J. King Saud Univ., Vol. 14, *Admin. Sci.* (2), pp. 105-114, Riyadh (1422/2002)

A Time-series Analysis of the Relationship between Government Expenditure and GDP in the Kingdom of Saudi Arabia (1965-1996)

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(Received 4/2/1421 H; accepted for publication 19/11/1421 H)

Abstract. The main objective of this paper is to examine statistically the causal relationship between government expenditure and gross domestic product in Saudi Arabia over the period 1965-1996. The study applies recent developments in time-series analysis to test statistical characteristics of both variables. The stationarity and cointegration tests indicate that government expenditure and GDP are first-difference stationary and cointegrated. The Granger causality statistical results provide some evidence of a unidirectional causation running from gross domestic product to government expenditure in Saudi Arabia over the period of 1965-1998.

Introduction

The relationship between government expenditure (GTE) and gross domestic product (GDP) has been subject to extensive research both in the public finance literature and in the literature dealing with macroeconomic modeling. In public finance the most famous early theory is Wagner's law of expanding state activity. This "law" reflects the importance of government activity and expenditure as an inevitable feature of a progressive state [1]. In its modern form, Wagner's law is formulated as follows: government expenditure tends to rise as gross domestic product increases because of (1) expansion of protective and administrative government functions; (2) expansion of government activities pertaining to education and culture, and (3) the increasing tendency toward monopoly because of technological progress and increasing returns to scale which need to be offset by government action [1,2]. Wagner's law is often considered to represent a long-term relationship between government spending and national income in countries which are in the early stages of the development [3]. The implication of Wagner's law is that causation runs from GDP to government

expenditure. A more important implication of this law, however, is that government spending "does not qualify as development finance because it plays no role in economic growth" [3].

Public expenditure in growth literature, on the other hand, is treated as "autonomously determined and exogenously given". Hence, in most macro-economic models public expenditure becomes a policy variable which can affect growth and development [3]. The multiplier concept in all Keynesian models is based on this particular feature of public expenditure. This is referred to as the Keynesian hypothesis which is considered to represent a short-term relationship. To the extent that government mainly responds to the aggregate level of economic activity and acts as a policy variable, statistically the causality is expected to run from government expenditure to gross domestic product [4].

A number of studies have examined empirically the causal relationship between government expenditure and gross domestic product. Unfortunately the outcome of these studies has been inconclusive. Ahsan, Kwan and Sahni (1990), for instance, have noted that in the case of the US, the reported results range the full continuum from no causality to bi-directional causality between these two variables [5]. The diversity in results might be due to differences in the nature of underlying data, test procedure and the periods studied [4,6].

In this study we apply recent developments on time-series analysis to shed new light on the causal relationship between gross domestic product and government expenditure in Saudi Arabia over the period 1965 to 1996. There is a strong belief that the government expenditure plays a major rule in the Saudi Arabian economy. The government owns the oil sector, which in turn has its influence on the national economy through the government expenditure variable. Thus it is expected that statistical results will show that the evidence in favor of the Keynesian hypothesis is stronger than that for Wagner's law.

A cointegration test suggested by Engle and Granger and Granger causality test are employed to determine the causal relationship between gross domestic product and government expenditure. The vector autoregressive model is applied to get the impulse responses between the variables in the study. Akaike's final prediction error (FPE) is used to determine the appropriate lag length for each variable. The rest of the study is organized as follows. In section II the econometric methodology and statistical results are addressed; and section III provides some concluding remarks.

II. The Econometric Methodology and Statistical Results

A necessary condition for examining the direction of causality between government expenditure and GDP, in the sense of Granger is that the relevant information is entirely

contained in the present and past values of these variables [4]. In more formal terms the Granger causality test is based on the following regression:

$$x_t = \alpha_0 + \sum_{i=1}^{r} \beta x_{t-i} + \sum_{i=1}^{s} \beta y_{t-i} y_{t-i} + \varepsilon_t \quad (1)$$

The null hypothesis that y does not Granger cause x is rejected if the coefficients, βy_{t-i} in equation (1) are jointly significant, based on a standard F-test. The null hypothesis that x does not Granger cause y is rejected if βx_{t-i} are jointly significant in equation (1), when x is replaced by y as the left-side dependent variable.

However, as Nelson and Plosser [7] have shown, most economic time series variables are non-stationary. To determine whether the series are stationary or not one should apply one of the stationarity tests. In this study the augmented Dickey-Fuller test was applied and then the cointegration of the variables used here is examined.

