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The validity of Wagner's Law in the United Kingdom during the Last Two Centuries

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Abstract: The objective of this paper is to examine the Wagner's law validity, and whether it can explain the U.K. public spending expansion for the period 1850-2010. According to Wagner's Law, economic development is the key determinant to public sector growth. Accordingly, the public sector grows overproportionally compared to national income when economies develop. We test this hypothesis for the UK. The data covers a period in which the U.K. economy experienced 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 the Granger causality test. 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 for Wagner's and Keynesian hypotheses.

Keywords: Wagner's Law, long time series, public finance, applied econometrics, economic development

1 Introduction

Adolph Wagner (1835-1917) was a German economist who supported a state welfare system in opposition to a socialist welfare state. Wagner was also a member of the Prussian parliament from 1882-1885 and the Prussian House of Lords from 1910 onwards. Wagner actively supported the monarchy against any (social) democratic movement. In this sense Wagner was a supporter of a kind of state socialism which should not be confused with state socialism communist or socialist style. His motivation was to preserve the monarchy and not to overcome it.

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Therefore, what makes Wagner's contribution to economics influential and important until today is that he was the first economist who postulated an active intervention of the government in the economy well before Keynes. However, in difference to Keynes, Wagner did not demand state intervention in order to stabilise the economy but to stabilise the political system. Although for different reasons, both Wagner and Keynes would increase government spending. As a result, Wagner can be seen as a predecessor of Keynes.

However, Wagner concluded from the events in Germany (especially after the 1848 revolutionary upheaval) that as an economy develops, social pressure increases for more social considerations by the state and the industry. He observed and predicted an overproportional increase of government spending at least for the purpose of the welfare state. According to Musgrave and Musgrave (1989), Wagner distinguished three main reasons why government expenditure should increase: first, there is a socio-political reason because of an increase in state functions over time, for example for retirement, insurance, and natural disaster aid. The second reason is of economic nature, for example an increase of state assignments into science and technology and thirdly, historical, for example serving previously accumulated debt.

For all these reasons Wagner (1883) predicted that economic growth would be accompanied by a relative large 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.

Over the years, the relationship between economic growth and government spending has attracted the interest of many economists (e.g. Henrekson 1993, Bohl 1996, Sideris 2007, Paparas et al. 2015a, Paparas et al. 2015b, Paparas and Richter 2018, Richter and Paparas 2013), as most of the developed (e.g. Greece, Spain, Portugal, Italy and Ireland) and developing countries (e.g. Chile, Bolivia, Philippines, and Morocco) saw the size of the public sector increasing.

As mentioned above, both Keynes and Wagner believe that there will be an in increase government expenditure under certain circumstances. For an empirical test it matters whether one is looking at the motivation of an action or the outcome of an action. The motivation for increasing government spending according to Wagner is to react to increased political pressure expressed in higher welfare which is indicated by a higher growth rate. So higher government expenditures are caused by a higher growth rate.

In the case of Keynes, an increased government spending may be caused by a recession in order to stabilise the economy. What this implies is that in government expenditure would react in the opposite direction as GDP growth is acting, i.e. in times of high economic growth, government expnediture should be low and vice versa. In Wagner's case we would expect government expenditure to be positively correlated with GDP growth. In the Keynesian case we would expect it to be negatively correlated.

However, one can also look at the outcome of an action. In Wagner's case, the result of an increased GDP growth would be increased government expenditure. In the Keynesian case, an increase in government expenditure would lead to an increased GDP growth (and vice versa). Here, the causality for Wagner and Keynes is just the opposite.

In this paper, we test Wagner's law in different versions (see below), but we also include a test in terms of causality as described above. What we are testing therefore is whether government expenditure has been driven by GDP growth or GDP growth was driven by government expenditure, the latter can be considered as very simple Keynesian hypothesis. So we test Wagner vs. Keynes although as mentioned above, Wagner and Keynes are not necessarily exclusive to each other. In fact they can overlap each other in terms of motivation for government spending. Given the recent Eurocrisis, the question of what drives government expenditures and economic growth has become more actual than ever and it is not surprising, that Wagner's Law is more widely discussed[5].

