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Causality Between Government Expenditure and Economic Growth in Sudan: Testing Wagner's Law and Keynesian Hypothesis

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This paper investigated the possible existence of short-term and long-term relationships between government expenditure and economic growth for Sudan by testing the validity of Wagner's law and Keynes's hypothesis for the period 1977-2016. Based on the econometric method and aggregate annual time-series data set used, we concluded that there is no evidence to support either Wagner's law or Keynes's hypothesis. Therefore, the growth of public expenditure in Sudan is not directly dependent on or determined by economic growth, as Wagner's law states. However, it is possible to examine disaggregated data to investigate public expenditure growth in Sudan in terms of Wagner's law.

Keywords: Wagner's law, public expenditure, economic growth, Keynesian hypothesis, co-integration, Granger causality, Sudan economy.

JEL Classification: C22, E62, H50, O47, O55.

Introduction

The amount of government expenditure (GE) has been an issue of debate for several decades. Recently, due to large budget deficits in almost all countries, this issue has received even more attention. If government spending causes economic growth, then government spending can be used to promote economic growth, so reducing public spending can lead to a decline in real output. Conversely, if the causality runs in the opposite direction, then budget deficit-reducing policies can be implemented without adverse effects on economic growth (Keho, 2015). Although there is widespread agreement in developing countries that the

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government's role is crucial for development, there appears to be little consensus about the optimal level of public intervention in the economy (Diamond, 1977). Wagner offered at least three factors that would cause public spending to grow proportionately faster than the level of economic development (Bird, 1971):

First, the greater division of labor and urbanization accompanying industrialization would require higher expenditures on contractual enforcement and regulatory activity. That is, as the country's economy progresses, the administrative and protective role of the government expands.

Second, the growth of real income economic development would lead to an increase in the demand for public services such as social and cultural goods and improved environment, education, and health facilities (i.e., an increase in "cultural and welfare" expenditures). Implicitly, Wagner assumed that the income elasticity of the demand for public goods is more than unity. Public expenditure on services basically includes general administration, social services, and community services, which come close to what Wagner termed expenditure on culture and welfare.

Third, economic development, changes in technology, and funding for long-term investments would have a dynamic impact on the level of fiscal activities of the state. Wagner felt that the lack of access to capital funds on a very large scale would produce state intervention in the long run because private sector firms would not be able to raise the required capital. Moreover, public infrastructure would be needed as a complement to private sector investment activities. Wagner saw that the increasing scale of technology-efficient production would make the government undertake certain economic services of which the private sector would be no longer capable (i.e., the heavy investments associated with railroad construction).

Finally, the technological progress of industrialized nations requires the government to undertake certain economic services, for which funds are not forthcoming from the private sector.

Based on the above analysis, at least three elements are crystal clear. First, Wagner's law is truly a dynamic law, which describes change over time

in a particular country. Second, the formulation of this law is based on the historical experiences of the early stages of industrialization, with the applicability of this law restricted to a country that has passed through the early stages of industrialization (i.e., developing countries). Third, this law does not embody a substantive theory and is based on Wagner's own philosophical or normative view of the nature and activities of the state (Bird, 1971). Wagner's law is often regarded as a long-term phenomenon, generally expected to prevail during the industrialization phase of an economy.

Several factors make Sudan a very interesting arena to test the validity of Wagner's law. First, Sudan has made remarkable economic progress over the last few decades. Second, we can eliminate the methodological shortcomings of earlier studies in terms of Wagner's law. Third, we can attempt to develop some insights to formulate better theories of public expenditure growth in the case of Sudan. Fourth, Sudan started its open door policy in the 1990s, and hence, sufficient data are available for researchers to evaluate the effects of economic liberalization on various economic phenomena. Fifth, in Sudan, the proportion of the dependent population is relatively high, and the need for expenditure on education, health, and welfare services tends to increase as the expenditure base expands. Similarly, the demand for roads and highways will increase as the number of vehicles increases with income.

Finally, this is the first study to test Wagner's law in Sudan using modern econometric techniques such as the co-integration and Granger causality tests.

Our purpose in the present paper was to examine long-term relationships and direction of causality between economic growth and GE for Sudan, using time-series data covering the period of 1977–2016. The rest of the paper is organized as follows: In Section 2, we briefly look at the theoretical framework of Wagner's law and Keynesian assumption. In Section 3, we describe the method of estimation. In Section 4, we review the model specification, data sources, and definitions of variables. In Section 5, we discuss the empirical results. Finally, in Section 6, we provide a summary of the findings and conclude with policy implications.

1. Literature Review

Most researchers hypothesized a positive correlation between the share of GE and gross domestic product (GDP) or income per capita. Moreover, Wagner hypothesized that causality flows from GDP to GE, that is, $GDP \rightarrow GE$.

In contrast, the macroeconomics framework, especially the Keynesian school of thought, suggests that GE accelerates economic growth and that indeed, some types of government spending are necessary to boost GDP, at least in initial stages of development. Thus, government spending is regarded as an exogenous force that changes aggregate output, that is, $GE \rightarrow GDP$.