II.1 Stationarity and cointegration tests

A series is said to be integrated of order d, denoted I(d), if d is the number of times the series must be differenced to achieve stationarity [8]. Thus, an I(1) series must be differenced once to induce stationary, while an I(0) series is stationary. An I(1) also indicate the series contains one unit root. One formal test for the hypothesis that the time series is an I(1) involved an augmented Dicky-Fuller (ADF) unit root test based on the equation

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{t-i}^{k} \Delta y_{t-i} + \varepsilon_t \quad (2)$$

where y is the series being tested, and k is the number of lagged differences included to capture any autocorrelation. The test is a pseudo-t- statistic for the null hypothesis that $\beta = 0$. The results of the ADF tests are reported in the Table 1.We include a constant but no trend as recommended by Dickey, Bell and Miller [9].

Table 1. Augmented Dickey-Fuller (ADF) test for unit roots

Series	ADF test		
	Level	1st. differences	K
GDP	1.971	4.455**	1
GTE	3.421**	6.004**	1
GDP	1.416	3.079**	2
GTE	2.694	4.640**	2
GDP	1.573	3.150**	3
GTE	2.300	6.066**	3
GDP	1.620	2.403**	4
GDP	1.342	3.454**	4

** Significant at the 5 percent level.

From the results we conclude that non-stationarity cannot be rejected for the levels of most of the cases at the 5-percent significance level based on the augmented Dickey-Fuller test. In contrast when data are differenced, non-stationarity can be rejected in all cases. Thus one can say that both GDP and GTE are I(1).

Finding that both variables have the same order of integration implies that both variables move together over time and thus there is a linear combination of the series so that they are bound in a long-run equilibrium relation. Engle and Granger refer to this characteristic as cointegration [10]. A cointegration test, therefore, is needed to detect any stable long-run relations between two or more variables. Assuming that the original variables in the cointegration equation are integrated of order k, cointegration among these variables requires that the residuals must be found integrated of order q where $q \prec k$ [3]. Thus, it is essential that the residuals of the cointegrating regression are stationary, i.e. I(0). To establish the stationarity of the residuals the following equation is estimated

$$TGE_t = \alpha_0 + \beta GDP_t + \varepsilon_t \qquad (3)$$

The result of this test with one lagged dependent variable is shown below, Table 2.

Table 2. Test results of the cointegration equations

Dependent variable	Independent variable	DW	R-squared	ADF
GTE	0.541GDP	0.603	0.826	-2.850*
GDP	1.526GTE	0.635	0.826	-3.234**

* Significant at the 10 percent level, ** Significant at the 5 percent level
- DW is Durbin-Watson Statistic

It is obvious from the results that the stationary of the residuals ε cannot be rejected at the 10% level. Thus, one can conclude that GDP and GTE are found to be cointegrated. In other words, there is a long-term equilibrium relationship between the gross domestic product and government expenditure in Saudi Arabia .

II.2 Testing for causality

Having established that the government expenditure and gross domestic product are cointegrated, let's turn now to examine the existence and direction of causality. Although there are many parametric and non-parametric forms for causality, the Granger form is used because of its popularity in the economic literature and, in particular, in these types of studies [10]. According to Assery "one important implication of the Granger representation theorem is the superconsistency property that can be used to formulate Granger causality with I(1) variables" [11]. The regression used to examine the causality are:

$$GTE_t = \alpha + \sum_{r=1}^{r} \beta_i GTE_{t-i} + \sum_{s=1}^{s} \lambda_i GDP_{t-i} + \varepsilon_t \qquad (4)$$

$$GDP_t = \delta + \sum_{r=1}^{r} \gamma_i GTE_{t-i} + \sum_{s=1}^{s} \zeta_i GDP_{t-i} + \varepsilon_t \quad (5)$$

where ε_t in equations 4 and 5 is zero-mean serially uncorrelated, constant variance residual term.

Equation (4) is used to examine that causality runs from GDP to government expenditure (Wagner's Law), where equation (5) is used to examine that causality runs from government expenditure to GDP (The Keynesian hypothesis). As mentioned before the null hypothesis that GDP does not Granger cause government expenditure is rejected if the coefficients, λ_i, in equation (4) are jointly significant, based on a standard F-test. Similarly, the null hypothesis that government expenditure Granger- causes GDP is rejected if the coefficients, γ_i in equation (5) are jointly significant. It is important to determine the appropriate lag length before running our equations. On the basis of minimizing Akaike final prediction error (FPE), it is obvious that the appropriate values of r and s in equations (4) and (5) are 2, 1, 1 and 3 respectively. See Table 3.

