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The Validity of Wagner's Law in the United Kingdom

by

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The Validity of Wagner's Law in the United Kingdom for the Period 1850-2010

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Abstract

The relationship between national income and government spending is one of the most debated topics between economists and policy makers during the last decades. The objective of this paper is to examine the Wagner's law validity, and if it can be applied in the U.K. public spending expansion for the period 1850-2010. According to Wagner's hypothesis, fundamental economic growth is a determinant to the public sector growth. The public sector is said to be able to grow at a very high rate when compared to the national income. The data covers a period in which U.K. economy faced increased economic growth, government spending and met most of the assumption of Wagner's Law (industrialisation, urbanisation, increased population). Furthermore, the long data set ensures the reliability of our results in terms of statistical and economic conclusions. We apply unit root tests, unit root tests with structural breaks, cointegration techniques and Granger causality tests. Our results indicate a presence of a long run relationship between national income and government spending, while the causality is bi-directional, thus we find support of Wagner's and Keynesian hypotheses.

Keywords: Wagner's Law, Long Time Series, Public Finance, Aplied Econometrics

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Introduction

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The relationship between economic growth and government spending has attracted the interest of many economists (e.g. Henrekson 1993, Bohl 1996, Sideris 2007) and policy makers during the last decades, because the size of the public sector (government spending) most of developed (e.g. Greece, Spain, Portugal, Italy and Ireland) and developing countries (e.g. Chile, Bolivia, Philippines, and Morocco) has expanded. Thus, it is very important for an economy to investigate if there is any long run relationship between these two variables and also identify the direction of causality. In other words, Wagner hypothesis suggests that government spending plays no crucial role in economic growth, and thus cannot be used as a policy instrument. In Keynesian view, government spending is an important policy variable, which can be used by the government authorities in order to influence economic growth of the economy.

Wagner (1883) predicted that economic growth would be accompanied by a relative growth of government spending. A modern formulation of Wagner's "law", mentioned by Bird (1971), might run as follows: as per capita income rises in industrializing nations, their public sectors will grow in relative importance. Thus, the causality according to Wagner's law is running from economic growth to government spending. On the other side, Keynesian hypothesis support that the causality is running from government spending to economic growth, which is in contrast with Wagner's law. Interest for the Wagner hypothesis attracted the attention of many economists after the translation of the original work of Wagner by Cooke (1958), however the interest had declined at the end of 1970s. Although, the increased public spending in most countries, new development of econometric techniques, and the last translation of Wagner's work by Biehl (1998) attracted again the interest of many policy makers and economists.

UK during the period of 1850-2010 was a country in the process of industrialisation, urbanisation. The country experienced increased economic growth, expanded government spending and increased population. Thus, the examination of Wagner's law in U.K. during this period is very important. The remainder of this paper is organized as follows. In section 2, we present some of the most important characteristics of previous studies examined the Wagner's Law. In section 3 we describe our data and explain our methodology. Section 4 discuses the empirical results (including stationarity, cointegration and structural breaks). Additionally, we include the results of the causality analysis. In section 5 we provide some conclusions, policy implications and suggestions for further research.

Different Versions of Wagner's Law

Wagner suggested that the development of government spending will take place because of industrialisation, social process and increasing incomes. He also recognised that this spending expansion has an upper limit and mentioned the important of economic regulation. However, he did not provide any mathematical formulation in order to examine his hypothesis. During the last 50 years there are available in the literature 6 different versions of Wagner's law: Peacock and Wiseman (1961), Gupta (1967), Goffman (1968) , Pryor (1969), Musgrave (1969), Goffman and Mahar (1971) and Mann (1980).

Versions of Wagner's law

1. **Peacock-Wiseman version**

$$LG_t = a_0 + a_1 LY_t + e_t \qquad a_1 > 1 \qquad \textbf{(1)}$$

Notes: LG is the log of real government expenditures, LGC is the log of real government consumption expenditure, LP is log of population, L(G/Y) is the log of the share of government spending in total output, L(Y/P) is the log of the per capita real output, L(G/P) is the log of the per capita real government expenditures ,L Y is the log of real GDP.