Without examining causality, Wagner's law is not validated, because his direction of causality could be incorrect and could well be from GE to economic development, which is against the essence of Wagner's law (Anwar et al., 1996, pp. 167–168).

Wagner's law has been empirically tested by many researchers. Some of the early studies in this literature using the traditional regression analysis in a time-series framework found strong support for Wagner's law, such as Abizadeh and Yousefi (1988), Ahsan et al. (1996), Bird (1971), Goffman (1968), Gupta (1967), Henrekson (1993), Musgrave (1969), Peacok and Wiseman (1961), and Timm (1961). Some researchers conducted multi-country studies, such as, Ganti and Kolluri (1979), Nagarajan and Spears (1990), Oxley (1994), Ram (1992), and Wagner and Weber (1977), whereas others studied a specific country: Bird (1970) studied Canada; Burney (2002) studied Kuwait; Iheancho (2016) studied Nigeria, Islam (2001), Vatter and Walker (1986), and Yousefi and Abizadeh (1992) studied the law for the USA; Murthy (1993, 1994), and Lin (1995) studied Mexico; Gyles (1991) studied the UK; Nomura (1995) studied Japan; and Singh (1997) studied India.

Afxentiou and Serletis (1991), Ashworth (1994), Bairam (1992), Courakis et al. (1993), Diamond (1977), Goffman and Mahar (1971), Henrekson (1993), Hayo (1994), Hondroyiannis and Papapetrou (1995), Pryor (1968), Pluta (1979), Singh and Sahni (1984), Sahni and Singh (1984), and Wagner and Weber (1977) cast doubts on the validity of

Wagner's hypothesis. Ansari, Gordon, and Akuamoach (1997) studied three African countries (Ghana, Kenya, and South Africa) and found no evidence supporting Wagner's law. Afxenriou and Serletis (1996) examined six European countries over the period of 1961–1991 and found no evidence supporting the Wagner's law. Ram (1986) covered the period of 1950–1980 for 63 countries and found limited support for Wagner's law.

The following studies yielded mixed results with respect to Wagner's hypothesis: Mann (1980), Pluta (1981), Abizadeh and Gray (1985), Ram (1986, 1987), Ansari et al. (1997), and Chletsos and Kollias (1997). Furthermore, many country-specific studies have been conducted by researchers such as Afxentiou and Serletis (1991), and Biswas et al. (1999), Singh and Sahni (1984), who studied Wagner's law for Canada. Nagarajan and Spears (1990), Murthy (1993), Hayo (1994), and Lin (1995) found mixed results concerning the validity of Wagner's law for Mexico.

Abisadeh and Gray (1985) covered the period of 1963–1979 for 55 countries, and their findings support the proposition for wealthier countries but not for the poorer ones. On the other hand, Chang (2002) studied three emerging countries in Asia (South Korea, Taiwan, and Thailand) and three industrialized countries (Japan, the USA, and the UK) over the period of 1951–1996 and found that Wagner's law is valid for the selected countries studied, with the exception of Thailand.

Recently, researchers such as Jalles (2019) revisited the validation of the Wagner's law in a sample of 61 advanced and emerging market economies between 1995 and 2015. He assessed the responses of different categories of government spending to changes in economic activity. His findings showed that the Wagner's law seems more prevalent in advanced economies and when countries are growing above potential. However, such result depends on the government spending category under scrutiny and the functional form used. Country-specific analysis revealed relatively more cases satisfying Wagner's proposition within the emerging markets sample.
Atasoy and Gur (2016) tested Wagner's hypothesis in China and found it valid during 1982–2011. Moore (2015) examined Wagner's law in Ireland for the period of 1970–2012 and found that the rate of growth has not outpaced growth in GDP per capita, thus weighing against Wagner's

law. Most researchers have assumed the respective time series to be stationary and proceeded to test Wagner's hypothesis through ordinary least squares regression of a measure of GE on income per capita. However, if the time series follows a stochastic rather than a deterministic process, it might contain a unit root and be nonstationary in levels. In recognition of this potential problem, we undertook unit root as well as co-integration tests in my examination of Wagner's law and Keynesian hypothesis in Sudan. Indeed, if co-integration is present, error correction models can be constructed to test for Granger causality.

In the present paper, we intended to overcome these serious methodological flaws of the previous studies in testing this hypothesis. As such, we used various advanced econometric and time-series techniques such as co-integration and Granger causality to examine this relationship, using long time-series data for a single country, Sudan. Thus, the empirical results are expected to be much more reliable than those of any previous study on this issue.

Cross-country and individual country studies on the relationship between public expenditure and national income, based on data of annual and quarterly frequencies, have yielded mixed results. It can be pointed out that Wagner's law, as mentioned above, is truly a dynamic law that describes change over time in a particular country, whereas evidence from cross-sectional data covering many developing countries or developed and developing countries combined deals with one point in time. Studies based on cross-sectional data are therefore completely irrelevant as tests of a hypothesis because they do not agree with the very basis of the spirit of Wagner's law. Furthermore, the problems associated with the selection of heterogeneous samples of developed and developing countries, or even only developing countries whose individual problems are so profuse and structural characteristics so diversified, render the studies meaningless (Gandhi, 1971).

