Hacienda Pública Española/Review of Public Economics

Manuscript 2042

Validity of Wagner’s Law in Transition Economies: A Multivariate Approach

Suzana Balaban

Dejan Živkov

Validity of Wagner's Law in Transition Economies: A Multivariate Approach

1. Introduction

The German economist Adolph Wagner (1835-1917) drew direct conclusion about an observed increase in a state activity. Wagner's law says that state activity would increase at a rate higher than that of national income throughout the stage of economic development. In that sense, Wagner stated that government expenditure is an endogenous factor of an increase in national income.[1] Although Wagner discerned two parts of state activity (fiscal and regulatory), the majority of previous studies tested Wagner's law (WL) as a law of government expenditure increase. It may be considered as the narrow version of Wagner's law, but Biehl (1998) noticed that such a simplification may be made in order to make the law easier to test.

Due to relevant policy implications, the Wagner's law has been one of the most widely examined law in public economics over the last three decades. According to Abizadeh and Gray (1985), Wagner's law is only supported for developed countries. Consequently, relatively small number of the previous studies has tested the validity of Wagner's law in the transition economies. This fact may be explained by a lot of different factors, such as the circumstances specific to such countries and the lack of correct and comprehensive data. Nevertheless, we assume that the transition economies are suitable for testing the validity of Wagner's law in the present days due to the fact that these economies have been experienced the progress of the economy since the nineties. Taking into account that transition economies should redefine the role of the government in order to reduce its influence on the economy, we reduce the measurement of government size to final government consumption expenditure.

The majority of previous studies that analyse panel data have ordinarily assumed the hypothesis of cross-section independence. The results obtained from these studies may lead to unreliable conclusions, considering that the independence assumption is too strong because of spill-over effects especially in the case when countries from one particular region are used in the panel. This paper employs non-stationary panel methodologies that assume some cross-section dependence to test the validity of Wagner's law in sixteen transition economies over the period from 1990 to 2017. The analysis consists in three steps. First, unit root tests for

[1] Contrary to that, Keynes saw public expenditure as an exogenous factor that should be used as a policy instrument to affect growth.

cross-sectionally dependent panels are used. Then, we employ a bivariate cointegration tests. In order to obtain relevant results, we considered an influence of omitted variables on testing the validity of Wagner's law. Hence, the money supply is added into the trivariate system. The Fully modified OLS (FMOLS) and the Panel Dynamic OLS (PDOLS) estimator are finally used to estimate the long run relationship between the government expenditure and economic growth.

To the best of our knowledge, there are a lot of economic studies that test the validity of Wagner's law in both developed and developing countries, whereas the transition economies remain mostly neglected. Our motivation is an attempt to generalise Wagner's law on transition economies using new econometric techniques that assume some cross-section dependence, in order to to examine the long-run relationship between the government final consumption expenditure and GDP as well as the nature of this relationship in the case when money supply is added in the model. Our models are slightly modified relative to Pryor's version. Bearing in mind that government should reduce its influence on the transition economy, we reduce the measurement of government size to final government consumption expenditure. Ram (1987) claimed that the cross-section studies based on conventional data are not comparable over time and across countries because of non-trade services that constitute a great part of government expenditure. Therefore, we correct the government share in GDP by the relative price of government expenditure. We try to answer whether the validity of Wagner's law in transition economies depends on a historical context or development stage and whether introduction of the money supply in the model has an impact on obtained results. That would be our contribution the literature.

Beside introduction, the remainder of the paper is structured as follows. Second section provides brief literature survey. Underlying model and data set are presented in third section. Fourth section presents applied methodology and summary of the results. Fifth section concludes.

2. Literature review

Wagner's law has provided scope for a range of different interpretations. It is possible to identify at least six of the specifications of WL that are dominant in the literature and can be expressed, as follows:

1. Model 1: $GE = f(GDP)$ Peacocok and Wiseman (1961)

2. Model 2: $\left(\frac{GE}{P}\right)=f\left(\frac{GDP}{P}\right)$ Gupta (1968) and Michas (1975)
3. Model 3: $CGE=f(GDP)$ Pryor (1968)
4. Model 4: $GE=f\left(\frac{GDP}{P}\right)$ Goffman (1968)
5. Model 5: $\left(\frac{GE}{GDP}\right)=f\left(\frac{GDP}{P}\right)$ Musgrave (1969)
6. Model 6: $\left(\frac{GE}{GDP}\right)=f(GDP)$ Mann (1980)

where *GE* represent the government expenditure, *GDP* denotes the gross domestic product, *P* is population and *CGE* denotes the government consumption expenditure. The noticeable difference in six observed models refers to the measurement of government expenditure and economic output.[2]

It could be said that Peacock and Wiseman (1961) enliven Wagner's law; they constructed the new measurement of state activity using only a fiscal activity. Gupta (1968) proposed a double logarithmic functional form considering that this form ensures a constant elasticity results on the both sides of the equation. Pryor (1968) analysed an increase of government consumption expenditure in market economies (USA, West Germany, Austria, Ireland, Italy, Greece and Yugoslavia) and centrally planned economies (Czechoslovakia, East Germany, the USSR, Hungary, Poland, Romania and Bulgaria) which is consistent with our panel. He found that Wagner's law seems applicable for countries that are in the process of transforming their economies from rural agricultural to urban industrial. He thought that this stage might be described as the beginning of an industrial economy. Goffman (1968) criticized previous approaches because they obtained results in terms of the growth or decline in government expenditures relative to income instead of in terms of the values of the elasticities. Goffman suggested that the percentage change in income leads to a greater percentage change in expenditures. Musgrave's (1968) interpretation considers shares instead of absolute levels, hence it is less likely to suffer the endogeneity problem. Moreover, he considered the cause of the growth/reduce of particular types of public expenditures. Man (1980) modified Peacock and Wiseman's interpretation into a share version and called it a structural version of WL.

The different versions of WL have been tested on the example of different countries

[2] Jaén-García (2018) used the public employment as a measure of public spending, which is in accordance with recommendations by Peacock and Scott (2000).

applying different methodologies and covering the different period of time. The obtained results are not unique, as can be seen from the Table A1 in Appendix A. Ashan et al. (1996) stated that the influence of omitted variables and econometric specification as the factors may explain the inconsistency among obtained results.[3]

Relatively small number of the studies has tested the validity of Wagner's law in transition economies. Dolenc (2009) concluded that the Wagner's law holds for Slovenia covering the period from 1992 to 2007. Notwithstanding, he did not examine the structure of government expenditure, he considered that general picture may be seen from his analysis. Moreover, he showed that the new political orientation would not notably affect the trends in government finances in Slovenia. Gurgul et al. (2012) utilized aggregated and disaggregated data of most important government expenditure in Poland, covering the period from 2000 to 2008. Conversely, his findings indicated that there is causality between government expenditure and economic growth, but it is valid in the opposite direction than Wagner asserts.[4] Magazzino (2012) examined the empirical evidence of Wagner's law and augmented Wagner's law for the EU-27 countries over the period from 1970 to 2009. According to obtained results Wagner's law is applicable for developing countries.[5] Magazzino's (2015) findings showed that the relationship between public expenditure and aggregate income in EU countries over the period from 1980 to 2013 seems to be more Wagnerian than Keynesian.

Ashan et al. (1992) asserted that an introduction of additional fiscal or monetary variable may reverse the causality between the public expenditure and income. Kennedy (1998) noticed that cointegration tests may give incorrect results if the relevant variables are excluded from the model. Burney (2002) suggested that besides the demand factors (per capita income), the supply factors are of essential significance as well, in affecting the government expenditure. Chow et al. (2002) considered that introducing money supply as an additional variable is prompted by the money-income causality literature. We agree with that claim. Namely, Sims, (1972, 1980) and Stock and Watson (1989) showed that money has an important impact on output fluctuations.[6] Chow's bivariate cointegration tests does

[3] Other factors include: (1) the quality and quantity of data; (2) test procedure and the observed period; (3) the chosen level of temporal aggregation; and (4) focus on short-run dynamics.

[4] It is consistent with Keynesian theory

[5] Considering that in an incipient stage of development public expenditure should be determined by an aggregate income.