2. Peacock-Wiseman share version (Mann version)

$$L(\frac{G}{Y}) = \beta_0 + \beta_1 LY_t + e_t \qquad \beta_1 > 0 \tag{2}$$

3. Musgrave version

$$L(G/Y)_t = \gamma_0 + \gamma_1 \; L(Y/P)_t + e_t \qquad \gamma_1 > 0 \tag{3}$$

4. Gupta version

$$L(G/P)_t = \delta_0 + \delta_1 L(Y/P)_t + e_t \qquad \delta_1 > 1 \tag{4}$$

5. Goffman version

$$LG_t = \lambda_0 + \lambda_1 \; L(Y/P)_t + e_t \qquad \lambda_1 > 1 \tag{5}$$

6. Pryor version

$$LGC_t = \theta_0 + \theta_1 LY_t + e_t \qquad \theta_1 > 1 \tag{6}$$

Previous studies used time series (e.g. Chletsos and Kollias 1997, Islam 2001, Liu et al. 2008) or cross section analysis (Michas 1974, AbIzabeh and Gray 1985, Dao 1995, Shelton 2007) in order to investigate the validity of these hypotheses in a country or group of countries. According to Bird (1971) studies using cross-sectional data in order to examine the validity of Wagner's law are irrelevant, since a postulated change in the public sector happens over time. Henrekson (1993) suggested that the growth of public sector is a process occurring over time in a single country.

There is a strand in literature examined the validity of Wagner's and Keynesian hypothesis (Liu et al. (2008), Katrakilidis and Tsaliki (2009), Samudran et al. (2009), however there is no common pattern in the empirical results. Albatel (2002) investigated the relationship between spending and economic growth in Saudi Arabia during 1964-1995 by using cointegration approaches and Granger causality tests. He found evidence indicates support of Wagner's law and Keynesian hypothesis. Finally, he suggested that the country has to reduce the government size to an optimal size by adopting a policy of privatization in order to cut the spending and the budget deficits.

Dritsakis and Adamopoulos (2004) examined the tendency of the Greek public sector as well as the existing relationship between the extent of government spending and economic growth, during the period of 1960-2001. Their empirical results support Wagner's Law because the estimated elasticity of consumption for total and partial public spending was consistent with the limitations of Wagner's Law. Finally, they concluded that Granger-causality tests on Wagner's Law and in the Keynesian model provided evidence supporting the complexity of the underlying interactions with most of the relationships being bi-directional in the causality models. Katrakilidis and Tsaliki (2009) examined the relationship between spending and economic growth by using annual data of the Greek economy during the period 1958-2004. They applied recent developments in the theory of cointegrated processes (ARDL) and obtained empirical results indicate that the causality runs from income to government expenditures, which is in accordance with Wagner's law. Conversely, they found that causality runs from expenditures to income which supports the Keynesian hypothesis and claimed that their study brought new evidence of two-directional causality between expenditures and income for the case of Greece.

There are several studies examined the validity of Wagner's law in U.K. (e.g. Gyles 1991, Georgakopoulos et al. 1992, Oxley 1994, Thornton 1999, Chow et al. 2002 , Chang 2002, Chang et al. 2004, Loizides and Vamvoukas 2005, Yuk 2005). All these studies with the exception of Yuk (2005) support the validity of Wagner's law in U.K., while Yuk (2005) found mixed evidence across different periods (Only during 1830-1867 Wagner's law is not valid). Georgakopoulos et al. (1992) developed a dynamic model of government behaviour for the U.K in order to examine the Wagner's law during the period of 1954-1983. They found a strong positive relationship between growth of real per capita income and the rise of public sector, which supports the Wagner's law for U.K during the tested period.

Thornton (1999) deployed data from 19th century (from 1850- 1913) and found supporting evidence for the "law" for six European countries (Denmark, Germany, Italy, Norway, Sweden, United Kingdom). Loizides and Vamvoukas (2005) implemented annual data for the period 1960-1995 in order to examine the relationship between government size and economic growth for three European countries (Greece, U.K. and Ireland). They used bivariate and trivariate (by adding inflation or unemployment rates separately) systems which based on cointegration analysis, Error Correction Model strategy and Granger causality tests. They found empirical evidence that the increase on government spending causes the economic growth in the short run for all the tested countries, while there is evidence in long run only for U.K. and Ireland. Moreover, they found that causality runs from economic growth to government spending in Greece and in U.K. (when inflation is included).