Table 3. Akaike information criterion

Dependent varible GTE_t			Dependent variable GDP_t		
GTE_{t-1}	GDP_{t-1}	FPE	GTE_{t-1}	GDP_{t-1}	FPE
3	3	20.52	3	3	21.57
3	2	20.45	3	2	21.68
3	1	20.39	3	1	21.95
2	3	20.45	2	3	21.50
2	2	20.34	2	2	21.61
2	1	20.27	2	1	21.77
1	3	20.44	1	3	21.44
1	2	20.32	1	2	21.47
1	1	20.27	1	1	21.77

The statistical results of equations (4) and (5) are presented in Table 4. Based on these results, it can be show that there is some evidence of the existence of Wagner's law in Saudi Arabia. The estimated coefficient of GDP_{t-2} is statistically significant with expected sign and greater than one. This finding is important since it does not only imply the existence of the positive relationship between gross domestic product and government expenditure but also indicates that the change in government expenditure is greater than the change in gross domestic product. The existence of causal relationship between gross domestic product is supported by the statistical finding on the Table 5 (Wald statistics test).

Table 4. Regression results of equations 4 and 5

	GTE_t	GDP_t
Constant	3999.899 (0.393)	37121.43 (0.095)
GTE_{t-1}	0.957 (3.827)**	0.072 (0.847)
GTE_{t-2}	-0.285 (-1.537)	
GDP_{t-1}	0.160 (1.947)*	1.574 (6.599)**
GDP_{t-2}		-1.109 (-3.499)**
GDP_{t-3}		0.0403 (1.665)
R^2	0.928	0.915
DW	1.735	1.933
SE	23868.23	41724.57

- "t" statistic in parentheses.
** Significant at the 5 percent level. * Significant at the 10 percent level.
- SE is the standard error of the regression

Table 5. Wald statistics for testing the direction of causality

Null hypothesis	Wald statistics
$\sum_{i=1}^{2} \lambda_i = 0$	F=3.790(0.063) χ^2 =3.790(0.051)
$\sum_{i=1}^{2} \gamma_i = 0$	F=0.078(0.847) χ^2 =0.0378(0.846)

On the other hand there is no evidence one can get to support the Keynesian hypothesis. This finding is obvious from the statistical results of equation (5) and the Wald statistic test.

To sum, while the results seem to be in contradiction with the Keynesian hypothesis, the statistical results together with the existence of a long-term relationship between government expenditure and gross domestic product confirm that the government expenditure was dependent on gross domestic product in Saudi Arabia over the period 1965-1996.

II.3 Impulse responses analysis

In order to analyze the dynamic effects of the impact of unitary shocks on government expenditure and gross domestic product, we apply the vector autoregressive model (VAR) [11, pp.161-164]. In the bivariate case, the VAR model takes the form:

$$\begin{bmatrix} \alpha_{11}(L) & \alpha_{12}(L) \\ \alpha_{21}(L) & \alpha_{22}(L) \end{bmatrix} \begin{bmatrix} GTE_t \\ GDP_t \end{bmatrix} = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \qquad (6)$$

where GTE_t and GDP_t are two separate time series, L is the lag operator, α_{ij} are the lag polynomials, and ε_{it} are uncorrelated error terms. Since equation (6) is considered to be an unconstrained bivariate causal system, we can test for the statistical significance of the coefficients of α_{ij} in order to determine the existence of a causal link between GTE and GDP. The statistical results of the VAR model seem to be consistent with the empirical

findings in the previous section. They indicate a unidirectional causality running from GDP to the government expenditure in Saudi Arabia over the period 1965-1996. See Table 6.

Table 6. Vector autoregression statistical results

	GDP	GTE
Constant	46066.68	4861.38
GDP_{t-1}	1.378 (7.135)**	0.2077 (1.934)*
GDP_{t-2}	-0.7604 (-3.420)**	-0.0865 (-0.700)
GTE_{t-1}	0.175 (0.384)	0.9650 (3.812)**
GTE_{t-3}	0.2904 (0.785)	-0.2271 (1.105)
R^2	0.916	0.929
SE	43396.78	24125.94

-"t" Statistic in parentheses.
**Significant at the 5 percent level. *Significant at the 10 percent level
- SE is the standard error of regression

Figures 1 and 3 show the time paths or impulse responses of GDP to a unitary shock in the standard deviation of GDP and government expenditure, and Figs. 2 and 4 present impulse responses of government expenditure to a unitary shock in the standard deviation of GDP and government expenditure. The responses are presented by the connected lines, whereas the dotted lines present the confidence intervals with two standard errors. It appears from Figs. 1 and 3 that GDP responds to the unitary shock in GDP and government expenditure. Meanwhile it should be pointed out that government expenditure responds immediately starting at point zero to a unitary shock in GDP, while the GDP response to government expenditure take a while. The figures indicate that during the latest periods of time the impulse responses become stable, which reflects the stability of the estimated model.

