

An Empirical Study of Wagner's Law Applied to the Spanish Case

MANUEL JAÉN GARCÍA
Universidad de Almería

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Abstract

This article analyzes the relationship between growth in Public Expenditure and the GDP over the course of 100 years in Spain. The author believes, as did Adolph Wagner himself, that the empirical test of his law should be carried out in a long-term context which has changing political and economic conditions.

In this context, we study the fulfillment of five versions of the law. This is done taking into consideration the most recent advances in the field of time series econometrics, including the possibility of changes or structural breaks in the data.

Our conclusions lead us to believe that Wagner's Law holds true in all the versions studied over a long-term period, that is, more than one hundred years in Spain.

Keywords: public expenditure, gross domestic product, unit root, cointegration, break points.

JEL Classification: H00, E62.

Resumen

Este artículo analiza la relación entre el crecimiento en el gasto público y el producto interior bruto a lo largo de un período de 100 años en España. El autor cree en el sentido de Wagner, que el contraste empírico de esta ley debe llevarse a cabo en un contexto de largo plazo con condiciones políticas y económicas cambiantes.

En este contexto, analizamos las cinco versiones de la ley considerando los más recientes avances en el campo de la econometría de series temporales, incluyendo la posibilidad de cambios o rupturas estructurales en los datos.

Nuestras conclusiones nos llevan a creer que no podemos negar la vigencia de la ley de Wagner a lo largo de un período de tiempo de más de un siglo en el caso español.

Palabras clave: gasto público, producto interior bruto, raíz unitaria, cointegración, puntos de ruptura.

Clasificación JEL: H00, E62.

1. Introduction

The growth of public expenditure in the last year especially after the II World War have been object of interest by scholars. Between the first explanations was the Wagner's Law

(WL) from XIX century. This law was recovered by Musgrave and Peacock in the compilation «Classics in the Theory of Public Finance» (1958). Its proper formulation has been (and continues to be) debated, given the ambiguity of Wagner's own work, and it is still tested time and time again on both developed countries and underdeveloped or developing countries. Empirical analysis of WL 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.

In the following sections we carry out a revision of Wagner's Law. In the third section, we consider the empirical literature about Wagner's Law. In the fourth section, five different versions of WL are formulated, while, in the fifth, a brief analysis of Spain's economy throughout the period of study is presented. In sections 6 to 9, the empirical analysis is carried out, followed by section 10, which presents the conclusions.

2. Wagner's Law

Wagner's analysis, as he himself argued, is based on the observation of reality. The law of increasing expansion of public, and particularly state, activities becomes for the fiscal economy the law of the increasing expansion of fiscal requirements. Both the requirements of the central government growth and, often even more so, those of local authorities, when administration is decentralized and local government well organized. Wagner presents three reasons for this increasing state participation (Bird, 1971):

1) Increased administration and security functions of the state due to the substitution of private activity for public.

2) Considerable relative expansion of «cultural and welfare» expenditures.

3) Inevitable changes in technology, and increasing investment volume required in many activities would create an ever-increasing number of private monopolies which the state would have to suppress, or at least neutralize their effects, for reasons of economic efficiency.

Wagner's Law has been widely criticized both in form and substance (Tim, 1961; Gupta, 1967; Peacock and Wiseman, 1967; Andic and Veverka, 1964).

Those critics have placed the focus on the aspects considered by Tim (1961). Firstly would be the fact that the law offers no justification for the continued dynamics of the independent variables (namely, income growth), nor does it provide any explanation about the relative expansion of public spending with respect to national income as a consequence of an increase in the latter. Bird (1971) adds the fact that Wagner does not consider, or views as unimportant, the effects of wars on public spending. Consequently, the failure of WL to adequately explain the growth of public sector, in function of certain independent variables, or to examine changes in variables themselves, which are supposedly causal in nature, means that this «law» is not conclusive to carrying out a rigorous test.

Given these criticisms, Bird (1971) reinterprets the suppositions of WL in the following terms:

1) A substantial number of public goods are classified as luxury goods, which means that public expenditure as a whole has an elasticity higher than one with respect to income.

2) As growth takes place, market breakthroughs can be expected in order to achieve an efficient allocation of resources.

Bird (1971) questions whether this is true and considers it impossible to confirm such a descriptive theory and that the most the empirical test can do is demonstrate that the «law» (or its suppositions) has still not been proven to be incorrect.

Despite the complexity of the line of argument presented above, the numerous attempts to prove the validity of the WL for different countries and periods of time have been limited, almost entirely, to a bivariate analysis in which the independent variable is a form of income and the dependent variable is a form of public spending. In very few cases, if in any at all, what was analyzed was the validity rather than the conditions set by Wagner for fulfilling his hypothesis.

3. Review of empirical literature

Published studies related to this subject have carried out empirical tests of the law in two different ways: for one only country 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) utilize transversal or cross-section data to compare different countries with different degrees of growth. Some of the first studies use time series (Tim, 1961; Andic and Veverka, 1964; Musgrave, 1970; Bird, 1971) as they analyse 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); Henning 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.