Our sample starts in 1850 and ends in 2010. During this period the UK was a country in the process of industrialisation, urbanisation. The country experienced increased economic growth, expanded government spending and increased population. Given that Keynes published his work only some 80 years later, one could assume that at least for the beginning of the sample Wagner's Law could hold. However, after the 1930s one could assume that the Keynesian hypothesis is more improtant than Wagner's Law. So we will also search for structural breaks.

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.

2 Review of 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).

1. ***Peacock-Wiseman version***

Peacock and Wiseman (1961) version is the first modern attempt of examining the Wagner's Law. The main point of their study was the rejection of the original Wagner's theory about the organic theory of the state and the mechanisms of the state expansion. They claimed that "Wagner's law is simply a collar of an outmoded and repugnant political philosophy and rests on Wagner's own very special view of the nature of the state as a political entity" (Peacock & Wiseman, 1961, pp. 18).

$$LG_t = a_0 + a_1 LY_t + e_t \qquad a_1 > 1 \tag{1}$$

where LG is the log of real government expenditures, and LY is the log of real GDP.

In the Peacock-Wiseman version, Wagner's Law has been specified as the link between national income and government spending.

In their paper, Peacock and Wiseman (1961) noted that Wagner ignored wars, which led to massive increases in government spending. As a result, government spending would increase stepwise in line with major events. This is the so called "displacement hypothesis".

Finally, they argued that a possible increase of public spending is limited by the revenues and that rates are fixed by socio-political forces and factors which can be increased by a serious crisis. They also implemented the concept of the "tolerable burden of taxation" in order to explain the displacement hypothesis.

Interestingly, as it stands, eq(1) can neither test for the displacement hypothesis nor for the tolerable tax burden.

Moreover, it is questionable whether government expenditure as a whole reflect the rationale of Wagner Law. One outcome of the 1848 turmoil was that the government increased welfare spending in order to appease the dissatisfied workers. Therefore, instead of government expenditure, eq(1) should have looked at welfare expenditures.

Despite all these flaws, in our empirical analysis we will not change eq(1). We will test it as it is bearing in mind the above limitations as this is one version used in the literature to test for Wagner's Law.

Bird (1971) tested Wagner's Law using eq(1) for the period 1933-1965 in Canada and found strong support for the law. He used cross-section data and measured the size of government by government expenditure plus transfers at current prices. At his exposition of the law he had as a dependent variable the total expenditure of central and local government and as an independent variables he had administration, defence, debt, environmental service, good and services and finally transfers.

Thornton (1999) deployed data from the 19th century (from 1850- 1913) and found supporting evidence for the "law" for six European countries (Denmark, Germany, Italy, Norway, Sweden, the United Kingdom). In his testing procedure he followed three steps and applied the Peacock-Wiseman version. In the first step he examined the stationarity properties to determine the order of integration of the series using Augmented Dickey-Fuller test (1979), secondly he used Johansen (1988) maximal likehood methodology and Engle-Granger (1987) residual based approach to test for integration of the series. Finally, in the third step he carried out Granger (1969) causality test augmented with error correction term.

Thorn (1972) examined the case of 52 countries and did not find evidence against Wagner's law. Courakis et al. (1993) tested Greece and Portugal, and found that the law does not hold. Kolluri et al. (2000) found support in G7 countries; Oxley (1994) found support in the U.K. Other studies using this formulation are: Bairam (1992) and Bird (1971).

2. Peacock-Wiseman share version (Mann version)

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

where L(G/Y) is the log of the share of government spending in total output and LY is the log of real GDP as above.

Oxley (1994) used this formulation and found supportive evidence for Wagner's law in the United Kingdom. The main difference to eq(1) is that the left hand side of (2) is that it uses the ratio of government expenditure to GDP. Oviously, eq(2) is emphasising the share of government expenditure in an economy. This is quite a different interpretation of Wagner's Law as outlined above. Here, the argument is that with an increase of GDP, the government expenditure needs to grow overproportionally to GDP. This version implies an ever-growing state sector for as long as the economy is growing. If this hypothesis was true then the economy would eventually end up as a state-run economy, which is not what Wagner had in mind. Yet, this version of Wagner's Law is widely used and Kolluri et al. (1989) found support in 6 countries.

3. **Musgrave version**

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

where L(G/Y) is the log of the share of government spending in total output and L(Y/P) is the log of real GDP per capita.

