Testing Wagner's Law for Romania

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This study will test Wagner's law for Romania using both an aggregate measure of public expenditures and a disaggregated form (military expenditures). For the aggregate measure we will estimate the parameters for the models developed by Peacock-Wiseman, Gupta, Goffman, Musgrave and Mann. We will also verify the validity of the Wagner's law in the case of military expenditures for Romania.

Keywords: *Wagner's law, military expenditures, econometric models, cointegration.*

1. Introduction

Country's economic development has allowed a continuous growth of the of public expenditures volume. Economic analysis underlined a series of long-term relationship between economic evolution of a country and the volume of public expenditures. At the end of nineteenth century, Wagner noted that for the industrialized countries there is a faster growth of public expenditures related to the economic growth. A series of empirical studies based on data series at a country level highlighted this relationship also for the period after the Second World War. Among the most important classical studies that have highlighted this issue, we mention: (Gupta 1967), (Pryor 1968), (Goffman 1968), (Musgrave 1969), (Tarschys 1975) etc. New developments in econometrics, as the cointegration techniques (Granger and Engle), the analysis of Granger-type causality etc., have led to new

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Acknowledgement: This work was supported by CNCSIS –UEFISCSU, project number PNII – IDEI code 1793/2008, financing contract no. 862/2009 and project number PNII – IDEI code 1814/2008, financing contract no 763/2009.

studies to detect the long-term relationships between the public expenditures' dynamics and the economic sector. Among the most important studies, mention (Demirbas 1999), (Murthy 1993), (Oxley 1994), (Ahsan et al. 1996), (Halicioglu 2003), (Akitoby et al. 2006) etc.

Strategies used to test the validity of this law using new econometric methods to estimate parameters are based on regression models or on ECM models. The models are estimated using data series for various economic variables recorded for a single country or for several countries. For the second situation are used panel data.

We must mention that, for certain countries were obtained contradictory results. Moreover, in certain cases, this law was not respected. In (Ahsan et al. 1996) are presented a series of reviews on the factors determining the inconsistency of results and on the differences obtained by various authors: different time periods that define the data series used to estimate the parameters, the econometric techniques used -including here the model's specification, tests used and the influence of the omitted variables from the model etc.

Regardless the econometric model used to verify Wagner's law we must not forget that this one postulates the existence of a long-term relationship between public sector's size and the economic development of a country. Therefore, this dependence is not required to be verified for shorter periods of time.

2. Methodology used

In the economic theory are defined several models to verify the validity of the Wagner's law. To define these models, we consider the following macroeconomic variables: G - Total public expenditures, GDP - Gross Domestic Product, C - Private Consumption, P - Population.

We present a series of models used to verify Wagner's law. In the first category (Peacock-Wiseman and Pryor models) are included regression models based on absolute values of data series. In the second category (Gupta, Goffman, Musgrave and Mann models) are included regression models in which for one or more variables are used per capita values.

The (Peacock-Wiseman 1967) Model proposes a relationship in which the elasticity of public expenditures relative to GDP is constant. The model is defined as follows:

$$\ln G_t = \alpha + \beta \ln GDP_t + \varepsilon_{1t} \qquad [1]$$

The (Pryor 1968) Model is based on the analysis of private consumption according to the Gross Domestic Product. In this case we consider that the elasticity of private consumption relative to GDP is constant for analyzed the period. The model is defined as follows:

$$\ln C_t = \alpha + \beta GDP_t + \varepsilon_{2t} \qquad [2]$$

The (Gupta 1967) Model proposes a linear dependence between public expenditures per capita and GDP per capita $(GDP/P)_t$:

$$\ln(G/P)_t = \alpha + \beta(GDP/P)_t + \varepsilon_{3t} \quad [3]$$

The (Goffman 1968) Model uses a linear model to explain public expenditures, including GDP per capita $(GNP/P)_t$ as exogenous variable:

$$\ln G_t = \alpha + \beta(GDP/P)_t + \varepsilon_{4t} \quad [4]$$

The (Musgrave 1969) Model is based on the expression of public sector's size at the national economy aggregate (the share of government expenditures in GDP) depending on the evolution of a country's economic development (measured by GDP per capita):

$$\ln(G/GDP)_t = \alpha + \beta(GDP/P)_t + \varepsilon_{5t} \quad [5]$$

The (Mann 1980) Model proposes a linear dependence between the share of government expenditures in GDP and GDP:

$$\ln(G/GDP)_t = \alpha + \beta GDP_t + \varepsilon_{6t}. \quad [6]$$

In all these situations we must check if the two variables involved in the model are cointegrated, respectively whether the following conditions are verified:

1. there are two variables, X_t and Y_t, which are first order integrated (X_t and $Y_t \rightarrow I(1)$);
2. the two series are cointegrated if for these ones is defined the following regression model:

$$Y_t = aX_t + u_t, \quad [7]$$

where u_t it's a stationary series. We mention that it is vital that the residuals series must be zero order integrated; otherwise we have a spurious regression. If the series is not a stationary one, then between the model's variables there is no cointegration relationship and the regression model defines a spurious regression. The regression models mentioned above can be estimated. In this case we will verify the validity of Wagner's law in an aggregated form or by replacing government expenditures by their components, meaning that we will verify the validity of the law on components.

