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RE-EXAMINING WAGNER'S LAW WITH THE COUNTRIES OF THE ORGANISATION OF EASTERN CARIBBEAN STATES

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Abstract

Wagner's law postulates that an increase in income leads to a more than proportional increase in public expenditure. This important law of public finance which justifies the growth of expenditure or government size has been empirically tested in various environments with different degrees of success. The objective of this paper is to re-examine Wagner's law in the context of the six countries of the Organisation of Eastern Caribbean States (OECS) – Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines –in the period 1980 - 2014. Using the ARDL approach à la Pesaran et *al*. (2001), we find that in the long run the more proportionate impact of income on public expenditure holds in Grenada, St. Kitts and Nevis as well as St. Vincent and the Grenadines. In addition, there is some role for natural disasters in influencing Wagner's law.

***Keywords*:** Wagner's law, OECS, public expenditure, income, ARDL bounds testing, natural disasters.

***JEL Classification*:** H50, E62, C32.

1. Introduction

No doubt, any government engages in public expenditure in the quest for economic growth/development. By the same token, it can also be argued that economic growth/development does positively affect public expenditure. In public finance, the latter relationship has been known as Wagner's law. Explicitly, the law postulates that an increase in GDP (income) leads to a more than proportional increase in public expenditure. To explain better, the law puts income growth at the core of expenditure growth or government size expansion leaving a marginal role or no role at all to special interest groups, "budget-maximizing bureaucrats", and political party agenda. This is of course only one side of the coin. Indeed, it can be validly argued with the Keynesians, for example, that expenditure growth is the cause of income growth through income growth identity. That is, both income and expenditure are endogenous variables.

In any case, Wagner's law has been justified on at least three grounds. First, industrialization and modernization give rise to a substitution of public for private activity. Second, the law in principle holds as in areas such as education and culture government or collective producers are in general more efficient than private producers. Third, big development projects or change in technology require the intervention of government because commanding large financing (Henrekson, 1993, 406). The law has been econometrically tested in its various formulations by quite a number of authors using most often time series data and rarely panel data, particularly for OECD countries and countries like India, china and Nigeria. Overall, the results obtained are rather mixed. For example, while Wagner and Weber (1977), and Lamartina and Zaghini (2011) in their studies confirm Wagner's law, Henrekson (1993), Ram (1987), Verma and Arora (2010), and Babatunde (2011) reach the opposite conclusion.

For the sake of this paper, the results pertaining to the Caribbean region are of interest. Grenada and Wright (2013) used a panel dynamic ordinary least squares (PDOLS) applied to 4 Caribbean countries (Barbados, Grenada, St. Lucia, and St. Vincent and the Grenadines) in various periods to test for Wagner's law. They failed to support Wagner's law but validated the ratchet hypothesis[1]. Iyare and Lorde (2004) tested Wagner's law in 9 Caribbean countries (Antigua and Barbuda 1977 - 2000, Barbados 1960 - 2000, Belize 1980 - 2000, Grenada 1977 – 2000, Guyana 1950 - 1999, Jamaica 1953 - 2000, St. Kitts and Nevis 1977 - 2000, St. Lucia 1980 – 2000 and Trinidad and Tobago 1950 – 2000). Using cointegration and causality approaches they found some support for Wagner's law in these different countries in the short run. Using cointegration/error correction methodology, Howard (2002) confirmed the validity of Wagner's law for Barbados in the period 1974 – 1998 and Trinidad and Tobago for the period 1967 – 1999. The latter results and those from Iyare and Lorde (2004) are at odds with the results obtained by Alleyne (1999) who used cointegration/unit root methodology and as countries Barbados (1960 – 1997), Guyana (1950 – 1990), Jamaica (1953 -1991) and Trinidad and Tobago (1950 – 1991) as well as Grenada and Wright (2013).

As can be seen, even for the Caribbean, the few related studies reveal that Wagner's law results are mixed. It can be pointed out that differences in time periods and methodologies, and perhaps misspecifications possibly explain the divergent results.

The present paper revisits Wagner's law in the context of the countries of the Organisation of Eastern Caribbean States (OECS) -- Antigua and Barbuda, Grenada, Dominica,

[1] The ratchet hypothesis or effect underlines the asymmetry of the ratio of government expenditure to GDP over the business cycle. Explicitly, while in a crisis or recession government expenditure declines at slower rate than income per capita, the reverse is true in a boom or upturn.

St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines -- in the period 1980 – 2014. Precisely, it attempts to answer the question of whether a shock to income increases public expenditure more than proportionally in each country of the interest. As a matter of fact, these small islands are characterized each by an appreciable per capita income and a high ratio of public expenditure to GDP justified by a great undertaking of big social projects and other projects such as the Argyle International Airport in St. Vincent and the Grenadines[2] as well as the financing of health and education by the government. Economic growth in the context of these countries is largely determined by "trade openness, foreign direct investment, external debt, budget deficit, government consumption, private consumption, inflation, inflation variability, natural increase rate, fertility rate and population growth" (for more details, see Mamingi and Borda 2015, 92-93).

The paper uses a time series approach. Precisely, a bounds testing approach à la Pesaran et *al*. (2001) is of interest to establish the link from income to public expenditure. The paper focuses on the long-run relationship between public expenditure and income as opposed to the short-run relationship. The testing approach just advocated is beneficial for three reasons: (i) it is valid even if the regression contains a mixture of stationary variables (variables integrated of order zero) and non stationary ones, precisely, integrated of order one, I(1); (ii) the issue of endogeneity is taken care of in this formulation, and (iii) the technique can also be used even if the sample size is small.

