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Testing Wagner's Law for sub-Saharan Africa: A panel cointegration and causality approach

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Abstract. *Wagner's law relates the positive relation between public spending and economic activity, where greater economic activity leads to increased public spending. Using Panel unit root, cointegration, Fully Modified Ordinary Least Squares (FMOLS) and Granger causality procedures this paper seeks to test the validity of Wagner's law for a group of sixteen sub-Saharan African countries during the period 2002-2015. The findings show validity for Wagner's law when "productive" government expenditure is taken as the measure of public spending. Compared to "productive" government expenditure, total government expenditure shows weaker evidence for the validity of Wagner's law. Therefore governments in SSA should direct more spending towards productive expenditures if they seek to exploit growth benefits in the long run.*

Keywords: Wagner's law, Panel cointegration, Sub-Saharan Africa, FMOLS Granger Causality.

JEL Classification: E62, O40, O55.

1. Introduction

On the role of the economic policy in the short run macroeconomics management of an economy, classical economists believe that the economy is inherently stable and any deviations from the long run equilibrium level of employment and output should be allowed to 'self-correct' and any outside interferences may create instability. So, there is no role for government short run stabilization policy except to promote the efficient functioning of the market. However, Keynesians are of the view that the economy is inherently unstable and once left alone will not quickly correct deviations in the short run. So, they see role for government in promoting employment and growth through its expansionary policies. This latter view is called the Keynesian hypothesis- that public expenditure promotes growth of the economy.

Adolf Wagner (1983, 1912) however has a different view of the relationship between public expenditure and the growth of the economy. Wagner's law, like the Keynesian hypothesis, relates a positive association between public expenditure and economic growth. However, instead of public expenditure triggering growth as believed by the Keynesians, Wagner's law holds that economic growth leads to increased public expenditure. The law is attributed to Adolph Wagner from his 1983 work published in "Grundlegung der politischen Ökonomie", and presents one of the first models of the determination of public expenditure.

According to the literature (Henrekson, 1993; Halicioglu, 2000) the law rests on the following three reasons. Firstly, as the economy grows government involvement will increase in an attempt to counter the displacement effect of the private sector, which is the direct result of the industrialization process. Secondly, technological progress requires government's taking over of natural monopolies to increase and enhance efficiency. Finally, increased real income, which comes with economic development, boosts the income elasticity for 'public' expenditures, which is better provided by the government.

This papers attempts to test the validity of Wagner's law for a group of sub-Saharan African countries for the period 2002-2015 using econometric techniques of panel unit roots, cointegration and granger causality tests. This paper adds to the few sporadic evidence for individual SSA countries are available (Keho, 2015; Babatunde, 2006), and differs from the extant literature in approach to uncover evidence for Wagner's law through panel cointegration and causality analysis. In addition, our measure of government expenditure has been augmented to capture 'productive' expenditure, which refers to total expenditure less general government consumption expenditure. Versions of Wagner's law is presented next before the literature review in section 3. Sections 4 and 5 present the econometric methodology and empirical results respectively. The final section has the conclusion and recommendations.

2. Versions of Wagner's Law

While Wagner himself was not specific on the nature of the functional form, several researchers attempt to test the law utilizing different functional forms. All in all, six common forms of the law are used.

$$GE = f(GDP) \quad (1)$$

$$GCE = f(GDP) \quad (2)$$

$$GE/GDP = f(GDP) \quad (3)$$

$$GE = f(GDP/N) \quad (4)$$

$$GE/N = f(GDP/N) \quad (5)$$

$$GE/GDP = f(GDP/N) \quad (6)$$

In the above representations, GDP is the gross domestic product, GCE is the total consumption expenditure of the government, GE is the total expenditure of the government, and N is the total population. Functional forms (1), (2), (4), (5), and (6) are developed by Peacock-Wiseman (1961), Pryor (1968), Goffman (1968), Gupta (1967) and Musgrave (1969) respectively. The version in (3) is the modified version of Peacock-Wiseman (1961) as shown in Mann (1980).

Models (1) and (2) relates government total and consumption expenditures to economic activity respectively. Government size, measured by government expenditure in total output is related to the level economic activity in Mann (1990) version in model (1), and to the per capital output level in Musgrave (1969) version in model (6). Grupta (1967) and Michas (1975) interpret the law in terms of per capital government expenditure and per capita output level, as shown in model (5). Finally, Goffman (1968) interprets the law in terms of government expenditure versus per capita output level.

