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National Income and Government Spending:

Co-integration and Causality Results for the Dominican Republic

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Abstract

This study investigates Wagner's Law and the Keynesian hypothesis on the relationship between national income and government spending in the Dominican Republic during the periods of 1960-1984 and 1985-2005. Using the 'bounds' testing approach to the analysis of level relationships of Pesaran *et al*. (2001) and a method developed by Bårdsen (1989) to derive long-run coefficients, the results show the existence of a co-integrated relationship between gross domestic product and government consumption expenditure during the period 1960-1984. The estimate of the long run coefficient shows that a one percent increase in gross domestic product produced a 1.39 percent increase in government consumption spending. Moreover, Granger Pairwise causality tests show causal linkages running from gross domestic product to government consumption expenditure. The findings for the 1985-2005 period also confirm the presence of co-integration between gross domestic product and government consumption spending. However, the elasticity is below unity (+0.78). There is also evidence of causality from gross domestic product to government consumption spending. Combined, all these results show that Keynes's hypothesis is found not to be valid for the case of the Dominican Republic.

Key words: Wagner's Law, Keynesian hypothesis, national income, public spending, error correction model, 'bounds' test, Granger Pairwise causality

1.Introduction

The analysis of the relationship between public expenditure and national income has been approached from two distinct perspectives. The classical view, espoused by Adolph Wagner (1883), argues that the process of economic growth is the fundamental determinant of state expenditure. Thus, according to 'Wagner's law' causality runs from economic growth to public expenditure. On the other hand, the Keynesian position contends that government spending is an effective policy tool for generating economic growth especially during periods of cyclical downturns. Consequently, the causal linkage runs from public spending to an expansion of national income. These contending hypotheses on the relationship between national income and

government spending have recently been the focus of empirical tests. Narayan et al. (2008) examined it for Fiji for the period 1970-2002. Using the Johansen test for co-integration, they find one co-integration relationship between national output and government expenditure. Using five different long run estimators, they obtain robust results on the impact of national income on government expenditure. Moreover, they find that in the long run national income Granger causes government expenditure. Samudram et al. (2009) investigate the Keynesian view and Wagner's Law on the role of public expenditure on economic growth for Malaysia for the period 1970-2004. The empirical results using the 'bounds test' approach to co-integration of Pesaran et al. (2001) find evidence of a long run relationship between total expenditures and Gross National Product. The results also show that the long run causality runs from GNP to government expenditures, which supports Wagner's Law. Iniguez-Montiel (2010) examines the relationship between government expenditures and national income in Mexico for the period 1950-1999 and finds a co-integrated relationship between the variables. He also finds unidirectional causality running from GDP to government spending. Thus, validating Wagner's Law. Rehman et al. (2010) examine the nature and the direction of causality in Pakistan between national income and public expenditure for the period of 1971-2006. The findings show unidirectional causality running from GDP to government expenditure, which supports Wagner's Law.

The objective of this study is to examine the validity of Wagner's Law and the Keynesian hypothesis for the Dominican Republic under alternative growth regimes during the periods of 1960-1984 and 1985-2005. The first period was characterized by an inward-oriented industrialization (IOI) approach directed at increasing production of nondurable consumer goods for an import-protected domestic market on the basis of subsidized imported intermediate and capital goods (World Bank 1985). By contrast, the second period, which began in the early 1980's when in response to a deceleration of growth and balance of payments difficulties attributed to trade distortions caused by the inward-oriented model the Dominican government began to put into practice an outward-oriented industrialization strategy (OOI) strategy designed to promote economic growth by expanding exports of light manufactures, non-traditional and agro-industrial products with a high content of domestically-produced inputs and by reducing the demand for imports of substitutable non-capital goods (World Bank ibidem). The approach is as follows. First, we use the recently developed 'bounds' testing approach to the analysis of level relationship of Pesaran *et al*. (2001) to investigate the existence of a co-integration relationship between national income and public consumption expenditure. Second, we estimate the long run coefficient of the responsiveness of government consumption spending to output expansion using a method developed by Bårdsen (1989) for error correction models. Thirdly, we use Granger Pairwise causality tests to determine the direction of causality among the variables of interest. The rest of this study is organized as follows. The model, variables and data used in the study are presented in the section titled "The Model, Data Sets, Variables, and Data Sources." The method employed to conduct the empirical analysis is discussed in the " Econometric Methodology" section. Empirical results are discussed in the section titled "Gross Domestic Product and Government Consumption Spending – Empirical Results." The "Conclusion" section summarizes the key findings of the study.