[6] Sims (1972) find the causality from money to income using the postwar U.S. data. Sims (1980) compared the interwar and postwar business cycles. According to his findings, the money stock emerges as firmly causally prior, in both periods and accounts for a substantial fraction of variance in production in both periods. Stock and

not support Wagner's law. However, the introduction of a third variable (money supply), re-establishes a cointegrating relationship and the results of the Granger causality test show a unidirectional causality from income and money supply to public spending in the long run. According to Loizides and Vamvoukas (2005), any variable that is related to the size of government sector and national income may be introduced as additional ones considering that the literature in these areas are empirical in nature. However, they noticed that various empirical studies find that unemployment and inflation are intimately connected with the size of public sector growth and national income. Using data on Greece, UK and Ireland, their analysis indicated that economic growth Granger causes increases in the relative size of government in Greece, and in the UK, when inflation is included. Kirchner (2012) introduced a new approach to testing the validity of Wagner's law taking into account a federal legislative activism in Australia since 1901. According to the obtained results, he concluded that a growth in legislation is without a robust long-run relationship with the level of income. The growth in the number of pages of legislation enacted and legislative complexity show a positive long-run relationship with the level of income. Oktayer and Oktayer (2013) demonstrated that a long-run correlation is found only in the case when a third variable (inflation ratio) is included in a trivariate system.

Using non-stationary panel methodologies that assume some cross-section dependence we analyse the long-run relationship between government final consumption expenditure and GDP in the sixteen economies in transition as well as the nature of this relationship in the case when money supply is added in the model.

3. Model and Data

According to Peacock and Scott (2000), there have been at least 14 different measures of size of government. The majority of previous studies have ordinarily used the measure of fiscal activity on an aggregate level. Notwithstanding, Bird (1971) considered that the incorporation of transfers overemphasized the government expenditure. Musgrave (1969) and Ram (1987) noticed that if a growth in the size of government expenditure appears due to an increase in transfer, this may not be explained by Wagner's law. Bearing in mind that transition economies should redefine the role of the government in order to reduce its influence on the economy, we reduce the measurement of government size to final government consumption expenditure which is consistent with Pryor's (1968) version of

---

Watson (1989) innovations in Ml have statistically significant marginal predictive value for industrial production, both in a bivariate model and in a multivariate setting including a price index and an interest rate.

Wager's law. He stated that in growing economies, public consumption expenditure has an increasing participation in the national income. According to Pryor (1968), the stages of economic development between the underdeveloped and post-industrial economies would seem to fit with the Wagner's law restricted to the linear form of the relationship between government consumption expenditure and GNP. Musgrave's interpretation considers shares instead of absolute levels, hence it is less likely to suffer the endogeneity problem. Our models are slightly modified:

$$Y_{it} = \alpha_i + x_{it}^{'}\beta + \upsilon_{it} \tag{1}$$

where, *i = 1, 2,…, N* and *t = 1, 2,…, T* indexes cross section and time series units respectively, Y_{it} is $\ln GCE_{it}/GDP_{it}$ (an I(1) process), β is parameter or (2×1) vector of parameters, α_i are intercepts and υ_{it} are the stationary disturbance terms. Here x_{it}^{i} are assumed to be independent variable ($\ln GDP_{it}/P_{it}$) or (2×1) vector of independent variables ($\ln GDP_{it}/P_{it}$ and $\ln M_{it}$) which are I(1) for all cross section units.

This functional relationship proposes that the share of government consumption expenditures in national income (GCE_{it}/GDP_{it}) will increase at a rate higher than that of *per capita* income with the development process represented by real *per capita* income (GDP_{it}/P_{it}). In accordance with Wagner's law, we expect that β should be positive even in the case when the money supply, broad money as per cent of GDP (M_{it}) is added in the model. Following the Wagner's law, the government consumption expenditure is an endogenous factor of economic development. In our models it depends on real GDP *per capita* or real GDP *per capita* and money supply. Our assumption that the transition economies are suitable for testing the validity of Wagner's law in the present days arises from the fact that these economies have been experienced the real GDP *per capita* growth since the nineties. Moreover, we correct the government share in GDP (expressed in constant 2010 US$) by the relative price of government expenditure (ratio between price level of government consumption and price level of household consumption[7]) bearing in mind the question of comparability[8].

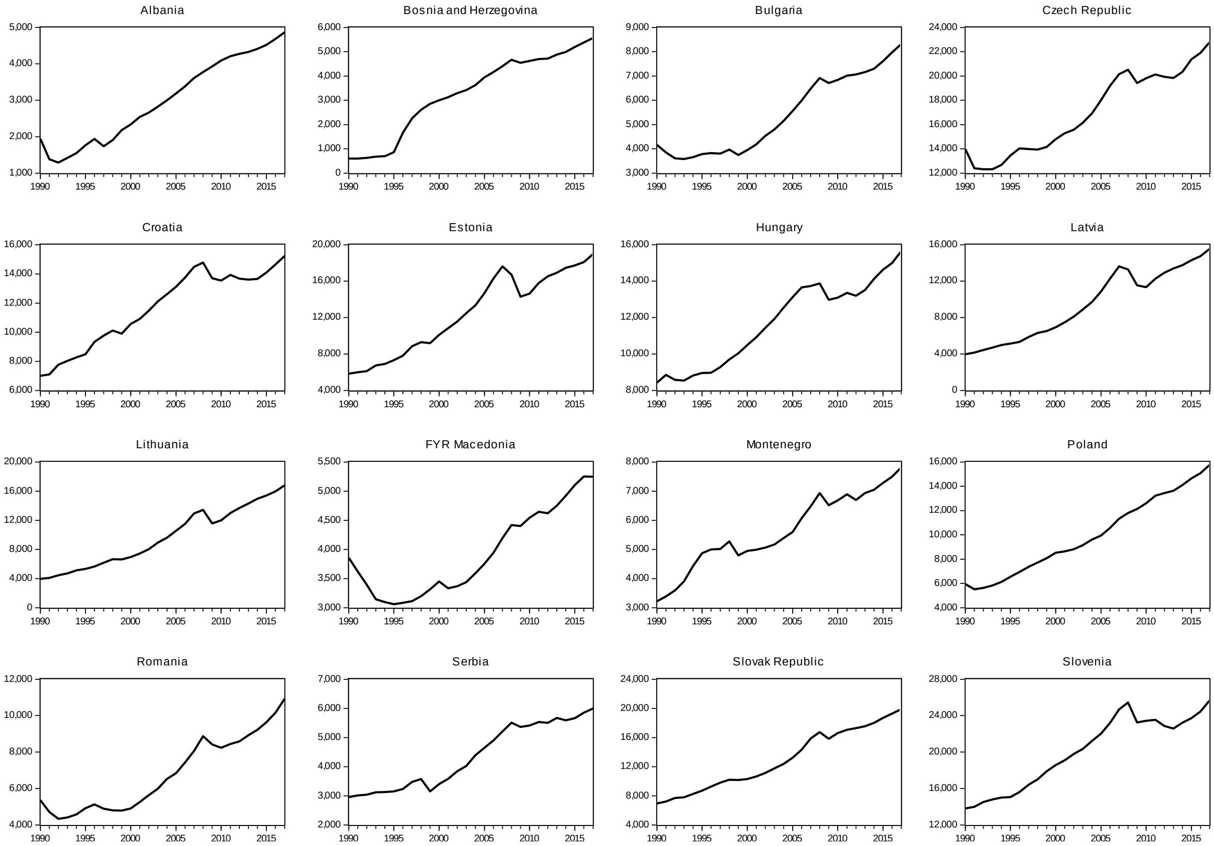
---

[7] Derived from Feenstra, R. C., Inklaar, R. and Timmer, M. P. (2015) *The Next Generation of the Penn World Table*, American Economic Review, Vol. 105, No. 10, p. 3150-3182

[8] Ram (1987) claimed that the cross-section studies based on conventional data are not comparable over time and across countries because of non-trade services that constitute a great part of government expenditure. Government share in GDP expressed in a conventional data can seem to grow with economic development because of the growth of the relative prices of government goods and services.

The panel used in this study contain annual time series data for sixteen economies in transition[9] covering the period from 1990 to 2017, which can be sourced from the World Bank DataBank. The observed economies in transition (1) belong to the group of Central and Eastern Europe economies, (2) were socialist states, (3) are members or candidates for the membership of the EU, and (4) have experienced similar real GDP per capita pattern in observed period as we can see in Figure 1.