While all representations are used in the empirical literature with some papers employing all version (Bagdigen and Beser, 2009; Verma and Arora, 2010) and in some a single version, the most widely applied single version is the Musgrave (1969) as found in (Henrekson, 1993; Halicioglu, 2000). This paper seeks to investigate the validity of the law utilizing Musgrave version for a sample of 18 Sub-Saharan African countries from 2000-2015, wherein an elasticity greater than one validates the law.

3. Literature review

Many empirical studies of the validity of Wagner's law have been conducted in both the developed and developing countries and the results of these studies are not unanimous. One of the first studies that employed modern cointgeration methods to avoid the problem of spurious regression in testing Wagner's law literature is the work of Henrekson (1993) for Sweden from1861 to 1988. Applying unit root and cointegration techniques, Henrekson (1993) finds no support for the law. However, Kumar et al. (2009) for New Zealand finds support for the Wagner's law.

Karagianni, Pempetzoglou and Strikou (2002) examined the validity of Wagner's law for 15 EU countries for the period 1949-1998 using Engle- Granger and Johansen cointegration techniques and Granger causality method. The results are sensitive to the technique used. While Engle-Granger (E-G) technique of cointegration mainly invalidates the law, papers that employ Johansen technique of cointegration mainly validate the law. The results from granger causality analysis are not unanimous for all countries. All in all, Wagner's law is clearly validated for only Finland and Italy.

Magazzino (2012) for EU-27 for the period 1970-2009 examines the validity of Wagner's law in its pure form and a public deficit-augmented version of the law. Times series econometric techniques of cointegration and causality analysis and panel GMM methods are used in the investigation process. Using six versions of the law, the empirical result is sensitive to the technique employed in both its pure and augmented version. The paper divided the countries into 'rich'-corresponding to old EU member- and 'poor'-referring to the new member, and the findings tend to show the validity of the law for the 'poor' than the 'rich', showing the appropriateness of the law for developing countries.

In addition, Anotmis (2013) studied the validity of Wagner's versus Keynesian hypotheses for pre-WWII Greece using ARDL cointegration and causality analysis for the period 1833-1938. The result favors Wagner's Law. Jaen-Garcia (2011) investigated the validity of Wagner's law for Spain's regions employing panel data techniques of unit root and cointegration. Using both static (FMOLS and DOLS) and dynamics (PMGE) panels this study show that Wagner's law is validated for Spain's region. This study is important in that it avoids the compromising effect of differing cultures and institutions in panel data studies. Moreover, Moore (2016) employed ARDL bounds testing approach to test Wagner's law for Ireland for the period 1970-2012. The results show that Wagner's cannot be validated for most of the specifications.

Bojanic (2013) tested the validity of Wagner's law for Bolivia for the period 1940 - 2010 using cointegration and causality analysis. The result of the study shows bidirectional causality between income and government expenditure in six of the nine versions of Wagner's law. In addition the five standard versions above, Bojanic (2013) further modeled version (1) in four disaggregated forms: government infrastructure, health, defense, and education expenses.

In Turkey, evidence for Wagner’s law is found in Halicioglu (2003) for a budget deficit augmented version for the period 1960-2000 using cointegration and Toda and Yamamoto (1995) causality test. Similarly Oktayer and Oktayer (2013) also found evidence for Turkey in a trivariate causality analysis between non-interest government expenditure, inflation and economic growth for 1950-2010 using bounds test and causality analysis.

Verma and Arora (2010) tested the validity of Wagner’s law for India for the period 1950-2007 using all six versions of the law. While their results validate the law in the long run, the short run evidence refutes the law. Afzal, M and Abbas, Q (2010) tested Wagner's Law in Pakistan for the period 1960- 2007 using time series econometric techniques of cointegration and causality analysis. The result largely did not validate the law for the period under study between aggregate pubic spending and income and no long run relationship exist between disaggregated expenditures and income as well. In addition, Pahlavani, Abed and Pourshabi (2011) validated Wagner’s law for Iran for the period 1960-2008 using empirical methods of ARDL cointegration and causality analysis.