In this version of Wagner's Law, the state sector only grows if per capita income grows. The intuition of this version of Wagner's Law seems to be counterintuitive. It states that as people of an economy are better off, they demand higher government spending. But why would they ask to government to spend more when their circumstances improve? What Wagner had in mind coming from the upheaval in 1848 was precisely that the increase in wealth was not shared across the population and therefore the government should step in with increased welfare expenditure. However, Musgrave was looking for an indicator for government expenditure to increase. As in eq(2) a problem with this formulation is that government expenditure grows for as long as per capita income is growing. Likewise, according to eq(3), if per capita income is shrinking so should be the share of government expenditure. It is questionable whether this is in the spirit of Wagner's Law.

The formulation of Musgrave was adapted by Islam (2001). He tested the validity of Wagner's hypothesis for the USA and employed annual time series data for the period 1929-1996. He applied advanced econometric techniques (Johansen and Juselious (1990) approach and exogeneity tests, and found strong evidence of a long-run equilibrium relationship between per capita real income and the size of the government.

On the other hand, Payne (1997) tested the sustainability of the G7 countries (Germany, France, Japan, Canada, Italy, the UK and the USA) during the period 1949-1994. They used cointegration tests between government revenues and spending, and found that fiscal policy is sustainable only for Germany. The budget deficit for France, Japan and Italy may have not been sustainable because there is no cointegration between government spending and revenues. Finally, the fiscal policy of the U.K., Canada, Italy and the USA may not have been sustainable since, even if there is coinetgration between spending and revenues, the estimated coefficients shows that government spending is increasing faster than revenues.

Finally, Abizadeh and Gray (1985) who found mixed results in 53 countries, Bohl (1996) who tested the G7 countries and also found mixed results, Lin (1995) who found supportive evidence for the validity of Wagner's law in Mexico, and Murthy (1993) who found support in Mexico. There are other scholars who used this formulation: Lall (1969), Ahsan et al. (1996) and Halicioglu (2003).

4. Gupta version

Gupta (1967) was not convinced about Peacock and Wiseman's argument. He argued that "according to them [Peacock and Wiseman, 1961], people's ideas about the tolerable burden can be separated from their notions of the desirable level of public expenditure, and there is likely to be a gap between the two sorts of ideas because the choices made through the political process are inherently different from those made through markets...thus a shift in people's ideas about the tolerable burden of taxation due to a special upheaval may give rise to a shift in the level of public expenditure with relation to national output" (Gupta, 1967, pp. 427). However, they imply that when a shift is associated with a depression, people get accustomed to a higher burden of taxation, because during a depression the taxes are reduced. As a result, he suggested a different model to test for Wagner's Law.

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

where L(G/P) is the log of per capita real government expenditure and L(Y/P) is the log of real GDP per capita.The Gupta version of Wagner's Law follows Musgrave's version in that it uses income per capita as as the indicator for economic welfare. The difference lies in the government expenditure side. Eq(4) states that it is not government's share of the economy that has to change but the government's expenditure per capita. If one accepts that income per capita is a sufficient indicator for economic wealth then the per capita government expenditure has to increase. But eq(4) only follows the rationale of Wagner's Law if the left-hand side of eq(4) is interpreted as the share of expenditure that the "average" person receives from the state. However, as the average income is calculated using all incomes in an economy, the right hand side of eq(4) does not exclude high income earners. As a result, if average income increases due to higher incomes of the high income earners, then this would imply a higher demand for government service. Question is why high income earners would demand more government support? Therefore eq(4) does not distinguish between those income classes which actually demand more government services and those which do not.

Again, this was not really in the spirit of Wagner given the 1848 revolutionary attempt. Regardless, Henrekson (1993) deployed Gupta version and investigated Wagner's law for Sweden for the period of 1861-1990 and concluded that "in a test of Swedish data we cannot find any long-run positive relationship between the two variables and we judge it to be probable that this finding carries over to other countries as well" (Henrekson, 1993, pp. 413). He implied that studies such as Mann (1980), Ganti and Kolluri (1979), Abizadeh and Gray (1985), Wagner and Weber (1977) and Ram (1987) which found strong empirical support to Wagner's "law", suffer from various methodological shortcoming and consequently, and their results are questionable.