Figure 1: Real GDP *per capita*[10]



Source: World Bank DataBank

Unfortunately, another common characteristic of these countries is the lack of data for the previous period due to their turbulent history, an emergence of new countries and war. Common features of observed countries may contribute to homogeneity of the panel data. In

[9] Albania, Bosnia and Herzegovina, Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Macedonia FYR, Monenegro, Poland, Romania, Serbia , Slovak Republic and Slovenia. The transition process is completed for the countries that joined the EU. These countries are classified as developed ones since then.

[10] GDP figures are in the real terms (constant 2010US$) in order to capture the effect of population growth and remove the differences in price levels between countries.

order to test this assumption formally, we apply *F* test.[11] We do not analyse data over a very long historical period, thus data quality could not become an issue.

4. Methodology and Results

The analysis consists in three steps. First, unit root tests for cross-sectionally dependent panels are used; Bai and Ng (2003) and Pesaran (2007). Second, the existence of a co-integrating relationship among general government final consumption expenditure as percentage of GDP and real GDP per capita is investigated in a bi- and multi-variate context. The WR_M test (Westerlund 2007) are applied bearing in mind that it allows for cross-sectional dependence. Finally, the Fully Modified OLS (FMOLS) estimators developed by Pedroni (2000) and the Panel Dynamic OLS (PDOLS) estimator proposed by Mark and Sul (2003) are used in order to estimate the long run relationship between the variables considered. All the estimators take into account some degree of cross-section dependence.

4.1. Unit root test

Narayan et al. (2008) noticed that the unit roots tests have been applied in the majority of analysis that test the validity of Wagner's law since the nineties. The problem that occurs in such studies is that they do not consider the problem of cross-sectional dependence. In the presence of cross-sectional dependence, the application of the first-generation unit root tests results in the size distortions and low power of the test (Strauss and Yigit 2003). Hence, we conduct a few cross-sectional dependence tests before applying unit root test on our panel data. The results of applied cross-sectional dependence tests show that our data indicate significant cross-sectional dependence between the observed countries in the panel data.[12] Consequently, in order to test the existence of unit roots we apply some of the second-generation panel unit root test that allows for cross-sectional dependence. We apply a dynamic factor model such as model proposed by Bai and Ng (2004). Alternative panel unit root tests include test proposed by Pesaran (2007) that specifies the cross-sectional dependencies as a common factor model. As representatives of two different approaches, tests are ideal for verification of the results of each other. Bai and Ng (2004) analysed the following dynamic factor model:

---

[11] However, the estimated $F = 4.5656$ (p-value = 5.504e-08) means that we can reject null hypothesis regarding homogeneous slope coefficients. This finding is in accordance with our assumption that the cross-section dependence may occur in the observed panel.

[12] The results are available in Appendix B.

$$y_{it} = \alpha_i + \wedge'_i \; f_t + y_{it}^0$$
$$y_{it}^0 = \rho_i y_{i,t-1}^0 + \varepsilon_{it} \quad (2)$$

They estimate the factor's stationarity and the idiosyncratic element proposing pool findings from individual ADF tests on the de-factored data by mixing p-values:

$$P_{\hat{e}}^C = \frac{-2\sum_{i=1}^N \ln p_{\hat{e}}^C(i) - 2N}{\sqrt{4N}} \xrightarrow{d} N(0,1) \quad (3)$$

where $p_{\hat{e}}^C(i)$ is the p-value of the ADF test on the estimated idiosyncratic shock for cross-section i.

Pesaran (2007) proposed an easier technique found on ADF regression with the lagged cross-sectional mean. Its first difference gets the cross-sectional dependence appearing by a single factor model. This simple CADF (cross-sectionally augmented DF) regression is

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + d_1 \Delta\bar{y}_t + \varepsilon_{it} \quad (4)$$

In the case of an existence of serial correlation, the regression should be augmented, as shown in the following regression:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + \sum_{j=0}^{\rho} d_{j+1} \Delta\bar{y}_{t-j} + \sum_{k=1}^{\rho} c_k \Delta y_{i,t-k} + \varepsilon_{it} \quad (5)$$

Pesaran (2007) applied the regression for every i, and then he averaged the t-statistics on the lagged value in order to estimate the CIPS statistic

$$CIPS = \frac{1}{N}\sum_{i=1}^N CADF_i \quad (6)$$

4.2. Panel cointegration test

Before applying panel cointegration test, we conduct a few cross-sectional dependence tests as in the case of unit root testing.[13] The estimated results show the presence of cross-section dependence; hence we apply four error correction based panel cointegration tests developed by Westerlund (2007) to reveal whether there is a linear combination of

[13] The results are available in Appendix B.

government consumption expenditure and real GDP per capita in our panel. The test is appropriate for application in our model due to the fact that it is developed to cope with cross-sectionally dependent data and it allow for a large degree of heterogeneity. Westerlund (2007) suggests a structural based test classified as second-generation test that allow for a dependence inside and across the cross-sectional units. The null hypothesis of no cointegration is estimated through analysis whether the error correction term in a conditional error correction model is equal to zero. The alternative hypothesis depends on the specific test. While, the group-mean tests (G_t and G_a) examine the alternative hypothesis that at least one unit is cointegrated, the panel test (P_t and P_a) have the alternative hypothesis that the panel is cointegrated as a whole. Consider the ECM described by equations (7) and (8) in which all variables in levels are assumed to be *I*(1):

$$\Delta Y_{i,t} = \alpha_i^Y + \lambda_i^Y \left(Y_{i,t-1} - \beta_i^Y X_{i,t-1}\right) + \sum_{j=1}^{n} \delta_{i,j}^Y \Delta Y_{i,t-j} + \sum_{j=1}^{m} \theta_{i,j}^Y \Delta X_{i,t-j} + \varepsilon_{i,t} \tag{7}$$

$$\Delta X_{i,t} = \alpha_i^X + \lambda_i^X \left(X_{i,t-1} - \beta_i^X Y_{i,t-1}\right) + \sum_{j=1}^{n} \theta_{i,j}^X \Delta X_{i,t-j} + \sum_{j=1}^{m} \delta_{i,j}^X \Delta Y_{i,t-j} + \mu_{i,t} \tag{8}$$

where $Y = \ln GCE_{it} / GDP_{it}$ and $X = \ln GDP_{it} / P_{it}$, the parameters $\lambda_i^k,\ k \in \{X, Y\}$ are the parameters of the EC term and provide estimates of the speed of error-correction towards the long equilibrium for country *i*, while $\mu_{i,t}$ and $\varepsilon_{i,t}$ are white noise random disturbances. We are mainly interested in the long-run behaviour of our model, so the next step is to determine the coefficients of the conditional long-run relationships between *Y* and *X* when the short-run terms are set to zero. The long-run coefficients can be easily derived from the following long-run equation, obtained from the reduced form of (7) when the terms representing short-run changes are $\Delta Y = \Delta X = 0$, as follows:

$$Y_{i,t} = -\frac{\alpha_i^Y}{\lambda_i^Y} + \beta_i^Y X_{i,t} \tag{9}$$

In the next step, we decide to introduce the money supply as an additional explanatory variable into the model in order to check these findings. Consider the ECM described by equations (10), (11) and (12) in which all variables in levels are assumed to be *I*(1):

$$\Delta Y_{i,t} = \alpha_i^Y + \lambda_i^Y\left(Y_{i,t-1} - \beta_i^Y X_{i,t-1} - \gamma_i^Y M_{i,t-1}\right) + \sum_{j=1}^{n}\delta_{i,j}^Y \Delta Y_{i,t-j} + \sum_{j=1}^{m}\theta_{i,j}^Y \Delta X_{i,t-j} + \sum_{j=1}^{p}\phi_{i,j}^Y \Delta M_{i,t-j} + \varepsilon_{i,t} \qquad (10)$$

$$\Delta X_{i,t} = \alpha_i^X + \lambda_i^X\left(X_{i,t-1} - \beta_i^X Y_{i,t-1} - \gamma_i^X M_{i,t-1}\right) + \sum_{j=1}^{m}\theta_{i,j}^X \Delta X_{i,t-j} + \sum_{j=1}^{n}\delta_{i,j}^X \Delta Y_{i,t-j} + \sum_{j=1}^{p}\phi_{i,j}^X \Delta M_{i,t-j} + \mu_{i,t} \qquad (11)$$

$$\Delta M_{i,t} = \alpha_i^M + \lambda_i^M\left(M_{i,t-1} - \beta_i^M Y_{i,t-1} - \gamma_i^M X_{i,t-1}\right) + \sum_{j=1}^{p}\phi_{i,j}^M \Delta M_{i,t-j} + \sum_{j=1}^{m}\theta_{i,j}^M \Delta X_{i,t-j} + \sum_{j=1}^{n}\delta_{i,j}^M \Delta Y_{i,t-j} + e_{i,t} \qquad (12)$$

where, $M_{it} = \ln M_{it}$, the parameters λ_i^k, $k \in \{X, Y, M\}$ are the parameters of the EC term, while $\mu_{i,t}, \varepsilon_{i,t}$ and $e_{i,t}$ are white noise random disturbances. The long-run coefficients can be derived from the following long-run equation, obtained from the reduced form of (10) when the terms representing short-run changes are $\Delta Y = \Delta X = \Delta M = 0$, as follows:

$$Y_{i,t} = -\frac{\alpha_i^Y}{\lambda_i^Y} + \beta_i^Y X_{i,t} + \gamma_i^Y M_{i,t} \qquad (13)$$