Finally, one might expect that any investigation of the validity of Wagner's law in a high income country for the period after the World War II will find no support of the law. These countries experienced industrialisation, urbanisation and increase demand for public services before 50-60 years, thus one might expect that the relationship between income and spending to be weaker. However, there are many studies tested developed countries such as the U.K (e.g. Gyles 1991, Chow et al. 2002, Islam 2001) and supported validity of the law for the period after World War II.

There are some authors (Singh, Sahni 1984, Demirbas 1999), claimed that the relationship between government spending and national income has been treated with a different way in two major areas of economic analysis. Most of the studies in public economics support the view that the expansion of public sector spending caused mainly by the increased economic growth (Wagner hypothesis), while most macroeconomic studies suggest that the economic growth of an economy is influenced by the government spending (Keynesian hypothesis).

Derimbas (1999) stated that "Public finance studies, following Wagner, have considered public expenditure as a behavioural variable, similar to private consumption expenditure. By contrast, macroeconometric models, essentially following Keynes, have treated public expenditure as an exogenous policy instrument designed to correct short-term cyclical fluctuations in aggregate expenditures"(Demirbas 1999,pp. 13).

Data

During the period 1870-1900 U.K. had a comparative economic advantage to other economies such as U.S.A. and Germany, moreover their industrial output followed an upward trend. However, at the beginning of the 20th century these countries developed their own industries. During the World War I there were reported significant losses in U.K. economy, and things were worst after the great depression during 30s (high unemployment). In figure 1 are illustrated the real government spending and real GDP. Annual data on real government expenditure, real GDP, population are obtained from the International Financial Statistics of the International Monetary Fund and by Maddison (2001) dataset.

Before World War I public spending were 15% of GDP, while at the end of this was it was accounted for almost 25% and remained stable for more than ten years. Government spending increased after the World War II at about 35% (probably because of the spending on infrastructure) and stabilised again since 1950. At 1960, spending followed an upward trend and accounted for 45% in 1980. During 1980s there was reported a decrease of almost 10% in public spending. In 2000 public spending were 35% of GDP, while is expected next year to rise to 45%.

Since 1900 GDP per capita at constant market prices rose by an estimated 300 %, however GDP has not increased steadily during this period. There are periods that GDP declined, especially during the great depression during 30s, during the World Wars, during 1918-21, during 1991-1992. The average annual increase during this period was about 1,5% .

The population in U.K. has been increased during the last 150 years but at a declining rate. However, the predictions for the next decade suggest that will continue to increase at about 62.250.000 at 2020. One reason for the increased population is the increased life expectancy and because of immigration. At the beginning of this century U.K. was an exporter of population, however, during the last decades many immigrants came in U.K. especially for E.U. and U.K. colonies.