Keho (2015) recently studied studies Wagner's law for 10 African economies using frequency domain causality analysis and his results show validity for only three countries: Cameroon, Ghana and Nigeria. While the law holds for Cameroon and Nigeria only in the medium and long term respectively, it holds for Ghana in the short, medium and long term. Biyase and Zwane (2015) used panel fixed effect, random effect and pooled regression to test the economic growth- government expenditure nexus for 30 African countries from 1995-2005. Their results show evidence for Wagner's law.

Babatunde (2006) used bound test and Toda and Yamamoto (1995) Granger non-causality approaches to test Wagner's law for Nigeria for the period 1970 - 2006 and found it invalid during this period. In addition, Ibok and Bassey (2012) studied the validity of Wagner's law for agricultural sector of Nigeria, 1961-2012. Using Johansen and Juselius cointegration method in conjunction with granger causality analysis, they show that long run relationship exist between government spending and national income and that causality runs from the latter to government spending validating Wagner's law. A summary table of the review of literature is given below.

Table 1. *Summary empirical results on Wagner's Law*

Author(s) and Date	Data	Method	Countries (Year)	Validity
Henrekson (1993)	TS	OLS	Sweden – 1861-1990	Yes
Kumar et al. (2009)	TS	ARDL, E-G, FMOLS	New Zealand – 1960-2007	Yes
Halicioglu (2003)	TS	Cointegration and Non-causality test	Turkey – 1960-2000	Yes
Verma and Arora (2010)	TS	Co-integration test	India 1950-2007	Yes
Keho (2015)	TS	Frequency Domain Causality	Ten African Countries	Yes (Three)
Karagianni, Pempetzoglou and Strikou (2002)	TS	Cointegration and Granger causality test	EU-15 – 1949-1998	Yes (Two Countries)
Anotmis (2013)	TS	ARDL and causality	Greece – 1833-1938	Yes
Jaen-Garcia (2011)	PD	FMOLS, DOLS, PMGE	Spain – 1984-2003	Yes
Bojanic (2013)	TS	Cointegration and causality	Bolivia – 1940-2010	yes (Five Versions)
Afzal and Abbas (2010)	TS	Cointegration and causality	Pakistan – 1960-2007	No
Pahlavani, Abed and Pourshabi (2011)	TS	Bounds Test and Toda and Yamamoto causality	Iran – 1960-2008	Yes
Babatunde (2006)	TS	Bounds Test and Toda and Yamamoto causality	Nigeria – 1970-2006	No
Ibok and Bassey (2012)	TS	Cointegration and causality	Nigeria – 1961-2012	Yes

In the table TS, PD, FMOLS, DOLS, E-G and PMGE refers to times series, panel data, fully modified ordinary least squares, dynamic ordinary least squares, Engle- Granger, and panel mean group estimator respectively.

4. Model and econometric methodology

4.1. The model

In line with the literature, the paper estimates a long run relationship between public expenditure and economic growth as given below, where lowercase letters represent natural logarithms. This paper estimated the Musgrave (1969) version of Wagner's law for SSA-16 in two models, one for general government expenditure and the other productive government expenditure. The specifications are as follows:

$$gey_{it} = a_{0i} + a_{1i}py_{it} + e_{it} \quad (7a)$$

$$pgey_{it} = a_{0i} + a_{1i}py_{it} + e_{it} \quad (7b)$$

In (7a-b) $pgey_{it}$ is productive government expenditure, gey_{it} is general government expenditure as a percentage of GDP for country i in time t, py_{it} is the real GDP per capita and e_{it} is the classical error term. The data is extracted from World Development Indicators database for the period 2002-2015 for sixteen Sub-Saharan African countries. Validity of Wager's law is indicated by $b_i > 1$- an elasticity greater than one and a positive coefficient a_{1i}.

4.2. The econometric methodology

The empirical methods of Fisher type-ADF panel unit root analysis by Maddala and Wu (1999), Pedroni (1999) panel cointgeration analysis, Fully Modified OLS (FMOLS) and finally Granger causality in panel vector error correction (PVECM) set-up. This is a sequential analysis where the applicability of the text method depends on the result of the previous method's result. In other words, we test for cointegration upon finding that our variables are integrated at first difference from the results of ADF test. In addition, the running of FMOLS regression is based on the finding that there exists cointegration between the variables in the second stage of the analysis. Finally, Granger causality in PVECM is applicable to a cointegration system. The rest of this section gives a description of each stage of the analysis followed in this paper.