4.3. Panel long-run estimators

In our data, $\ln GCE_{it} / GDP_{it}$ and $\ln M_{it}$ may become endogenous and also the error terms can be serially correlated which would result in the dependence of OLS estimators on nuisance parameters. In order to solve these problems, two estimators namely FMOLS and DOLS can be introduced. Phillips and Hansen (1990) proposed a semi parametric correction for the problem of long run correlation among cointegrating equation and stochastic regressors innovations, resulting in FMOLS estimators. It is asymptotically unbiased. On the other hand, Saikkonen (1992) and Stock and Watson (1993) proposed an asymptotically efficient estimator which eliminates the feedback in the cointegrating system by augmenting the cointegrating regression with lags and leads of independent variables. The resulting estimator is known as DOLS estimator. With a view to explain the idea of FMOLS estimator consider the aforementioned fixed effect model:

$$Y_{it} = \alpha_i + x_{it}^{'}\beta + \upsilon_{it} \qquad (1)$$

It is assumed that it follows an autoregressive process of the following form:

$$x_{it} = x_{it-1} + \varepsilon_{it} \qquad (14)$$

$$\textit{Innovation Vector},\ w_{it} = \left(\upsilon_{it}, \varepsilon_{it}\right)$$

Given that $w_{it} = (\upsilon_{it}, \varepsilon_{it}) \sim I(0)$, the variables are said to be cointegrated for each members of the panel with cointegrating vector *β*. The asymptotic distribution of the OLS estimator is condition to the long run covariance matrix of the innovation vector. The FMOLS estimator is derived by making endogeneity correction (by modifying variable $\ln GCE_{it} / GDP_{it}$) and the serial correlation correction (by modifying long run covariance of innovation vector, w_{it}). The resulting final estimator is expressed as follows:

$$\hat{\beta}_{FMOLS} = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \bar{x}_i)(x_{it} - \bar{x}_i)' \right]^{-1} \times \left[\sum_{i=1}^{N} \left(\sum_{t=1}^{T} (x_{it} - \bar{x}_i) \hat{Y}_{it} - T \hat{\Delta}_{\varepsilon\upsilon} \right) \right] \tag{15}$$

The cointegrating regression is augmented by lead and lagged differences of $\ln GDP_{it} / P_{it}$ and $\ln M_{it}$ as independent variables in DOLS framework for controlling endogeneity (by following Saikkonen 1992). In order to control serial correlation, lead and lagged difference of the $\ln GCE_{it} / GDP_{it}$ has also been included in the model (by following Stock and Watson, 1993). Thus, the estimated regression equation under DOLS framework was as follows:

$$Y_{it} = \alpha_i + \beta_i x_{it} + \sum_{k=-p_1}^{p_2} \delta_k \Delta Y_{it-k} + \sum_{k=-q_1}^{q_2} \lambda_k \Delta x_{it-k} + \mu_{it} \tag{16}$$

4.4. Summary of the results

The problem that occurs in the recent studies is that they do not consider the problem of cross-sectional dependence. Hence, we conduct a few cross-sectional dependence tests before applying unit root test on our panel data. Before all, we examine descriptive statistics, estimate a correlation matrix, calculate the IQR for each observed variable and conduct the Chaw test to detect potential structural breaks in our panel data (see Appendix B).

The results of all applied cross-sectional dependence tests show that our data indicate significant cross-sectional dependence between the observed countries in the panel (see Table B3 in Appendix B). Hence, we apply two test that belong to the group of the second generation unit root test that allows for cross-sectional dependence: (1) a dynamic factor model by Bai and Ng (2004) and (2) an alternative panel unit root test proposed by Pesaran (2003) that specifies the cross-sectional dependencies as a common factor model.

Obtained results (see Table 1) show that all variables are nonstationary. Although we cannot reject the null hypothesis in the levels of all variables, we may reject the null hypothesis in the case when we apply the test to their first differences. This fact leaves open the question that government consumption expenditure and real GDP per capita could share a long-run relationship. According to our results, all observed variables have a panel unit root. Hence, the next question is: are the observed variables panel cointegrated?

Table 1: Unit root tests

Variable	CIPS test			Bai and Ng	
	None	Const	Trend	Idiosyncratic	Common
ln GCE_{it}/GDP_{it}	-1.9715 (0.0100)	-1.9667 (0.1000)	-2.2249 (0.1000)	-2.135218 (0.2217)	-2.207594 (0.1913)
Δ ln GCE_{it}/GDP_{it}	-2.8762 (0.0100)	-2.9386 (0.0100)	-3.1982 (0.0100)	-4.392280 (0.0001)	-4.571902 (0.0001)
ln GDP_{it}/P_{it}	-1.5854 (0.0754)	-2.0726 (0.1000)	-2.2025 (0.1000)	-1.908216 (0.3179)	-1.962547 (0.2873)
Δ ln GDP_{it}/P_{it}	-2.8569 (0.0100)	-2.8972 (0.0100)	-3.0320 (0.0100)	-3.566352 (0.0061)	-3.707951 (0.0037)
ln M_{it}	-0.7605 (0.1000)	-2.3196 (0.0375)	-2.4792 (0.0100)	-2.081427 (0.2985)	-2.118763 (0.2054)
Δ ln M_{it}	-2.3174 (0.0100)	-2.6089 (0.0100)	-2.9512 (0.0100)	-4.114236 (0.0001)	-4.198475 (0.0001)

Notes: CIPS test is based on individual CADF regressions with l=2 lags of differences. The outcomes are not very sensitive to the choice of number of lagged differences l. On the basis of the common unobserved factor assumption for the error process, the Pesaran test gives indication of non-stationarity of all observed variables. Numbers in parenthesis are p-values. Entries in the fifth and sixth column represent the results of ADF test for PANIC (2004). The approximate p-values for these tests are calculated on the basis of MacKinnon (1996). The obtained ADF statistics also give indication of non-stationarity of all observed variables. To determine the lag of the ADF test Bai and Ng (2002) suggest $4\left(\frac{T}{100}\right)^{1/4}$. We use the BIC_3 to estimate the number of common factors as Bryne and Fiess (2010) point out, the BIC_3 is more robust to cross-sectional correlation.

Before applying panel cointegration tests we conduct a few cross-sectional dependence tests as in the case of unit root testing. The estimated results show an existence of cross-section dependence (see Table B2 in Appendix B). Therefore, we apply four error-correction–based panel co-integration tests developed by Westerlund (2007).

Table 2: Westerlund panel cointegration test

	Constant				Constant and trend			
	Value	Z-value	p-value	Robust p-value	Value	Z-value	p-value	Robust p-value
Cointegration based on Equation (9)								
G_t	-2.738	-4.221	0.000	0.000	-3.425	-6.447	0.000	0.000
G_a	-5.492	-4.276	0.000	0.003	-11.698	-6.251	0.000	0.000
P_t	-10.095	-5.093	0.000	0.001	-13.537	-7.108	0.000	0.000
P_a	-6.024	-4.817	0.000	0.000	-12.011	-6.365	0.000	0.000
Cointegartion based on Equation (13)								
G_t	-3.327	-5.782	0.000	0.000	-3.982	-6.197	0.000	0.000
G_a	-15.799	-6.009	0.000	0.000	-22.417	-6.154	0.000	0.000
P_t	-6.125	-2.093	0.018	0.052	-8.078	-2.821	0.009	0.019
P_a	-9.038	-4.115	0.000	0.031	-14.544	-2.906	0.003	0.030

Notes: "a" refers to the estimation of the error correction estimate, while "t" refers to the estimation for the standard error of "a". The group-mean tests are based on weighted sums of the λ_i^k estimated for individual countries, whereas the panel tests are based on an estimate of λ^k for the panel as a whole. The all test statistics are normally distributed. The two tests (G_t and P_t) are computed with the standard errors of λ_i^k estimated in a standard way, while the other statistics (G_a and P_a) are based on Newey and West (1994) standard errors, adjusted for heteroskedasticity and autocorrelations. We use AIC to determine the optimal lag and lead length. We examine a cointegration with a constant and with a constant and trend in the error correction relation.