Figure 1: LGDP and LG in U.K. during 1850-2010

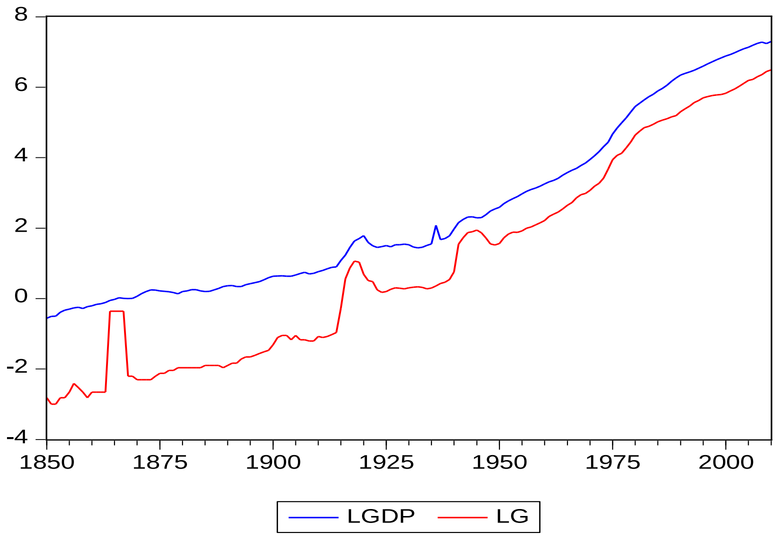
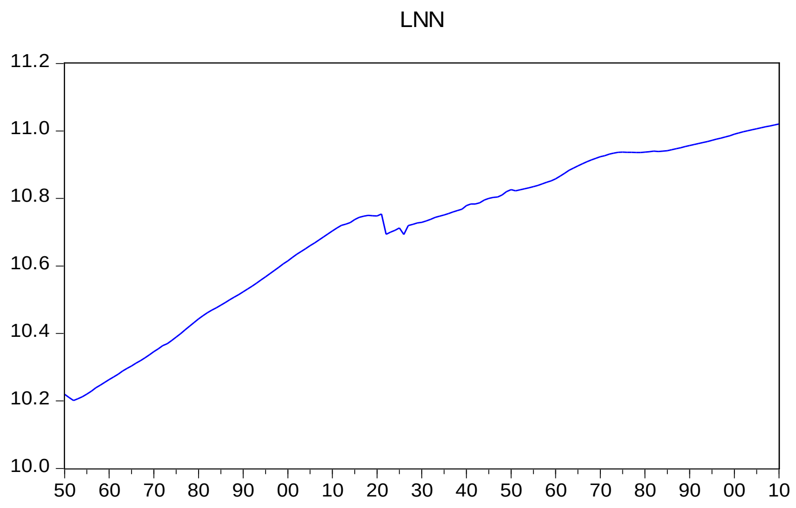


Figure 2: LNN in U.K. during 1850-2010



Empirical Results

Unit root tests

We apply the Augmented Dickey Fuller (1979) and the Phillips Perron (1988) unit root tests and examine the null hypothesis that there is a unit root and series are non-stationary. In Table 1 we have the results of these tests conducted with intercept on the log values of the tested series. In levels all series have unit root, while in first difference we reject the null hypothesis and all series are integrated of order 1 (I(1)). In table 2 we obtain the same results, when unit root test conducted with intercept and trend all series are I(1).

Table 1 ADF and PP Unit root tests (Intercept)

1850-2010							1850-2010						
Variables	**t(ADF)**	**P-Value**	**Variables**	**t(ADF)**	**P-Value**	**Critical value**	**Variables**	**PP**	**P-Value**	**Variables**	**PP**	**P-Value**	**Critical value**
LG(4)**	0.45	0.98	**ΔLG(3)**	-8.74*	0.00	-2.87	**LG(15***)**	0.72	0.99	**ΔLG(20)**	-11.8*	0.00	-2.87
LGDP(0)	3.07	1.0	**ΔLGDP(1)**	-8.70*	0.00	-2.87	**LGDP(4)**	2.56	1.00	**ΔLGDP(5)**	-11.19*	0.00	-2.87
L(G/GDP)(0)	-2.6	0.07	**ΔL(G/GDP)(3)**	-8.78*	0.00	-2.87	**L(G/GDP)(13)**	-2.29	0.17	**ΔL(G/GDP)(23)**	-16.11*	0.00	-2.87
L(G/P)(4)	0.51	0.98	**ΔL(G/P)(3)**	-8.70*	0.00	-2.87	**L(G/P)(15)**	0.76	0.99	**ΔL(G/P)(20)**	-11.7*	0.00	-2.87
L(GDP/P)(0)	3.26	1.0	**ΔL(GDP/P)(1)**	-6.26*	0.00	-2.87	**L(GDP/P)(5)**	2.62	1.00	**ΔL(GDP/P)(6)**	-11.34*	0.00	-2.87

Table 2 ADF and PP Unit root tests (Intercept and trend)

