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Empirical Analysis of Wagner's Law for the Spain's Regions

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Abstract
In this paper a panel cointegration analysis is made of both overall development of government expenditure and economic growth in the seventeen Spanish regions (comunidades autónomas, in Spanish). Empirical evidence offers us a positive correlation between public expenditure and per capita GDP that is consistent with Wagner's Law (WL). A long-run elasticity larger than one suggests a more than proportional increase in public expenditure with respect to economic activity. The principal contribution made by this paper is that, for the first time, empirical testing is carried out on WL, in both its static and dynamic forms, using the methods of unit roots and cointegration in panel data.
Keywords: Wagner law, Public Expenditure, Cointegration, Panel Data.

Introduction

Wagner's Law (WL) has aroused a great deal of interest among public sector economists ever since its rediscovery thanks to the compilation "Classics in Theory of Public Finance" (1958) by Musgrave and Peacock. WL is one of the theories that place emphasis on economic growth as a determining factor of public sector growth. In accordance with some of its interpretations, growth of public expenditure occurs more quickly than that of national income, meaning either public expenditure is elastic to income or public expenditure is a superior good. From this point of view, a growing economy generates additional tax revenues and offers legislators opportunities to increase public sector expenditures and government subsidies. Empirical analysis of Wagner's Law has evolved in parallel with the development and dissemination of econometrics in such a way that increasingly advanced and sophisticated econometric techniques have been utilized to carry out testing.

This paper uses panel cointegration data techniques to carry out its analysis. In order to do so, this study analyzes the existence of integration in data and also cointegration in both series so as to later conduct an empirical estimation of the relationship over the long-term utilizing Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) for the static models and Pooled Mean Group Estimation (PMGE) for the dynamic models. The results obtained indicate that WL holds true for the case of Spain with both panel data as well as time series (Jaen, 2004).

There are advantages to examining public expenditures on a provincial or regional scale in order to verify WL (Abizadeh and Yousefi, 1988). Firstly, one of the law's suppositions is the prevalence of peace and stability, as Wagner does not consider the effect of wars on public expenditure. The use of regional data is consistent with the supposition of peace and stability considering regional governments does not incur military expenditures. Secondly, WL is based on the supposition that cultures and institutions are similar from country to country. Although this is not a problem for time series studies, Bird (1971) argues that given the institutional and cultural differences among different countries, cross-section multi-country studies do not necessarily validate the law. The use of subnational data offers the means to exploit the cross-section dimension while minimizing the effect of cultural and institutional differences.

In the following section a revision of Wagner's Law is carried out. The third section considers various methodological aspects related to the empirical test of the law, while the fourth section contains the empirical test for the case of Spain. In the fifth section a robustness analysis is conducted by means of various alternative estimations. The sixth section closes the study with a summary of the paper itself and conclusions.

Wagner's Law

Although the accelerated trend in government spending is a recent phenomenon, its stationary growth attracted the attention of economists in the past.

One of the first analyses was that of Wagner, who showed that growth in industrial output was accompanied by an increase in state expenditure. Based on empirical evidence, Wagner postulated a "Law of Public Expenditure Growth" and "Law of Expanding State Activity**"** **"**whose explanation, justification and cause is the pressure for social progress and the resulting changes in the relative spheres of private and public economy, especially compulsory public economy" (*Wagner, 1890*)[1].

The proposition of Wagner was inspired by the empirical observation that growth in public expenditure and per-capita output has a tendency to be correlated in countries of quite different characteristics. It can be inferred from this fact that there is some kind of general law that relates government growth to per-capita output growth. By proposing this causal relationship between industrialization and public expenditure, Wagner adopted what would today be considered a "demand-side" explanation for increased public expenditure. He also identified three possible causes to explain government intervention (*Tim, 1961; Bird, 1971; Mann, 1980; Henrekson, 1993*).

First of all, expanding urbanization and industrialization cause greater economic and social diversity and greater complexity in society leading to the substitution of private activity for public activity. The administrative and protective functions of the government increase due to the growing complexity of both legal relationships and communications. Moreover, the increase in urbanization and the concentration of population require greater expenditures on law and order and socioeconomic regulation.

Second of all, Wagner pointed out that certain services cannot be adequately supplied by the private sector, but are necessary for sustaining economic growth (such as education), or for battling their negative effects (expenditures on social services). He finally determined that the growth of industrialization required greater and greater capital investments, as in the case of railroads, which

[1] In Musgrave and Peacock (1958) pg. 8.

could be more effectively provided and managed by the government through public corporations rather than by private investments. Wagner also stated that economic growth and technological changes make it necessary for governments to direct and manage natural monopolies in order to achieve economic efficiency.

The theoretical context of Wagner's Law has been subjected to a great deal of criticism, which can be systematized as follows (*Tim, 1961; Bird, 1971*): a) ambiguity in its definition: it was not clear whether Wagner was referring to the absolute growth of public expenditure or to relative growth; b) inappropriate title; it was pretentious to give the title of 'law' to a theory which is not universally valid; c) normative theory: Wagner's reasoning to justify the law reads more like "lawyer discourse" than impartial analysis; d) organicistic view of government, which is an underlying element of the theory; and e) lack of a coherent theory that explains the fundamental proposition of the law.