The paper makes two contributions to the literature. First, this is the prime study for the Caribbean which deals with the full set of the OECS countries. This is particularly interesting as

[2] It is my view the expenditure on this undertaking affects overall expenditure first before affecting income or income growth.

the case illustrates the fact that homogeneous countries in terms of monetary policy may follow different paths concerning their degrees of realization of Wagner's law.

Second, this paper includes natural disasters in the formulation of Wagner's law for the OECS countries to avoid potential misspecification[3] given that natural disasters are an important component of the OECS countries.

Showing that Wagner's law holds is basically showing that economic growth or development is being inevitably accompanied by larger public expenditure compared to income expansion. From that point of view, public expenditure is most likely not a nuisance but rather a sign of economic growth/development.

The paper proceeds as follows. Section 2 introduces the OECS countries. Section 3 contains the methodology. Section 4 deals with the results of estimation and their interpretations. Section 5 contains concluding remarks.

2. The OECS Countries: A Background[4]

The Organisation of Eastern Caribbean States (OECS) consists of six independent member States – Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines--- as well as 1 member and 2 associated members which are British dependent territories --- Montserrat, Anguilla, and the British Virgin Islands. This paper only deals with the independent states.

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[3] See Oktayer and Oktayer (2013) for another type of misspecification.

[4] This section is somewhat an up-to date of section 2 in Mamingi and Borda (2015).

The OECS was officially launched in June 1981 with the signing of the treaty of Basseterre by the individual Heads of Government. The two major objectives of the Organisation are to promote economic integration as well as to issue and manage a common currency (Eastern Caribbean dollar) through the Eastern Caribbean Central Bank (see Mamingi 1999 or other documents).

The OECS countries, all colonized by Great Britain, gained independence either in the late 70's or early 80's. These countries have the following other salient characteristics. They are all small in population, land area and economic endeavours. Indeed, their populations in 2014 range from 60,000 inhabitants in St. Kitts and Nevis to 170,000 inhabitants in St. Lucia. Precisely, their total population is just about 600,000 inhabitants. Their land areas range from 261 square kilometres in St. Kitts and Nevis to 750 square kilometres in Dominica. They are also characterized by small economic sizes. The latter, in terms of GDP (PPP), are in 2014 (estimates) International $billion: 0.780 for Dominica, 1.198 for St. Vincent and the Grenadines, 1.220 for St. Kitts and Nevis,1.248 for Grenada, 1.989 for Antigua and Barbuda, and 1.893 for St. Lucia . These countries are highly opened and vulnerable to external shocks and natural disasters (environmental shocks), particularly hurricanes (e.g., Luis and Marilyn (1995) in Dominica, Georges (1999) in St. Kitts and Nevis, Ivan (2004) in Grenada, and Tomas (2010) in the Windward Islands), and earthquakes including volcano eruptions (for example, Montserrat in 2009). The impact of natural disasters has somehow decreased since resilience mechanisms have been put in place in many countries. Natural resources in the sense of minerals and fuel are rather scarce. The share of agriculture to GDP has been dwindling over time. Indeed, agriculture, which occupied a great deal of good position at the independences, has been progressively replaced by industry and services. To corroborate, the share of agriculture to GDP in percentage passed from 7.10 in 1980 to 2.28 in 2014 in Antigua and Barbuda, from 30.60 in 1980 to 17.17 in 2014 in Dominica, from 24.71 in 1980 to 5.61 in 2014 in Grenada, from 15.94 in 1980 to 1.68 in 2014 in St. Kitts and Nevis, from 14.39 in 1980 to 3.06 in 2014 in St. Lucia, and from 14.28 in 1980 to 7.12 in 2014 in St. Vincent and the Grenadines. The literature underlines the negative role played by globalisation and trade liberalisation on major commodity exports, sugar and banana, in addition to environmental catastrophes or disasters such as hurricanes, floods and volcanic eruptions.

The OECS is also characterised by a high level of public expenditures. For example, for Antigua and Barbuda the level of public expenditure reached EC $776 million in 2014 from EC $234 million in 1990. Are illumining the following statistics which give percentage changes in public expenditures in the period 1990 – 2014: 231.6 % for Antigua and Barbuda, 164.8% for Dominica, 235.3% for Grenada, 601.9% for St. Kitts and Nevis, 345.4% for St. Lucia and 292.2% for St. Vincent and the Grenadines. These public expenditures are generally used to undertake big social projects and finance education and health. It is worth noting that for St. Vincent and the Grenadines, the financing of Argyle International Airport has been sensibly affecting overall expenditure since 2005.

Remarkably, despite their small sizes and other impediments, the economies of the region have performed well compared to many large middle income countries. To substantiate the records, the 2014 per capita GDP (PPP) ranges from current international $ 10,619.2 in St. Vincent and the Grenadines to 22,733.10 in St. Kitts and Nevis. The countries also rank high in the Human Development Index (HDI). In fact, all the six countries are in the category of "higher human development" in 2014. For sure, the economic growth /development of the region is attributed to the importance attached to the development of human capital, physical capital, and societal capital. The recent economic crisis has, however, shaken the region, which has to revamp itself to stay afloat, particularly from rising unemployment, pockets of poverty (1/3 to 1/5 of population), high level of indebtedness (from 90% to 170% of GDP), and high sensitivity to environmental quality.