Many authors consider the possibility of testing using transversal studies that they are inadequate for a study of dynamic processes such as government growth (Bird, 1971; Gray, 1976; Lowery and Berry, 1983)¹. Nevertheless, Gemmell (1993) does state that since transversal evidence can be interpreted as an approximation of changes over time, this could be an argument to support the proposition that Wagner's law is proven in the rapid industrialization phase of growth but not in the pre and post-industrial phases.

The analyses which use time series can be divided into two types: those that consider changes in the ratio of government spending to national income or that compare said ratio

¹ Bird (1971) categorically discredits comparisons which make comparison between countries: «The inferences obtained from mixed section international comparisons at a moment in time are completely irrelevant as tests of a hypothesis whose essence is to postulate a long-term change in a given country.»

with changes in per capita income over time and those that make a regression from a measure of national income (total or per capita) to a measure of public spending (normally total, per capita or as a ratio of income). Among the second type we can find those that utilize ordinary least squares, or some variant, for the test, and those that consider the inherent characteristics of time series and utilize unit root and cointegration analysis. Regarding the above mentioned breakthroughs, it was necessary to elaborate the corresponding econometric theory, and it was not until the 1990s (Henrekson, 1990, 1993; Murthy, 1993) that this method was used to test Wagner's Law for the first time. This type of analysis improved the reliability of the most recent works, allowing a distinction between long-term relationships and the short-term dynamic relationship (Henrekson (1990, 1993), Gemmell (1993), Hondroyannis and Papastreou (1995), Biswal et al. (1999), Burney and Musallam (1999), Petry et al. (2000), Legrenzi (2000), Karagianni et al. (2002), Burney (2002), Chang (2002), Chang et al. (2004), Wahab (2004), Akitoby et al. (2006)).

Oxley (1994) showed 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 after 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.

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 an individual country (Narayan et al., 2008). Finally, it is worth considering the possibility of structural breaks and regime shifts in the data (Priesmeier and Koester, 2012; Richter and Paparas, 2013; Kuckuck, 2014).

Recently numerous articles on this topic have been published, although they may feature analogous methodologies (public spending, unit roots and cointegration, and series or panel data), and they are published regularly (including 2016). They focus on both developed and developing countries, as well as groups of countries such as OECD and the EU.

In general, most of the empirical analysis of WL applied to only one country over a long period of time have confirmed the law with few exceptions. However, strong scepticism exists among 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.

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.

4. Formulation of the versions of Wagner's Law and problems they consider.

The four approximations that have been utilized in the literature to measure Wagner's formulation of expanding state activity are public expenditure, public consumption, and 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 five specific alternatives. The following models are formulated:

Model 1

$$\text{Lnexp}_t = \alpha_0 + \alpha_1 \text{LnGdp}_t + \varepsilon_t \quad \alpha_1 > 1 \quad (1)$$

Model 2

$$\text{Ln exp/Gdp}_t = \lambda_0 + \lambda_1 \text{LnGdp}_t + \varepsilon_t \quad \lambda_1 > 0 \quad (2)$$

Model 3

$$\text{Ln exp/Gdp}_t = \delta_0 + \delta_1 \text{LnGdppc}_t + \varepsilon_t \quad \delta_1 > 0 \quad (3)$$

Model 4

$$\text{Lnexppc}_t = \beta_0 + \beta_1 \text{LnGdppc}_t + \varepsilon_t \quad \beta_1 > 1 \quad (4)$$

Model 5

$$\text{Lnexp}_t = \mu_0 + \mu_1 \text{LnGdppc}_t + \varepsilon_t \quad \mu_1 > 1 \quad (5)$$

Where Lnexp is the natural logarithm of nominal public expenditure, Lnexppc is the corresponding per capita value, Lnexp/Gdp is the natural logarithm of the ratio between the two variables, LnGdp is the natural logarithm of GDP, and LnGdppc is the natural logarithm of GDP per capita. Model 1 is the version of Peacock and Wiseman (1979); Model 2 is the version of Mann (1980); Model 3 is the version of Musgrave (1969); Model 4 is the version of Gupta (1967) and Michas (1975); and Model 5 is the version of Goffman (1968)².