1850-2010							1850-2010						
Variables	**t(ADF)**	**P-Value**	**Variables**	**t(ADF)**	**P-Value**	**Critical value**	**Variables**	**PP**	**P-Value**	**Variables**	**PP**	**P-Value**	**Critical value**
LG(4)**	-2.14	0.51	**ΔLG(7)**	-6.26*	0.00	-3.43	**LG(10**)**	-2.37	0.39	**ΔLG(21)**	-12.40*	0.00	-3.43
LGDP(0)	-0.79	0.96	**ΔLGDP(0)**	-11.56*	0.00	-3.43	**LGDP(4)**	-0.88	0.94	**ΔLGDP(5)**	-11.66*	0.00	-3.43
L(G/GDP)(4)	-2.69	0.25	**ΔL(G/GDP)(3)**	-8.77*	0.00	-3.43	**L(G/GDP)(9)**	-2.84	0.54	**ΔL(G/GDP)(23)**	-16.24*	0.00	-3.43
L(G/P)(4)	-2.03	0.57	**ΔL(G/P)(3)**	-6.25*	0.00	-3.43	**L(G/P)(11)**	-2.22	0.47	**ΔL(G/P)(21)**	-12.38*	0.00	-3.43

L(GDP/P)(0)	-0.76	0.96	**ΔL(GDP/P)(1)**	-6.91*	0.00	-3.43	**L(GDP/P)(4)**	-0.84	0.95	**ΔL(GDP/P)(3)**	-11.58*	0.00	-3.43

Johansen Technique

We found evidence from ADF and PP tests that all the series are integrated of order one (I(1)). Firstly, will have five two dimensional VARs for the 5 versions. In order to determine the optimal number of lags in the 5 VARs, which is very important ensure that the residuals are uncorrelated and homoskedastic across time. We use several selection criteria[3], with each test performed at the five percent significance level. The criteria indicate that the optimal number of lags are 5 for Peacock and Goffman versions, 1 lag for Musgrave and Gupta versions and 8 for Mann version. Moreover we include one dummy variable[4] (DummyAll) in order to account for specific structural breaks (1869, 1917, 1933, 1947) in the British economy during the tested period. In all the estimated models the dummy is kept in the respective VARs as they turned to be significant, whereas its absence will mean non normal residuals for the relevant VARs. Finally, VARs satisfy all the statistical assumptions required for the Johanshen (1988, 1990) approach and we can apply the cointegration analysis. In table 3 are reported the diagnostic tests for heteroskedasticity and autocorrelation in all the VARs.

Table 3: Diagnostic Tests

	Heteroskedasticity	F-critical		Autocorrelation	
Peacock Version	F(22,136)= 1.12	2,03		**LM-STAT**	**Critical (Chi-sq)(df=9)**
Goffman Version	F(22,136)=0.72	2,03	**Peacock Version**	5.51	16.91
Musgrave Version	F(22,136)=1.96	2,03	**Goffman Version**	7.58	16,91
Gupta Version	F(22,136)=1.96	2,03	**Musgrave Version**	2.85	16,91
Mann Version	F(22,136)=1.83	2,03	**Gupta Version**	2.85	16,91
		Chi-sq critical	**Mann Version**	3.32	16,91
Peacock Version	Chi-sq(22)=24.45	33.92			
Goffman Version	Chi-sq(22)=17.1	33.92			
Musgrave Version	Chi-sq(22)=20.82	33.92			
Gupta Version	Chi-sq(22)=20.52	33.92			
Mann Version	Chi-sq(22)=20.96	33.92			

[3] A sequentially modified Likelihood Ratio (LR) test, a Final Prediction Error (FPE) test, an Akaike Information Criterion (AIC) test, the Hannan-Quinn (HQ) Information Criterion test, and the Schwartz Information Criterion (SIC) test

[4] In the previous section we included the unit root tests without allowing for possible structural changes. However, since our data set covers a long period, we cannot assume that our tested series are stable across time. Thus, we include the Recursive Chow test (1960) in order to examine for possible structural changes. Our null hypothesis is that there are no structural changes at specified breakpoints. We reject the null hypothesis if the calculated F value is higher than the critical F value. Our empirical results of Chow test for the logged values of government spending and GDP indicate that the break points in LG are 1869, 1917, while in LGDP are 1933, 1947.