Table 3 Estimation of Cointegrating Regression

	FMOLS			PDOLS		
	Pooled	Weighted	Grouped	Pooled	Weighted	Grouped
	$\ln GCE_{it}/GDP_{it} \sim \ln GDP_{it}/P_{it}$					
$\ln GDP_{it}/P_{it}$	-0.183609 (0.0000)	-0.207683 (0.0000)	-0.205499 (0.0000)	-0.176880 (0.0000)	-0.186630 (0.0000)	-0.208329 (0.0000)
	$\ln GCE_{it}/GDP_{it} \sim \ln GDP_{it}/P_{it} + \ln M_{it}$					
$\ln GDP_{it}/P_{it}$	-0.107343 (0.0045)	-0.149166 (0.0000)	-0.144875 (0.0206)	-0.133726 (0.0000)	-0.179330 (0.0000)	-0.153689 (0.0678)
$\ln M_{it}$	-0.075719 (0.0017)	-0.055707 (0.0004)	-0.075643 (0.1816)	-0.054705 (0.0532)	-0.020552 (0.3990)	-0.115682 (0.1292)

Notes: DOLS (Pooled) and FMOLS (Pooled) estimation coefficient of covariance was computed using sandwich method and in DOLS (Grouped) estimation individual heteroscedasticity and autocorrelation consistent standard errors and covariances were used. Automatic leads and lags specification are based on SIC criterion. Number in the parenthesis indicate p-value.

We use bivariate cointegration tests in order to test the relationship between government final consumption expenditure and GDP. Afterwards, we introduce the money supply as an additional explanatory variable into the model. Obtained results (see Table 2) indicate that the null hypothesis of no cointegration is rejected at any meaningful significant level by the simple and by the robust p-values. Using Westerlund (2007) cointegration tests to the sixteen economies in transition, we may draw a conclusion that the cointegration between government final consumption expenditure and real GDP *per capita* exists, even in the case when the money supply is added in the model. In other words, by an inclusion of additional variable co-integration between the observed variables remains unchanged. As a robustness checks, we compare the results of Westerlund cointegration tests with those by Pedroni and Kao's tests[14]. The results of Pedroni and Kao's tests confirm the obtained results (see Appendix B).

Finally, in order to estimate the long-run relationship between government final consumption expenditure and real GDP per capita, we apply the FMOLS and PDOLS. According to our results (see Table 3), real GDP per capita has a significant impact on government final consumption expenditure, but the sign of coefficient is not in accordance with Wagner's Law. Wagner asserted that throughout the economic development the public activities would increase at a rate higher than that of national income. By analysing panel data of sixteen transition economies, we find a completely different relationship. In these economies, government final consumption expenditure would decrease at a rate lower than the growth rate of real GDP per capita. Instead of estimating the coefficient greater than one and positive, our estimated coefficient is less than one and negative. However, we have to agree with the Wagners' claim that the government expenditure is an endogenous factor of an increase in national income. The results also show that an inclusion of additional variable (money supply) has no implication on the obtained results.

4.5. Further examination

Bearing in mind that some of transition economies in our panel are now classified as developed ones, we introduce dummy variables assuming that results can be different among different type of development stages. The dummy variables take the value 1 in the case when a country is classified as developed or the value 0 otherwise.

[14] Following the comments of an anonymous reviewer.

In order to test the cointegration between government final consumption expenditure and GDP we apply a LM-based panel cointegration test developed by Westerlund and Edgerton (2008). We chose this test taking into account that the test considers both structural breaks and cross-section dependence. Based on $LM_{\phi}(i)$ and $LM_{\tau}(i)$ Westerlund and Edgerton (2008) propose the two panel LM-based test statistics for the null of no cointegration as

$$\overline{LM}_{\phi}(N) := \frac{1}{N}\sum_{i=1}^{N} LM_{\phi}(i) \quad \text{and} \quad \overline{LM}_{\tau}(N) := \frac{1}{N}\sum_{i=1}^{N} LM_{\tau}(i). \tag{17}$$

In consideration of the asymptotic properties of $\overline{LM}_{\phi}(i)$ and $\overline{LM}_{\tau}(i)$ Westerlund and Edgerton (2008) obtain the following normalised test statistics

$$Z_{\phi}(N) = \sqrt{N}\left(\overline{LM}_{\phi}(N) - E(B_{\phi})\right) \tag{18}$$

$$Z_{\tau}(N) = \sqrt{N}\left(\overline{LM}_{\tau}(N) - E(B_{\tau})\right) \tag{19}$$

Table 4 Panel cointegration test results with structural breaks and cross-section dependence

Model	$Z_{\phi}(N)$	$Z_{\tau}(N)$
No break	-4.28***	-1.52**
Mean Shift	-2.45**	-1.46*
Regime Shift	-2.08**	-1.72***

Notes: The LM-based test statistics $Z_{\phi}(N)$ and $Z_{\tau}(N)$ are normal distributed. The number of common factors is determined by means of the information criterion proposed by Bai and Ng (2004) and the maximum is set to 5. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Both test statistics $Z_{\phi}(N)$ and $Z_{\tau}(N)$ of Westerlund and Edgerton (2008) reveal evidence in favour of a long-run relationship between government final consumption expenditure and real GDP per capita when allowing for breaks in the level and the slope of this relationship. We may conclude that the introduction of dummy variables do not change the relationship between observed variables.

Table 5: Estimation of Cointegrating Regression

	FMOLS			PDOLS		
	Pooled	Weighted	Grouped	Pooled	Weighted	Grouped
$\ln GCE_{it}/GDP_{it} \sim \ln GDP_{it}/P_{it}+D_{it}$						
$\ln GDP_{it} / P_{it}$	-0.193524 (0.0000)	-0.212461 (0.0000)	-0.209774 (0.0000)	-0.181523 (0.0000)	-0.186632 (0.0000)	-0.213569 (0.0000)
D_{it}	-0.054173 (0.2106)	-0.091517 (0.0713)	-0.081268 (0.1146)	-0.105323 (0.0915)	-0.050106 (0.0079)	-0.100953 (0.0801)
$\ln GCE_{it}/GDP_{it} \sim \ln GDP_{it}/P_{it} + \ln M_{it}+D_{it}$						
$\ln GDP_{it} / P_{it}$	-0.120416 (0.0032)	-0.162475 (0.0007)	-0.193341 (0.0000)	-0.101588 (0.0047)	-0.190422 (0.0000)	-0.161143 (0.0000)
$\ln M_{it}$	-0.095214 (0.0103)	-0.061689 (0.0098)	-0.082847 (0.1012)	-0.077524 (0.0663)	-0.035215 (0.2016)	-0.138546 (0.1057)
D_{it}	-0.040184 (0.2065)	-0.102561 (0.0623)	-0.079455 (0.1201)	-0.096858 (0.1174)	-0.100216 (0.0108)	-0.094261 (0.0728)

Notes: DOLS (Pooled) and FMOLS (Pooled) estimation coefficient of covariance was computed using sandwich method and in DOLS (Grouped) estimation individual heteroscedasticity and autocorrelation consistent standard errors and covariances were used. Automatic leads and lags specification are based on SIC criterion. Number in the parenthesis indicate p-value.

The FMOLS and PDOLS models (see Table 5) show that real GDP per capita has a significant impact on government final consumption expenditure. Once again, the sign of coefficient does not comply with Wagner's law and an inclusion of additional variables (dummy and money supply) has no implication on the obtained results.

