_j \Delta(InGDP)_{t-j} - \delta_i EC_{t-1} + \eta_t^*$$

Where Δ is the first difference operator, μ_t^* and η_t^* are the white noise error terms. Given these equations, the independent variables are said to cause the dependent variable if the error correction terms $[\tau_i]$ and $[\delta_i]$ are significantly different from zero or the estimated coefficients of the lagged independent variables $[\varphi_i]$ and $[\omega_i]$ are jointly different from zero. If, however the series are not cointegrated, then the Granger test is conducted without the error correction terms.

4. RESULTS

Table 1: Summary Statistics

	Mean	*Min*	*Max*	*Std err*	*CV*	*Skewness*	*kurtosis*
GDP	3.6592	−12.432	14.047	4.3272	−1.1825	−1.1465	2.6046
GVT	$1.3529e^{+009}$	$1.4147e^{-008}$	$5.517e^{-+009}$	$1.6480e^{+009}$	1.2181	1.5334	0.8129

Source: Word Bank Data, 2022 (1961-2020)

Table 1 shows the summary statistics of our variables with a mean score ranging from 1.3529^{+009} to 3.6592

Table 2: OLS Output: Observations (1961 − 2020)

	Coef	*Std Er*	*t*	*p*	*R square*	*R square Adj*
Model 1						
Const	$8.56280e^{+08}$	$2.64636e^{+08}$	3.236	0.0020		
GDP	1.35729^{+08}	$5.43572e^{+07}$	2.497	0.0154	0.1270	0.1120
Model 2						
Const	2.3931	0.8293	2.886	0.0055		
GVT	$9.35793e^{-010}$	$9.19566e^{-011}$	10.18	$1.62e^{-014}$	0.1270	0.1120

Source: GRETL Estimation (2022)

The OLS output revealed that, the estimated coefficients have positive signs with expected significance level, this means that, the underlying growth in government spending has been positive, that is public spending can influence GDP growth and vice versa. The significant coefficient of the time series depicts that they all cause one another in the long run. Positive coefficients means that there is a positive relationship among between the series. In order words, if GDP increases, GVT also increase and vice versa. In model 1, a 1 percent increase in GVT causes $9.35793e^{-010}$ percentage increase in GDP. In model 2, a 1 percent increase in GDP causes $1.35729e^{+08}$ percent increase in GVT. But the levels of R^2 in both models are very low (close to zero), indicating that the values of GVT(GDP) have a limited ability for the prediction of GDP(GVT). This result showed that, the OLS output does not support a strong direction of relationship between the two variables. The unit root of stationarity of the series was determined using Augmented Dickey-Fuller (ADF) to examined whether the series are covariance stationary or integrated of the same order. The results revealed that for all the series, the null hypothesis: H_0 of non-stationarity was rejected at a 5 % confidence level, meaning that the series are stationary as shown by the acceptable p-values.

Table 3: Model Diagnostic Tests

Name of Test	GDP	GVT
Misspecification		
Ramsey Reset 1	0.133	0.102
Ramsey Reset 2	0.079	0.126
Ramsey Reset 3	0.046	0.167
Normality (Jarque-Bera)	$2.9032e^{-007}$	$3.43601e^{-006}$
Heteroskedasticity (Breusch-Pagan)	0.073184	0.446217
Autocorrelation (Breusch-Godfrey)	$2.43211e^{-20}$	0.0229

Source: World Bank Data 1961-2020

As shown in Table 2, a number of diagnostic tests showed robustness of regression models. Ramsey RESET mis-specification test revealed that the models have no misspecification problem, the tests for Jarque-Bera normality, heteroscedasticity (Breusch-Pagan) and autocorrelation (Breusch-Godfrey) showed that the null hypothesis is not rejected at the 5 percent level of significance. This means that the specification of our model is an adequate represent of the dataset.