Since all the variables are I(1) we can apply the Johansen cointegration technique for examining if government spending and national income are related in the long run. We are examining 5 versions of the law[5] and found that our variables are co-integrated (Table 4, 5, 6, 7).

Table 4: Cointegration test on Peacock Version, Wagner's law

1833-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0.251979	60.51292*	29.79707	0.0000	**r=0**	0.251979	45.29067*	21.13162	0.0000
r=1	0.076633	15.22225	15.49471	0.0549	**r=1**	0.076633	12.43759	14.26460	0.0953
r=2	0.017692	2.784660	3.841466	0.0952	**r=2**	0.017692	2.784660	3.841466	0.0952

Note: * indicate rejection of the null hypothesis at the 5% level of significance.

Table 5: Cointegration test on Goffman Version, Wagner's law

1833-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0.237883	57.17613*	29.79707	0.0000	**r=0**	0.237883	42.37813*	21.13162	0.0000
r=1	0.082697	14.79799	15.49471	0.0635	**r=1**	0.082697	13.46544	14.26460	0.0666
r=2	0.008506	1.332552	3.841466	0.2484	**r=2**	0.008506	1.332552	3.841466	0.2484

Note: * indicate rejection of the null hypothesis at the 5% level of significance.

Table 6: Cointegration test on Musgrave Version, Wagner's Law

1833-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0.380118	101.9153*	29.79707	0.0000	**r=0**	0.380118	75.55982*	21.13162	0.0000
r=1	0.136226	26.35543*	15.49471	0.0008	**r=1**	0.136226	23.13823*	14.26460	0.0016
r=2	0.020156	3.217201	3.841466	0.0729	**r=2**	0.020156	3.217201	3.841466	0.0729

Note: * indicate rejection of the null hypothesis at the 5% level of significance.

Table 7: Cointegration test on Gupta Version, Wagner's law

1833-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0.249101	60.66023*	29.79707	0.0000	**r=0**	0.249101	44.69148*	21.13162	0.0000
r=1	0.084547	15.96876*	15.49471	0.0424	**r=1**	0.084547	13.78043	14.26460	0.0595

[5] We are not examining the version of Pryor, since there is no available data for government consumption spending for our tested period.

r=2	0.013930	2.188324	3.841466	0.1391	**r=2**	0.013930	2.188324	3.841466	0.1391

Note: * indicate rejection of the null hypothesis at the 5% level of significance.

Table 8: Cointegration test on Mann Version, Wagner's law

1833-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0.251979	60.51292*	29.79707	0.0000	**r=0**	0.251979	45.29067*	21.13162	0.0000
r=1	0.076633	15.22225	15.49471	0.0549	**r=1**	0.076633	12.43759	14.26460	0.0953
r=2	0.017692	2.784660	3.841466	0.0952	**r=2**	0.017692	2.784660	3.841466	0.0952

Note: * indicate rejection of the null hypothesis at the 5% level of significance

Moreover, we calculate the income elasticities (Table 9) in order to investigate the validity of Wagner's law. All the calculated elasticities are in accordance with the theory and we can state that according to Johansen technique Wagner's law is valid in U.K. during the tested period.

Table 9: Calculated income elasticities from Johansen approach

Peacock version	LG	LGDP	St. Errors
	1	1,23	0.052
Goffman version	**LG**	**L(GDP/P)**	**St. Errors**
	1	1.37	0.92
Gupta version	**L(G/GDP)**	**L(GDP/P)**	**St. Errors**
	1	0.51	0.12
Musgrave version	**L(G/P)**	**L(GDP/P)**	**St. Errors**
	1	1.24	0.6
Mann version	**L(G/GDP)**	**LGDP**	**St. Errors**
	1	0.23	0.05