5. Conclusion

There are only a few studies that test the validity of Wagner's law in transition economies. One of the possible explanations may be an imposed obligation for transition economies to redefine the role of the government in order to reduce its influence on the economy. We may say that observed economies followed a more political vision that claims for non-intervention. Since they are former socialist countries, transition economies have inherited a high level of public expenditure which raises the question of sustainable level and efficiency of public expenditure. Although we reduce the measurement of government size to final government consumption expenditure, our findings show that government final consumption expenditure has been decreasing at a rate lower than the rate of growth of real GDP per capita in the observed economies in transition. Namely, GDP per capita has a significant impact on the government final consumption expenditure, but the sign of coefficient is not in accordance with Wagner's Law.

Our assumption that the transition economies are suitable for testing the validity of Wagner’s law in the present days arises from the fact that these economies have been experienced the real GDP *per capita* growth since the nineties. However, along with the continued economic growth, transition economies have been faced with a budget deficit. It is normally expected that as economic development progresses, the budget deficit ratio would increase in the case of developing countries since government revenue increases less in proportion to the expenditure (Murthy 1994). Reducing the budget deficit by the increase in taxes, further reduces the investment and the only solution may be to reduce public expenditure. This fact might be one of the possible explanations of the obtained results.

Gurgul et al. (2012) did not confirm the validity of the Wagner’s law in Poland, covering the period from 2000 to 2008. Dolenc (2009) showed that the new political orientation would not notably affect the trends in government finances in Slovenia (the Wagner’s law holds for Slovenia in the period 1992 - 2007). We draw a completely different conclusion analysing the panel of sixteen economies in transition. However, in the 1990s Slovenia have experienced a lower level of government consumption expenditure[15] than the most of other observed countries and maintain the same level to this day.

Bearing in mind that some of transition economies in our panel are now classified as developed ones, we introduce dummy variables assuming that results can be different among different type of development stages. However, our findings show that an inclusion of dummy variables has no implication on the obtained results. All the economies in our panel are the former socialist states that may lead to conclusion that our results are extremely influenced by historical contexts rather than the development stage of obtained economies.

Another explanation may be the fact that Wagner’s law originates from the late 19th century. A century from which the circumstances has changed. Thus, confirming the validity of Wagner's law for transition economies in the present days looks somewhat unrealistic. We failed in our attempt to generalise Wagner’s law on transition economies. However, our finding may indicate that observed economies in transition are on the right way to achieve the underlying legal and institutional reforms and/or confirm the common belief that the Wagner’s law is not applicable to transition economies. Economic and political changes as well as the specific circumstances in observed economies in transition lead to the conclusion

[15] Government consumption expenditure has been corrected the government share in GDP by the relative price of government expenditure.

that Wagner's law does not give a good explanation for government expenditure pattern. However, the government expenditure is an endogenous factor of an increase in national income.

In order to obtain relevant results, we take into account an influence of omitted variables on testing the validity of Wagner's law in the transition economies. Taking into account that Sims (1972, 1980) and Stock and Watson (1989) showed that money has an important impact on output fluctuations, Chow et al. (2002) considered a money supply as a variable that should be included when examining the validity of Wagner's law. He confirmed his claim. However, our findings show that an inclusion of a money supply has no implication on the obtained results.

For further research, we recommend an inclusion of the budget deficit into the model because its reduction may be one possible explanation of declining public spending in the observed countries, and it is not contradictory to the spirit of the law.

We consider reasonable criticism that the possible inclusion of investment components may contributes more valid results, while, in our opinion, the inclusion of transfers overstates the size of the public sector. This fact also should be recommended for further research.

The authors (Hutter 1982; Corado and Solari 2010) mostly agree that interpretation of Wagner's law requires a multidisciplinary approach. We pay only attention to economic interpretation of Wagner's law, which is certainly one of the limitations of this study as well as the fact that we consider the government as a fiscal entity.

Compliance with Ethical Standards:

The authors received no specific funding for this article.

The authors have declared that no conflict of interest exist.

This article does not contain any studies with human participants or animals performed by any of the authors.

References

Abizadeh, S. and Gray. J. (1985) Wagner's law: a pooled time-series, cross-section comparison. National Tax Journal, 38(2), 209-218

Ahsan, S. M., A. C. C. Kwan and Sahni. B. S. (1992) Public expenditure and national income causality: Further evidence on the role of omitted variables. Southern Economic Journal, 58(3), 623-634. https://doi.org/10.2307/1059830

Akitoby, B., Clements, B., Gupta, S. and Inchauste, G. (2006) Public spending, voracity, and Wagner's law in developing countries. European Journal of Political Economy, 22(4), 908-924. https://doi.org/10.1016/j.ejpoleco.2005.12.001

Bai, J. and S. Ng. (2004) A PANIC Attack on Unit Roots and Conitegration. Econometrica, 72(4), 1127-1178. https://doi.org/10.1111/j.1468-0262.2004.00528.x

Babatunde, M.A. (2011) A bound testing analysis of Wagner's law in Nigeria: 1970-2006. Applied Economics, 43(21), 2843-2850. https://doi.org/10.1080/00036840903425012

Barra, C., Bimonte,G. and Spennati, P. (2015) Did fiscal institutions affect Wagner's law in Italy during 1951-2009 period? An empirical analysis. Applied Economics, 47(59), 6409-6424. https://doi.org/10.1080/00036846.2015.1071475

Biehl, D. (1998) Wagner's Law: An Introduction to and a Translation of the Last Version of Adolph Wagner's Text of 1911. Public Finance/Finances Publiques, 53(1), 102-111.

Bird, R. M. (1971) Wagner's 'Law' of Expanding State Activity. Public Finance Quarterly, 26,1-26.

Breusch, T. S. and Pagan. R. A. (1980) The Lagrange Multiplier test and its application to model specifications in econometrics. Review of Economic Studies, 47(1), 239-253. https://doi.org/10.2307/2297111

Burney, A. N. (2002) Wagner's hypothesis: Evidence from Kuwait Using Cointegration Tests. Applied Economics, 34 (1), 49-57. https://doi.org/10.1080/00036840010027540

Chow, Y-F., Cotsomitist, J. A. and Kwan, A. C. C. (2002) Multivariate Cointegration and Causality Tests of Wagner's Hypothesis: Evidence from the UK. Applied Economics 34(13), 1671-1677. https://doi.org/10.1080/00036840110115659

Corado, D. and Solari, S. (2010) Natural law as inspiration to Adolph Wagner's theory of public intervention. The European Journal of the History of Economic Thought, 17(4), 865-879. https://doi.org/10.1080/09672567.2010.511871

Dolenc, P. (2009) Wagner's Law is still applicable: Empirical evidence for Slovenia. Naše Gospodarstvo, 55(5-6), 68-76.

Durevall, D. and Henrekson. M. (2011) The futile quest for a grand explanation of long-run government expenditure. Journal of Public Economics, 95(7-8), 708–722. https://doi.org/10.1016/j.jpubeco.2011.02.004

Goffman, J. J. (1968) On the Empirical Testing of Wagner's Law: a Technical Note. Public Finance/Finances Publiques, 3(3), 359–364.

Gupta, S. P. (1968) Public Expenditure and Economic Development: A Cross-Section Analysis. Finanzarchiv, 28, 26-41.