Most empirical studies have been conducted using inter-country cross-sectional data sets, despite large differences in the socioeconomic and demographic structures of different countries. The researchers randomly selected samples of countries with varying levels of economic development.

Generally, country-specific studies have provided support for Wagner's proposition. However, past studies raise a number of issues. First, virtually all of them were carried out in relatively economically developed countries, whereas Wagner's law was originally conceived as applicable to countries in the early stages of development. Second, many of them did not take into account the statistical properties of the data series and hence might have produced unreliable estimates. In addition, if Wagner's law is to be regarded as a long-term phenomenon, co-integration and unidirectional causality from GDP to GE should be regarded as necessary characteristics of the model (Thornton, 1999, p. 413).

Many empirical studies that tested the Wagner's law were controversial. Some studies support the Wanger's proposition, while others suggest the opposite. As Asseery, Law, & Perdikis said "One possibility for these conflicting results could be that the tests have been carried out at an aggregate level lumping all government expenditure together" (Asseery, Law, & Perdikis, 1999, p39). Few studies use disaggregated data and then it is usually only partial (Courakis et al., 1993)".

It has been stressed that to gain meaningful insights into GE behavior in the context of Wagner's law, time-series data for individual economies must be utilized. In the words of Michas " the reason why Wagner's law must be tested with time-series data for individual nations rather than with a cross section data for a group of nations is that, Wagner's law is intended to describe the Engel's curve for the government activity for a particular nation . To treat them as being at different points on the same Engle curve, which is what a cross-sectional analysis does, would be improper" (Michas, 1975, p77). Thus, there has emerged a need to test Wagner's law for individual nations using the appropriate measure. In the present study, we attempted to address these issues in the Sudan case.

As Henrekson (1992) pointed out, a test of Wagner's law should focus on the time-series behavior of public expenditure in a country for as long a time period as possible, rather than on a cross-section of countries at different income levels. Therefore, in this paper, we examined whether there is a long-term relationship between public expenditure and gross national product (GNP), along the lines suggested by Wagner's law, for the case of Sudan.

Although there have been some studies of public expenditure growth in Sudan, no public finance literature, as mentioned above, to the best of our knowledge, has applied modern econometric techniques. Thus, the present paper contributes to the literature on the growth of public expenditure in terms of Wagner's law in Sudan by applying recent econometric techniques that investigate time-series properties of the variables, using co-integration analysis, and examining the causal relationship between national income and public expenditure.

2. Method of Estimation

2.1 Versions of Wagner's Law

There are several models to explain public expenditure growth, the oldest and the most cited of which is Wagner's law. In line with the suggestion of Timm (1961), Michas (1975) argued that the appropriate version to be used in testing Wagner's law is the Musgrave version, in which the share of real GE to GDP is a function of real GDP per capita as the most appropriate functional form of Wagner's law. To derive the direct elasticity, Equation 1 is specified in double logarithmic form:

$$\text{Ln } (E/Y) = \alpha + \beta \ln (Y/N) \quad (1)$$

where β is a measure of direct elasticity (in this formulation, $\beta > 0$ supports Wagner's law);

E is the level of GE; Y is the real GDP or national income (GNP); and N is the size of the population.

The following variables are used:

$$E/Y_t = \alpha_0 + \alpha_1 \mathrm{Y/N_t} + \varepsilon_t \quad (2)$$

Wagner's law implies causality from income to GE. An opposite flow of causality is implied by Keynesian hypothesis, in which GE is exogenous and is postulated to cause changes in income. These two variables provide the most commonly used formulations for testing Wagner's law, the relationship between GDP per capita and the share of GE in GDP.

2.2. Time-Series Properties of the Series: Stationarity and Unit Root Tests

2.2.1 Stationary test. Before conducting causality tests, the variables must be found to be stationary individually, or, if both are nonstationary, they must be co-integrated. The series X_t will be integrated into order d, that is, $X_t \sim I(d)$ if it is stationary after differencing d times, so X_t contains d unit roots, a series that is I (0) (Anwar, 1996, pp. 168–160).

To determine whether a series is stationary or not, we used a unit root test developed by Fuller (1976) and Dickey and Fuller (1981), augmented Dickey and Fuller (ADF).

2.2.2. Co-integration test. Co-integration is the statistical implication of the existence of a long-term relationship between economic variables (Thomas, 1993). From a statistical point of view, a long-term relationship means that the variables move together over time, so that short-term disturbances from the long-term trend will be corrected (Manning & Andrianacos, 1993).

2.2.3. Two tests of co-integration. The γ_{max} statistic tests the null hypothesis that the number of co-integrating vectors is (r) against the alternative of (r + 1) co-integrating vectors. If the estimated value of the characteristic root is close to zero, then the γ_{max} will be small. The trace statistic, on the other hand, tests the null hypothesis that the number of distinct characteristic roots is less than or equal to (r) against a general alternative. In this statistic, the trace will be small when the values of the characteristic roots are closer to zero, and its value will be larger the farther the values of the characteristic roots are from zero. In these likelihood ratio tests, the null hypotheses are accepted if the estimated values are less than the critical values at the appropriate significance level and degrees of freedom. If the series are found to be co-integrated, then Granger causality tests are to be used.