Engle and Granger test

Another cointegration technique is the Engle-Granger (1987) two-step approach, which based in the idea that there is no cointegration between the variables. However, we reject the null hypothesis (see table 10) in all the tested versions and we obtain the following income elasticities:

$$E\,(Peacock) = \frac{\left\{\frac{d(lnG_t)}{d(lnY_t)}\right\}}{\left\{\frac{lnG_t}{lnY_t}\right\}}\text{=1.177, } E\,(Mann) = \frac{\left\{\frac{d(\ln(\frac{G}{Y})t)}{d(lnY_t)}\right\}}{\left\{\frac{\ln(\frac{G}{Y})t}{lnY_t}\right\}}\text{=0.177, } E\,(Musgrave) = \frac{\left\{\frac{d(\ln(\frac{G}{Y})t}{d(\ln(Y/P)_t)}\right\}}{\left\{\frac{\ln(\frac{G}{Y})t}{\ln(Y/P)_t}\right\}}\text{=0.188,}$$

$$E\,(Gupta) = \frac{\left\{\frac{d(\ln(G/P)_t)}{d(\ln(Y/P)_t)}\right\}}{\left\{\frac{\ln(G/P)_t}{\ln(Y/P)_t}\right\}}\text{=1.188, } E\,(Goffman) = \frac{\left\{\frac{d(lnG_t)}{d(\ln(Y/P)_t)}\right\}}{\left\{\frac{lnG_t}{\ln(Y/P)_t}\right\}}\text{=1.27}$$

We are testing if the residuals $e_t = -lnG_t - c - blnY_t$ have a unit root, by performing a unit root test (ADF). The results reported in Table 11 indicate that we cannot reject the null hypothesis that there is unit root in 5% critical value for the tested period. Since the computed t value for the first period is much higher than the critical value, our conclusion is that the residuals from the equation ($lnG_t = c + blnY_t + e_t$) are stationary. According to Gujarati (2003), hence the equation ($lnG_t = c + blnY_t + e_t$)) is a cointegrating regression and this regression is not spurious. Hence, we can reject the null hypothesis for the tested period, so ε_t is stationary and there is evidence of long run relationship between government spending and GDP.

Table 10: Engle-Granger technique in 5 versions of Wagner's Law (1st step)

Peacock Version	Coefficient	t-stat	Std.Error	Mann Version	Coefficient	t-stat	Std.Error
LGDP	1.177	74.01	0.0000	**LGDP**	0.177	11.16	0.0000
C	-1.830	-33.63	0.0000	**C**	-1.830	-33.63	0.0000
N	161			**N**	161		
R-squared	0.97			**R-squared**	0.43		
Adjusted R-squared	0.97			**Adjusted R-squared**	0.43		
Durbin-Watson	0.29			**Durbin-Watson**	0.29		
F-stat	5478			**F-stat**	124		
Musgrave Version	**Coefficient**	**t-stat**	**Std.Error**	**Gupta Version**	**Coefficient**	**t-stat**	**Std.Error**
LGDP/P	0.188	10.56	0.0000	**LGDP**	1.188	66.73	0.0000
C	0.156	1.02	0.3051	**C**	0.156	1.02	0.3051
N	161			**N**	161		
R-squared	0.41			**R-squared**	0.96		
Adjusted R-squared	0.40			**Adjusted R-squared**	0.96		
Durbin-Watson	0.28			**Durbin-Watson**	0.28		
F-stat	111			**F-stat**	4453		
Goffman Version	**Coefficient**	**t-stat**	**Std.Error**				
LNGDP/P	1.27	62.04	0.0000				
C	11.61	65.72	0.0000				
N	16						
R-squared	0.96						
Adjusted R-squared	0.96						
Durbin-Watson	0.21						
F-stat	3849						

The empirical results of this approach are in accordance with the theory, the calculated b of the Mann version is equal with the b of the Peacock version minus 1 (1.177-1=0.177) and the coefficient of Musgrave is equal with the coefficient of Gupta minus 1(1.188-1=0.188). Finally, the income elasticity of Goffman is more than one (1.27).

Table 11: Unit root tests in residuals (Engle-Granger 2nd step)

Peacock Version		Mann Version	
t-statistic	-3.55* (0.00)	t-statistic	-3.55* (0.0077)
t-critical	-2,87	t-critical	-2,87
Conclusion	Stationary	Conclusion	Stationary
Musgrave Version		**Gupta Version**	
t-statistic	-3.48* (0.0096)	t-statistic	-3.48 *(0.0096)
t-critical	-2,87	t-critical	-2,87
Conclusion	Stationary	Conclusion	Stationary
Goffman Version			
t-statistic	-3.04* (0.0325)		
t-critical	-2,87		
Conclusion	Stationary		

Note: * indicate rejection of the null hypothesis at the 5% level of significance.