GRANGER-CAUSALITY

The standard Granger causality test estimated for Ghana's economy for models (1) and (2) with their lags are reported in Table 4. Given that our series are stationary, we proceed with the VAR models in STATA to examine the number of lags to introduce in the models. Unfortunately, the Granger-causality test applied on Ghana's economy did not provide any causality direction from GDP to GVT or from GVT to GDP as formulated. This may be due to possible simultaneous causality among the series. The unfolding result does not provide any evidence for the validity of the Wagner or Keynesian hypothesis in this particular case. The null hypothesis of no causality in any direction is not rejected at the 5% level of significance (probability values are far above the 5% level), this means that $\varphi_j = 0$ and $\omega_j = 0$. But the question is, how many lags are to be selected for this model to determine direction of causation.

Table 4: VAR Model & Granger Causality Wald Test (lagged variables)

Lags	*Equation*	*Excluded*	*F*	*df r*	*Prob > F*
2 *lagged*	*GDP*	*GVT*	.7782	53	0.4644
	GDP	*ALL*	√	√	√
	GVT	*GDP*	.6925	√	0.5048
	GVT	*ALL*	.√	√	√
4 *lagged*	*GDP*	*GVT*	.2330	47	0.9184
	GDP	*ALL*	√	√	√
	GVT	*GDP*	.6521	√	0.6283
	GVT	*ALL*	√	√	√
6 *lagged*	*GDP*	*GVT*	.1606	41	0.9857
	GDP	*ALL*	√	√	√
	GVT	*GDP*	.4037	√	0.8723
	GVT	*ALL*	√	√	√
8 *lagged*	*GDP*	*GVT*	.3827	35	0.9226
	GDP	*ALL*	√	√	√
	GVT	*GDP*	.2924	√	0.9639
	GVT	*ALL*	√	√	√

Source: VAR model and Granger-causality

COINTEGRATION

The theory of cointegration by Engel and Granger (1987) determine if the linear combination of the series is stationary. The series are cointegrated or have a long-run relationship if there exists a linear

combination of these series. It does provide formal framework for testing and estimating long-run models from actual time series data.

Table 5: Cointegration Test

$Rank$	$Eigenvalue$	$Trace\ Test$	$p-value$	$Max\ Test$	$p-value$
0	0.37093	27.350	[0.0004]	27.347	[0.0002]
	$14.3044e^{-005}$	0.0025397	[0.9598]	0.0025397	[0.9598]

Source: Annual Data, 1961-2020

As reported in Table 5, the results showed that the null hypothesis of no co-integration between GDP and GVT is accepted, this means that the speed of convergence to equilibrium of the impact of the series is not determined. Both the trace and max eigenvalue confirm this conclusion

5. DISCUSSION AND CONCLUSION

Using annual dataset from 1961-2020, this paper examined the causal relationship between government size growth and GDP growth based on VAR model and Granger causality test. And on the basis of our empirical results, the following conclusions emerged. First, the Granger causality test reveals that neither government size growth (public spending) Granger-cause GDP growth nor GDP growth Granger cause public spending. This implies that both series are independent as suggested by theory. The null hypothesis that public spending does not Granger cause GDP growth rate or GDP growth does not Granger-cause government expenditure was not rejected. This may imply that the causality from government spending to GDP growth (vice versa) is not a distinctive feature of the Ghanaian case as suggested by the results. This means that the result did not support either the Keynesian view which states that public expenditure is an exogenous factor that influences economic growth and can be used as a policy instrument or the Wagner view that the public expenditure is seen as an endogenous factor or an outcome, not a cause, of economic growth. The results of the Granger-causality and the cointegration tests are very important for Ghana. The issues of no Granger-causation and no cointegrated structures raise some important practical issues that have to be addressed. The paper suggested a number of policy options. Firstly, since Ghana has been declared as a middle-income country, the policy authority should focus on public expenditure as an important exogenous factor or policy instrument to improve macroeconomic reforms, that is government expenditure framework should be institutionalized in order to plan public spending over a period so that expenditures are projected as a stable share of all anticipated flow of future levels of real income in order to stimulate economic growth in line with the Keynesian hypothesis. Secondly, policy authority needs to continuously determine whether its policy instruments are very effective and has gain reliable knowledge. This can be determined whether government's desired goals are feasible for some policy options and if there are multiple feasible implementations, the policy authority should select a preferred implementation options and begin the policy operationalization taking into account objective it wants to address and thirdly, once the policy operationalization begins, the policy authority has to monitor the system to determine whether any shift would require policy intervention in order to keep the implementation on track.

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