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. Supposing the relationship in the stationary state between public expenditure and Gdp is provided by one of the five equations detailed previously:

$$\text{Lnexp}_t = \mu_0 + \mu_1 \text{LnGdppc}_t \quad (6)$$

if the adjustment to the stationary state is gradual, then the expenditure level will respond to transitory changes in the Gdppc, and exp 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:

$$\text{Lnexp}_t = \gamma + \sum_i \theta_i \text{Lnexp}_{t-i} + \sum_i \nu_i \text{LnGdppc}_{t-i} + \varepsilon_{it} \quad |\theta| < 1 \quad (7)$$

² We expect that $\lambda_1 = \alpha_1 - 1$ and $\delta_1 = \beta_1 - 1$

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

$$\Delta \text{Lnexp}_t = \mu + \sum_i v_i \Delta \text{LnGdppc}_{t-i} + \rho [\text{LnGexp}_{t-1} - \psi \text{LnGdppc}_{t-1}] + \varepsilon_{it} \quad (8)$$

It can be interpreted that $v_0 \Delta \text{LnGdpcap}_{it}$ is the short-run impact of Gdppc on exp and v_0 is the short-run elasticity of exp with regard to the output. The error correction term $\rho [\text{Lnexp}_{it-1} - \psi \text{LnGdpcap}_{it-1}]$ gathers the deviations of the stationary state where ψ is the long-run elasticity of exp with regard to Gdppc and ρ is the rate at which Gexp adjusts to the past imbalance.

The previous derivation clarifies the underlying supposition that there is a constant elasticity relationship between exp and Gdppc while transitional deviations are random.

The period of time studied in this work is from 1901 to 2011, which is in keeping with the suggestions of Ram (1992) and Henrekson (1993). Moreover, Wagner's original hypothesis is, essentially, an affirmation of the long-term relationships between economic growth and the relative scope of public activities. Therefore, an empirical analysis should be based on sampling data for a long period of time (Jaen and Molina, 1999).

The data utilized were taken from the following sources: From 1901 to 1992, the data for Gdp and Gdppc come from economic reports for 1973 and 1993 from Banco Bilbao Vizcaya (BBV) Study Services. As of 1993, they come from the General State Comptroller. Data on public spending are taken from Comín (1985): «Basic data for financial history», edited by the IEF, and, from 1981 to 2011, from the General State Comptroller: «Public administration accounts». In each case overlapping of data was carried out bearing in mind the different starting years³.

The 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 coefficients of regression equation. Valid estimations for the five models 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 whether they have one or more unit roots. If they are integrated, an analysis will be made to verify 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.

Given the long period of time studied, it is possible to find instances of structural change in the series. For this reason we allow structural breaks in the series in both the unit root and cointegrating tests (Jaén and Molina, 1999; Priesmeier and Koester, 2012; Richter and Paparas, 2013; Kuckuck, 2014). These structural breaks may be the result of changes in the economy or in the different factors that affect or determine the series utilized. In this situation, if the structural changes are not taken into consideration when the existence of a long-term relationship is investigated, said relationship might not be detected when it does indeed exist.

Finally, following the suggestion of Oxley (1994), this study will examine the existence of unidirectional Granger causality as a condition for the confirmation of WL. As

³ We use legal links. All series in constant pesetas.

highlighted by Peacock and Scolt (2000), the cointegrating 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 weary sense, is only statistical evidence of a cointegrating 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 zero or one in the different cases.

5. A brief analysis of the Spanish economy in the 20th century and the beginning of the 21st.

The early years of the 20th century in Spain are characterized by frequent political and social upheaval which included successive coups d'état, abdications and the overthrowing of a king (Alphonse XIII in 1931). This turmoil ultimately culminated with the failed coup of 1936 that led to the Spanish Civil War (1936-1939) and a long period of authoritarian rule until 1978. The authoritarian Spain which emerged from the 1936 coup saw social and political repression and an autarchic economy. It was not until 1959 when the first stabilization plan was adopted that the Spanish economic outlook began to change. This change can be summarized as follows (García Delgado, 2015):

1st) 1959-1974: Expansion of the global economy, which had begun in the 1950s, arrived late to Spain, but thanks to the Stabilization Plan during this period Spain's GDP per capita increased 20 points with respect to the European average and climbs to 72.2% of the latter.

2nd) 1975-1985: Political normalization and reconciliation upon becoming a full member of the European Economic Community (EEC). Set against the backdrop of the global energy crisis, this period is characterized by successive adjustment plans (the Moncloa Pacts and medium-term programs created by the Socialist government) with the objective of normalizing the economy.

3rd) 1986-1991: The recovery which began in the United States in 1983 reaches Europe a few months later and Spain in 1985. The stimulating effects of the international economy combined with the entry of Spain in the EEC and, most of all, the positive results of the adjustment policies of the Union of the Democratic Centre (UCD, Spanish) and the Spanish Socialist Workers' Party (PSOE, in Spanish). Job creation increases dramatically.

4th) 1992-1999: Around 1994, the economy had hit rockbottom but then began to undergo a period of recovery. This coincided with the signing of the Maastricht Treaty, whose conditions which were applied at a time of recession, should have been implemented during a period of prosperity.

5th) 2000-2011. Following the beginning of the 21st century, which saw strong expansion brought on by real estate speculation, the Spanish GDP per capita reaches the UE average (27) in 2008. At that point, the Spanish economy, caught in the wake of those of the U.S.A. and Europe, combined with its own internal problems, enters a deep recession, in which it still finds itself today.