4.2.1. ADF Fisher Panel Unit Root Test

This test is proposed by Maddala and Wu (1999) based on the original work of Fisher (1932) where the test statistics for individual cross sections is added to form the panel test-statistic

$$\lambda = -2 \sum_{i=1}^{N} log_e \pi_i \quad (8)$$

In (8) π_i represent the p-value of the test statistic in each country unit$i$. With two degrees of freedom, λ is χ^2 –distributed. This method is applicable irrespective of whether the null hypothesis is unit root or stationarity.

4.2.2. Pedroni (1999) Panel Cointgeration Test

The Pedroni (1999) method of panel cointegration is similar to the Engle –Granger time series cointegration approach. It works by storing the estimates of the residuals from a panel cointegration equation like the one below.

$$y_{it} = \alpha_i + \rho_i t + \beta_{1i} X_{1it} + \cdots + \beta_{Mi} X_{Mit} + \xi_{it} \quad (9)$$

In the second stage, the estimate of the residual from the differenced regression is calculated from the difference regression. This is the difference version of (9) given in (10) below. The variance of the estimate of η_{it} is calculated using a kernel estimator, and it is denoted$\ddot{L}_{11i}^2$.

$$\Delta y_{it} = \delta_{1i} \Delta X_{1it} + \cdots + \delta_{Mi} \Delta X_{Mit} + \eta_{it} \quad (10)$$

In the final stage a suitable autoregressive model is estimated from the residual of equation (9), which is then used to estimate the long run variance of the residual from the AR model. These long run variances are denoted $\ddot{\sigma}_i^2$ and $\ddot{s}_i^2$ for non-parametric and parametric statistics respectively. The estimate of λ, $\ddot{\lambda}$ is given by $\ddot{\lambda}_i = 1/2(\ddot{\sigma}_i^2 - \ddot{s}_i^2)$. Using the above procedure, Pedroni (1999) constructs the followings test statistic for decision making[1].

Panel v-statistics

$$Z_v = T^2 N^{3/2}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\ddot{L}_{11i}^{-2}\ddot{\xi}_{i,t-1}^{2}\right]^{-1}$$

Panel ρ-statistics

$$Z_\rho = T\sqrt{N}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\ddot{L}_{11i}^{-2}\ddot{\xi}_{i,t-1}^{2}\right]^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\ddot{L}_{11i}^{-2}\left(\ddot{\xi}_{i,t-1}\,\Delta\ddot{\xi}_{i,t} - \ddot{\lambda}_i\right)$$

Panel t-statistics

$$\bar{\bar{Z}}_t = \ddot{S}_{N,T}^{2}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}\ddot{L}_{11i}^{-2}\ddot{\xi}_{i,t-1}^{*2}\right]^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\ddot{L}_{11i}^{-2}\,\ddot{\xi}_{i,t-1}^{*}\,\Delta\ddot{\xi}_{i,t}^{*}$$

Group ρ-statistics

$$\tilde{\bar{Z}}_\rho = TN^{-1/2}\sum_{i=1}^{N}\left[\sum_{t=1}^{T}\ddot{\xi}_{i,t-1}^{2}\right]^{-1}\sum_{t=1}^{T}\left(\ddot{\xi}_{i,t-1}\,\Delta\ddot{\xi}_{i,t} - \ddot{\lambda}_i\right)$$

Group t-statistics

$$\bar{\bar{Z}}_t = N^{-1/2}\sum_{i=1}^{N}\left[\sum_{t=1}^{T}\ddot{s}_i^{*2}\;\ddot{\xi}_{i,t-1}^{*2}\right]^{-1/2}\sum_{t=1}^{T}\ddot{\xi}_{i,t-1}^{*}\,\Delta\ddot{\xi}_{i,t}^{*}$$

In addition to these Eviews return panel PP-statistics and group PP-statistics. In the above equations $\ddot{L}_i$ is used to correct for autocorrelation in the parametric model. $\ddot{\xi}_{i,t}^{*}$ and $\ddot{\xi}_{i,t}$ are the residuals estimated from the non-parametric and parametric models respectively. $\ddot{L}_{11i}$ is the estimate of the long run variance of $\Delta\ddot{\xi}_{i,t}$, the lags of which are determined by Newey-West method.