Gurgul, H., Lach, L. and Mestel, R. (2012) The relationship between budgetary expenditure and economic growth in Poland. Central European Journal of Operations Research, 20(1), 161-182. https://doi.org/10.1007/s10100-010-0186-z

Hutter, M. (1982) Early Contributions to Law and Economics: Adolph Wagner's Grundlegung. Journal of Economic Issues, 16(1), 131-147. https://doi.org/10.1080/00213624.1982.11503965

Iniquez-Montel, J. A. (2010) Government expenditure and national income in Mexico: Keynes versus Wagner. Applied Economics Letters, 17(9), 887-893. https://doi.org/10.1080/13504850802599433

Jaén-García, M. (2018) Wagner's Law: A Revision and a New Empirical Estimation. Revista Hacienda Pública Española/ Review of Public Economics 224 (1): 13-35. https://doi.org/10.7866/hpe-rpe.18.1.1

Kargi, B. (2016). Is Wagner's law applicable for fast growing economies? BRICS and MATIK countries. Timisoara Journal of Economics and Business, 9(1): 1-15. https://doi.org/10.1515/tjeb-2016-0001

Kennedy, P. (1998) A Guide to Econometrics, fourth edition, MIT Press, Cambridge

Kirchner, S. (2012) Federal legislative activism in Australia: a new approach to testing Wagner's law. Public Choice 153(3-4), 375-392. https://doi.org/10.1007/s11127-011-9799-6

Kumar, S., Webber, D. J. and Fargher, S. (2012) Wagner's Law revisited: cointegration and causality tests for New Zealand. Applied Economics, 44(5), 607-616. https://doi.org/10.1080/00036846.2010.511994

Lamartina, S. and Zaghini, A. (2011) Increasing Public Expenditure: Wagner's Law in OECD Countries. German Economic Review, 12(2): 149-164. https://doi.org/10.1111/j.1468-0475.2010.00517.x

Legrenzi, G. and Milas. C. (2002) The role of omitted variables in identifying a long-run equilibrium relationship for the Italian government growth. International Tax and Public Finance, 9(4), 435–449. https://doi.org/10.1023/a:1016568003489

Loizides, J. and G. Vamvoukas. (2005) Government Expenditure and Economic Growth: Evidence from Trivariate Causality Testing. Journal of Applied Economics, 8(1), 125-152. https://doi.org/10.1080/15140326.2005.12040621

Magazzino, C. (2012) Wagner versus Keynes: Public spending and national income in Italy. Journal of Policy Modeling, 34(6), 890-905. https://doi.org/10.1016/j.jpolmod.2012.05.012

Magazzino, C. (2012) Wagner's Law and Augmented Wagner's Law in EU-27. A Time-Series Analysis on Stationarity, Conitegration and Causality. International Research Journal of Finance and Economics, 89

Magazzino, C., Giolli, L. and Mele, M. (2015) Wagner's Law and Peacock and Wiseman's Displacement Effect in European Union Countries: a Panel Data Study. International Journal of Economics and Financial Issues, 5(3), 812-819.

Forte, F. and Magazzino, C. (2018) Wagner's Law, Government Size and Economic Growth: an Empirical Test and Theoretical Explanation for Italy 1861-2008, 129-151. in Backhaus, J., Chaloupek, G. and Frambach, H. (eds.), Gustav von Schmoller and Adolph Wagner. The European Heritage in Economics and the Social Sciences, Cham: Springer. https://doi.org/10.1007/978-3-319-78993-4_10

Mann, A. (1980) Wagner's law: an econometric test for Mexico, 1925-1976. National Tax Journal, 33(2), 189-201.

Mark, C., N. and Sul, D. (2003) Cointegration Vector Estimation by Panel DOLS and Long-run Money Demand. Oxford Bulletin of Economics and Statistics, 65(5), 655-680. https://doi.org/10.3386/t0287

Michas, N. A. (1975) Wagner's Law of Public Expenditures: What Is Appropriate Measurement for a Valid Test. Public Finance/Finances Publiques, 30(1), 77-84

Murthy, N. R. V. (1994) Wagner's Law, Spurious in Mexico or Misspecification: a reply. Public Finance/Finances Publiques, 49(2), 295-303.

Musgrave, A. R. (1969) Fiscal System, New Haven: Yale University Press

Narayan, K. P, Prasad, A. and Singh, B. (2008) A test of the Wagner's hypothesis for the Fiji Islands. Applied Economics, 40(21), 2793-2801. https://doi.org/10.1080/00036840600972472

Produced by The Berkeley Electronic Press, 2010

Narayan, S., Narayan, B. R. and Narayan, K. P. (2012) Evidence of Wagner's law from Indian states. Economic Modelling, 29(5), 1548-1557. https://doi.org/10.1016/j.econmod.2012.05.004

Oktayer, A. and Oktayer, N. (2013) Testing Wagner's Law for Turkey: Evidence from a Trivariate Causality Analysis. Prague Economic Papers, 22(2), 284-301. https://doi.org/10.18267/j.pep.452

Peacock, A. T. and Wiseman, J. (1979) Approaches to the Analysis of Government Expenditure Growth. Public Finance Quarterly, 7(1), 3-12.

Peacocok, A. and Scott, A. (2000) The curious attraction of Wagner's law. Public Choice 102 (1-2), 1-17. https://doi.org/10.1023/a:1005032817804

Pedroni, P. (2000) Fully-modified OLS for heterogeneous cointegrated panels and the case of purchasing power parity" in Badi H. Baltagi, Thomas B. Fomby, R. Carter Hill (ed.) Nonstationary Panels, Panel Cointegration, and Dynamic Panels (Advances in Econometrics, Volume 15) Emerald Group Publishing Limited: 93 – 130. https://doi.org/10.1016/s0731-9053(00)15004-2

Pesaran, M. H. (2004) General Diagnostic Tests for Cross Section Dependence in Panels. Discussion Paper Series, IZA, Bonn

Pesaran, M. H. (2007) A simple panel unit root test in the presence of cross section dependence. Journal of Applied Econometrics, 22(2), 265-312 https://doi.org/10.1002/jae.951

Pryor, F. L. (1968) Public Expenditures in Communist and Capitalist Nations. London: George Allen & Unwin Ltd.

Ram, R. (1987) Wagner's Hypothesis in Time Series and Cross Section Perspectives Evidence: from Real Data for 115 Countries. Review of Economics and Statistics, 69(2), 194-204. https://doi.org/10.2307/1927226

Saikkonen P. (1992) Estimation and testing of cointegrated systems by an autoregressive approximation. Econometric Theory, 8(01), 1–27. https://doi.org/10.1017/s0266466600010720

Sims, C. A. (1972) Money, income, and causality, American Economic Review, 62, 540-552.

Sims, C. A. (1980) Comparison of interwar and post-war business cycles: Monetarism reconsidered, American Economic Review, 70, 250-257.

Stock, J. H. and Watson, M. W. (1989) Interpreting the evidence on money-income causality, Journal of Econometrics, 40(1), 161-181. https://doi.org/10.1016/0304-4076(89)90035-3

Stock J. H and Watson M. W. (1993) A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica, 61(4), 783–820. https://doi.org/10.2307/2951763

Strauss, J. and Yigit, T. (2003) Shortfalls of Panel Unit Root Testing. Economics Letters, 81(3), 309-313. https://doi.org/10.1016/s0165-1765(03)00210-6

Westerlund, J. (2007) Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69(6), 709–748. https://doi.org/10.1111/j.1468-0084.2007.00477.x

Westerlund, J. and Edgerton, D., L. (2008) A simple test for cointegration in dependent panels with structural breaks, Oxford Bulletin of Econimics and Statistics 70(5): 665-704. https://doi.org/10.1111/j.1468-0084.2008.00513.x

Wu, S., Tang, J. and Lin, E.S. (2010) The impact of government expenditure on economic growth: How sensitive to the level of development? Journal of Policy Modeling, 32(6), 804-817. https://doi.org/10.1016/j.jpolmod.2010.05.011

APPENDIX A.

Table A1: Summary of Existing Studies

Author(s)	Version of Wagner's law		Sample	Period	Methodology	Other variable	Finding
	GE	GDP					
Chow et al. (2002)	RGE/RGDP RGE	RGDPpc RGDP	The UK	1948-1997	Cointegration Granger causality	Money supply	Mixed
Loizides and Vamvoukas (2005)	RGE/RGNP	RGNPpc	The UK, Ireland and Greece	1950-1990	ECM	Unemployment Inflation	Mixed
Akitoby et al. (2006)	RGE	RGDP	51 developing countries	1970-2002	ECM	No	Support
Narayan et al. (2008)	RGE	RGDP	Fiji island	1970-2002	Five long-run estimators Granger causality	No	Support
Dolenc (2009)	GE GC GE GE/GDP GE/P GE/GDP	GDP GDP GDP/P GDP/P GDP/P GDP	Slovenia	1992-2007	Regression	No	Support
Wu et al. (2010)	RGE RGE RGEpc RGDP/RGE RGDP/RGE	RGDP RGDPpc RGDPpc RGDP RGDPpc	182 countries	1950-2004	Panel Granger causality	No	Support
Iniguez-Montiel (2010)	RGE RGEpc	RGDP RGDPpc	Mexico	1950-1999	Cointegration Granger causality	No	Support