In present-day terms, Wagner's argument is reduced to the fact that the income elasticity demand of goods and services provided by the State is superior to the unit and, therefore, the ratio of expenditures on public or civil goods and services tends to grow when the per-capita income grows.[2]

Methodology

The numerous attempts at empirical tests of Wagner's "law" have utilized, fundamentally, two possible versions of the law. One is based on absolute expansion of public expenditure in relation to income, and the second, the version supported by Tim (1961) and Bird (1971), is based on relative expansion. Gemmell (1993) offers three possible interpretations of the law for empirical tests: "1) narrow/absolute: government goods are "normal" (have a positive income elasticity demand) causing an absolute rise in government expenditure as per-capita income rises. 2) narrow/relative: government goods are "superior" (have an income elasticity of demand greater than the unit) causing the ratio of government expenditure to national income to rise when the per-capita income rises. 3) wide/relative: an increase in per-capita income *will be associated with* an increase in the ratio of government expenditure to national income"[3]. In whichever way we approach the possible test, there are numerous questions that arise given the theoretical aspects and the empirical interpretation itself. Previously published empirical literature identifies at least six possible verifiable versions of the law (Mann, 1980): The traditional version by Peacock and Wiseman (1967) GP=f(PNB), where GP is public expenditure and PNB is gross national product, Pryor's version (1968), C=f(PNB) where C is consumption expenditure, the version by Goffman (1968), PE=f(PNB/POB) where PNB /POB is the gross domestic product per capita, the version by Musgrave (1970), GP/GDP=f(PNB /POB), the version by Gupta (1967) and Michas (1975), GPPOB=f(PNB /POB) and, finally, a modified version formulated by Mann (1980) of Peacock and Wiseman's version, GP/PNB=f(PNB).

These specifications can be expanded to the point that Peacock and Scout (2000) identify twelve possible versions in their analysis of 15 articles on WL. In addition, it is necessary to consider the possible definition of public expenditure, national income, the type of series utilized and so on, which will all now be examined.

[2] In the words of Henning and Tussing (1974) "Wagner's Law has come to be a shorthand way of saying that public expenditures rise relative to total output over time."

[3] P. 109-110.

One of the first questions to consider is the measure of public expenditure to be utilized. By reading the works of Wagner, those which are available, it is understood that he constantly refers to all tiers of government, both central and local, and all government expenditures. It could therefore be understood that he refers to all expenditures made by public administration. Tim (1961), in his appendix of statistics, utilizes the federal expenditures of the United States and the total public expenditures of Great Britain and Sweden, but he also includes a breakdown of expenditures into ordinary public expenditures or current public expenditures, or municipal expenditures for ordinary services in Holland and other countries. Bird (1971) examines not only total public expenditure, but also expenditure changes that have occurred in central and local government and various items that comprise the functional classification: Administration, Debt Service, Defense, Social Services, Environmental Services and other expenditures. Many subsequent studies, based on the fact that Wagner places little importance on war situations, contend that defense expenditures should be excluded (*Henning and Tussing, 1974*) and that even transfers should be excluded (*Henrekson, 1991, 1993*)[4] or that only purchases of goods and services in government units should be utilized (Henning y Tussing, 1974). The level of casuistry is quite profound, reaching the point where the same study tests two or three measures of public expenditure. The last study to cause controversy, as relates to measure of expenditure, was that of Peacock and Scott (2000) who considers the previous interpretations to be completely erroneous as they believe Wagner's writings make it perfectly clear that public companies, specifically public services (public utilities), must be considered part of the public sector.

The dependent and independent variables utilized also vary, although not to the extent that the definition of public expenditure does. Public expenditure is represented here in absolute terms or rather as the ratio of public expenditure to national income or total population, that is, public expenditure per capita. The independent variable, which is unique in most cases, is either a measure of national income, GDP or GNP, in absolute terms or, in relation to the population, income per capita. This measurement is carried out in both nominal and real values, which correspond to a specific year, thereby deflating the variables. Taking into consideration the works of Beck (1976, 1981) on how public sector productivity lags behind that of the private sector, the deflators should be different for both sectors[5] although the same deflator is used for absolute values on some occasions.[6]

Published studies related to this subject have carried out empirical tests of the law in two different ways: for one country alone over time and second, for various countries at a certain point in time, although there is a chronological order utilized to do so. Seminal studies on the subject (*Martin and Lewis, 1956; Williamson, 1961; Thorn, 1967; Gupta, 1967; Musgrave, 1970; Gandhi, 1971, Goffman and Mahar, 1971*) and other more recent ones (Abizadeh and Gray, 1985; Ram, 1987)

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[4] The argument is that these expenditures would form part of the numerator and not the denominator, meaning the ratio would not have a limit superior and, consequently, could be greater than the unit. (Crystal y Alt, 1979).

[5] For authors like Musgrave (1981) or Henrekson (1993), the implicit deflator for GDP offers the best measurement of public expenditure variation, considering the fact that it accurately reflects what political and economic markets have said over the years about the allocation of resources by governments.

[6] If the ratio of public expenditure is considered in relation to national income, it does not vary in nominal values utilizing the same deflator.

utilize transversal or cross-section data to compare different countries with different degrees of growth. Some of the first studies to use time series (Tim, 1961; Andic and Veverka, 1964; Musgrave, 1970; Bird, 1971) analyze different statistics for public expenditure and income per capita by making comparisons among them or measurements of the elasticity of public expenditures in relation to income. Gupta (1967), Hennig and Tussing (1974), and numerous authors, use various functional forms that are almost always bivariate, normally taking into consideration logarithms for both variables, thus carrying out the test with ordinary least squares or a related variant. Most authors consider these analyses to be inadequate for a study on dynamic processes, as is government growth, (Bird, 1971; Gray, 1976; Lowery and Berry, 1983)[7] although Gemmell (1993) states that insofar as transversal evidence can be interpreted as an approximation of changes over time, it can be argued that this supports the proposition that Wagner's Law holds true in the rapid industrialization phase of development, but not in pre and post-industrial periods.