Until the second half of the 20th century, public spending in Spain followed the precepts of Adam Smith, in the sense that it was limited to funding the indispensable functions of the State: national defense, justice and civil order, maintenance of public works and institutions, and ensuring the dignity of citizens.

In parallel to the evolution of the economy, five distinct periods can be identified in the evolution of public spending in Spain. The first period encompasses 1958 to 1975. In it, public spending, in real terms, remained below 25% of GDP. The level of spending in the Spanish economy during the first part of this period was very low. Intervention in the economy on the part of the government was primarily carried out through regulation. Spanish economic activity was totally restricted as a result of laws and regulations. In this way, for example, relations between workers and business owners were controlled by maintaining those with low salaries and no right to strike in exchange for job stability. Spanish industrialization in the 1970s favored the growth of public spending. In keeping with Wagner's principles, this economic development was accompanied by a population increase and rising demand for housing, education, healthcare and the redistribution of income.

The second period, between 1975 and 1982, was essentially marked by two factors. On one hand, the transition to democracy provoked an avalanche of social demands, which had been repressed during Franco's regime, that had to be added to state budgets. Secondly, the economic crisis made it necessary to aid businesses by means of subventions to combat losses or by money transfers to prevent bankruptcies. Similarly, the crisis brought about a significant increase in unemployment as well as the number of early retirees, who opted for this as an alternative to being sacked.⁴

In the third period, 1982-1993, spending growth came as a result of the expansion of public welfare assistance propelled by socialist governments. These policies expanded healthcare coverage to the entire population and increased the number of pensioners, by including noncontributory schemes, in addition to the amount of the benefits. The increase in the population enrolled in schools caused education spending to rise, both at primary school level as well as at secondary school and university level. Furthermore, the number of agreements with subsidized schools also rose during this time.

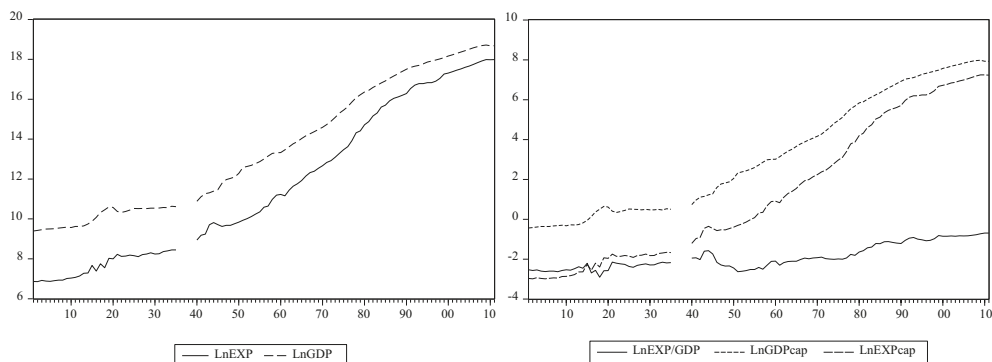
During the fourth period, 1994-2000, the Spanish executive accepted the Maastricht Treaty, which meant, firstly, that Spain would have to adjust its spending so that both its deficit and debt must meet the conditions of the agreement and, secondly, that it had to fulfill the Pact of Stability and Growth Pact (SGP).

The fifth period saw an expansion of public spending parallel to the speculative growth of the economy. Thus, in 2000, public spending accounted for 39.19% of GDP. And in 2009, despite entering a recession, it still represented 46.26%, with slight decreases from previous years (45.67% in 2011).

⁴ In 1975, the unemployment rate was 3.85 while in 1982 it was 16.29%.

6. Empirical analysis

The following diagram shows, in logarithms, the five series considered during 1901-2011.



It can be observed that the series reveal a trend that may or may not be linear, in addition to an evolution in the same direction. At the same time, it can be inferred that they may have a unit root. Consequently, we conduct various tests of unit roots considering that both variables reveal a trend in the data. The empirical test of the law is carried out as described in Section 3. First of all, we analyze the integration order of the series, the possible existence of unit roots in the level and first difference of the series. If all the series have the same integration order, this would facilitate studying the possible cointegration between them and the coefficients that correspond to the cointegrating equations.

Tables 1 and 2 present the results of the various unit root tests for level series and first difference series.

Table 1
Unit root tests of the time series considered⁵

Variable	ADF test	ADFGLS test	PP test	KKPSS test
Lnexp	-1.877*	-0.457*	-2.137*	0.268*
LnGDP	-1.694*	-0.27*	-2.413*	0.272*
Lnexp/GDP	-2.069*	-1.667*	-2.263*	0.237*
Lnexppc	-1.845*	-0.454*	-2.105*	0.270*
LnGDPpc	-1.677*	-0.791*	-2.387*	0.276*

None of the tests reject the null hypothesis of a unit root in time series. Utilizing the graph, all the tests are calculated including a constant and a trend in the test equation: The lags number for ADF was calculated using SIC. The bandwidth for the PP and KPSS test is selected based on Newey-West using Bartlett Kernell. The symbols *, **, y *** indicate significance and 1%, 5% and 10% using critical values from MacKinnon.