2.2.4. Error correction model. The error correction model "developed by Engle and Granger is a means of reconciling the short-run behavior of an economic variable with its long-run behavior, i.e. correct for disequilibrium" (Gujarati, 1995, p. 730).

2.2.5. Granger's causality test. Regression analysis deals with the dependence of one variable on other variables; it does not necessarily imply causation. However, consider this situation: Suppose two variables, say G/GDP and Y/N, affect each other with (distributed) lags. It is then possible to say that real GE "causes" real GDP:

$$G/GDP_t \rightarrow Y/N_t$$

Alternatively, real GDP causes real GE:

$$Y/N_t \rightarrow G/GDP_t$$

Or, there is feedback between the two:

$$Y/N_t \rightarrow G/GDP_t \; and \; G/GDP_t \rightarrow Y/N_t$$

The Granger causality test assumes that the information relevant to the prediction of the respective variables, G/GDP and Y/N, is contained solely in the time-series data on these variables. The test involves estimating the following regressions:

$$G/GDP_t = \sum_{i=1}^{n} \alpha_i Y/N_{t-i} + \sum_{j=1}^{n} \beta_j \, G/GDP_{t-j} + \mu_{1t} \qquad (3)$$

$$Y/N_t = \sum_{i=1}^{m} \gamma_i Y/N_{t-i} + \sum_{j=1}^{m} \delta_j \, G/GDP_{t-j} + \mu_{2t} \qquad (4)$$

where it is assumed that the disturbances $\mu_{1t} \; and \; \mu_{2t}$ are uncorrelated.

Equation 3 postulates that the current G/GDP is related to past values of G/GDP itself as well as of Y/N, and Equation 4 postulates a similar behavior for Y/N.

Thus, we distinguish four cases:

(1) Unidirectional causality from (GDP) Y/N to GE: G/GDP is indicated if the estimated coefficients on the lagged Y/N in Equation 4 are statistically different from zero as a group (i.e., $\sum \alpha_i \neq 0$), and the set of estimated coefficients on the lagged G/GDP in Equation 6 is not

statistically different from zero (i.e., $\sum \delta_i = 0$; as hypothesized by Wagner's Law).

During economic development, some segments of the population are left behind and income inequality increases; therefore, governments use transfer payments to decrease this inequality. Furthermore, over time, the role of government increases through provision of public goods and improved health and education facilities, so the process of economic development causes GE to grow (Anwar et al., 1996, p. 175).

(2) Conversely, unidirectional causality from GE G/GDP to GDP, Y/N exists if the set of lagged Y/N coefficients in Equation 4 is not statistically different from zero (i.e., $\sum \alpha_i = 0$) and the set of the lagged G/GDP coefficients in Equation 3 is statistically different from zero (i.e., $\sum \delta_i \neq 0$).

From a macroeconomic perspective, a causal sequence from GE to GDP can be expected, particularly for countries at early stages of economic development, where governments invest in infrastructure to accelerate the development process. These expenditures might create a consequent increase in GDP (Anwar et al., 1996, p. 175).

(3) Feedback, or bilateral causality, might arise with interdependence between economic growth and GE, when both factors indicated above are at work, and is suggested when the sets of Y/N and G/GDP coefficients are statistically and significantly different from zero in both regressions.

(4) Finally, independence is suggested when the sets of Y/N and G/GDP coefficients are not statistically significant in both regressions. In other words, there might be no causality suggested by the analysis. Both economic growth and GE might grow, or even appear to move together, but neither influences the other, and changes in both occur due to other independent factors.

More generally, because the future cannot predict the past, if variable X (Granger) causes variable Y, then changes in X should precede changes in Y. Therefore, in a regression of Y on other variables (including its own past values), if we include past or lagged values of X and it significantly improves the prediction of Y, we can say that X (Granger) causes Y. A similar definition applies if Y (Granger) causes X.

The null hypothesis is $H_0: \sum \alpha_i = 0$, that is, lagged Y/N terms do not belong in the regression.

To test this hypothesis, we applied the F test. If the computed F value exceeds the critical F value at the chosen level of significance, the null hypothesis is rejected, in which case the lagged Y/N terms belong in the regression. This is another way of saying that Y/N causes G/GDP.

A similar step can be repeated to test Model 2, that is, whether G/GDP causes Y/N.

Before proceeding to application of the Granger test, it has to be kept in mind that the number of lagged terms to be included in regressions such as (1) and (2) is an important practical question (Gujarati, 1995, pp. 620–622).

For the ADF, co-integration, and causality tests, we used E-Views software package version 9. We used ADF tests with constants and trends, and the results are reported in Table 1. For the co-integration tests, we tried five combinations of constants and trends.

The testing procedure follows a three-step process:

Step 1: The stationarity properties of the data are examined to determine the order of integration of the series. To this end, tests for unit roots are carried out using an ADF test. Sequential tests are constructed, first testing for non-stationarity of the levels of the series around a non-zero mean, then repeating the test of the levels of the series, including a time trend in addition to the non-zero mean, and finally testing the first difference of the series for the evidence of non-stationarity around a non-zero mean. Sufficient lag lengths are included in the ADF test to eliminate serial correlation, with the number of lags and the test statistic reported in parentheses.