Analyses that use time series can be divided into two types: those that consider changes in the ratio of government expenditures to national income or that compare said ratio with changes in per capita income over time and those that regress a measure of national income (total or per capita) to a measure of public expenditure (usually total, per capita or as a ratio of income). Among the second type we find analyses that utilize ordinary least squares, or some variant, for the test, and others that consider the inherent characteristics of time series and utilize unit root and cointegration analysis. In order to make the aforementioned breakthrough it is was necessary to elaborate a corresponding econometric theory, and it was not until the 1990's (Henrekson 1991, 1993; Murthy, 1993) when this method was utilized for the estimation of Wagner's Law for the first time[8]. This type of analysis has strengthened the integrity of the most recent studies creating a distinction between relationships over the long-tem and dynamic over the short-term (Jaen, 2004). However, the scope of research has usually been limited to evidence for only one country or multi-country comparisons. Studies that used this methodology include that of Henrekson (1991, 1993); Gemmell (1993); Hondroyiannis and Papatreou (1995); Biswal et al. (1997); Burney and Musallam (1999); Petry et al. (2000); Legrenzi (2000); Karagianni et al. (2002); Burney (2002); Chang (2002); Chang et al. (2004) and Wahab (2004), Akitoby et al. (2006)[9].

Oxley (1994) revealed that the existence of a unidirectional Granger causality relationship was necessary; more specifically one running from "measure of income to measure of public expenditure," in addition to cointegration between variables and elasticity. The most recent works consider, along with Wagner's Law, the Keynesian hypothesis which states that when government expenditures increase so does national income. Therefore, studies published as of 1995 almost all implement the direction of the causality in order to verify if Wagner's Law or its complete opposite, the Keynesian hypothesis, hold true in one country or specific group of countries.

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[7] Bird (1971) categorically discredits comparisons which make comparison between countries since "there is nothing in any conceivable formulation of Wagner's law which tells us country A must have a higher government expenditure ratio than country B simply because the level of average per capita income is higher in A than B at a particular point in time" (page 10)

[8] If the variables are not stationary, the stationary regression method is not appropriate as the usual contrasts t and F are not valid and the estimate regression coefficient only reflects spurious correlation.

[9] For a complete analysis see Jaén (2004).

The development of the cointegration techniques utilizing panel data has allowed tests of the law to be carried out for groups of countries (*Lamartina and Zaghini, 2008*) and for only one country (Narayan et al., 2008).

The results obtained in the tests vary significantly. A study of different authors' writings has revealed that it is not surprising that the empirical analyses required for examining Wagner's Law are not conclusive. The standard list of factors that can explain inconsistency between the results obtained by different authors includes: 1) the quality and quantity of data; 2) the estimation procedures and the examined period: 3) the chosen level of time aggregation (since data are compiled at different moments in time); 4) the econometric specification and 5) the influence of omitted variables.

In general, most of the empirical analysis of Wagner's Law carried out in only one country over a long period of time have confirmed the law with few exceptions. However, there is strong skepticism by some researchers with regard to these conclusions. Studies carried out as of the 1990's that utilize unit root and cointegration analysis in time series indeed reject the law for the most part.

Empirical Analysis of Wagner's Law for the Case of Spain

The four approximations that have been utilized in previously published literature in order to measure Wagner's formulation of expanding state activity are public expenditure, public consumption, public expenditure per capita and public expenditure as a proportion of the GDP.

In this study public expenditure and public expenditure per capita are used in two specific alternatives. The following models are formulated:

Model 1

$$LnGexp_{it}= \alpha_{oi}+\alpha_{1i}LnGdpCap_{it}+ \varepsilon_{it} \quad (1)$$

And Model 2

$$LnGexpCap_{it}=\alpha_{0i}+\alpha_{1i}+LnGdpCap_{it}+\varepsilon_{it} \quad (2)$$

Where LnGexp is the natural logarithm of public expenditure in current euros, LnGexpCap is the corresponding per capita value and LnGdpCap is the natural logarithm of Gdp per capita in current euros. Model 1 is the version of Goffman (1968). Model 2 is the version of Gupta (1967) and Michas (1975). In both cases, if WL holds true, the coefficient LnGdpCap will be positive and public expenditure elasticity with regard to GdpCap will be greater than the unit. Panel data are taken from the 17 Spanish Autonomous Regions from the period 1984/2003, for which data for Gexp, Gdp, GexpCap and GdpCap are available. Gexp data come from the BADESPE database, which belongs to the Institute for Financial Studies (IEF), and Gdp data and population come from the database of the National Statistics Institute (INE).