2.The Model, Variables, and Data Sets, and Data Sources

Following Iniguez-Montiel (2010), the 'Peacock-Wiseman Traditional Version' of Wagner's Law was used to test the validity of Wagner's Law and Keynes's hypothesis on the relationship between the growth of national income and government consumption spending:

$$Gc = f(Y) \qquad (1)$$

where: Y is real gross domestic product and Gc represents real government consumption spending. The empirical analysis uses annual statistics. In line with Serrano et al. (1999) the data used in the econometric analysis were converted into index numbers with 1960 and 1985 equal 100. Data on the Dominican Republic's gross domestic product and government spending were downloaded from the Dominican Central Bank's web site. They are available in constant 1970 pesos for the 1970-2005 period. Data for the pre-1970 period were obtained from Ceara-Hatton (1986).

3.Econometric Methodology

The methodological framework for conducting the empirical analysis uses the recently developed 'bounds' testing approach to the analysis of level relationships of Pesaran et al. (2001). These researchers have developed a method for the analysis of time series that takes into consideration whether the variables under consideration are stationary or non-stationary. Failure to take into account the time series properties of the underlying variables can lead to spurious results and invalid inferences. One way to avoid the problems of 'spurious results' is to estimate a dynamic function which includes lagged dependent and independent variables, i.e., an error correction model (ECM). Pesaran *et al*. (2001) have extended and formalized an unrestricted error correction model (UECM) approach to test for the existence of co-integration between the dependent variable and its determinants. The theoretical logic behind the concept of co-integration is that although the dependent variable and its determinant(s) may be individually non-stationary, over the long-run they will nonetheless tend to move together, so that a linear combination of them will be stationary (Engle and Granger 1987). Moreover, "[d]ata generated by such a model are sure to be co-integrated" (Granger 2004:422). This follows directly from Granger's Representation Theorem which states that if the dependent variable and the independent variable(s) are co-integrated, then an ECM representation generates co-integrated series (Engle and Granger ibidem). According to Harris (1995:25), "the practical implications of Granger's theorem for dynamic modelling is that it provides the ECM with immunity from the spurious regression problem, provided that the terms in levels co-integrate."

The method developed by Pesaran et al. (2001) has been chosen to conduct the empirical analysis of this research project because it offers the following advantages over alternative procedures. It can be reliably used to estimate and test hypotheses on the long-run coefficients irrespective of whether the underlying regressors are purely $I(0)$, purely $I((1)$, or mutually co-integrated. Therefore, unlike other applications of co-integration analysis, which require that the order of integration of the underlying regressors be ascertained prior to testing the existence of a long-run relationship between the dependent variable and the independent

variables, this method does not necessitate a precise identification of the order of integration of the underlying data. It thus eliminates the uncertainty associated with pre-testing the order of integration; this can be particularly troublesome in studies that have a small sample size as is the case in the present study. Simulations conducted by Pesaran and Shin (1997) found that it outperformed other estimators in most experiments, especially those involving small samples.

Thus, Wagner's hypothesis of the relationship between gross domestic product and government spending can be represented by the following UECM equation:

$$\Delta \log Gc = \chi_0 + \chi_1 \log Y_{t-i} + \chi_2 \log Gc_{t-i} + \sum_{i=0}^{k_3} \chi_3 \Delta \log Gc_{t-i} + \sum_{i=0}^{k_3} \chi_4 \Delta \log Y_{t-i} + \sum_{i=1}^{k_3} \chi_5 \Delta \log Gc_{t-i} + e \quad (2)$$

where Gc and Y stand for the growth of government consumption spending and gross domestic product, respectively, and e is the error term. In performing the UECM estimation, the maximum number of lags of the level variables is set equal to one, and on the first-differenced variables the process starts off from a maximum of three lags, then the optimum number is chosen based on the Akaike's Information Criterion (AIC), the Ramsey RESET test, and the adjusted R^2. Thus, the formulation with the lowest AIC, the Ramsey RESET test results for the best-fit specification, and the highest adjusted R^2 is selected. The test for the existence of co-integration between the terms in levels is conducted by means of a Wald F-test as follows:

$H_o : \chi_1 = \chi_2 = 0$ (no co-integration exists)
$H_A : \chi_1 \neq \chi_2 \neq 0$ (co-integration exists)

Pesaran et al. (2001) provide two sets of critical value bounds covering the two polar cases of the included lagged level explanatory variables (Table 1 below). If the computed Wald F-statistic falls below the lower bound (indicating that $\chi_1 = \chi_2 = 0$), then this would lead us to conclude that there is no co-integration between overall output growth and government spending. If, on the other hand, the computed F-statistic exceeds the upper bound of the critical value (signifying that $\chi_1 \neq \chi_2 \neq 0$), then the alternative hypothesis of co-integration between gross domestic product and government spending will be accepted. However, if the computed F-statistic falls within the respective critical bound values, then the inference of co-integration, or the lack thereof, between the dependent variable and its determinants will be inconclusive, and the order of integration of the regressors would need to be determined before any statistically valid inferences can be made.

Table 1. Critical value bounds for the Wald *F*-statistic

Level of Significance	Lower Bound Value *I*(0)	Upper Bound Value *I*(1)
1%	6.84	7.84
5%	4.94	5.73
10%	4.04	4.78

Source: Pesaran et al. (2001), Table C1.iii:Case III: Unrestricted intercept and no trend.

After establishing a co-integration relation between the variables, following Bårdsen (1989), the long-run elasticity of government consumption spending to variations in gross domestic product (μ) is $-(\chi_1/\chi_2)$. Wagner's Law requires that $\mu > 1$. The next step involves estimating the entire model by using ordinary least squares (OLS). In performing the UECM estimation, the maximum number of lags of the levels variables is set equal to one, and on the first-differenced variables the process starts off from a maximum of three lags, then the optimum number is chosen based on the Akaike's Information Criterion (AIC), the Ramsey RESET test, and the adjusted R^2. Thus, the formulation with the lowest AIC, the Ramsey RESET test results for the best-fit specification, and the highest adjusted R^2 is selected.

4.Gross Domestic Product and Public Consumption Spending – Empirical Results

The estimates of examining the relationship between the growth of gross domestic product and government consumption spending for the 1960-1984 sub-period are presented in Table 2. The Wald *F*-statistic is 6.19 and exceeds the upper bound value at 5 and 10 percent levels of significance (see Table 1 above). The result presented shows that a one percent increase in GDP growth produced a 1.39 percent increase in government consumption spending. The coefficient of determination (R^2) shows that this equation explains 72 percent of the variation in the rate of government consumption spending to aggregate output. The estimated equation passes the battery of diagnostic tests up to third order. The Breusch-Godfrey's LM test for serial correlation rejects the presence of serial correlation. The ARCH test rejects the existence of first and second order heteroskedasticity in the disturbance term. The Ramsey RESET specification test shows no general equation specification error.

Table 2: Results for UECM for GDP and government consumption spending, 1960-1984
Dependent Variable: growth of government consumption spending
Included observations: 22 after adjusting endpoints

Regressor	Coefficient	*t*-Statistic	Probability
Constant	-0.14	-0.60	0.55
Log*Y* (-1)	0.10	3.34	0.00
Log*Gc* (-1)	-0.08	-1.23	0.24
Dlog*Y*	-0.34	-2.12	0.05
Dlog*G* c(-1)	0.65	3.84	0.00
DlogGc (-1)	0.53	3.18	0.01
Elasticity (μ)	1.39		
Model Criteria			
R^2	0.72		
Adjusted R^2	0.63		
DW	1.70		
SER	0.04		
F-statistic	8.30		
Wald *F*-Test	6.19		0.01
Diagnostic Tests	[1]	[2]	[3]
Breusch-Godfrey LM	0.82 (0.38)	0.51 (0.61)	1.09 (0.39)
ARCH	0.00 (0.95)	0.74 (0.49)	0.51 (0.68)
Ramsey RESET	4.62 (0.05)	2.24 (0.14)	2.07 (0.15)

Table 3 presents the estimates of examining the relationship between the growth of gross domestic product and government consumption spending during the 1985-2005 sub-period. The Wald *F*-statistic is 18.29 and exceeds the upper bound value at the three levels of significance (see Table 1 above). The result presented shows that a one percent increase in GDP growth produced a 0.74 percent increase in government consumption spending. The coefficient of determination (R^2) shows that this equation explains 74 percent of the variation in the rate of government consumption spending to aggregate output. The Breusch-Godfrey's LM test for serial correlation rejects the presence of serial correlation. The ARCH test rejects the existence of first and second order heteroskedasticity in the disturbance term. The Ramsey RESET specification test shows no general equation specification error.