Step 2: Tests for co-integration of the series identified as I(1) in Step 1 using Johansen's (1988) maximal likelihood methodology are conducted.
Step 3: Granger-type causality tests augmented with the error-correction term derived from the appropriate co-integrating relationship as identified in Step 2 are carried out.

3. Empirical Model

In the present paper, we investigate the relationship between the natural logarithm of the share of GE in income G/GDP_t and the natural logarithm of per capita real income $/N_t$. The basic empirical specification models can be written as follows:

$$G/GDP_t = \alpha_0 + \alpha_1 . \mathrm{Y/N_t} + \varepsilon_t \quad (5)$$

$$LNG/GDP_t = \alpha_0 + \alpha_1 . LNY/N_t + \varepsilon_t \quad (6)$$

$$\varepsilon_t = LNG/GDP_t - \alpha_0 - \beta . \mathrm{LNY/N_t} \quad (7)$$

where ε_t represents the random disturbance term.

Support for Wagner's law would require that the elasticity of relative GE with respect to per capita real income α_1 exceed zero.

The unidirectional Granger causality from Y/N_t to G/GDP_t exists.

$$DLNY/N_t = \alpha_0 + \sum_{i=1}^{p} \beta_i . \mathrm{DLNY/N_{t-i}} + \sum_{i=1}^{p} \emptyset_i . DLNG/GDP_{t-i} + \mu_{1t} \quad (8)$$

$$DLNG/GDP_t = \delta_0 + \sum_{i=1}^{p} \omega_i . DLNG/GDP_{t-i} + \sum_{i=1}^{p} \theta_i . DLNY/N_{t-i} + \mu_{2t} \quad (9)$$

The long-term relationship between GE and GDP in the context of the hypotheses can be specified as follows:

$$lnYP_t = \beta_0 + \beta_1 lnGY_t + \varepsilon_t \quad (10)$$

where YP represents the share of GE in income, or this variable is used as a proxy for the relative size of the public sector, the total GE including transfer payments (federal, state, and local governments combined) in nominal pounds.
Regarding GY per capita real income, β_0 and β_1 are the parameters to be estimated, ε is a serially uncorrelated random disturbance term, and ln denotes natural logarithms. Support for Wagner's law would require the elasticity of total government spending with respect to real income to exceed unity (i.e., $\beta_1 < 1$). The operation of Wagner's law in Sudan would

be confirmed if $\beta_1 > 0$. On other hand, $\beta_1 < 0$ could imply adherence to the Keynesian notion.

Thus, valid tests of the above equation require that the data be stationary, that is, integrated of order zero, denoted I(0), or, if nonstationary I(1), co-integrated, and that the appropriate pattern of causality be identified.

When the null hypothesis that (r) is less than or equal to one cannot be rejected by the two test statistics, it can be concluded that there is only a single co-integrating vector in the two endogenous variable vector autoregression (VAR) system.

Data Sources and Definition of Variables

The data used in this paper are annual data taken from numerous official publications, mainly various issues of *Economic Reviews*, the Ministry of Finance and Economic Planning, and the Central Statistical Bureau of Sudan. The year 1977 was taken as the starting point. There are several reasons for the choice of this year, it being the year prior to the devaluation of the Sudanese currency. All the data series were transformed to logarithmic form to achieve stationarity in variance.

A close examination of the literature suggests that most researchers have interpreted Wagner as referring to the ratio of total public expenditure (which includes transfer payments) to GDP. Following Kuznets (1967) and North and Wallis (1982), we used total GE, including transfer payments as the appropriate measure of government. Public expenditure herein refers to that of the federal government because the overall public sector expenditure data are only available on an annual basis.

Following many researchers, such as Mann (1980), Ram (1987), and Henrekson (1990), we used per capita real income as a proxy for Wagner's broader concept of development. The variables used are defined as log GDP = logarithm of GDP per capita, and log GE = logarithm of share of general GE in total GDP. GDP and GE were at constant local market prices for the years 1977–2015.

4. Empirical Findings

In this section, we report the examination results of Wagner's law and Keynesian hypothesis in Sudan. Because for this procedure, it is appropriate to check for stationarity before examining the direction of the long-term relationship, we present the results first for the order of integration found in LNG/GDP and LNY/N.

Recent advances in time-series analysis have permitted the investigation of the long-term relationship between public expenditure and GNP in terms of co-integration analysis, error-correction mechanism, and causality testing.

Prior to assessing relationships among variables based on the concept of co-integration, their orders of integration have to be examined. Co-integration acknowledges the possibility that although a unit root might be present in individual time series, a linear combination of them might not display any unit root behavior.

Economic time series are typically integrated of order one, I(1), which implies that their non-stationarity is typically stochastic rather than deterministic. They can be rendered stationary by the first differencing.