On the other hand, it is supposed that public expenditure does not reach its desired level in the short-term. Only in the long-term does public expenditure reach either its desired level or its equilibrium level. Supposing the relationship in the stationary state between public expenditure and GDP is provided by the first equation of those detailed previously:

$$LnGexp_{it}= \alpha_{oi}+\alpha_{1i}LnGdpCap_{it} \qquad (1)'$$

If the adjustment to the stationary state is gradual, then the expenditure level will respond to transitory changes in the GdpCap, and Gexp will gradually move towards its stationary state or equilibrium level. In order to include this gradual movement, an autoregressive distributed lag (ARDL) model is specified as:

$$LnGexp_{it}=\mu+\alpha LnGexp_{it-1}+\beta_0 LnGdpCap_{it}+\beta LnGdpCap_{it-1}+\varepsilon_{it} \quad |\alpha| <1 \qquad (3)$$

So as to reflect the stationary state, the previous equation can be presented as an error correction model

$$\Delta LnGexp_{it}=\mu+\beta_0\Delta LnGdpCap_{it}+\gamma[LnGexp_{it-1}-\delta LnGdpCap_{it-1}]+\varepsilon_{it} \qquad (4)$$

It can be interpreted that $\beta_0\Delta LnGdpCap_{it}$ is the short-run impact of GdpCap on Gexp and β_0 is the short-run elasticity of Gexp with regard to the output. The error correction term $\gamma[LnGexp_{it-1}-\delta LnGdpCap_{it-1}]$ gathers the deviations of the stationary state where $\delta$the long-run elasticity of Gexp with regard to GdpCap is and γ is the rate at which Gexp adjusts to the past imbalance.

The equation can be rewritten as

$$\Delta LnGexp_{it}=\mu+\beta_0\Delta LnGdpCap_{it}+\gamma LnGexp_{it-1}-\varphi LnGdpCap_{it-1}+\varepsilon_{it} \qquad (5)$$

Where $\varphi=\gamma*\delta$. The long-run coefficient δ can be recovered simply by dividing the estimated coefficient φ by γ.

The previous derivation makes clear the underlying supposition that there is a constant elasticity relationship between Gexp and GdpCap while transitional deviations are random.

The previous model will be Model 3 in this study. In the same way, Model 4 can be formulated by taking into consideration the variables GexpCap and GdpCap.

Wagner considered three conditions necessary for his law to hold true:

1) Rising national income and general welfare, and also per capita income.
2) Importance of technological progress.
3) Democratization and constitutional state: Participation of the population in political financial decisions.

Regarding the first condition, GDP data at market price and per capita GDP demonstrate how consistent elevated growth has taken place in all of the Spanish Region economies, except in 1993, which saw negative growth.

During the period being studied, Spanish per capita income increased 69% and a process took place by which the regions with per capita income below the mean at the beginning of the period moved closer to those with higher per capita income. For example, in the case of Andalusia, this region represented 75% of the Spanish per capita income but increased to 77%.

As for the second condition, it is obvious that current development and economic growth in Spanish regions as well as in the country and, in general, in all developed countries, is based on technological progress.

As relates to the third condition, since 1978 Spain has enjoyed a democratic constitution that has facilitated a strong decentralization of the public sector whose authority and responsibilities were taken on by the regional governments.

An empirical analysis has to be carried out carefully to verify the nature of the series, because if they are not stationary, problems could arise in the estimation of the regression equation coefficients. Valid estimations for Model 1 and 2 require that data be stationary (integrated zero-order) or, if they are not stationary (integrated first-order), that they be cointegrated. More specifically, the first step will be to verify whether the variables are stationary or if they have one or more unit roots. In case they are integrated, an analysis will be made of the possible existence of cointegration between the two. If they are cointegrated, the relationships or cointegration equations will be estimated. These cointegration equations specify the long-run relationships between the variables. In order to do so, the estimation will be carried out utilizing Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) for static models and the Pooled Mean Group Estimator (PMGE) for the dynamic model. Finally, following the suggestion by Oxley (1994), this study will examine the existence of unidirectional Granger causality as a condition for the confirmation of WL. As highlighted by Peacock and Scout (2000), the cointegration relationship itself is the best econometric translation for the mutual evolution of government expenditure and economic expansion that Wagner had in mind when he formulated his law. Cointegration refers to combined long-term trajectory and it does not imply causality. Therefore, a test of WL in its loose sense is only statistical evidence of a cointegration relationship with a positive coefficient. Moreover, WL in its strict sense can be easily assessed by testing whether the long-run elasticity is significantly greater than one.

Unit root tests for panel data rather than for individual time series have the advantage of being able to increase test power as they simultaneously exploit cross-section and time series information. This study utilizes tests by Levin, Li and Chu (LLC), Breitung, Im, Pesaran and Chin (IPS), and those that use Fisher's test, by Maddala and Wu, whose null hypothesis is the existence of a unit root. The first two are processes of common unit roots, while the last three are processes of individual unit roots. Finally, another perspective, in the form of Hadri's test, maintains the null hypothesis that the time series for each cross-section unit is stationary against the alternative of a common unit root.

Table 1 contains the results of the stationarity tests for the three variables in terms of levels and first differences.

Table 1. Stationarity Test of Series

	LnGexp	**ΔLnGexp[10]**	**LnGexpCap**	**ΔLnGexpCap**	**LnGdpCap**	**ΔLnGdpCap**
H_o=unit root (common process)						
Constant rend						
Levin, Lin and Chu	-1.6198 (0.0526))*	-2.772 (0.0027)	-1.657 (0.0487)	-3.057 (0.0011)	-5.5453 (0.000)	-6.8321 (0.000)
Breitung	1.535 (0.937)	-4.297 (0.000)	2.329 (0.9901)	-4.485 (0.000)	2.6385 (0.9958)	-6.3019 (0.000)
H_o=unit root (individual process)						
Constant rend						
Im, Pesaran and Shin	-0.27322 (0.392)	-3.308 (0.0005)	-0.235 (0.407)	-3.628 (0.0001)	0.365 (0.6424)	-4.8142 (0.000)
ADF- Fisher**	35.6976 (0.3885)	64.0347 (0.0014)	36.644 (0.3471)	67.448 (0.0006)	30.221 (0.6535)	82.625 (0.000)
PP-Fisher**	57.932 (0.064)	161.442 (0.000)	58.830 (0.3471)	166.177 (0.0000)	47.924 (0.0571)	167.896 (0.000)
Hadri,H_o=There is no unit root)						
Constant trend	7.1393 (0.000)	4.929 (0.000)	6.9902 (0.000)	6.633 (0.000)	10.3772 (0.000)	6.715 (0.000)