3. Modelling and Data Analysis

This section proceeds as follows. Subsection 3.1 deals with the different formulations of Wagner's law. Subsection 3.2 contains the methodology to test the law. Subsection 3.3 examines data.

3.1 Wagner's Law Formulations

At the outset, we would like to forcefully point out that Wagner (1893) himself did not translate his observation into a mathematical or econometric model. As a consequence, a couple of econometric models have been advanced by others to interpret his idea. Here are 5 useful interpretations found in the literature:

$$Log\left(\frac{G_t}{GDP_t}\right) = \alpha + \beta\, Log\left(\frac{\overline{GDP}_t}{P_t}\right) + u_t \tag{1}$$

where t is an index for time, Log symbolizes logarithm, G represents nominal public expenditure, GDP stands for nominal gross domestic product or income and $\overline{GDP}$ is real GDP (nominal deflated by the GDP deflator), P is population size and u is the error term. Wagner's law in this context holds if $\beta > 0$.

$$Log(G_t) = \alpha + \beta\, Log(GDP_t) + u_t \tag{2}$$

where Equation (2) is either in nominal terms or real terms (both variables deflated by the GDP deflator). This formulation is due to Goffman (1968), Goffman and Mahar (1971) and Musgrave (1969). Here, it is assumed $\beta > 1$ for Wagner's law to hold. In fact, this is only true if population size is constant.

$$Log\left(\frac{\overline{G}_t}{P_t}\right) = \alpha + \beta\, Log\left(\frac{\overline{GDP}_t}{P_t}\right) + u_t \tag{3}$$

where the $\overline{G}$ is real public expenditure (G deflated by the GDP deflator) and $\overline{GDP}$ is real GDP (nominal deflated by the GDP deflator). The validity of Wagner's law requires that $\beta > 1$. This formulation is due to Gupta (1967).

$$Log(G_t) = \alpha + \beta\, Log\left(\frac{GDP_t}{P_t}\right) + u_t \tag{4}$$

and

$$Log\left(\frac{G}{GDP_t}\right) = \alpha + \beta\, Log(GDP_t) + u_t \tag{5}$$

Wagner's law holds if $\beta > 1$ in Equation (4) and $\beta > 0$ in Equation (5). The two formulations are due to Mann (1980).

To the best of our knowledge, there is no clear cut guidance from the literature as to the conclusion to take if two or more formulations yield conflicting results. In the spirit of this paper, Wagner's law holds if at least two of the formulations advocated above hold.

3.2. Modelling

The autoregressive distributed lag approach (ARDL) to cointegration initiated by Pesaran *et al.* (2001) also known as the bounds testing approach is the tool used to fulfill the major goal of the paper. The advantages of such a technique have been advocated above.

Consider the following function

$$y_t = f(V_t) \tag{6}$$

where t stands for time index, y is the dependent variable and V is the matrix of explanatory variables. In linear form, relationship (6) reads as follows:

$$y_t = V_t B + e_t \tag{7}$$

where V, the matrix of explanatory variables, is of dimension $n \times k$, B is the vector of parameters of dimension $k \times 1$, and e is a random variable which represents the error term.

In the first instance, the bounds approach requires estimating an unrestricted error correction model version of Equation (7) by OLS. The unrestricted error correction model (ECM) proposed by Pesaran *et al*. (2001) follows the fundamental principles of the Johansen five error correction multi-variance VAR (see Pesaran *et al.* 2001; Boamah *et al*. 2011, 28-30):

Case 1: no intercepts and no trend

$$\Delta y_t = \pi_{yy} y_{t-1} + \pi_{yVV} V_{t-1} + \sum_{i=1}^{p-1} \beta' \Delta z_{t-i} + \delta' \Delta V_t + u_t \tag{8}$$

Case 2: Restricted intercepts and no trend

$$\Delta y_t = \pi_{yy}(y_{t-1} - \mu_y) + \pi_{yVV}(V_{t-1} - \mu_V) + \sum_{i=1}^{p-1} \beta' \Delta z_{t-i} + \delta' \Delta V_t + u_t \qquad (9)$$

Case 3: Unrestricted intercepts and no trend

$$\Delta y_t = c + \pi_{yy} y_{t-1} + \pi_{yVV} V_{t-1} + \sum_{i=1}^{p-1} \beta' \Delta z_{t-i} + \delta' \Delta V_t + u_t \qquad (10)$$

Case 4: Unrestricted intercepts and restricted trends

$$\Delta y_t = c + \alpha t + (\pi_{yy} y_{t-1} - \alpha_y t) + (\pi_{yVV} V_{t-1} - \alpha_V t) + \sum_{i=1}^{p-1} \beta' \Delta z_{t-i} + \delta' \Delta V_t + u_t \qquad (11)$$

Case 5: Unrestricted intercepts and unrestricted trends

$$\Delta y_t = c + \alpha t + \pi_{yy} y_{t-1} + \pi_{yVV} V_{t-1} + \sum_{i=1}^{p-1} \beta' \Delta z_{t-i} + \delta' \Delta V_t + u_t \qquad (12)$$

where y_t is defined as above, V_t is the matrix of explanatory variables, Z_t is $(y_t V_t)$, Δ represents the first difference operator, μ_y is the mean y_t, μ_V is the mean for V_t or individual V_t, t as a variable captures the deterministic trend, and u_t is the error term.