⁵ The tests used were: Augmented Dickey-Fuller (ADF), ADFGLS, Phillip-Perron (PP), Kwiatkowski, Philips, Smith and Shin. CV 5% are ADF -3.35; DF-GLS -3.03; PP -3.45; KPSS 0.14

Table 2
Unit root tests for the first differences of the time series⁶

Variable	ADF test	ADFGLS test	PP test	KKPSS test
Lnexp	-4.384*	-3.418*	-11.552*	0.4274*
LnGDP	-4.831*	-3.847*	-4.771*	0.316*
Lnexp/GDP	-7.546*	-7.600*	-11.495*	0.147*
Lnexppc	-4.358*	-3.438*	-11.523*	0.422*
LnGDPpc	-4.915	-3.943*	-4.796*	0.313*

Unlike the previous table, this shows that all the series are stationary at the 1% level. The analysis was carried out considering the series to be constant with no trend and using the same conditions as in the level series analysis.

However, in line with Perron, the standard unit root tests tend to erroneously identify trending stationary processes as stationary in differences and may have very low power, even asymptotically, if changes in regime are ignored. Moreover, during the period studied, there was a great deal of social and political upheaval in Spain, which could have altered the course of public spending and the GDP. Therefore, supposing that the series might have breakpoints, different tests were conducted to detect them. Firstly, utilizing the sequential test of Bai-Perron, we obtained up to 4 structural breaks corresponding to the years 1917 (end of the First World War), 1946 (during post-war Spain), 1965 (the beginning of stabilization plans) and 1982 (corresponding to the early years of the institution of democracy in Spain and the late recovery of the country from oil shortage in the late 1970s)⁷. Considering the Chow breakpoint test, and using the same breakpoints, it rejects the null hypothesis of non-existence of breakpoints at the points specified.

Given the existence of these breakpoints, in general, we conduct unit root tests allowing one or several structural breakpoints at unknown moments in time. The following chart displays the results obtained.

Table 3
Unit root tests considering structural breaks in the data⁸

Variable	ZA test	P test	LP test
Lnexp	-3.063*	-2.108*	-4.514
LnGDP	-2.854*	-3.199*	-4.331
LnGDPpc	-2.844*	-2.100*	-4.052
Lnexp/GDP	-5.288*	-3.55*	-5.290
Lgexppc	-3.109*	-2.28*	-4.409

The tests conducted are Zivot Andrews unit root test, Perron unit root test and Lumsdaine-Papell unit root test. All the cases of breakpoints are detected endogeneously by the test. In the first two cases a maximum of one breakpoint

⁶ CV to 5% ADF -2.89; DF-GLS -1.94; PP -3.45; KPSS 0.46

⁷ The first democratic government under the UCD party did not react to the price increases in the world oil markets during this time for fear of the possible disturbances that could arise. Instead, it opted for gradual measures over the course of this period.

⁸ CV to 5% ZA -4.23; PP -4.83; LP -6.16

is admitted, while the LP test can detect two or more breakpoints. The ZA test detects breakpoints endogeneously in 1973, 1973, 1971, 1945, 1973 for the different variables. In none of the cases does it reject the unit root hypothesis in the variables against the stationary alternative with structural change in both intercept and trend at an unknown date. The P test observes breakpoints in 1921, 1919, 1919, 1979, 1921 for the different variables. The lags selection method belongs to the criteria of Schwartz. It is assumed there is a constant and trend in the data generation process, and that there are breaks in the constant and trend. The critical values are taken from Vogelsang. The values obtained with alternative specifications confirm the existence of unit roots in all of the variables in every case. The LP test detects breakpoints in 1936 and 1992 for the LnGdppc variable, 1949 and 1992 for the Lnexp series, 1936 and 1952 for the LnexpGdp series, 1949 and 1993 for the series Ln expc and 1940, and 1991 for LnGdp. In all the cases the statistical test values reveal, in relation to the critical values, that the series have a unit root against the most general alternative hypothesis. The tests of the first differences of the series (not displayed) confirm that all the series are stationary. Therefore, it can be inferred that all the series are order one integrated $I(1)$, whether the possible structural breakpoints are considered in the series or not.

Both of these preliminary steps are important for ensuring that we employ the correct econometric procedure. The estimation of a cointegrating relationship using ordinary least squares, in general, is biased due to problems of endogeneity with the variables. Consequently, the corresponding t statistics do not follow a normal Student- t distribution, which is why it is not possible to make any kind of inference about its significance. On the other hand, performing a regression on the first difference of the variables when there actually exists a long-term relation of balance between them leads to the well-known problem of spurious regression. In fact, what disappears in this type of regression is the error correction term.