4.2.3. FMOLS Panel Estimates

FMOLS is efficient estimation method for cointegration system proposed by Philips and Hansen (1992). For the panel in (7) where i = 1, 2, …, 16 and t = 2002, …, 2015, consider system

$$gey_{it} = a_{0i} + a_{1i}py_{it} + e_{it} \;\&\; py_{it} = py_{it-1} + \mu_{it}$$

where the vectors $Z_{it} = (gey_{it}, py_{it})' \sim$ I (1) and $\widetilde{\omega}_{it} = (e_{it}, \mu_{it})' \sim$ I(0). For L_i representing the lower triangular decomposition of Ω_i, the long run covariance matrix is of the above system is $\Omega = L_i L_i$. Ω_i is given as $\Omega_i = \Omega_i{}^0 + \Gamma_i + \Gamma_i'$ where the first term is the contemporaneous covariance and the later term denotes the weighted sum of the auto-covariances. The FMOLS estimator for $a_1$is

$$a_{1NT}{}^{*} = N^{-1}\sum_{i=1}^{N}\left(\sum_{i=1}^{T}(py_{it} - \overline{py}_i)^2\right)^{-1}\left(\sum_{i=1}^{T}(py_{it} - \overline{py}_i)gey_{it}{}^{*} - T\ddot{\tau}_i\right)$$

Where

$$gey_{it}{}^{*} = (gey_{it} - \overline{gey_i}) - \frac{\ddot{L}_{21\,i}}{\ddot{L}_{22\,i}}\Delta py_{it}\text{ , and } \ddot{\tau}_i = \ddot{\Gamma}_{21\,i} + \ddot{\Omega}_{21\,i}{}^{0} - \frac{\ddot{L}_{21\,i}}{\ddot{L}_{22\,i}}(\ddot{\Gamma}_{22\,i} - \ddot{\Omega}_{22\,i}{}^{0}$$

4.2.4. Granger causality

In this part of the econometric investigations, efforts are geared towards establishing the nature of directional causality between public spending and economic growth. A unidirectional causality from economic growth to public spending serves as evidence for the validity of Wagner's law. In a co-integrated system the appropriate way to derive Granger causality results is from a vector error correction not VAR in difference (Engle and Granger, 1987). Accordingly, an error correction term is added to VAR in difference to capture the long run effects. The VECM for the (7-a) is presented below.

$$\Delta gey_{it} = \pi_{1g} + \sum_{\rho}\pi_{11i\rho}\Delta gey_{it-\rho} + \sum_{\rho}\pi_{12i\rho}\Delta py_{it-\rho} + \psi_{1i}ECT_{t-1}$$

$$\Delta py_{it} = \pi_{2g} + \sum_{\rho}\pi_{21i\rho}\Delta py_{it-\rho} + \sum_{\rho}\pi_{22i\rho}\Delta gey_{it-\rho} + \psi_{2i}ECT_{t-1}$$

Long run causality from economic growth to public spending is established when ψ_{1i} is negative and significant. Similarly, the negative significance of ψ_{2i} is supportive of the Keynesian view that public spending spurs economic growth. Short run causalities are derived based on the joint significance of $\pi_{12i\rho}$ terms for Wagner's law and the joint significance of $\pi_{22i\rho}$ for the Keynesian hypothesis. The same procedure is valid for model (7-b).

5. Empirical results

The data we use in this study is sourced from World Bank's World Development Indicators (WDI) and the IMF World Economic Outlook 2016 databases available online. Productive government expenditure is derived by subtracting government consumption expenditure from its total expenditure. The per capita gross domestic output at market prices (at 2010 constant $) is used to measure economic growth and all variables are converted into their natural logarithms to allow for easy interpretation in growth terms. The period under study is 2002-2015.

The results are shown in the Appendix. Table 1 shows the result of the ADF- Fisher unit root for all three variables in their level and difference. Clearly all variables are integrated of order one by according to the model with no trend. As for the model with trend, except for output per capita all others are integrated of order one. Therefore, it can concluded that all variables are integrated of order one.

In Table 2, the Pedroni cointegration test result is shown. In model 1 cointgeration is established by all statistics except for panel group-rho in no trend model and panel rho and panel group rho in model with trend. However, since four out of seven statistics agree that cointegration exist we conclude the long run relationship exist in public spending and economic growth in model 1. For model 2, where productive public spending is related to economic growth, the results are even stronger with all statistics indicating cointegration for a model with no trend, and only panel v and rho failing to indicate cointegration in model with trend. Hence, it is clearly evident that cointegration exists in both models depicted in (7a-b).