In order to verify the validity of Wagner's law we must test the stationarity of the data series included in the regression model. In this sense we can use the following tests: Dickey-Fuller test (Dickey-Fuller 1979, 1981), Augmented Dickey-Fuller test (Dickey-Fuller 1979, 1981), Philips-Perron test etc. In this situation we use the augmented Dickey-Fuller and the testing procedure proposed by (Bourbonnais-Terraza 2008). We consider X_t, a non-stationary series, which is first order integrated, $I(1)$. To test the presence of unit root test we use the following model:

$$\Delta X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta_i \Delta X_{t-i} + \varepsilon_t \quad [8]$$

In the last relationship was noted by ΔX_t the first order difference of the X_t series. Depending on α_0 and α_2 parameter values we define particular models used for testing the presence of unit root for the series $(x_t)_{t=1,...,T}$. If $\alpha_0 = 0$ and $\alpha_2 = 0$ we obtain the M_1 model without constant and trend. The M_2 model with constant is obtained from the general model if $\alpha_0 \neq 0$ and $\alpha_2 = 0$. In the [8] relationship we define the M_3 model with constant and trend. Testing the unit root presence in the data series is realized by an algorithm in cascade having the form: $M_3 \to M_2 \to M_1$. The natural parameter *p* value is determined using Akaike criterion. To test the presence of unit root - in which case the series is non stationary –we define the null hypothesis: $H_0 : \alpha_1 = \alpha_2 = 0$. The rejection of the null hypothesis recommends a data series with deterministic trend rather than one with stochastic trend.

3. The analysis of government expenditures in Romania's case

The validity of Wagner's law in Romania' case is verified using the above methodology. In this case are used data series for GDP and total budgetary expenditures for the period 1985-2000. Indicators are expressed in 1990 constant prices.

The parameters of the five regression models were estimated using OLS. As in all cases there was a significant first order autocorrelation of the residuals we used a first order moving average process, MA (1). Results are shown in Table 1.

Table 1. Peacock-Wiseman, Gupta, Goffman, Musgrave and Mann models for Romania's case

	α	β	t_α	t_β	R^2	LL	F
Peacock-Wiseman	-11.48 (2.04)	2.55 (0.31)	-5.62	8.17	0.90	11.36	52.61
Goffman	-3.7 (1.28)	2.61 (−0.79)	-2.88	6.95	0.88	10.23	44.41
Musgrave	-6.70 (1.21)	1.57 (0.35)	-5.51	4.42	0.75	10.70	17.8
Gupta	(-6.70 1.21)	2.57 (0.35)	-5.51	7.24	0.88	10.67	52.61
Mann	-11.47 (2.08)	1.55 (0.31)	-5.49	4.9	0.77	11.36	20.09

Observations: between parentheses are presented standard errors of the estimators.

Source: own creation

Analyzing the results from Table 1 we observe that Wagner's law is verified for all five models for aggregate budgetary expenditures.

To deepen the analysis of this law are considered two nonlinear models to explain the evolution of total budget expenditures. Thus, for aggregate public expenditures is defined the nonlinear model: $G_t = \alpha GDP_t^{\beta}$. For its linearization we use the Box-Cox transformation. The model used to verify the validity of Wagner's law for public expenditures has the following form:

$$\frac{G_t^{\lambda}-1}{\lambda}=\alpha+\beta\frac{GDP_t^{\lambda}-1}{\lambda} \qquad [9]$$

where $\lambda \in R^*$. For $\lambda = 0$ we obtain the particular case which defines the Peacock-Wiseman model presented above. For the $\lambda = 0$ case the elasticity is constant: $e=\frac{\partial \ln ME}{\partial \ln GNP}$. In the opposite case, the elasticity is not constant for the entire period. This one is calculated using the following relation:

$$e_t=\beta\left(\frac{ME_t}{GDP_t}\right)^{-\lambda} \qquad [10]$$

To determine the best value of the λ parameter were used various values from the [-1, 1] interval. In Table 2 are presented the results for the $\lambda = 0$ and $\lambda = -0.8$ cases. The parameters are estimated in the situation of non correlated residuals. The value of Durbin-Watson statistics suggested the introduction of a first order autocorrelation.