Table 3: Results for UECM for GDP and government consumption spending 1985-2005
Dependent Variable: growth of government consumption spending
Included observations: 18 after adjusting endpoints

Regressor	Coefficient	*t*-Statistic	Probability
Constant	0.50	3.49	0.00
Log*Y* (-1)	0.39	6.04	0.00
Log*Gc* (-1)	-0.50	-5.68	0.00
Dlog*Y*	-0.09	-0.85	0.41
Dlog*Gc* (-2)	-0.19	-1.26	0.23
Elasticity (μ)	0.78		
Model Criteria			
R^2	0.74		
Adjusted R^2	0.66		
DW	2.42		
SER	0.01		
F-statistic	9.35		
Wald *F*-Test	18.29		0.00
Diagnostic Tests	[1]	[2]	[3]
Breusch-Godfrey LM	1.17 (0.30)	0.66 (0.53)	1.46 (0.28)
ARCH	0.64 (0.44)	1.44 (0.27)	0.83 (0.51)
Ramsey RESET	0.07 (0.79)	0.91 (0.43)	0.60 (0.64)

Engle and Granger (1987:259) point out that a two-variable co-integrated system must have a causal ordering in at least one direction. Thus, having established a co-integration relationship between the growth of government consumption spending and gross domestic product, the next logical step is to apply Pairwise Granger causality tests to establish whether there is a causal association between these variables. The findings presented in Table 4 and Table 5 show the existence of a causal link running from gross domestic product to government consumption spending during the two periods of interest.

Table 4. Pairwise Granger causality tests, 1960-1984

Null Hypothesis:	Observations	*F*-Statistics	Probability
One Lag:	24		
log*Y* does not Granger Cause log*Gc*		2.311	0.143
log*Gc* does not Granger Cause log*Y*		0.465	0.503
Two Lags:	23		
log*Y* does not Granger Cause log*Gc*		4.539	0.025
log*Gc* does not Granger Cause log*Y*		2.898	0.081
Three Lags:	22		
log*Y* does not Granger Cause log*Gc*		3.040	0.062
log*Gc* does not Granger Cause log*Y*		1.389	0.285

Table 5. Pairwise Granger causality tests, 1985-2005

Null Hypothesis:	Observations	*F*-Statistics	Probability
One Lag:	20		
log*Y* does not Granger Cause log*Gc*		36.679	1.284
log*Gc* does not Granger Cause log*Y*		0.034	0.855
Two Lags:	19		
log*Y* does not Granger Cause log*Gc*		17.686	0.000
log*Gc* does not Granger Cause log*Y*		0.667	0.529
Three Lags:	18		
log*Y* does not Granger Cause log*Gc*		11.279	0.001
log*Gc* does not Granger Cause log*Y*		1.835	0.199

5.Conclusion

This study has employed the 'bounds' testing approach to co-integration and Granger Pairwise causality tests to identify the long-run equilibrium and causal relationships between gross domestic product and government consumption spending in the Dominican Republic under alternative growth strategies. In spite of the existence of a potentially negative impact of the limited size of the domestic market on aggregate output expansion, which would have necessitated an expansionist Keynesian-type fiscal policy, this study did not find evidence in support of the Keynesian hypothesis during the 1960-1984 period. The estimate of the long run coefficient shows that a one percent increase in gross domestic product produced a 1.39 percent increase in government consumption spending. In addition, Granger Pairwise causality tests show causal linkages running from gross domestic product to government consumption expenditure.

The findings for the 1985-2005 period also confirm the presence of co-integration between gross domestic product and government consumption spending. However, the elasticity is below unity (+0.78). This is an

interesting outcome since the outward-oriented industrialization strategy appeared to be the 'right' approach for generating higher growth rates of national income and thus well-suited for sustaining the tendency for government consumption expenditure to expand at a faster rate than that of national output established under the previous growth model. There is also evidence of causality from gross domestic product to government consumption spending. Combined, all these results show that Wagner's Law is found to be valid for the case of the Dominican Republic.

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