In addition, in the case under study, we have to analyze the possible existence of structural breaks in the data. In order to carry out said analysis, the usual cointegrating tests were implemented: Johansen-Juselius, Engle-Granger and Philip-Outlaris without considering breakpoints. An analysis was subsequently conducted using two types of tests: Gregory and Hansen (GH), in which the break can be considered both in the constant and trend, and Johansen-Mosconi and Nielsen (JMN), in which one or two breakpoints can be considered at the levels.

Table 4
Cointegrating test without considering breakpoints

Model	Johansen 1 Trace Statistic	Johansen 1 Maximun Eigenvalue	Johansen 2 Trace Statistic	Johansen 2 Maximun Eigenvalue	Engle- Granger	Philip- Outlaris
Model 1	$r=0$ 34.64* $r\leq 1$ 0.1654	$r=0$ 34.47* $r\leq 1$ 0.1654	$r=0$ 46.698* $r\leq 13$ 1.178	$r=0$ 43.519* $r\leq 1$ 3.178	-2.640	-2.581
Model 2	$r=0$ 34.642* $r\leq 1$ 0.165	$r=0$ 34.476* $r\leq 1$ 0.165	$r=0$ 46.698* $r\leq 1$ 3.178	$r=0$ 43.519* $r\leq 1$ 3.178	-2.640	-2.581
Model 3	$r=0$ 34.863* $r\leq 1$ 0.1349	$r=0$ 34.728* $r\leq 1$ 0.134	$r=0$ 46.337* $r\leq 3$ 0.067	$r=0$ 43.270* $r\leq 1$ 3.067	-2.712	-2.622
Model 4	$r=0$ 34.863* $r\leq 1$ 0.134	$r=0$ 37.728* $r\leq 1$ 0.134	$r=0$ 46.337 $r\leq 1$ 3.067	$r=0$ 43.270* $r\leq 1$ 3.067	-2.712	-2.622
Model 5	$r=0$ 38.763* $r\leq 1$ 0.073	$r=0$ 38.689* $r\leq 1$ 0.073	$r=0$ 43.019* $r\leq 1$ 2.752	$r=0$ 40.267* $r\leq 1$ 2.752	-3.101	-2.808

Johansen (1) allows for a constant in the cointegrating space and for a linear trend in the level data. Johansen (2) allows for a constant and a trend in the cointegrating space and for a linear trend in the level data. The basic lags length in the test specifications is chosen by SIC. The symbol * indicates significance to 5% level employing critical

values for MacKinnon-Haug and Michelis. The results indicate that the existence of a cointegrating relationship between variables is not rejected, neither in the trace statistic nor in the maximum eigenvalue contrast. The Engle and Granger and Philip-Outlarios tests feature the no-cointegration null hypothesis between variables by considering the existence, or absence, of a unit root in the residuals of the linear regression estimated for least squares in the first case and in likelihood based analysis of cointegration. In both cases the residuals indicate the existence of a unit root of 5% using MacKinnon's critical values in the first case, automatic lags specification based on Schwarz criterion (maxlag=12), and in the second case, long run variance estimate (Barlett Kernel, Newey-West fixed bandwidth). Consequently, they reject cointegration between the two variables in all cases.

Table 5
Cointegration test with structural breaks

	GH test Full structural break. Trend included: In bracket break point	GH test. Break in intercept. Trend included	JMN trace cointegration test 1	JMN trace cointegration test 2	JMN trace cointegration test 3	JMN trace cointegration test 4
Model 1	-4.556 (1957)	-5.754* (1949)	Break in 1973 r=0 41.33 r≤1 0.07371*	Break in 1973 r=0 42.419 r≤1 5.791		
Model 2	-4.556 (1957)	-5.754* (1949)	Break in 1945 r=0 58.860 r≤1 7.311 Break in 1973 r=0 41.335 r≤1 0.073	Break in 1945 r=0 52.036 r≤1 2.569 Break in 1973 r=0 47.357 r≤1 4.026	Break in 1945 and 1973 R=0 60.929 r≤1 11.548	Break in 1945 and 1973 R=0 61.128 r≤1 11.555
Model 3	-5.107 (1949)**	-5.82* (1949)	Break in 1971 r=0 39.107 r≤1 0.361 Break in 1945 r=0 58.194 r≤1 6.794	Break in 1971 r=0 39.267 r≤1 4.169 Break in 1945 r=0 59.751 r≤1 8.294	Break in 1945 and 1971 r=0 67.285 r≤1 17.335	Break in 1945 and 1971 r=0 67.560 r≤1 17.416
Model 4	5.326** (1949)	-5.82* (1949)	Break in 1973 r=0 41.660 r≤1 0.020	Break in 1973 r=0 47.730 r≤1 4.257		
Model 5	-5.952* (1949)	-5.326** (1949)	Break in 1973 R=0 41.334 r≤1 0.012	Break in 1973 R=0 45.278 r≤1 3.898		

This table displays the results obtained taking into consideration the different structural breakpoints detected in the data. They were tested using the Gregory and Hansen test and that of Johansen et al. In the first case the test was conducted so that the deterministic components had constant and/or trend and that the break was produced only in the constant, or rather both in the constant and in the trend. The number of lags was selected utilizing SIC and BIC. Gregory and Hansen's test contrasts the null of no cointegration against the cointegrating alternative in the presence of a possible regime shift. More specifically, it considers the cases in which the constant and the coefficient of the slope have only one structural break at an unknown moment in time. The different models are analyzed and the moment at which the structural break takes place is highlighted according to the test, which detects the break endogeneously. The symbols * and ** indicate rejection of the null hypothesis.