To test for the existence[5] of a level relationship between y_t and V_t, in Equations (8) – (12), the bounds procedure recourses to an *F*-test (or *Wald* test) on the joint null hypothesis that the coefficients of the level variables are jointly zero. Concretely, the null hypotheses are defined as

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[5]The text below up to Data is almost an excerpt from Boamah, Jackman and Mamingi (2011, 28-30).

$\pi_{yy} = 0$ and $\pi_{yVV} = 0$, and the alternatives as $\pi_{yy} \neq 0$ or $\pi_{yVV} \neq 0$. Here, these *F*-statistics follow a non-standard distribution. This means that the critical values of the regular *F* distribution are no longer valid. Instead, use can be made of two asymptotic critical bounds derived by Pesaran *et al*. 2001, covering three possible classifications of the variables (all are I(0), all are I(1), or variables are mutually cointegrated). While the lower value bounds concern the case of the variables being purely I(0), the upper value bounds assume that they are purely I(1). A computed *F*-statistic that is greater than its respective upper value bound indicates the existence of a long-run relationship between or among variables, that is, cointegration; on the contrary, if smaller than the lower value bound, then the null of no-cointegration is not rejected; and finally, if the value lies within the bounds, inference is inconclusive. In fact, for cointegration to really hold the *F*-test needs to be supplemented by a *t* test on the adjustment coefficient. The latter *t*-statistic does not follow a *t* distribution. Concretely, if $\pi_{yy} = 0$ and $\pi_{yVV} = 0$ are rejected then test $\pi_{yy} = 0$ against $\pi_{yy} < 0$. If the *t*-statistic to test for the latter null hypothesis is negative and greater, in absolute value, than the upper value bound of the *t* (see for example table 1), then cointegration is confirmed. Naturally, the existence of cointegration implies that the long-run relationship among variables and corresponding error correction models can be estimated.

Algebraically, we can write $\pi_{yVV} = LR_{yVV} * (-\pi_{yy})$. In other words, the long-run parameter(s) $LR_{yVV} = \dfrac{\pi_{yVV}}{-\pi_{yy}}$. This relationship can be better understood, for example, in the context of Equation (10’), the equivalent of Equation (10):

$$\Delta y_t = c + \pi_{yy}(y_{t-1} + LR_{yVV} V_{t-1}) + \sum_{i=1}^{p-1} \beta' \Delta z_{t-i} + \delta' \Delta V_t + u_t \qquad (10')$$

where the first relationship in parentheses represents the long-run relationship between y_t and V_t. Model (10') has to pass a battery of diagnostic/misspecification tests (heteroscedasticity, autocorrelation, misspecification and normality). In addition, the lag structure must be appropriate. To this end, we use a stepwise procedure.

3.3. Data

The data were obtained from the following sources: Eastern Caribbean Central Bank; World Bank: World Tables (various issues), International Monetary Fund, World Economic Outlook, October 2013, World Development Indicators and EM-Dat (for natural disasters). The time series dimension covers the period 1980-2014. The sample size is in some countries reduced because a couple of years lack data.

There are significant positive correlations between GDP and public expenditure: 0.757 for Antigua and Barbuda, 0.745 for Dominica, 0.601 for Grenada, 0.722 for St. Kitts and Nevis, 0.931 for St. Lucia and 0.733 for St. Vincent and the Grenadines. Although these correlations can be spurious we can still propose a workable research hypothesis according to which there is a positive relationship between income and public expenditure.

That said, it is relevant to examine the time series properties of data. We use the Augmented Dickey-Fuller (*ADF*) test to test for unit root in each series of interest. Since the *ADF* test is common knowledge, it is not presented here. Table 1 contains the results of the investigation. Given the *ADF* values of variables in levels and first differences, we can conclude that most variables are non-stationary, precisely integrated of order one and the rest are stationary (e.g., population in 4 of the 6 countries) at least at the 10% level of significance. This mixture of I(1) and I(0) variables is justly one of the reasons to use the bounds approach à la Pesaran et *al*. (2001).

Table 1: Augmented Dickey-Fuller Unit Root Test Results for Some Selected Variables

ADF	Antigua	Dominica	Grenada	St. Kitts	St. Lucia	St. Vincent
	GDPn	GDPn	GDPn	GDPn	GDPn	GDPn
Level	-2.573	-2.239	-2.474	-0.321	-2.702	-2.573
	(0.294)	(0.452)	(0.338)	(0.985)	(0.242)	(0.294)
1st dif	-3.668	-4.697	-6.138	-3.851	-3.966	-3.668
	(0.095)	(0.001)	(0.000)	(0.916)	(0.005)	(0.009)
	GDPr	GDPr	GDPr	GDPr	GDPr	GDPr
Level	-3.634	-1.889	-0.814	-3.621	-2.101	-1.699
	(0.042)	(0.638)	(0.802)	(0.043)	(0.246)	(0.729)
1st dif		-5.127	-2.180		-5.768	-4.277
		(0.000)	(0.030)		(0.008)	(0.002)
	GDP defl.	GDP defl.	GDP defl.	GDP defl.	GDP defl.	GDP defl.
Level	-1.771	-1.451	-1.966	-2.668	-2.147	-3.524
	(0.697)	(0.827)	(0.598)	(0.255)	(0.503)	(0.053)
1st dif	-4.694	-6.587	-6.112	-8.006	-6.513	
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	
	Expend.	Expend.	Expend	Expend.	Expend	Expend.
Level	-1.692	-2.235	-3.069	-2.569	-1.6129	-1.855
	(0.423)	(0.451)	(0.136)	(0.296)	(0.755)	(0.655)