To examine the long-term relationship between the variables given in Equation 3, I determined the stationarity of the respective time series, as well as their co-integration properties. Without a similar order of integration, causality analysis cannot be done on nonstationary variables. Additionally, causality analysis differs when variables are co-integrated. Therefore, the co-integration results will be presented and then causality investigated separately for co-integrated variables and for those that are not co-integrated.

Co-integration and causality tests are carried out only on the first-difference stationary variables. If co-integration exists, there can be no systemic divergence amongst the variables from some long-term equilibrium relationships. Co-integration constitutes a sufficient condition for causality. Hence, if variables are co-integrated, then either a unidirectional or bidirectional Granger causality relationship must exist between them.

In practice, most economic time series are nonstationary. At the informal level, a visual plot of the data is usually the first step in the analysis of any time series. The first impression from the time series plotted in Figures 1 and 2 is that they all seem to be trending upward, although the trend is not smooth, especially in the time series. These time series are in fact examples of nonstationary time series (Gujarati, 1995, p. 710).

Equation 3 is sufficient to understand that Wagner's thesis, which suggests that as a country's real per capita income rises, its public expenditure rises more than proportionately, is true for Sudan. The elasticity of public expenditure per capita with respect to per capita GDP is greater than unity, which suggests that Wagner's law was operative in Sudan during the period covered in this paper; $\beta > 0$ supports Wagner's law.

The evidence in support of Wagner's law in the case of a developing country such as Sudan can be rationalized by the following factors:

First, it is well known that as economic development unfolds, there are substantial demands for social goods and services provided by the government. During the period under study, the economy of Sudan progressed, and as such, not only did the administrative and protective roles of the government expand, but so did GE in social sectors, most notably in education and health, manifold.

Second, during the period under study, the economy of Sudan was hit by a large number of shocks. For example, the country witnessed a long-drawn war in the south from 1955 to 2005; mutiny against the government in Darfur, South Kordofan, and Blue Nile States in 2003; the secession of the southern part of the country in 2005; and the large-scale of nationalization of industries in 1972, which shattered investors' confidence. These incidents were sufficient to create uncertainty in the economy, and as a result, the private sector was hesitant to play a role in the development process. The public sector had no choice but to step in to take responsibility for the development process.

4.1.Testing for Orders of Integration

The investigation of stationarity (or non-stationarity) in a time series is closely related to the tests for unit roots. Existence of unit roots in a series denotes non-stationarity. A number of alternative tests are available for testing whether a series is stationary.

The first step of the empirical investigation is to examine the order of integration of the individual time series. The well-known unit root tests proposed by Dickey and Fuller are used.

To establish the order of integration of the variables in my data set, we employed the ADF test. The first stage of my analysis involved testing LNG/GDP and LNY/N for their order of integration using the ADF test statistics.

Phillips and Perron (1988) used a nonparametric adjustment to the Dickey-Fuller test statistics, which allows for weak dependence and heterogeneity in the error term. However, Kim and Schmidt (1990) indicated that the Phillips-Perron tests do not perform well in finite samples. Nonetheless, we performed the Phillips-Perron tests, and the results confirmed our findings using the ADF tests (Payne & Ewing, 1996). These results are presented in Tables 1 and 2.

Table 1: *ADF Unit Root Tests*

Variable	Levels	First Differences	Second Differences
GY	-0.167	-6.32*	
YP	-1.43	-2.69	-8.50*

Notes. Critical values for the ADF unit root tests were drawn from MacKinnon (1991).
* significant at the 1% level; ** significant at the 5% level; *** significant at the 10% level.

In the case of the levels of the series, the null hypothesis of non-stationarity cannot be rejected for any of the series. Therefore, the levels of all series are nonstationary. Applying the same tests to first differences

to determine the order of integration, the critical value(s) is (are) less (in absolute terms) than the calculated values of the test statistic for all series in all cases. This shows that not all of the series are integrated of order one {I(1)} and become stationary after differencing once. Because not all of the series are integrated of the same order, the series cannot be tested for the existence of a long-term relationship between them (i.e., a co-integration relationship).

Theoretically, the GDP series might be more vulnerable to external shocks, especially for small least developed countries (LDCs) that export primary goods or are dependent on imports. The prices and markets of these primary goods fluctuate substantially over time and can have a material influence on GDP. This in turn affects imports of capital inputs, which determine the level and growth of GDP. On the other hand, GE is controlled by the government and probably shows less dramatic changes over time. That is why GDP and GE might not be integrated of the same order (i.e., integrated of different orders; Anwar et al., 1996, pp. 171–172).

4.2.Causality Results

The next step of the analysis is to test for causality between GDP and GE. The lack of co-integration implies there will be no Granger causality in any direction. Causality studies based on Wagner's reasoning are hypothesized to run from GNP (and/or GNP/P) to the dependent variable, which takes four different forms: E, C, E/P, and E/GNP. We also looked at the Keynesian approach, which assumes that causality is hypothesized to run from public expenditure to GNP. Wagner's law requires that public expenditure does not cause GNP, because of which it is necessary to apply bivariate causality. The null hypothesis of non-causality was tested using F-statistics. The results of the F-tests are presented in Table 2.