Table 2. The parameters of total budgetary expenditures model

λ	α	β	t_α	t_β	LL	$-2\log\theta$	R^2	F	MA(1)
0	-11.59 (1.69)	2.57 (0.26)	-7.46	10.91	10.48	-	0.88	99.00	-
MA(1)	-11.48 (2.09)	2.59 (0.32)	-5.62	8.07	11.35	0.12	0.90	52.6	0.28* (1.08)[1]
-0.8	-7.82 (0.99)	7.27 (0.79)	7.9	9.14	72.37	-	0.86	84.89	-
MA(1)	-7.76 (1.30)	7.22 (1.04)	-5.99	6.94	73.1	0.27	0.88	44.07	0.25* (0.99)[1]

Observations: * Parameters are not significant for the 5% level of significance.

Source: own creation

Based on the above results we assert the following conclusions:

1. In both cases, β parameter is significantly different from zero. Moreover, the estimators are positive, indicating that the dependence between the two variables is positive;
2. Between the model for which $\text{cov}(\varepsilon_t, \varepsilon_s) = 0$ for $t \neq s$ and the model for which $\varepsilon_t \to MA(1)$ the differences are insignificant. To argue this conclusion was applied the likelihood ratio test, whose statistics, based on the relation $-2\log\theta$, follows a χ^2 distribution with one degree of freedom. For a 5% significance level resulted that: $\chi^2_{0.05} = 3.84 > -2\log\theta = 0.12$.

Finally, we state the following conclusions:

1. In Romania, Wagner law is valid for the aggregate budgetary expenditures;
2. The elasticity of total budgetary expenditures, which is defined by the following nonlinear function, is not constant over time:

$$\varepsilon_{G/GDP} = \frac{\partial \ln G_t}{\partial \ln GDP_t} = 7.22 \cdot (G_t / GDP_t)^{0.8} \qquad [11]$$

3. Throughout the entire period, the average elasticity is over unitary and is equal to 1.33.

4. The analysis of the Wagner law for military expenditures

Using the above mentioned methodology we will check if Wagner's law is verified for a component of public expenditures, respectively military expenditures (CM). The validity of this law is verified for Romania. First, we verify that the series used in the case of the above presented models are first-order integrated- see Table 3.

Table 3. The determination of the integration order for various data series

$\ln(GDP)$	$-0{,}869\ (p=1)$	$-4{,}350^{a}\ (p=1)$	-	I(1)
$\ln(CM)$	$-1{,}120\ (p=0)$	$-4.350^{a}\ (p=2)$	-	I(1)
$\ln(CM/GDP)$	$-2{,}720\ (p=0)$	$-3{,}690^{b}\ (p=1)$	-	I(1)

Observations: Critical values of the integration test for 1%, 5% and 10% significance levels are, respectively, -4,67, - 3,73, - 3,31. a – significant for 1%. b - significant for 5%. c – significant for 10%.

Source: own creation

In Table 4 is presented the model used to represent the ΔCM stationary variable:

Table 4. The model for ΔCM representation

Romania	$\underset{(-2.872)}{-0.1060}$	$\underset{(-2.872)}{-0.1060}$	$\underset{(-4.350)}{-1.0470}$	$\underset{(3.320)}{0.0116}$	$\underset{(0.02)}{-4.350}$

Source: own creation

Using a Granger-type test we determine the type of causal relationship between GDP and CM variables. The obtained results from the application of this test are presented in Table 5.

Table 5. The analysis of causality

Romania	Lags	F-statistic	
L_GDP	2	3.04 (0.080)	$GDP \rightarrow CM$
L_CM	2	1.30 (0.307)	No causality

Source: own creation

The above results show that, in the case of Romania, there is a weak causal relationship between the level of GDP and the one of military expenditures. For Romania there is no causal relationship having the $CM \rightarrow GDP$ form.

5. Conclusions

Testing Wagner's law emphasizes some interesting aspects. In the case of all the models, Peacock-Wiseman, Gupta, Goffman, Musgrave and Mann, we observe that Wagner's law is verified for aggregate budgetary expenditures for Romania.

By applying Wagner Law for military expenditures, we also obtained a valid model. Moreover, in this case it resulted that there is a weak causal relationship between GDP and military expenditures. Similar calculus made for Bulgaria (Andrei 2010) show that this causal relationship is not verified for this country.

If we apply this law for education expenditures in Romania's case we obtain a regression model of Musgrave type, which is valid, but with negative slope. Moreover, by applying the Engle-Granger causality test it resulted that there is no causal relationship between GDP and education expenditures.

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