In the models of Johansen, Model 1 allows deterministic linear trend in the data: constant without trend in CE and VAR test. It assumes a structural break in the constant (level shift) that is taken into consideration by adding dummy variables to the deterministic part of the process. In Model 2, both constant and trend are assumed in CE, and with constant in

VAR, structural break is assumed in the constant. Every case rejects the null hypothesis of non-existence of cointegration between the two variables, which is why both are considered to be cointegrated. Models 3 and 4 are analogous to 1 and 2 assuming two breakpoints. The critical values are obtained by considering the response surfaces, which is in line with Johansen et al. (2000). In all cases the lags order is determined by the information criteria (AIC and SBC) for the corresponding VAR processes. The symbols * and ** indicate rejection of the null hypothesis.

7. A VEC approximation to analyze long-term causality.

The analysis made in the previous section allows us to conclude that in all the models considered, the variables are order one integrated $I(1)$ and cointegrated. Therefore, it is possible to estimate the cointegrating relationship that exists between them. Given the existence of structural breaks with changes in the constant and, possibly, in the trend, it proves suitable to analyze long-term causality by means of a restricted VAR in terms of an error correction model, as has been detailed earlier, but with the addition of a term that expresses the structural break that occurs in the data. The model can be written as:

$$\Delta \text{Lnexp}_{it} = \mu + \sum_i \nu_i \Delta \text{LnGdppc}_{t-i} + \rho [\text{LnGexp}_{t-1} - \psi \text{LnGdppc}_{t-1}] + \sum_i [\kappa_{45i} \Delta C_{t-i, T45} + \kappa_{73i} \Delta C_{t-i, T73}] + \varepsilon_{it} \quad (9)$$

Where the dummy variables $C_{t, T45}$ and $C_{t, T73}$ are defined as equal to zero for dates prior to the breakpoint and equal to one after it (the dates utilized were 1945 and 1973). Due to the cointegrating relationship, at least one of the variables must adjust significantly to the deviations of the long-term relationship which are captured by ρ . This parameter describes the speed of adjustment towards equilibrium and measures the proportion of error with respect to the equilibrium that is corrected at each stage. Thus, in the previous equation, the VEC permits stating that Lnexp causes Granger LnGdppc , or vice-versa, as long as the coefficient of the correction error term is negative and statistically significant, even if the other coefficients are not. Confirmation of Wagner's Law is obtained when there exists significant causality from public spending to GDP per capita. The magnitude of the adjustment parameter ρ contains information about the capacity to absorb exogenous shocks at different stages and also about the reaction of public spending to changes in GDP. A significant statistically negative value in the adjustment parameter implies causality from GDP to exp as described by Engle-Granger.

The results obtained are displayed in Table 6

Table 6
Coefficient of VEC model to analyze causality between variables

	Coefficient	t statistic	R ²	Coefficient	t statistic	R ²
Model 1	-0.178	-3.971	0.455	0.103	0.407	0.427
Model 2	-0.308	-6.076	0.433	0.001	0.407	0.427
Model 3	-0.286	-6.278	0.441	0.001	0.376	0.415
Model 4	-0.176	-3.949	0.463	0.0123	0.37	0.415
Model 5	-0.164	-3.716	0.449	0.007	0.003	0.414

This table estimates the error correction terms of the corresponding VEC. Displayed here are the t statistics and R² values are obtained. The number of lags (regressors) included in the VEC are calculated utilizing AIC and

SBC. The first three columns correspond to VEC in the direction public spending to GDP, while the last three indicate the direction GDP to public expenditure. The results obtained reveal the existence of a causality relationship from GDP to exp but not the opposite, as proposed in the various models (Keynesian Hypothesis).

8. Cointegrating equations

Three methods of estimating the cointegrating vector are utilized: First, fully modified ordinary least squares (FMOLS) estimators, second, dynamic ordinary least squares (DOLS) and, finally, canonical cointegrating regression (CCR). FMOLS propose an estimator which employs a semi-parametric correction to eliminate the problems caused by the long run correlation between the cointegrating equation and stochastic regressors innovations. The resulting fully modified ordinary least squares (FMOLS) estimator is asymptotically unbiased and has fully efficient mixture normal asymptotics allowing for the standard Wald test using asymptotic Chi-square statistical inference. Dynamic ordinary least squares (DOLS) is a parametric approximation where the lags terms in first differences are explicitly estimated. The method involves augmenting the cointegrating regression with lags and leads of the first differences of independent variables so that the resulting cointegrating equation error term is orthogonal to the entire history of the stochastic regressor innovations. Finally, canonical cointegrating regression (CCR) is closely related to FMOLS, but instead employs stationary transformations of data to obtain least squares estimates to remove the long run dependence between the cointegrating equation and stochastic regressor innovations. Like FMOLS, CCR estimates follow a mixture normal distribution which is free of non-scalar nuisance parameters and allows asymptotic Chi-square testing.