** p-value in parenthesis.*

*** In the Fisher tests, the p-values are computed utilizing an asymptotic chi-squared distribution. For all other tests, asymptotic normality is supposed.*

The results in Table 1 show that the variable LnGexp is first-order integrated, as both common process tests and individual process tests clearly accept the null hypothesis, as opposed to what occurs with Hadri's test, which rejects the null hypothesis of non existence of a unit root. By examining the data for first differences, it is observed that the null hypothesis is rejected on all occasions and Hadri's test accepts the null in the case of the first difference for Public Expenditure. Consequently, it can be stated that both variables are I(1).

As for LnGexpCap, all of the tests clearly accept the existence of a unit root while the first difference variable is stationary. In the case of LnGdpCap, discrepancy only exists in the LLC test. As a result it can be concluded that both variables are I(1).

Once the existence of a panel unit root has been established, the question arises whether a long-run equilibrium relationship exists between the variables. Since all of the variables are I(1), an analysis is then done for panel cointegration utilizing different tests. This produces the result in Table 2. The seven variants of cointegration tests derived by Pedroni are then utilized, bearing in mind that the first four have common AR coefficients and the last three have individual AR coefficients, just like the test by Kao. Both tests expand upon the cointegration test technique by Engle and Granger based

[10] First differences of the variables

on an analysis of the residuals of a spurious regression carried out using variables I(1). If the variables are cointegrated, then the residuals will be I(0); while if they are not cointegrated, the residuals will be I(1).

Pedroni's seven tests take the null hypothesis of no cointegration, with different alternative hypotheses. This allows the endogeneity of the regressors as well as considerable heterogeneity among dynamics, fixed effects and cointegrating vectors for individual *i* in panel data, which contrasts with Kao's approximation in which homogeneity is imposed on cointegrating vectors. Pedroni also demonstrates that his tests are distributed under the standard normal distribution. In the case of the first test, the right tail of the standard normal distribution is needed to reject the null of no cointegration (large positive values imply rejection), while in the other six, large negative values imply that the null of no cointegration is rejected.

Finally, the Johansen-Fisher test is carried out in which Maddala and Wu use Fisher's combined test results in order to propose an alternative approximation for the panel data cointegration test by combining individual cross-section tests to obtain a test statistic for the complete panel.

Table 2. Cointegration Test Results

Pedroni Tests	**Model 1**		**Model 2**	
H_0= There is no cointegration				
H_1= common AR coefficients (within-dimension)				
Panel v	3.3225 (0.0004)		-0.4956 (0.6899)	
Panel ρ	-2.2867 (0.001)		-0.7653 (0.222)	
Panel PP	-3.8248 (0.0001)		-2.9844 (0.0014)	
Panel ADF	-1.8127 (0.0035)		-3.5327 (0.0002)	
H_1= individual AR coefficients (between-dimension)				
Group ρ	-0.5069 (0.3061)		0.2916 (0.6147)	
Group PP	-3.3701 (0.0004)		-3.9803 (0.000)	
Group ADF	-0.7583 (0.0002)		-5.5013 (0.000)	
Kao ADF	-1.8349 (0.003)		-1.9543 (0.0025)	
Johansen Fisher	Trace test	Eigenvalue Test	Trace test	Eigenvalue Test
Hypothesis (No cointegrating vector)	70.46 (0.0005)	72.84 (0.0003)	109.6 (0.000)	88.98 (0.0000)
At most one	30.85 (0.7118)	30.85 (0.7118)	52.62 (0.0217)	52.62 (0.0217)

For the first model results of both Pedroni's and Kao's tests reject the null of non existence of cointegration while the Johansen-Fisher test rejects the null of no cointegrating vector and does not reject the existence of a cointegrating vector. Consequently, it can be considered that both vectors are cointegrated.

As for Model 2, of Pedroni's seven tests, three accept the null of no cointegration while four of them reject it. Kao's test also accepts cointegration and the Johansen-Fisher test rejects that no cointegrating vector exists and accepts the existence of a cointegrating vector.

These two preliminary steps are important to ensure that the correct econometric procedure is being used. The estimation of a cointegration relationship using ordinary least squares is generally biased due to problems of variable endogeneity, which is why the corresponding t statistics do not follow a habitual Student t distribution; therefore, it is impossible to make any inference about its significance. On the other hand, regressing the first difference of the variables when a long-run equilibrium relationship does actually exist between them leads to the well-known problem of specification for omitted variables. In fact, what disappears in this kind of regression is the error correction term.

In order to tackle these problems, two methods of estimating the cointegrating vector are utilized: first, Fully Modified Ordinary Least Squares (FMOLS) estimators and, second, Dynamic Ordinary Least Squares (DOLS). FMOLS is a non-parametric correction utilizing corrections for autocorrelation, which means it takes into account the possible correlation between the error term and the first differences of regressors, as well as the presence of a constant term. DOLS is a parametric approximation where the lag terms in first differences are explicitly estimated. With DOLS, errors increase with leaded, lagged and contemporary values of the regressors. The results obtained are shown in Tables 3 and 4.