Table 2: *Granger's Causality Test*

Direction of Causality	F-Statistic	*P*-value of F	Decision
Y/P → G/GDP	0.168	0.85	Do not reject
G/GDP→Y/P	0.59	0.56	Do not reject

Because the calculated F is greater than the tabulated F, we cannot reject the null hypothesis. Consequently, the results in Table 2 indicate that there is no evidence to support either Wagner's law in the Musgrove version or the Keynesian hypothesis. In this paper, we have demonstrated that the coefficient of YP is less than unity. The present empirical results support neither the Wagner's law postulate that as economic activity grows, there is a tendency for government activities to increase, nor the views of the Keynesian state, according to which fiscal policy variables are major determinants of economic growth.

Empirical studies about the relationship between public expenditure and economic growth have obtained conflicting results. Some of them found a positive correlation between public spending and economic growth, and others found no significant relationship. General studies of the relationship have not produced robust results because the results of many are sensitive to small changes in model specification (Guandong & Muturi, 2016; Levine & Renelt, 1992).

Regarding the comparison of the present results with studies on Sub-Saharan African countries, they are consistent with the study done by Ansari et al. (1997), who found that there is no long-term relationship between GE and national income in Ghana, Kenya, and South Africa. On the other hand, the present results contradict those found by Salih (2012) for Sudan, which supported Wagner's law in the short term only. They are also inconsistent with those obtained in the study by Muse, Olorunleke, and Alimi (2013) for Nigeria and by Ebaidalla (2013) for Sudan, which supported both Wagner's law and the Keynesian hypothesis, as well as those obtained by Gadinabokao and Daw (2013) for South Africa, which provided support for the Keynesian view.

5. Conclusion and Policy Implications

Our main purpose in this paper was to test for Granger causality between GE and economic growth (testing of Wagner's law and the Keynesian hypothesis) by using aggregate data for Sudan covering the period of 1977–2016. We tested for the existence of unit roots by ADF. We found that both the public expenditure (GY) and GNP (YP) variables were nonstationary in levels, but (GY) stationary in first differences and (YP) in the second differences; that is, they were not integrated of the same order {I (1)}. Consequently, we could not apply a co-integration test.

Although there is some evidence that public expenditure and GDP are nonstationary and not co-integrated in this study, it is still possible to apply the Granger causality test, using I (0) series (i. e., first difference in this case).

In the absence of co-integration between variables, it still remains of interest to examine the short-term linkages between them. We tested the causality by using the Musgrave model of Wagner's law. However, there is no evidence to support either Wagner's law in this model or Keynes' hypothesis. Over the period of analysis, GE increased relative to national income because of people's continuous demand for more and better public goods and services, which can only be provided by the public sector due to market failure.

Based on our findings, one could tentatively suggest that the growth of public expenditure in Sudan is not directly dependent on and/or determined by economic growth, as Wagner's law states. Of course, public expenditure is the outcome of many decisions in light of changing economic and political circumstances. It is shaped by decisions about how public expenditure should be distributed among competing groups, whether geographically concentrated or aggregated in organized interests. Thus, other factors such as political processes, interest group behavior, and the nature of Sudan development can be considered possible explanatory variables for the increase in the size of public expenditure.

This empirical study does not support either the Keynesian or Wagner hypothesis in Sudan for the study period. The implication of this study is that expenditure is not an important tool for achieving growth in Sudan.

This implies that an increase in GE or expansion in the public sector is not a determinant of economic growth. The inconsequential impact of government spending on the economic growth of Sudan could be attributed to high rates of corruption, misappropriation of public funds, and continuous excess of recurrent expenditure over capital expenditure over the years. This indicates that the government should strengthen its efforts to curtail corruption, as well as implement stricter checks and controls in its agencies to reduce or eliminate the profligacy of public funds. Additionally, the government should increase its investment in productive sectors, specifically agriculture and manufacturing, and invest more in capital projects.

We found no evidence for Wagner's law using aggregate data for Sudan. However, it is possible to examine disaggregated data to investigate public expenditure growth in Sudan in terms of Wagner's law.

Because this law suggests that public expenditures grow more than proportionately with the level of economic development, financing these expenditures has always been a major problem for developing economies. Sudan is no exception. Although public expenditure grew more than proportionately vis-à-vis the level of per capita income, public revenues were not commensurate with the rise in expenditure. As a result, overall deficit grew, leading to the entire development expenditure and a part of non-development expenditure being financed by borrowing from the banking system, non-bank sources, and external borrowings. These, in turn, increase the burden of debt servicing and further widen the budgetary deficit.

For a developing country such as Sudan, where the public sector plays a dominant role in managing the economy, it is not possible to restrain the trend of continuous growth of public sector expenditure. Aside from the responsibilities of providing administrative, protective, and social goods and services to citizens, the public sector in Sudan has become the major source of employment generation in recent years.

What is required at this stage is prudent fiscal management that can generate domestic resources, reduction in nonproductive expenditure, and maintenance of the budgetary deficit at a level consistent with other macroeconomic objectives such as controlling inflation, promoting private investment, and so on.