Al-Faris (2002) used a dynamic model to investigate the nature of the relationship between public spending and economic growth for the Gulf Cooperation Council (GCC) countries (Saudi Arabia, the United Arab Emirates (UAE), Kuwait, Oman, Bahrain, and Qatar) by using annual data for the period 1970-1997. He applied Unit root tests test, Johansen procedure and Granger causality test. He did not find any supporting evidence of Keynesian hypothesis or Wagner's law. He found that national income is a predictive factor of the growing role of government, as suggested by Wagner. Finally, his empirical investigations do not support the hypothesis of public spending causing national income as proposed by the Keynesian theory.

Ansari et al. (1997) tested three African countries (Ghana, Kenya and South Africa) and found that the hypothesis of public expenditure causing national income is not supported. They used time-series data for Ghana (1963- 88), Kenya (1964- 89) and South Africa (1957-90), and provide empirical evidence on causality results achieved by Granger (1969) and Holmes and Hutton (1990) testing procedures.

Finally, Nomura (1995) examined the displacement effect for the two oil crises in Japan, and then tested the validity of Wagner's "law" during the period 1960-1991(time-series data). He employed simultaneous estimation of multiple structural changes in the switching regression model and his results were mixed as the law was supported only for some periods.

5. **Goffman version**

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

where LG is the log of real government expenditures and LY/P is the log of per capita income. Eq(5) is very close to eq(1). The only difference is that it uses per capita income instead of total income. Therefore, what has been said with regards to the Peacock-Wiseman version is valid for the Goffman version as well.

Dritsakis and Adamopoulos (2004) applied the Goffman version and examined the tendency of the Greek public sector as well as the existing correlation between the extent of government spending and economic growth, during the period of 1960-2001. They made an attempt to establish causal relationships between spending and economic development through the use of Wagner's theory, by implementing cointegration approaches and Granger causality test. 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.

Biswal et al. (1999) made an attempt to test Wagner's and Keynesian hypothesis by examining the relationship between national income and total government spending in Canada during the period 1950-1995. They used the Engle and Granger (1987) two-step cointegration, error correction procedures and Granger (1969) causality procedures. They stated that "The results of this study support both the hypotheses when tested with broader aggregate expenditure data, i.e. total government current expenditure (CE) and total current expenditures on goods and services (CEGS). Although the results of this study do not support the existence of any long-run relationship between GDP and the disaggregated public expenditure variables, they do support the existence of short-run causation implying that national income may be causing or caused by a component of the total government current expenditure in the short run" (Biswal, Dhawan & Lee, 1999, pp. 1283). Thus, they found support of both hypotheses.

Many other economists used this version of Wagner's law. For instance, Wagner and Weber (1977) tested 34 countries and found no support of the law, Nagarajan and Spears (1990) examined the case of Mexico and found support, Lin (1995) also tested the case of Mexico and found supportive evidence.

6. Pryor version

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

where LGC is the log of real government consumption expenditure and LY is the log of real GDP. The Pryor version of Wagner's Law distinguishes between overall government expenditure and consumption expenditure. Therefore consumption expenditure is a closer indicator to welfare expenditure than overall expenditure. But depending on the definition of consumption expenditure, this indicator may include still more than just welfare expenditure. Having said that, one reason why Pryor may have chosen consumption expenditure may be that data for welfare expenditure may not have been available. Pryor examined both developed and under-developed countries in order to show that both of them do not support the Wagner hypothesis. Several other studies used this formulation. Abizadeh and Yousefi (1988) tested the USA and found support.

Hondroyiannis and Papapetrou (1995) tested the validity of the "law" for Greece for the period 1951-1992. They used the MLM (Maximum Likelihood Method), the real total government expenditure as a dependent variable, while as independent he sets the following variables: real consumption expenditure real GDP, ratio of real GDP to population, ratio of real government expenditure to GDP, ratio of real government expenditure to population. They found that there is no supporting evidence of the law during the tested period.

7. Time Series Based Results

Iyare and Lorde (2004) used six versions of the "law" and found strong support for nine Caribbean countries using aggregate annual time-series data. Firstly, they tested the stationarity properties of the data and the order of integration. Secondly, they used the two step Engle and Granger (1987) cointegration and error correction procedures and the Granger (1969) causality procedure are utilized in an attempt to uncover if a long run equilibrium relationship exists between income and government expenditure, and if not, whether there is short-run causal relationship between the two variables.