Table 3. FMOLS and DOLS estimation[11] for Model 1

Region	**FMOLS**	**t-statistical**	**DOLS**	**t-statistical**
Andalusia	1.31	5.65**	1.16	2.75**
Aragon	2.48	15.6**	2.52	10.78**
Asturias	2.23	9.22**	2.39	5.92**
Balearic Islands	2.66	7.7**	3.24	7.91**
Canary Islands	1.62	14.56**	1.74	7.91**
Cantabria	1.71	2.91**	2.06	4.27**
Castilla y León	2.32	16.04**	2.57	11.24**
Castilla La Mancha	2.17	10.81**	1.99	5.88**
Catalonia	1.25	6.46**	1.06	0.77
Valencia	1.65	4.59**	1.41	1.58
Extremadura	2.34	11.93**	2.44	13.18**
Galicia	1.62	4.92**	1.38	1.66*
Madrid	1.79	5.93**	1.51	2.53**
Murcia	2.33	6.68**	2.61	7.3**
Navarra	1.41	3.58**	1.13	1.00
Vizcaya	1.33	2.4**	1.21	1.19
Rioja	2.17	7.6**	2.06	4.67**
Group Mean	1.90	33.13**	1.91	21.51**
Panel Results				
Without time dummies (between)	1.92	31.04**	1.73	21.62**

*The t statistics are for H: β=1 *, ** indicate levels of rejection of 10% and 1% respectively.*

[11] In both estimations 1 lead and 1 lag have been utilized in the individual estimation and two in the group estimation.

Table 4. FMOLS and DOLS estimation for Model 2

Region	FMOLS	t-statistical	DOLS	t-statistical
Andalusia	1.23	3.93**	1.08	1.3
Aragon	2.47	16.24**	2.5	11.02**
Asturias	2.27	9.79**	2.44	6.25**
Balearic Islands	2.39	7.5**	2.95	8.25**
Canary Islands	1.44	7.33**	1.58	3.81**
Cantabria	1.69	2.84**	2.05	4.24**
Castilla y León	2.36	16.74**	2.62	11.73**
Castilla La Mancha	2.11	11.01**	1.92	5.86**
Catalonia	1.2	4.48**	1.02	0.19
Valencia	1.56	3.76**	1.34	1.24
Extremadura	2.35	12.24**	2.44	13.42**
Galicia	1.65	5.00**	1.41	1.75*
Madrid	1.71	5.86**	1.45	2.4**
Murcia	2.15	6.21**	2.43	6.84**
Navarra	1.34	2.85**	1.05	0.40
Vizcaya	1.36	2.53**	1.24	1.32
Rioja	2.13	7.84**	2.03	4.77**
Group Mean	1.85	30.6**	1.85	20.56**
Panel Results				
Without time dummies (between)	1.86	28.6**	1.68	19.82**

*The t statistics are for H: β=1 *, ** indicate levels of rejection of 10% and 1% respectively.*

The results obtained both in cross-sections and panel show that the elasticity of public expenditure is greater than the unit during the period 1984-2003 in the FMOLS estimation, both for regions on an individual basis and the panel group mean as well as the panel without time dummies. The result is slightly different for the DOLS estimation, where it can seen how in the cases of Catalonia, Valencia, Navarra and Vizcaya the law is not accepted, and therefore the null hypothesis that the coefficients are equal to one cannot be rejected.

As for examining expenditure and per capita income, the results are similar. The FMOLS test completely accepts WL both in estimations for different regions and for the panel group mean as well as the panel results without time dummies. In the DOLS estimation the null is rejected for Catalonia, Valencia, Navarra and Vizcaya.

For Models 3 and 4 the estimation is carried out by means of PMGE (Pesaran, Shin and Smith, 1999) which restricts long-run coefficients if they are identical in an error correction approach, but allows short-run coefficients and error variances to differ across the groups. In this way we implement the following model $\Delta LnGexp_{it}=\mu_{0i}+\mu_{1i} \quad t+\sum\beta_{ik}\Delta LnGdpCap_{it-k}+\sum\lambda_{ik}\Delta LnGexp_{it-k}+\gamma_i LnGexp_{it-1}-\varphi_i LnGdpCap_{it-1}+\varepsilon_{it}$ where $-\varphi_i/\gamma_i=\delta_i$ as the long-run elasticity of public expenditure in relation to the GDP in each region. The estimation can be carried out using three procedures. That of the group mean (MG) separately estimates the previous equation for the 17 autonomous regions and averages out the estimated coefficients. In this way, the long-run elasticity will be $1/17\sum\delta_i=\delta_{MG}$. This estimator is consistent; however, it does not exploit the cross-section dimension of the sample so as to take advantage of the given opportunity for the fact that some parameters may be the same between regions. The approximation of the PMG estimator is based on the homogeneity of this coefficient; therefore, for each region $\delta_i=\delta$. However, the speed of adjustment to imbalance over the long-term freely varies across autonomous regions. In this way, the previous equation can be rewritten as $\Delta LnGexp_{it}=\mu_{0i}+\mu_{1i}t+\sum\beta_{ik}\Delta LnGdpCap_{it-k}+\sum\lambda_{ik}\Delta LnGexp_{it-k}+\gamma i(LnGexpit_{-1}-\delta_i LnGdpCap_{it-1}+\varepsilon_{it}$. In accordance with WL, the coefficient δ must be positive and, for a strict interpretation, greater than one. Finally, there is the traditional fixed effects estimator (dynamics) (FE) which allows the constant to differ between regions while the slope estimator is the same for all regions. However, this kind of pool does not permit differentiation between short-run and long-run dynamics. Furthermore, it often leads to inconsistent estimators of parameters (unless the slopes are indeed equal) and this inconsistency does not disappear when the sample size grows, both in its cross-section and time dimensions. Lastly, the PMG estimator allows dynamic specification over the short-term to vary among regions, which is not possible with the FE estimator.