The present paper suggests that strong inferences from time series data can be drawn only if data for a longer time period are available. Unit root and co-integration tests are very sensitive to the number of observations. Structural changes in an economy over the years also changes the results of these tests. For this paper, data were available only for 38 years, which is not quite long enough, and over this period, the Sudanese economy also underwent structural changes. Future studies could examine the role of disaggregated data in explaining public expenditure growth in Sudan.

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Figure 1

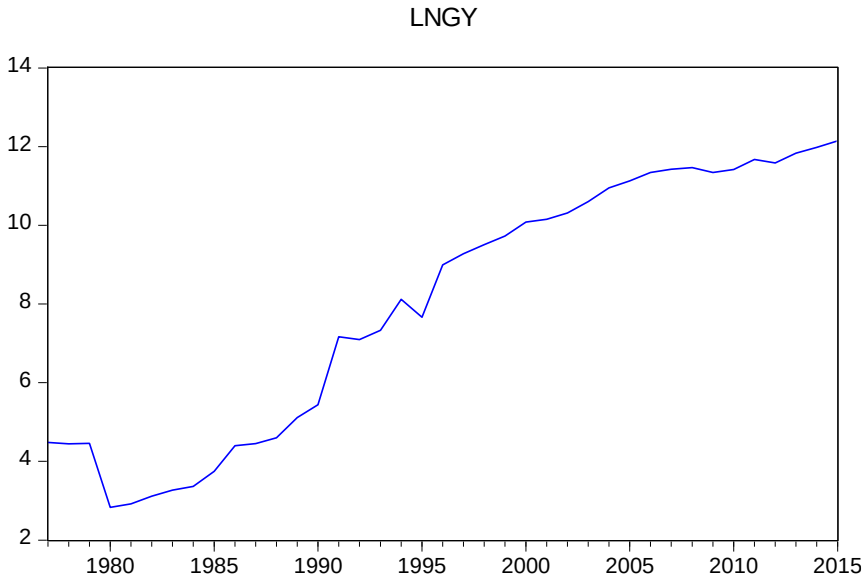

Figure 2

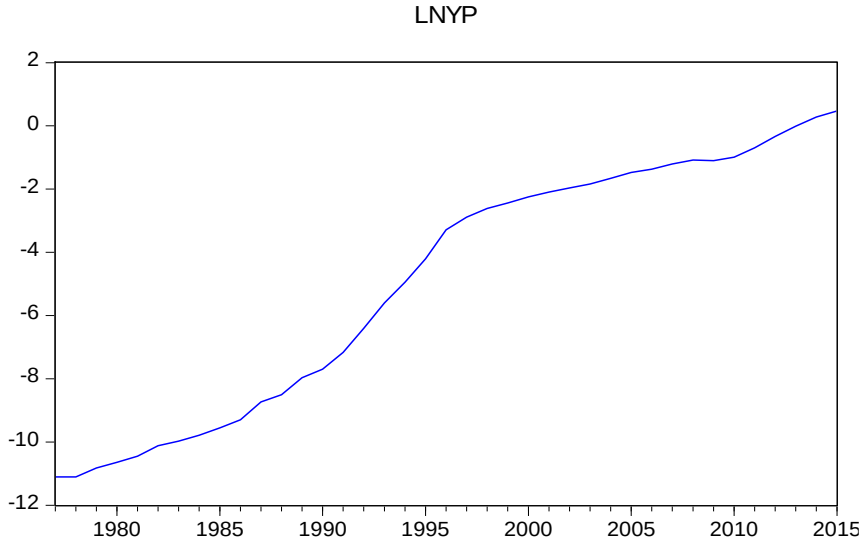

Figure 3

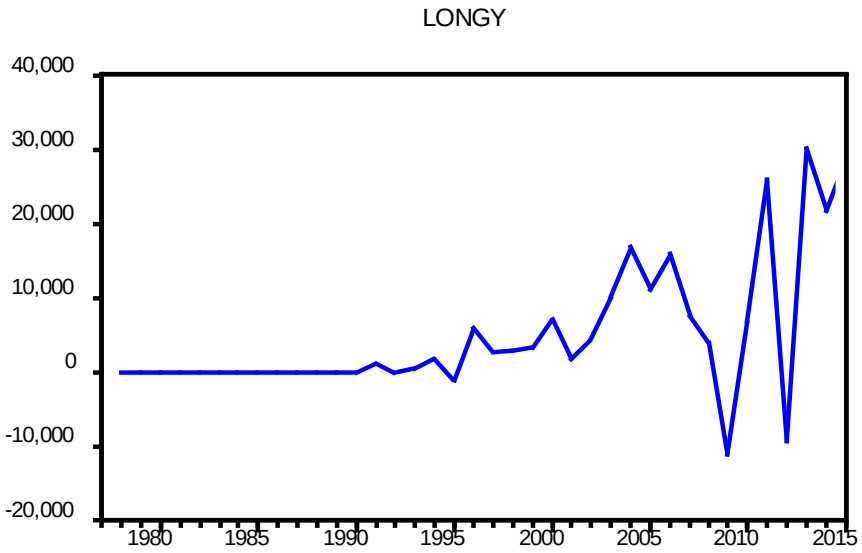

Figure 4