The results obtained are displayed in Table 7

Table 7
Estimation of the different versions of Wagner's law using FMOLS, DOLS AND CCR

	FMOLS	DOLS	CCR
Model 1	1.137 (35.875)	1.177 (78.96)	1.143 (35.197)
Model 2	0.337 (10.023)	0.298 (8.253)	0.337 (9.932)
Model 3	0.366 (9.803)	0.302 (8.339)	0.367 (9.714)
Model 4	1.127 (37.16)	1.189 (71.667)	1.127 (31.997)
Model 5	1.240 (35.333)	1.282 (54.589)	1.240 (35.522)

In FMOLS method we have estimated long run covariance using Bartlett kernel and Newey- West fixed bandwidth=5.0. In DOLS we use automatic leads and lags specification based on AIC criterion. In CCR regression equations are estimated using differences. In brackets t-statistics. All coefficients of independent variables are significant to 5%. The determination coefficient is above 0.99 in every case. One or two structural break were included in all the equations (in the cases where two breaks were detected) in the constant adding a variable dummy. In all cases dummy variables are significant.

Taking into consideration the results obtained, it can be stated that Wagner's Law is generally holds true in the long term for Spain, in the five standard versions.

9. Robustness Analysis

In addition to the work carried out in the section above, we saw fit to analyze the fulfillment of Wagner's Law in the different subsamplings identified by the breakpoints studied previously. To this end, the breakpoints utilized were those detected using Bai-Perron tests of $L+1$ versus L sequentially determined breaks. Therefore, the breakpoints and subsampling obtained are the same for all the equations.

A second possibility is to consider one only endogeneous break in the model determined sequentially. In this case the breakpoint determined by the model is 1947 and the results obtained categorically confirm that Wagner's Law is valid in the time context considered for Spain.

Table 8
Robustness analysis

	1901-1920	1921-1945	1946-1981	1982-2011	R ²
Model 1	0.916 (13.513)	1.578 (21.685)	1.170 (80.321)	1.289 (38.306)	0.999
Model 2	0.083 (1.238)	0.5786 (7.948)	0.170 (11.683)	0.289 (8.600)	0.967
Model 3	0.102 (1.364)	0.691 (7.926)	0.185 (11.660)	0.312 (8.567)	0.967
Model 4	0.897 (12.00)	1.691 (19.382)	1.185 (74.637)	1.312 (35.979)	0.998
Model 5	0.997 (12.535)	1.883 (20.269)	1.267 (71.192)	1.405 (39.139)	0.998

Virtually all of the results obtained confirm (except for the period 1901-1920 in Models 2 and 3) the pertinence of Wagner's Law and its robustness against model changes and in the various subsamples utilized.

Table 9
Robustness analysis

	1901-1946	1947-2011	R ²
Model 1	1,3376 (32,93)	1,2774 (134,99)	0,999
Model 2	0,3376 (8,31)	0,2774 (29,31)	0,931
Model 3	0,3876 (7,91)	0,2980 (28,91)	0,929
Model 4	1,3876 (28,31)	1,2980 (125,93)	0,997
Model 5	1,5745 (30,17)	1,3714 (124,95)	0,997

In this second analysis we can see a little decrease in the variables coefficients in the second subsampling. There is not an objective reason for that conduct.

10. Conclusions

In this paper an empirical test has been conducted of 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.

Five formulations have been evaluated in order to consider public expenditure and output in both absolute terms and per capita. Unlike previous studies, this test has been carried out utilizing the possible structural breaks in the data. Taking into consideration those breaks, tests were used to evaluate unit roots, cointegration, causality and the calculation of corresponding coefficients of the cointegration equations.

The results obtained lead to the confirmation that Wagner's Law generally holds true in the case of Spain during the period 1901-2011.

This result implies a relationship between economic growth and public expenditure. A rise in economic growth implies a rise in public expenditure. The reasons can be varied, such as population growth or increasing demand for education and healthcare. This relationship can be direct but can be indirect because an increase in the public revenues, e.g. increase in the tax revenues, can imply an increase in the expenditure using the relationship tax-expenditure (Friedman, 1976).

There is not a causality relationship between public expenditure and GDP (Keynesian hypothesis). That implies that GDP is an exogenous variable and we can think in other different reasons to the growth of economic. This argument is contradictory with the economic politics of many developed countries after II War World.

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