1^{st}dif	-6.888	-4.563	-4.804	-7.615		-5.957
	0.000)	(0.002)	(0.001)	(0.000)		(0.000)
	Expen.(%)	Expen.(%)	Expen.(%)	Expen.(%)	Expen.(%)	Expen.(%)
Level	-2.112	-2.858	-4.604	-4.480	-3.367	-3.025
	(0.514)	(0.194)	(0.007)	(0.006)	(0.076)	(0.141)
1^{st}dif.	-7.520	-5.115				-7.227
	(0.000)	(0.004)				(0.000)
	Population	Population	Population	Population	Population	Population
Level	-4.379	Constant*	-6.851	-1.086	0.542	-3.398
	(0.009)		(0.000)	(0.916)	(0.990)	(0.003)
1^{st}dif				-4.378	-4.651	
				(0.008)	(0.004)	

Notes: GDPn : gross nominal domestic product in EC dollars; GDPr: Gross real domestic product in EC dollars; GDP defl.: GDP deflator; Expend.: total expenditure in EC dollars; Expen.(%): Expenditure/GDP in %. Population in millions. Numbers are the Dickey-Fuller ADF *t*-statistics for variables in levels (Levels) and those for variables in first differences (1^{st} dif.). In most cases, a constant and a trend were used in regressions in levels and only a constant in regressions in first differences. *: Population is constant (stationary). Numbers in parentheses are the *p*-values.

4. Results and Interpretations

Before presenting and interpreting the results, some remarks are in order. First, only the results of Equation (10) or its ECM version (10') are presented here because being the most appropriate in the present situation. Second, as pointed out above we use a stepwise regression search to arrive in the first instance at an acceptable model. Third, because the stepwise search procedure does not deal with the major econometric issues, we submit the candidate models to a battery of tests (autocorrelation, heteroscedasticity, normality and misspecification). Fourth, since we are dealing with small samples[6] we use in most times the *F*-version of the large sample tests (*LM* test, Wald test, etc.). Fifth, we interpret with prudence the results of the Jarque-Bera test for normality in the context of small samples. Indeed, its chi-squared asymptotic approximation under normality does not hold in small samples as it leads to a substantial increase in type I error. Sixth, to avoid to alter the spirit of Wagner's law, a bivariate relationship between expenditure and income, we avoid adding control variables with the exception of natural disasters. Seventh, natural disasters captured by a dummy variable in a given country may well approximate some structural change. An argument can be made though that a dummy variable is not necessarily the best way to capture natural disasters.

Tables 2 through 7 in the appendix contain each the ARDL results of Equation (10) for a given country. Are indeed reported in each table the results of the 5 formulations of Wagner's law such exposed above in Equations (1) to (5).

Table 2 which deals with Antigua and Barbuda provides us with the following information. First, all models representing the 5 formulations of Wagner's law pass the key

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[6] Having a sample size of more than 30 does not necessary mean having a large sample. In fact, in many instances what matters the most is the number of degrees of freedom. What is the point of having 35 observations with 36 parameters to estimate.

diagnostic/misspecification tests (autocorrelation, heteroscedasticity, normality and misspecification tests) as indicated by the sizes of the associated *p*-values (*p*-values greater than 0.10 or 0.05). Second, only the fifth formulation of the law (see last column of the table) is indicative of some degree of cointegration at the 10% level of significance. Indeed, although its cointegration *F*- value is in the zone of undeterminacy (4.04 < 4.309 <4.78), its *t*-value in absolute value is just above the upper limit (2.926> 2.91). There is thus potentially a long-run relationship between income and expenditure. A 1% increase in income (GDP) leads to a 0.585 % increase in expenditure/GDP ratio. In fact, 63.7% (see the adjustment coefficient) of disequilibrium in the previous year is eliminated in the current year. Wagner's law is realized with this formulation. Natural disasters do not seem to impact the law.

Table 3 is concerned with the results of Dominica. No formulation passes the *F* bounds test for cointegration and 3 formulations are in the indeterminacy zone regarding the *t*-test. Overall there is no strong evidence of cointegration. That is, a long-run relationship between income and expenditure does not exist here. On the contrary, there is some existence of short-run relationship between the two macro-aggregates.

Table 4 allows us to point out the following observations for the realization of Wagner's law in Grenada. According to the values of the *F* and *t* bounds, cointegation is fulfilled in all the five versions of Wagner's law. In addition, apart from some issues of normality in two versions of the Law all diagnostic/misspecification tests are passed by all the formulations of the Law. The long-run relationship going from income to expenditure is largely verified. A 1% increase in income gives rise to a 1.595% increase in expenditure at least according to one formulation of Wagner's law. The adjustment to equilibrium is ultra quick being in the range between 82.2% to

96.6%. To repeat, Wagner's law strongly holds in Grenada. Natural disasters seem to have some impact on the link between income and expenditure.

For St. Kitts and Nevis (see Table 5), according to the sizes of the cointegration *F* and the adjustment coefficient *t*, 3 formulations out of 5 seem to exhibit cointegration relationships between income and expenditure. Apart from some issues with heteroscedasticity with a couple of formulations the different models pass the diagnostic/misspecification tests. Overall, it can be retained that Wagner's law is verified in St. Kitts and Nevis with a slow speed of adjustment to equilibrium of the order of 33%. More importantly, natural disasters do positively impact Wagner's law.