	RGE/RGDP RGE/RGDP	RGDPpc RGDP					
Lamartina and Zaghini (2011)	NGE RGE	NGDP RGDP	23 OECD countries	1970-2006	Panel cointegration ARDL and PMG	No	Support
Babatunde (2011)	RGE RGE RGEpc RGE/RGDP RGE/RGDP	RGDP RGDPpc RGDPpc RGDPpc RGDP	Nigeria	1970-2006	ARDL Granger causality	No	No support
Durevall and Henrekson (2011)	NGE/NGDP	RGDPpc	Sweden and the UK	1800-2006 1830-2006	Cointegration	No	Mixed
Kumar et al. (2012)	RGE RGE RGEpc RGE/RGDP RGE/RGDP	RGDP RGDPpc RGDPpc RGDPpc RGDP	New Zealand	1960-2007	ARDL and Granger causality	No	Support
Narayan et al. (2012)	RGE RC_AGE RC_OGE RGEpc RC_AGEpc RC_OGepc	RGDP RGDPpc	15 Indian states	1986-2008	Panel cointegration Panel Granger causality	No	Support
Gurgul et al. (2012)	BUDGET HEALTH EDU SEC	$RGDP_{RATE}$	Poland	Q1:2000-Q3:2008	Granger causality Bootstrap	No	No support

	ADM						
Magazzino (2012)	RGEIP RGECF RGELD RGECP RGEIL[16]	RGDP	Italy	1960-2008	Cointegartion Granger causality	No	Mixed
Magazzino (2012)	RGE RGEpc CAGE/GDP RFCE BDef/GDP	RGDP RGDPpc	EU-27	1970-2009	Cointegration Causality	No	Mixed
Oktayer and Oktayer (2013)	RGE RGEpc RGE/RGNP	RGNP RGNPpc	Turkey	1950-2010	ARDL	Inflation	Mixed
Barra et al. (2015)	RGE RGE RGEpc RGE/RGDP RGE/RGDP	RGDP RGDPpc RGDPpc RGDPpc RGDP	Italy	1950-2009	ECM	No	Support
Magazzino et al. (2015)	GGE TCE IE	RGDP	EU	1980-2013	Cointegration Causality	No	Mixed
Kargi (2016)	GE/GDP	GDP_{RATE}	BRICS and MATIK	1961-2013	Cointegration Granger causality	No	No support

[16] Disaggregated level of government expenditure

Jaén-García (2018)	PE PE/TE	GDP GDP pc	Spain	1964-2015	Cointegration	No	No support
Forte and Magazzino (2018)	GDP growth	PE/GDP $(PE/GDP)^2$	Italy	1861-2008	ARIMAX	Population Inflation rate Public revenues Deficit Public debt Openness Unemployment Wars Tax reforms	Support

APPENIX B.

All observed variables seem to have a normal distribution, taking into account that mean and median values are similar for each series, the all estimated values of skewness are near 0, and all the estimated values of kurtosis are near 3. We calculate the IQR (interquartile range) for each observed variable in order to reveal potential severe outliers. The interquartile range rule shows absence of outliers for any of observed variables.

Table B1: Descriptive statistics

Variable	Mean	Median	SD	Skewness	Kurtosis	IQR	Range
ln GCE_{it}/GDP_{it}	2.537471	2.621763	0.384339	-0.401038	3.970561	0.391534	2.278204
ln GDP_{it}/P_{it}	8.917744	8.941642	0.689848	-0.610955	3.620188	1.064999	3.757095
ln M_{it}	3.674274	3.819799	0.536050	-0.842802	3.359609	0.583239	2.161779

In order to detect the structural breaks in our panel data, we first plot the graph of the all observed variables. Then we conduct an exogenous detection using the Chow test for any known break dates we noticed on the graph as potential break point. None of the estimated *F*-statistics is statistically significant. Hence, we may not reject the null hypothesis of no break points.

Table B2: Chow test

Structural break test					
ln GCE_{it}/GDP_{it}	F-statistisc	Probability	ln M_{it}	F-statistisc	Probability
I – 1994	3.521894	0.162477	V – 1999	3.072141	0.196578
V – 1999	1.624158	0.924785	VI – 2004	1.008532	0.931401
X – 2002	2.175242	0.824562	XII – 2004	1.529616	0.876252
XII – 1991	2.882451	0.265443			

In order to detect the potential correlation among the observed variables, we evaluate a correlation matrix. As can be seen from Table B3 none of the estimated correlation coefficients exceeds 0.5. According to these findings we may draw the conclusion that the observed variables in our panel are not correlated.

Table B3: Correlation matrix

	ln GCE_{it}/GDP_{it}	ln GDP_{it}/P_{it}	ln M_{it}
ln GCE_{it}/GDP_{it}	1.000000	0.372374	-0.150183
ln GDP_{it}/P_{it}	0.372374	1.000000	0.465306
ln M_{it}	-0.150183	0.465306	1.000000

When *N* is small and *T* is sufficiently large the cross-sectional dependence can be estimated employing the SURE framework. In the SURE framework Breusch and Pagan (1980) suggested a Lagrange Multiplier (LM) statistic valid in heterogeneous panel for fixed *N* as $T\rightarrow\infty$. H_0 is that all pair-wise correlations are zero and is defined by following equation:

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2 \tag{3}$$

Under H_0, LM is asymptotically distributed as chi-squared with $N(N-1)/2$ degrees of freedom. $\hat{\rho}_{ij}^2$ is the estimate of the pair-wise correlation of the residuals (u)

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T}\hat{u}_{it}\hat{u}_{jt}}{\left(\sum_{t=1}^{T}\hat{u}_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T}\hat{u}_{jt}^2\right)^{1/2}} \tag{4}$$

Pesaran (2004) proposed the test of error cross-section dependence appropriate to a spectrum of panel models based on an average of pairwise correlation coefficients of OLS residuals from the individual regressions in the panel:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij} \tag{7}$$

where $\hat{\rho}_{ij} = \sum_{t=1}^{T}e_{it}e_{jt} / \left(\sum_{t=1}^{T}e_{it}^2\right)^{1/2}\left(\sum_{t=1}^{T}e_{jt}^2\right)^{1/2}$ with e_{it} denoting the OLS residuals.[17]

[17] Monte Carlo experiments show that the standard Breusch–Pagan LM test performs badly for *N* > *T* panels, whereas Pesaran's CD test performs well even for small *T* and large *N*.

Table B4: Cross-sectional dependence test

Variable	Test	Statistic	Probability
ln GCE_{it}/GDP_{it}	Breusch-Pagan LM Pesaran CD	539.0351 12.5439	0.0000 0.0000
ln GDP_{it}/P_{it}	Breusch-Pagan LM Pesaran CD	297.4401 5.4464	0.0000 0.0000
ln M_{it}	Breusch-Pagan LM Pesaran CD	235.4598 6.3556	0.0000 0.0000
ln GCE_{it}/GDP_{it} ~ ln GDP_{it}/P_{it}	Breusch-Pagan LM Pesaran CD	598.4701 5.0375	2.2e-16 2.2e-16
ln GCE_{it}/GDP_{it} ~ ln GDP_{it}/P_{it} + ln M_{it}	Breusch-Pagan LM Pesaran CD	593.28 4.2455	2.2e-16 0.0000

Table 4 reports the empirical realisations of Kao's and Pedroni's panel cointegration tests. With the exception of the group ρ-statistic and panel υ-Statistic in the case with trend all of the test statistics result in the rejection of the null hypothesis of no cointegration.

Table B5: Panel cointegration test results

Pedroni's panel cointegration test results			
without trend		with trend	
Test statistics	Values	Test statistics	Values
Panel υ-Statistic	3.202535***	Panel υ-Statistic	1.111576
Panel ρ-Statistic	-4.629232***	Panel ρ-Statistic	-2.776373**
Panel PP-Statistic	-7.047688***	Panel PP-Statistic	-6.018434***
Panel ADF-Statistic	-3.905104**	Panel ADF-Statistic	-2.342793*
Group ρ-Statistic	-0.675491	Group ρ-Statistic	0.926099
Group PP-Statistic	-2.725555*	Group PP-Statistic	-2.225184*
Group ADF-Statistic	-2.903919***	Group ADF-Statistic	-2.117476*
Kao's panel cointegration test results			
ADF-Statistic			-6.393385***

Note: The null hypothesis is that the variables are not cointegrated. Under the null hypothesis, all statistics are distributed as standard normal distributions. The finite sample distribution for the seven statistics has been tabulated in Pedroni (2004) *, ** and *** indicate that estimated parameters are significant at the 10%, 5% and 1% levels, respectively.