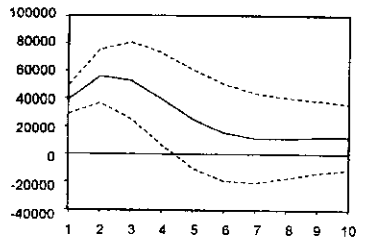

Fig. 1. Response of RGDP to RGDP.

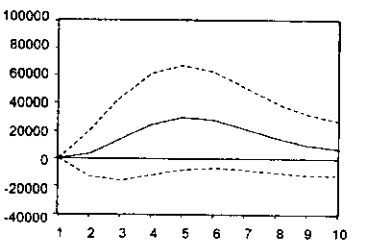

Fig. 2. Response of RGDP to RGTE.

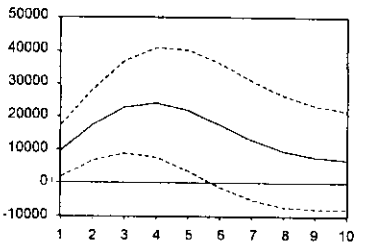

Fig. 3. Respnse of RGTE to RGDP.

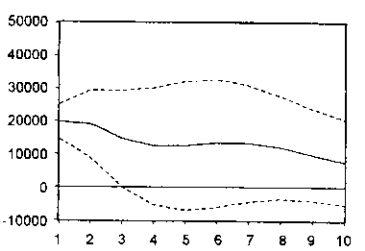

Fig. 4. Response of RGTE to RGTE.

Summary and Conclusion

The primary objective of this study is set to examine empirically the causal relationship between government expenditure and gross domestic product in Saudi Arabia over the period 1965-1996. The objective of the study has been carried out within the Wagner-Keynesian framework. In the public finance literature, the change in government expenditure is treated as an increasing function of the change in GDP, but macroeconomic models consider government expenditure as exogenously given. While the first characterization renders government expenditure policy ineffective, the second characterization makes it an effective instrument of policy. The study uses recent advances in time-series analysis to examine the statistical characteristics of both variables. Stationarity and unit roots tests indicate that government expenditure and GDP in our sample are non-stationary in the levels but are first-difference stationary. The cointegration test shows that the two time series are cointegrated. The study then examines the direction and pattern of the causal relationship between the two variables. The results indicate a unidirectional causation running from GDP to government expenditure. Thus, our findings seem to support the existence of Wagner's law in Saudi Arabia, which implies that government expenditure in Saudi Arabia is dependent on GDP and ineffective as a policy instrument. The impulse response analysis shows that both variables GDP and government expenditure respond to shocks in either variables in the study. However, it should be pointed out in that spite of the contribution which have been provided, results are limited and further research is obviously needed in this area.

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تحليل السلاسل الزمنية للعلاقة بين الإنفاق الحكومي والناتج المحلي الإجمالي في المملكة العربية السعودية في الفترة ١٩٦٥-١٩٩٦م

علي بن عثمان الحكمي

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(قدم للنشر في ١٤٢١/٢/٤هـ ؛ وقُبل للنشر في ١٤٢١/١١/١٩هـ)

ملخص البحث. تهدف هذه الورقة إلى تحليل العلاقة السببية بين الإنفاق الحكومي والناتج المحلي الإجمالي في المملكة العربية السعودية خلال الفترة من ١٩٦٥ إلى ١٩٩٦م. تم في هذه الدراسة تطبيق النهج الجديد في تحليل السلاسل الزمنية للوقوف على الخصائص الإحصائية لكل من الإنفاق الحكومي والناتج المحلي الإجمالي. وتوضح نتائج اختباري جذور الوحدة والتكامل المشترك أن الإنفاق الحكومي والناتج المحلي الإجمالي يتصفان بخاصية الجذور الوحدوية وأنهما على علاقة تكاملية مشتركة. وتقدم النتائج الإحصائية لنموذج قرانجر السببي بعض الدلائل على أن هناك علاقة سببية تتجه من الناتج المحلي الإجمالي إلى الإنفاق الحكومي خلال فترة الدراسة.