The results obtained are included in the following table.

Table 5. Estimation by means of PMGE procedure

	PMGE	**MGE**	**FE**
Modelo3			
Long-run coefficient (t statistic)	1.1051 (17.462)	1.8465 (16.939)	1.5853 (2.36)
Adjustment coefficient (t statistic)	-0.16518 (8.621)	-0.3393 (7.523)	
Model 4			
Long-run coefficient (t statistic)	0.96157 (10.56)	1.84824 (16.64)	1.513 (2.5637)
Adjustment coefficient (t statistic)	-0.1375 (10.55)	-0.32965 (-7.332)	

For Model 3, the three procedures give us an estimator for the income elasticity of public expenditure that is highly significant and greater than the unit. The adjustment coefficient is, as expected, negative and statistically different from zero suggesting that any deviation in public expenditure from a given value in relation to the long-run equilibrium with the GNP produces a correction in the opposite direction. Specifically, in the PMGE estimation, the error correction coefficient is -0.17 suggesting a relatively slow adjustment to balance over the long term of between 5 and 6 years.

For Model 4, estimators for income elasticity are obtained that are greater than the unit in the MGE and FE procedures. This is not the case for the PMGE estimation where the estimator is slightly lower than the unit. The adjustment coefficients are both negative and statistically different from zero as in the previous case.

Therefore, the results obtained in Model 3 support the confirmation of Wagner's Law in its strict sense. At the same time, Model 4 brings about certain reservations regarding the PMGE, which does, however, support the confirmation of WL in its loose sense, while the MG and FE estimators do so in the strict sense.

Bearing in mind the suggestion by Oxley (1994), an analysis is conducted of the Granger causality relationship between variables. The results of Table 6 suggest that there is a unidirectional causality relationship, in the sense of Wagner's Law, of LnGdp and LnGdpCap towards the respective measures of public expenditure.

Given the time series x_t and y_t when the past and present values of y_t give some information to predict x_t at time t, it is said that y_t causes Granger x_t. The Granger causality concept implies precedence but not causality in the traditional sense of the term, that is, it does not imply that x_t is the effect or result of y_t. If series are cointegrated, there will be Granger causality in one or both directions.

Table 6. Granger causality test results

Null hypothesis	**F statistic**	**Probability**
LGdpCap does not cause Granger Lgp	7.14063	0.0009
Lgp does not cause Granger LgdpCap	1.01782	0.3626
LGdpcap does not cause Granger Lgpcap	6.00643	0.0028
Lgpcap does not cause Granger Lgdpcap	0.5436	0.5802

This study rejects, in both tests, the null hypothesis that LnGdpCap does not cause LnGexp and LnGexpCap respectively, but it does accept the null in the opposite direction. Therefore, a direction of unidirectional causality is obtained as well as, consequently, support for the confirmation of WL.

Robustness Analysis

In order to analyze the robustness of the model various alternatives to the analysis carried out in this paper are utilized.

Initially, the results obtained are examined by utilizing panel data divided into two parts. The first part examined includes those regions that have a Gdp per capita greater than the Spanish mean (7 regions) and the other includes those with a Gdp per capita less than said mean (10 regions).

Table 7. Estimation with partial samples

	Model 1	**Model 2**	**Model 3**	**Model 4**
FMOLS 17 Regions	1.92 (31.04)	1.86 (28.6)		
DOLS 17 Regions	1.73 (21.62)	1.68 (19.82)		
FMOLS 7 Regions	1.87 (17.06)	1.8 (16.49)		
DOLS 7 Regions	1.57 (9.1)	1.49 (7.99)		
FMOLS 10 Regions	1.95 (26.19)	1.9 (23.35)		
DOLS 10 Regions	1.85 (20.58)	1.81 (19.15)		
PMGE 17 Regions Long-run coefficient (t statistic)			1.1051 (17.462)	0.96157 (10.56)
Adjustment coefficient (t statistic)			-0.16518 (-8.621)	-0.1375 (-10.55)
PMGE 10 Regions Long-run coefficient (t statistic)			1.384 (15.5)	1.2938 (13.45)
Adjustment coefficient (t statistic)			-0.205 (-7.03)	-0.1997 (-7.27)
PMGE 7 Regions Long-run coefficient (t statistic)			1.1319 (12.37)	1.0718 (8.085)
Adjustment coefficient (t statistic)			-0.1316 (-4.94)	-0.10665 (-4.77)
MGE 17 Regions Long-run coefficient (t statistic)			1.8465 (16.939)	1.84824 (16.64)
Adjustment coefficient (t statistic)			-0.3393 (-7.523)	-0.32965 (-7.332)
MGE 10 Regions Long-run coefficient (t statistic)			1.8289 (15.66)	1.8176 (14.54)
Adjustment coefficient (t statistic)			-0.3959 (-6.42)	-0.371 (-6.1)
MGE 7 Regions Long-run coefficient (t statistic)			1.8844 (8.03)	1.91 (8.73)
Adjustment coefficient (t statistic)			-O.2618 (-4.03)	-0.27051 (-4.09)

In the FMOLS and DOLS estimations of Models 1 and 2 it is observed that large variations do not exist in the obtained results. In all cases test statistics are highly significant and elasticity estimators are greater than 1 and very close to the values obtained with the complete sample.