There is a strand in literature examined the validity of Wagner's and Keynesian hypothesis jointly (e.g. 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. His results indicate support of Wagner's Law and Keynesian hypothesis. Hence, 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.

More specific to the U.K. Gyles (1991), Georgakopoulos et al. (1992), Oxley (1994), Thorton (1999), Chow et al. (2002), Chang (2002), Chang et al. (2004), Loizides and Vamvoukas (2005) and Yuk (2005) supported the validity of Wagner's law in U.K apart from Yuk (2005). Yuk (2005) found mixed evidence across different periods (only in between 1830 and 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.

Loizides and Vamvoukas (2005) analysed 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).

After World War II may countries extended or built the welfare state. This was independent from their experienced industrialisation, urbanisation and increased demand for public services, which happened 50-60 years before the end of World War II. Thus, one might expect the relationship between income and government spending to be weaker so that Wagner's Law would not hold. Yet, quite a few studies analysed developed countries, such as the U.K (e.g. Gyles 1991, Chow et al. 2002, Islam 2001), and found evidence in support of Wagner's Law for the period after World War II.

According to Verbeek (2000) any model that includes government spending or any measure in levels of government spending on the left hand side of the equation, could suffer from endogenous regressor problems. A solution to this problem could be the introduction of lagged variables as instrumental variable in the two stage least square model (Greene, 2003, pp. 74).

Lately, however, many reserachers have investigated the relationship between public spending and national income during business cycles. In advanced economies, government expenditure has been found to be countercyclical (Alesina et al. 2008) or procyclical or unrelated to business cycles (Talvi and Végh 2005). A small number of studies examined for asymmetries in accordance with the displacement and ratchet effect, concluded that expenditures increases more during expansions than it decreases during contractions (Gavin and Perotti 1997; Hercowitz and Strawczynski 2004). Hercowitz and Strawczynski (2004), deployed a panel of advanced countries and found support for the Buchanan-Wagner hypothesis. Nevertheless, they highlighted that asymmetries only have a short-term effect on public spending.

3 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 years 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

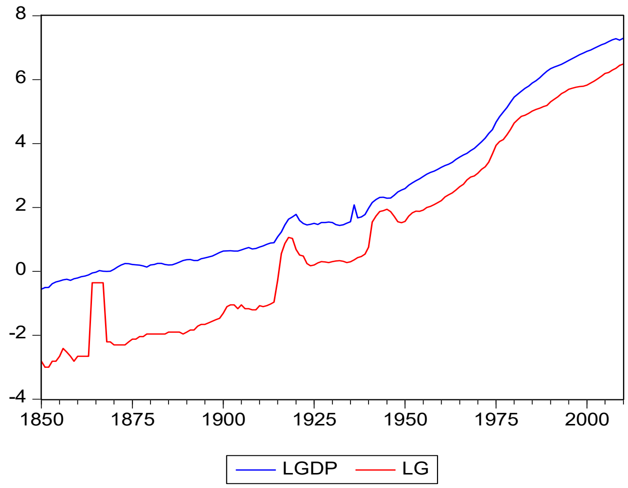
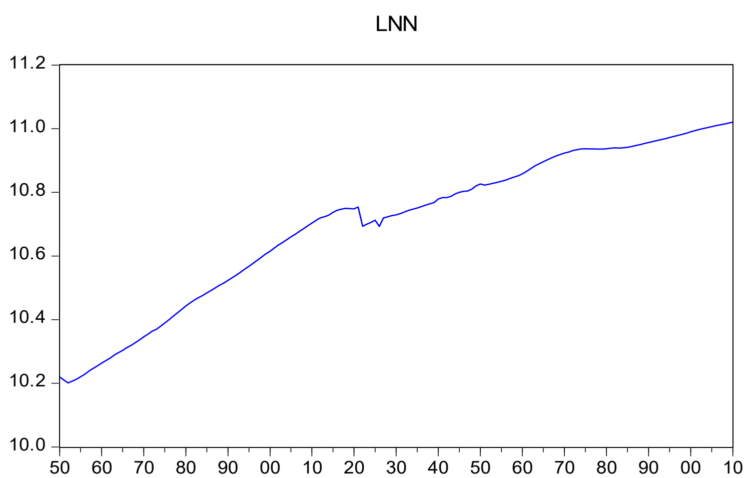