Long run elasticities are estimated by the FMOLS and DOLS estimators in Table 3. Accordingly, Wagner's law is supported with elasticities of 1.3 and 1.7 in the FMOLS and DOLS results of model. Model 1 results are weaker with elasticities closed to but less than one. This shows that productive government expenditure responses more to economic growth than total expenditure. All coefficients are statistically significant.

Finally, Granger causality test result is conducted using optimal lags of 2 advised by AIC. The long run causality results depicted in ECM show a unidirectional causality from economic growth to output per capita for both specifications. That is, the ECM term for difference public spending variable is negative and significant for both models. However, the short run causality results given by the joint significance of the lags variables in each equation is not the same for both models. Short run unidirectional causality from economic growth to public expenditure exist in only model 2. Here again model two beats model 1. In summary, the validity of Wagner's law can be established for SSA-16 from 2002-2015 from the elasticities and Granger causality analysis; but we can even say more- that productive government expenditure is what seems to matter than total expenditure in test for Wagner's law.

6. Concluding remarks

We tested for the validity of Wagner's law for sixteen Sub-Saharan African countries (SSA-16) during the period 2002 to 2015. This was conducted in spirit of panel data methods of cointegration and causality. The results show that the validity of Wagner's law for these countries cannot be rejected, and this finding is even more robust when 'productive' government expenditure is taken as the measure of public spending. Therefore, African countries should not only boost government spending but also channel more spending towards productive expenditure than consumption expenditure. These results are in line with Biyase and Zwane (2015) for 30 African countries and Ibok and Bassey (2012) for the agricultural sector for Nigeria.

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Appendix

Table 1. *ADF – Fisher unit root test results*

Series	No Trend	Trend
Gey	29.10 (0.61)	39.41(0.17)
Δgey	82.13 (0.00)***	52.47 (0.01)***
Py	27.74 (0.68)	51.65 (0.01)***
Δpy	78.78 (0.00)***	66.79 (0.00)***
pgey	32.25 (0.45)	31.60 (0.48)
Δpgey	70.26 (0.00)***	48,73 (0.02)**

***, ** and * indicate 1%, 5% and 10% level of significance respectively.

Table 2. *Panel cointegration test results*

Test Statistics	Model 1: No trend		Model 1: Trend		Model 2: No trend		Model 2: Trend	
	statistic	p-value	statistic	p-value	statistic	p-value	statistic	p-value
panel v-statistics	1.706972	0.0439**	-1.38743	0.9173	1.484224	0.0689*	-1.28904	0.9013
panel rho-statistics	-2.267395	0.0117***	0.45232	0.6745	-2.22987	0.0129***	0.089409	0.5356
panel pp-statistics	-3.867446	0.0001***	-2.92034	0.0017***	-3.52532	0.0002***	-3.8753	0.0001***
panel adf-statistics	-4.060107	0.0000***	-2.86533	0.0021***	-2.35823	0.0092***	-1.54635	0.061*
group rho-statistics	-1.090288	0.1378	1.201713	0.8853	-0.51796	0.3022	1.699118	0.9554
group pp-statistics	-5.754579	0.0000***	-4.13519	0.0000***	-3.47187	0.0003***	-3.76843	0.0001***
group adf-statistics	-3.96396	0.0000***	-2.70745	0.0034***	-3.26617	0.0005***	-2.41614	0.0078***

***, ** and * indicate 1%, 5% and 10% level of significance respectively.

Table 3. *Long run elasticities*

	FMOLS	DOLS
Model 1	0.5354 (0.00)***	0.7127 (0.00)***
Model 2	1.3526 (0.00)***	1.7704 (0.00)***

***, ** and * indicate 1%, 5% and 10% level of significance respectively.

Table 4. *Granger causality test results*

Model 1

Dependent variable	Δgey	Δpy	ECMt-1
Δgey	-	1.9112 (0.16)	0.0316 (0.01)***
Δgey	0.6405 (0.42)	-	0.0009 (0.21)

***, ** and * indicate 1%, 5% and 10% level of significance respectively.

Model 2

Dependent variable	Δpgey	Δpy	ECM_{t-1}
Δpgey	-	3.7179 (0.05)**	0.1497 (0.04)**
Δpy	0.1613 (0.68)	-	0.0040 (0.92)

***, ** and * indicate 1%, 5% and 10% level of significance respectively.