Granger causality test

If two variables are cointegrated, we can use the Granger causality test (1969) to check the relationship between government spending and economic growth in the short run. The Granger causality test examine whether variable Y's current value can be explained by its own past value and whether the explanatory power could be improved by adding the past value of another variable X. If the coefficient of X is statistically significant, X is said to Granger cause Y.

In our tests, causality is hypothesised to run from national income (GDP or GDP/P) to the dependent variable, which takes three different forms: G, G/P, G/GDP. In more depth, the hypothesis that national income causes government spending requires that spending does not cause national income. The tests applied in this section using the first differences of each series (i.e., the stationary values)

We found in the previous section that there is one cointegration vector for all the models, so we can define the Granger causality tests as joint test (F-tests) for the significance of the lagged value of the assumed exogenous variable and for the significance of the error correction term. We examined the 5 different versions of the law and found that the causality is bi-directional, so there is support of Wagner's and Keynesian hypotheses. The results of Granger causality test are presented in Table 12.

Table 12: Granger causality test, Wagner's Law

		F-stat	P-value		F-stat	P-value
Peacock Version	**LGDP causes LG**	9.03*	0.0002	**LG causes LGDP**	3.18*	0.044
Goffman Version	**L(GDP/P) causes LG**	6.41*	0.0021	**LG causes L(GDP/P)**	4.07*	0.018
Musgrave Version	**L(GDP/P) causes L(G/GDP)**	5.98*	0.0031	**L(G/GDP) causes L(GDP/P)**	3.73*	0.026
Gupta Version	**L(GDP/P) causes L(G/P)**	8.24*	0.0004	**L(G/P) causes L(GDP/P)**	3.73*	0.026
Mann Version	**LGDP causes L(G/GDP)**	6.40*	0.0021	**L(G/GDP) causes LGDP**	3.18*	0.0441

Conclusion

In this paper we investigate the validity of Wagner's law in U.K. for the period of 1850-2010. One of the advantages of our study is the long data that we used, which ensures the reliability of our empirical results. Moreover, during this period the British Economy faced increased economic growth, expanded public activities, included the phase of industrialisation and urbanisation of the economy and the increased population, all the assumptions of the original Wagner's hypothesis.

We use recent econometric techniques in order to test if there is any long run relationship between economic growth and government spending, and also examine the direction of the causality between these variables. We apply unit root tests without allowing structural breaks (ADF, PP) and find that all the series are integrated of order one. Secondly, we use the recursive Chow test, allowing for possible structural changes. Then, we deploy two different cointegration techniques (Johansen and Engle-Granger) to see if there is long run relationship between the variables. We find that there is long run relationship between them, thus the law is valid according to Johansen and Engle –Granger approach. In our final step of our analysis, we use the Granger Causality test and find bi-directional causality between national income and government spending. These results indicate support of Wagner's and Keynesian hypotheses. The empirical support of both classical hypotheses: Wagner's law and Keynesian hypothesis, provides a further direction for analyzing policy issues, and exposes a fundamental understanding to the government or policy makers about inter-linkages between public expenditures and economic growth. The indication of this inter-dependency between these variables reproduce the effectiveness of government expenditure as fiscal instrument in stimulating economic growth, and the contribution of economic growth in government budget formulation. Our empirical results are in accordance with previous studies examined the case of U.K. (e.g. Gyles 1991, Georgakopoulos et al. 1992, Chow 2002, Chang 2002, Chang 2004, Loizides and Vamvoukas 2005), or tested the validity of the law for a long period (e.g. Oxley 1994, Thornton 1999, Guerrero and Parker 2007, Sideris 2007). It will be very interesting someone examines if our results can be generalised for other similar economies across the world, and also investigate specific determinants of public spending such as education, health, infrastructure or military spending. Finally, it will be very interesting an inclusion of the regulatory activity of the state in the examination of Wagner's hypothesis, as well as, any attempt of measuring the upper limit of the state expansion with respect to economic growth.

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