Table 6 contains Wagner's law results for St. Lucia. Although the basic diagnostic/misspecification tests are satisfied no cointegration relationship can be found by the two tests of interest for all formulations of Wagner's law. In simple terms, Wagner's law as a long–run relationship going from income to expenditure is not verified for St. Lucia.

Table 7 deals with St. Vincent and the Grenadines. An examination of the results reveals that 4 formulations deliver sure cointegration and 1 somehow as the sizes of the cointegration *F* and the adjustment coefficient *t* values reveal. It can be retained that cointegration between income and expenditure is uncovered in St. Vincent and the Grenadines. A 1% increase in income leads to a 1.093% increase in expenditure. 42.4% to 60.1% of past disequilibrium is eliminated in the current year. Wagner's law is largely verified in St. Vincent and the Grenadines. There is some role for natural disasters as the latter affect the magnitude of the relationship between income and expenditure. Note that it was not found necessary to include the expenditures for the new international airport in the model. Indeed, the impact of the variable is already reflected in overall expenditure or the ratio of expenditure to income.

5. Conclusion

The objective of this paper is to re-examine Wagner's law in the context of the six independent countries of the Organisation of Eastern Caribbean States (OECS) – Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines –in the period 1980 - 2014. The results of the ARDL approach à la Pesaran et *al*. (2001) indicate that the more proportionate impact of income on public expenditure holds in Grenada, St. Kitts and Nevis as well as St. Vincent and the Grenadines, at least in the long run. To repeat, the results show that the six countries can be divided in two regarding Wagner's law realization. In other words, while income growth is important in explaining expenditure growth or government expansion in three countries, it is not the case for the three other countries. In addition, there is some role for natural disasters in influencing Wagner's law despite the paucity of strong empirical evidence. Indeed, since the region is prone to natural disasters, not taking into account the latter in a regression most likely results in misspecification bias (omitted variable bias).

These results point out that although the 6 independent nations of OECS belong to the same monetary union their fiscal policies are not necessary the same. Anyway, in one set of countries Wagner's law holds due mainly to the undertaking of big projects such as the Argyle International Airport in St. Vincent and the Grenadines. Here, as the multiplier effect is greater than one, the possibility of expenditure leading to sustained income or even economic growth is real.

In any case, the results for Grenada, St. Kitts and Nevis, and St. Vincent and the Grenadines obtained here are different from those by Grenada and Wright (2013) as well as

Iyare and Lorde (2004)[7] at least in the long run. That is, overall we can retain that for the Caribbean the homogeneity of Wagner's law results is far from being found.

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[7]The same conclusion holds if Wagner's law is given a short-run interpretation.

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Appendix

Table 2: The ARDL Results for Wagner's Law: Antigua and Barbuda, 1980 -2014

	Eq. 1 Variables	Eq. 2 Variables	Eq. 3 variables	Eq. 4 Variables	Eq. 5 Variables
Constant	2.541 (1.686)	-1.088 (-0.769)	-1.130 (-0.437)	4.420 (0.949)	1.790 (2.809)
Adjustment Coefficient Var.	-0.111 (-0.520)	-0.196 (-0.894)	-0.282 (-1.253)	0.010 (0.046)	-0.637 (-2.926)
Lon-run I. Income	-5.863 (-0.400)	0.587 (0.369)	0.443 (0.222)	129.7 n.a	0.585 (1.465)
Natural Disasters	-0.095 (-0.944)	-0.064 (-0.661)	-0.080 (-0.786)	-0.113 (-1.080)	-0.050 (-0.444)
Dincome	-1.547 (-1.567)			-1.286 (-1.060)	
Dincome(-1)	0.858 (0.953)	1.536 (2.076)	1.402 (1.802)	1.852 (1.746)	0.586 (0.684)
Dincome(-2)	1.301 (1.504)			-0.199 (-0.633)	0.983 (1.184)
Dexpenditure(-1)	-0.618 (-2.582)	-0.473 (-2.151)	-0.306 (-1.152)	-0.820 (-2.235)	
Dexpenditure(-2)			0.202 (0.895)	2.055 (1.645)	0.565 (2.081)
Dexpenditure(-3)					0.385 (1.287)
$\overline{R}^2$	0.493	0.279	0.265	0.290	0.218
F auto	0.002 (0.998)	0.641 (0.541)	1.436 (0.273)	0.067 (936)	1.729 (0.222)
F hetero.	0.401 (0.887)	0.214 (0.952)	0.131 (0.990)	1.285 (0.330)	0.272 (0.954)
Normal	1.484 (0.476)	0.108 (0.635)	1.214 (0.289)	1.382 (0.501)	0.988 (0.610)
Ramsey	0.524 (0.481)	0.041 (0.312)	3.405 (0.065)	0.354 (0.569)	0.035 (0.856)
Coint. *F*	1.868	0.533	1.512	2.727	4.309

Note: Equation (10') estimated using the long-run relationship derived from either one of the 5 Wagner's law formulations. Adjustment coefficient var.: adjustment coefficient variable in Equation (10) or (10'). Long-run I. income: Long-run impact for income in Equation 10', valid if cointegration holds. D: first difference indicator except for Disasters: e.g. $Dincome = income_t - income_{t-1}$. *F* auto: *F*-statistic for Breusch-Godfrey test for autocorrelation. *F* hetero: *F*-statistic for Breusch-Pagan-Godfrey test for heteroscedasticity. Normal is the Jarque-Bera test for normality. Ramsey: Ramsey reset test for misspecification. (…) represents either *t*-

value (upper part of the table) or *p*-value (lower part of the table). Coint.*F* is the cointegration *F* value to compare with the Pesaran *F* critical value(s). From Pesaran (2001)'s table III , with k = 1 the *F* bounds are 4.04 (I(0)) and 4.78 (I(1)) at the 10% level of significance, 4.94(I(0) and 5.73 (I(1)) at the 5% level of significance. For the *t*-test to confirm cointegration, the *t*-value of the adjustment coefficient is compared with the following bounds: -2.57 (I(0)) and -2.91 (I(1)) at the 10% level of significance and -2.86(I(0)) and -3.22 (I(1)) at the 5% level of significance. n.a: not available.