In the PMG and MG estimations the results obtained for Model 3 are very similar in both the complete sample and partial samples. All of the tests are significant and the elasticity values are very similar. In Model 4, the MG estimations are similar to those of the complete sample. However, in the PMG estimation, the elasticities are significantly greater than one in the estimations with partial samples while it is less than one in the estimation with the complete sample.

Secondly, all estimations have been repeated utilizing demeaned variables[12]. In doing so, possible correlations of cross-section errors are taken into consideration.

Table 8. Estimation with demeaned variables

	Model 1	**Model 2**	**Model 3**	**Model 4**
FMOLS	1.92 (31.04)	1.86 (28.6)		
DOLS	1.73 (21.62)	1.68 (19.82)		
PMGE Long-run coefficient (t statistic)			1.1051 (17.462)	0.96157 (10.56)
Adjustment coefficient (t statistic)			-0.16518 (-8.621)	-0.1375 (-10.55)
MGE Long-run coefficient (t statistic)			1.8465 (16.939)	1.84824 (16.64)
Adjustment coefficient (t statistic)			-0.3393 (-7.523)	-0.32965 (-7.332)

The results obtained coincide in their entirety with the basic estimation.

Thirdly, in order to assess the stability of the model, a recursive estimation has been carried out for the four models utilizing different sample periods from 1984-1999 to 1984-2003. The results are shown in the following table.

[12] The mean has been subtracted from each one of the cross-sections.

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Table 9. Recursive estimation

	Model 1	Model 2	Model 3	Model 4
FMOLS 1984-99	1.78 (29.97)	1.75 (28.36)		
1984-00	1.81 (31.18)	1.77 (29.37)		
1984-01	1.83 (32.21)	1.78 (30.25)		
1984-02	1.89 (31.38)	1.84 (29.18)		
1984-03	1.92 (31.04)	1.86 (28.6)		
DOLS 1984-99	1.61 (23.43)	1.57 (21.21)		
1984-00	1.66 (23.97)	1.62 (21.73)		
1984-01	1.66 (21.76)	1.61 (20.04)		
1984-02	1.71 (20.92)	1.66 (19.14)		
1984-03	1.73 (21.62)	1.68 (19.82)		
PMGE 1984-99			1.1128 (15.99)	1.08 (15.244)
1984-00			1.1278 (16.96)	1.082 (16.019
1984-01			1.1137 (17.79)	1.044 (15.53)
1984-02			1.1148 (17.03)	1.006 (12.13)
1984-03			1.1051 (17.462)	0.96157 (10.56)
MGE 1984-99			1.723 (24.5)	1.691 (23.86)
1984-00			1.8135 (26.98)	1.786 (26.74)
1984-01			1.85588 (26.52)	1.82175 (26.03)
1984-02			1.9375 (18.83)	1.9266 (19.11)
1984-03			1.8465 (16.939)	1.8176 (14.54)

In Models 1 and 2 the elasticity values are significantly greater than one in both the FMOLS estimation and that of DOLS. Furthermore, upon increasing the size of the sample, the coefficient value slightly increases in both cases. This may be related to the fact that when the expansion of an economy is greater, as is the case of the Spanish economy during this period, public expenditure increases in a proportionally greater manner. In Models 3 and 4, it is observed how the elasticity values are maintained over that of the unit and that they are significant, in accordance with WL in the strict sense, with the exception previously highlighted of the PMG estimator of the complete sample. Although the coefficients in this estimation do not reveal a continued decline, it can be observed in both models that there is a decrease (in absolute value) of the adjustment coefficient, which would indicate a slower speed of adjustment and, therefore, a greater gap between the actual value and equilibrium. This leads to the conclusion that the size of the Spanish public sector is still far from its equilibrium value.

Conclusions

In this paper an empirical test has been carried on Wagner’s Law, which states that growth in output is accompanied by an increase in state expenditure. This proposition by Wagner was inspired by the empirical observation that growing public expenditure and output tend to be correlated in countries of quite different characteristics.

Two formulations have been adopted in order to consider public expenditure and output in both absolute terms and per capita. Unlike previous studies, this test has been carried out implementing two formulations, static and dynamic, and utilizing a method of panel data cointegration.

The results obtained lead to the confirmation that Wagner's Law generally holds true in the case of Spain during the period 1984-2003. Moreover, it is observed that those regions that begin with the lowest per capita incomes and move closer to the Spanish mean over time tend to have greater elasticity. This suggests that the role of the public sector in economy tends to grow more quickly when the region becomes richer. Not only does the need for regulatory and production functions increase more quickly with economic development, but also the demand for cultural and educational services as well as the aging of the population, which causes an increase in the demand for greater expenditure on pensions and healthcare when economies become richer.

These conclusions carry some clear connotations for economic politics. If economic growth is considered to be an exogenous factor, public expenditure will grow as a consequence of economic growth regardless of the manner in which the latter is measured (although always in relation to the GNP). However, an increase in public expenditure is not going to determine economic growth. This obtained result contrasts with the Keynesian hypothesis. If it is economic growth that influences public expenditure, the latter will be an endogenous factor in an economy that is determined by purely economic factors in which politicians have little influence. On the other hand, the Keynesian hypothesis implies that the exogenous factor is public expenditure, which can be influenced by politicians in order to spur on positive economic growth. In statistical terms, this implies causality between public expenditure and GNP. This last hypothesis is that which, to different extents, has marked the course of economic politics in various developed countries during the post-World War Two period.

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