Figure 2: LNN in U.K. during 1850-2010



4 Empirical Results

Unit root tests

We apply the Augmented Dickey Fuller (1969) 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

Note: * indicate rejection of the null hypothesis at the 5% level of significance. .** parentheses in ADF indicate the lag length based on SIC.***Parentheses in PP indicate the Bandwith, Newey-West using Barlett kernel

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

Note: * indicate rejection of the null hypothesis at the 5% level of significance. .** parentheses in ADF indicate the lag length based on SIC.***Parentheses in PP indicate the Bandwith, Newey-West using Barlett kernel

Engle and Granger test

One 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 3) in all the tested versions and we obtain the following income elasticities:

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

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

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 3: 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 4: 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.

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[1], 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[2] (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 out 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 Johansen (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 5: 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			

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[3] and found that our variables are co-integrated (Table 6, 7, 8, 9 and 10).

Table 6: 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. **MacKinnon-Haug-Michelis (1999) p-values.

Table 7: 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. **MacKinnon-Haug-Michelis (1999) p-values.

Table 8: 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. **MacKinnon-Haug-Michelis (1999) p-values.

Table 9: 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
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. **MacKinnon-Haug-Michelis (1999) p-values.

Table 10: 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. **MacKinnon-Haug-Michelis (1999) p-values.

Moreover, we calculate the income elasticities (Table 11) 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 11: 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

Error Correction Model

The error correction model aims to establish the short-term dynamics of a price relationship by calculating the time it takes for a price trend to return to the steady state after a shock (Wooldridge, 2013). The speed of adjustment is calculated as the error correction term (ECT), and must be negative and statistically significant in order to ensure that the cointegration is valid.

Since we have found evidence of a long-run relationship, we then estimate the error correction model (ECM), which incorporates variables both in their levels and first difference and captures the short-run disequilibrium situations as well as the long-run equilibrium adjustments between the variables.

The short-run dynamics of the error correction model (ECM) is presented in Table 12. The results show that the estimated error correction term is significant at 1 percent level for all five examined versions of the Wagner's law and carries a significant negative sign, indicating that in the UK. The government spending and gross GDP are cointegrated. It also shows that 17% of the deviation of the real GDP from its long-run equilibrium level is corrected each year in Peacock version, while other Goffman, Gupta, Musgrave and Mann versions indicate 10%, 15%, 18% and 18%, respectively.

Table 12 : Error Correction Model

Version	Intercept	Short-run income elasticity	ECM term

Peacock version	**1.65***	**-1.10***	**-0.17***
	(0.00)	**(0.00)**	**(0.00)**
Goffman version	**-10.43***	**-1.13***	**-0.10***
	(0.00)	**(0.00)**	
Gupta version	**0.61***	**-1.09***	**-0.15***
	(0.00)	**(0.00)**	**(0.00)**
Musgrave version	**0.61***	**-0.09***	**-0.18***
	(0.00)	**(0.00)**	**(0.00)**
Mann version	**1.65***	**-0.10***	**-0.18***
	(0.00)	**(0.00)**	**(0.00)**

Note: * indicate 5% level of significance, while figures in parentheses represent the P value of the respective coefficient on the estimated regression.

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 examines 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 13.

Table 13: 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

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

5 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.

During the global financial crisis and the EMU financial crisis interest in government debt and government spending increased. Initially the discussion focussed on Austerity and its impact on economic growth. More recently, especially for the U.K., the argument focusses on neglected public services which are not in line with people's expectations anymore (due to Austerity). This example highlights how the Keynesian argument is intertwined with Wagner's hypothesis. Accordingly, in this paper we test both hypotheses simultaneously.

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 Wagner's 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), or tested the validity of the law for a long period(e.g. Oxley 1994, Thorton 1999, Richter and Paparas 2013).

These results are by no means surprising. After all, all tests include a measure of GDP and government expenditure. As government expenditure is part of the GDP, we are actually estimating a sort of identity making it difficult to identify any causal relationship. Therefore, it is necessary to re-think the concept of using government expenditure. We suggest to include for future research welfare expenditure by the government. Although, it is true that welfare expenditure as part of government expenditure is also included in the overall GDP calculation, it does not necessarily move in line with GDP. For example, welfare expenditure could well fall or remain constant if GDP increases. The question is whether those data are available which therefore constitutes a new research project.

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