Table 3: The ARDL Results for Wagner's Law: Dominica, 1980 -2014

	Variables of Eq.1	Variables of Eq.2	Variables of Eq.3	Variables of Eq.4	Variables of Eq.5
Constant	1.009 (1.284)	-4.825 (-2.742)	-4.561 (2.029)	-7.693 (-2.689)	2.895 (2.541)
Adjustment Coefficient.	-0.391 (-1.417)	-0.840 (-2.723)	-1.916 (-1.882)	-0.840 (-2.723)	-0.836 (-2.568)
Lon-run Income	0.292 (0.902)	1.290 (9.435)	1.286 (7.787)	1.290 (9.435)	0.331 (2.314)
Natural Disasters	0.059 (0.954)	0.039 (0.744)	0.300 (1.100)	0.039 (0.744)	0.020 (0.377)
Dincome	1.367 (1.615)	2.281 (2.604)	2.390 (2.707)	2.281 (2.604)	0.908 (1.022)
Dincome(-1)	-1.032 (-1.105)	-1.916 (-1.882)	-1.786 (-1.739)	-1.916 (-1.882)	-1.043 (-1.164)
Dincome(-2)	1.505 (1.559)		0.916 (0.996)		
Dexpenditure(-1)	0.258 (0.918)	0.300 (1.100)	0.208 (0.670)	0.300 (1.100)	0.342 (1.112)
Dexpenditure(-2)	1.367 (1.615)	0.567 (2.454)	0.457 (1.781)	0.567 (2.454)	0.491 (1.800)
$\overline{R}^2$	0.186	0.455	0.452	0.455	0.189
F auto	3.730 (0.062)	6.989 (0.009)	6.021 (0.017)	6.989 (0.009)	3.820 (0.052)
F hetero.	0.443 (0.873)	1.011 (0.464)	0.622 (0.746)	1.011 (0.464)	1.036 (0.450)
Normal	0.023 (0.989)	0.303 (0.987)	0.242 (0.886)	0.303 (0.987)	0.085 (0.958)
Ramsey	3.350 (0.077)	4.554 (0.053)	3.496 (0.086)	4.554 (0.053)	6.003 (0.030)
Coint. F	1.020	3.750	2.133	3.750	3.299

Notes: see Note to Table 2

Table 4: The ARDL Results for Wagner's Law: Grenada, 1980 -2014

	Variables of Eq. 1	Variables of Eq. 2	Variables of Eq. 3	Variables of Eq. 4	Variables of Eq. 5
Constant	2.048 (3.571)	-5.852 (-4.140)	-6.043 (-3.057)	-8.144 (-4.043)	2.854 (4.351)
Adjustment Coefficient Var.	-0.822 (-4.198)	-0.9513 (-4.168)	-0.966 (-3.336)	-0.868 (-4.004)	-0.924 (-4.300)
Long-run I. Income	0.308 (3.016)	1.590 (7.939)	1.128 (10.320)	1.441 (14.47)	0.487 (2.499)
Natural Disasters	-0.086 (-1.563)	-0.110 (-1.593)	0.022 (0.310)	-0.108 (-1.762)	-0.125 (-1.910)
Dincome		1.056 (2.686)		1.440 (3.200)	0.324 (1.091)
Dincome(-1)		-0.499 (-1.793)	0.532 (1.746)		
Dincome(-3)			0.259 (1.264)	0.428 (1.134)	
Dexpenditure(-1)			-0.940 (-1.876)		
Dexpenditure(-3)			-0.785 (-1.892)		
$\overline{R}^2$	0.408	0.376	0.433	0.428	0.422
F auto *F hetero.*	1.125 (0.345) 0.404 (0.752)	0.807 (0.463) 0.320 (0.895)	0.023 (0.977) 0.392 (0.904)	0.686 (0.518) 0.762 (0.589)	1.389 (0.276) 0.433 (0.783)
Normal	8.140 (0.017)	2.771 (0.250)	1.544 (0.461)	4.549 (0.103)	8.500 (0.014)
Ramsey	0.027 (0.973)	1.057 (0.371)	0.821 (0.465)	1.006 (0.388)	0.148 (0.864)
Coint. F	9.131	8.697	7.275	8.172	9.355

Notes: see Table 2

Table 5: The ARDL Results for Wagner's Law: St. Kitts and Nevis, 1980 -2014

	Variables of Eq.1	Variables of Eq.2	Variables of Eq.3	Variables of Eq. 4	Variables of Eq.5
Constant	0.966 (2.258)	-1.937 (-3.105)	-2.044 (-2.413)	-1.639 (-1.843)	1.102 (3.061)
Adjustment Coefficient Var.	-0.365 (-2.987)	-0.330 (-3.060)	-0.306 (-2.334)	-0.132 (-1.382)	-0.330 (-3.131)
Long-run I. Income	0.272 (1.098)	1.426 (6.749)	1.288 (4.034)	2.274 (2.043)	0.425 (2.238)
Natural Disasters	0.078 (1.153)	0.098 (1.386)	0.129 (1.668)	0.066 (0.872)	0.101 (1.446)
Dincome		1.018 (1.554)	0.953 (1.437)	0.987 (1.383)	
Dincome(-1)					
Dincome(-2)	-1.461(-) (-2.789)		-0.841 (-1.382)		
Dexpenditure(-1)				-0.178 (-1.077)	
$\bar{R}^2$	0.296	0.305	0.218	0.118	0.302
F auto	0.122 (0.885)	0.708 (0.502)	0.065 (0.937)	0.051 (0.951)	0.788 (0.464)
F hetero.	1.445 (0.248)	2.907 (0.039)	2.163 (0.089)	2.703 (0.042)	3.851 (0.019)
Normal	1.628 (0.443)	4.947 (0.084)	4.715 (0.095)	4.213 (0.122)	4.724 (0.094)
Ramsey	0.412 (0.682)	0.998 (0.326)	0.017 (0.897)	2.612 (0.212)	2.270 (0.143)
Coint. F	4.461	6.461	2.941	2.418	6.776

Note: see Table 2; (-) is related to Dincome(-4)

Table 6: The ARDL Results for Wagner's Law: St. Lucia,1980 -2014

	Variables in Eq.1	Variables in Eq.2	Variables in Eq.3	Variables in Eq.4	Variables in Eq. 5
Constant	-0.650 (-1.170)	-1.503 (-1.553)	-1.387 (-1.242)	-0.479 (-0.291)	0.526 (1.263)
Adjustment Coefficient Var.	-0.318 (-2.326)	-0.243 (-1.618)	-0.147 (-1.079)	-0.054 (-0.436)	-0.182 (-1.349)
Lon-run I. Income	1.954 (3.074)	1.475 (4.913)	2.334 (2.064)	1.735 (0.441)	0.585 (1.271)
Natural Disasters	-0.049 (-1.159)	-0.050 (-1.329)	-0.060 (-1.488)	-0.063 (-1.470)	-0.059 (-1.560)
Dincome		0.431 (1.119)	0.587 (1.465)	0.313 (0.635)	
Dincome(-1)			0.337 (0.976)	0.395 (1.080)	
Dincome(-2)					-0.454 (-1.393)
Dincome(-3)					0.337 (1.038)
Dexpenditure(-1)		-0.159 (-0.852)	-0.228 (-1.180)	-0.297 (-1.494)	
Dexpenditure(-2)	-0.361(>) (-2.116)			-0.171 (-0.796)	
$\overline{R}^2$	0.354	0.160	0.110	0.089	0.230
F auto *F hetero.*	0.160 (0.853) 0.762 (0.563)	0.138 (0.872) 1.445 (0.248)	0.983 (0.392) 1.949 (0.120)	0.572 (0.575) 1.962 (0.115)	0.428 (0.658) 0.965 (0.460)
Normal	0.065 (0.968)	1.628 (0.443)	0.226 (0.893)	0.605 (0.739)	0.214 (0.898)
Ramsey	0.07 (0.994)	0.829 (0.416)	0.072 (0.943)	0.099 (0.756)	1.620 (0.120)
Coint. F	2.900	1.322	0.870	0.147	1.219

Note: see Table 2; (>):Dexpenditure(-5)

Table 7: The ARDL Results for Wagner's Law: St. Vincent and the Grenadines, 1980 -2014

	Variables in Eq. 1	Variables in Eq. 2	Variables in Eq.3	Variables in Eq. 4	Variables in Eq. 5
Constant	1.167 (2.141)	-3.159 (-3.303)	-3.647 (-3.485)	-4.270 (-3.231)	1.498 (2.947)
Adjustment Coefficient Var.	-0.424 (-2.621)	-0.601 (-3.337)	-0.596 (-3.552)	-0.507 (-3.309)	-0.446 (-2.931)
Long-run I. Income	0.233 (1.518)	1.093 (15.96)	1.120 (16.70)	1.157 (15.06)	0.096 (1.098)
Natural Disasters	0.042 (1.474)	0.039 (1.246)	0.035 (1.194)	0.033 (1.114)	0.028 (0.961)
Dincome	-0.685 (-1.775)				-0.413 (-0.948)
Dincome(-1)	0.584 (1.495)				
Dincome(-2)	0.318 (0.994)				
Dexpenditure(-1)		0.171 (0.980)	0.123 (0.743)		
Dexpenditure(-2)		0.108 (0.645)			
$\bar{R}^2$	0.263	0.201	0.244	0.221	0.151
F auto	0.007 (0.993)	0.159 (0.854)	0.152 (0.860)	0.057 (0.945)	0.070 (0.933)
F hetero.	0.618 (0.714)	0.763 (0.584)	1.081 (0.385)	1.778 (0.173)	4.653 (0.325)
Normal	0.580 (0.748)	1.462 (0.481)	1.582 (0.453)	2.203 (0.530)	0.745 (0.649)
Ramsey	0.840 (0.445)	0.274 (0.605)	0.686 (0.415)	1.228 (0.277)	0.672 (0.419)
Coint. F	4.120	5.920	6.356	5.757	4.300

Note: see Table 2