Testing Wagners's Law at Different Stages of Economic Development
A Historical Analysis of Five Western European Countries

Jan Kuckuck

Working Paper 91
August 2012

INSTITUTE OF EMPIRICAL ECONOMIC RESEARCH
Osnabrueck University
Rolandstrasse 8
49069 Osnabrück
Germany

Testing Wagner's Law at Different Stages of Economic Development - A Historical Analysis of Five Western European Countries

Jan Kuckuck*

August 2012

Abstract: Using historical data, we test the validity of Wagner's law of increasing state activity at different stages of economic development for five industrialized European countries: the United Kingdom, Denmark, Sweden, Finland and Italy. In order to investigate the coherence between Wagner's law and development stage, we classify every country into three individual stages of income development and apply advanced cointegration and vector error correction analyses. In line with Wagner's hypothesis, our findings show that the relationship between public spending and economic growth has weakened with an advanced stage of development. All countries support the notion that Wagner's law in its pure form may have reached its limit in recent decades.

Keywords: Wagner's law; government expenditure; economic development, cointegration, structural breaks, VECM.

JEL: E62, H5, N43, N44

*University of Osnabrueck, Department of Economics, D-49069 Osnabrueck, Germany, e-mail: jan.kuckuck@uni-osnabrueck.de.

1 Introduction

In order to shed light on the coherence between Wagner's law and development stage, we study five European advanced welfare states United Kingdom, Denmark, Sweden, Finland and Italy which can be regarded from an income perspective as equally developed in present days. By using historical data on government expenditure and GDP from the mid-19th century, we classify every country into three individual stages of development following the World Bank's income definitions. This feature allows us to analyze and compare the dynamics of Wagner's law at different stages of economic development from a within-country perspective and additionally enables us to identify commonalities across countries despite differences in size, development pattern as well as individual economic and social characteristics.

In the literature, the size of the public sector with respect to a country's economic development has received much attention. The expansion of the public sector with an ongoing economic development has become a widely accepted stylized fact.[1] In this context, Wagner's law of increasing state activity has received much attention, postulating a positive correlation between economic growth and government activity in the long-run. Wagner explains this nexus with an ongoing 'cultural and economic progress' (Wagner (1893): 908) which substitutes private economic activity for state activity. In general, the empirical assessment of Wagner's law has focused on the relationship between government spending and national income in both cross-sectional (e.g. Akitoby, Clements, Gupta et al. (2006)) and time series manner (e.g. Babatunde (2011), Iniguez-Montiel (2010)). Following a recent review by Durevall and Henrekson (2011), around 65 % of the studies find direct or indirect evidence in favor for Wagner's notions while 35 % provide no support.

According to the spirit of Wagner's law, an expanding government accompanies social progress and rising incomes. This relationship weakens with an advanced stage of development because the requirement of basic public infrastructural expenditure declines in the process of economic development. Thus, a country's development stage is a crucial consideration for

[1] A vast variety of theoretical and empirical contributions provide different determinants to explain this linkage. These explanatory variables embrace various aspects like trade openness (Rodrik (1998)), country size (Alesina and Wacziarg (1998)), population density (Dao (1995)), business cycle volatility (Andres, Domenech and Fatas (2008)), demographic factors (Annett (2001), Alesina, Baqir and Easterly (1999)), income inequality (Mattos and Rocha (2008)), electoral systems (Milesi-Ferretti, Perotti and Rostagno (2002)), periods of major social disturbances (Peacock and Wiseman (1961)) and unbalanced sectoral growth (Baumol (1967)).

the validity of Wagner's law. The vast majority of studies focus either on emerging or industrialized countries in order to issue a statement about the coherence between development level and Wagner's law (e.g. Chang (2002)). However, the interpretation results in certain difficulties because the ex-post comparability between less and high developed countries from a within-country perspective is limited. In addition, many of the low and middle income countries under review do not satisfy the requirements of Wagner's definition of a 'culture and welfare state'.[2]

To test the hypothesis of a long-run relationship between income and government spending which is in line with Wagner's interpretation that there is not necessarily a cause and effect relationship between the variables, we employ cointegration analysis suggested by Johansen (1988) and Johansen and Juselius (1990). To hedge against structural breaks in the data series, we additionally exercise the Johansen, Mosconi and Nielsen (2000) cointegration procedure allowing for a maximum of two structural breaks which are endogenously detected by the Bai and Perron (1998) breakpoint test. To subsequently issue a statement about the long-run causal relationship and the adjustment speed of public spending to changes in economic growth, we estimate vector error correction models (VECM) and compare the results throughout countries and development stages.

Our findings exhibit that a long-run equilibrium between public spending and economic growth in the United Kingdom, Sweden, Finland and Italy exists independent of development stage or functional form. Nevertheless, in the case of Denmark, a cointegration relationship was only detected in the second and third development stage. In general, this finding is consistent with Wagner's notion that public expenditures rise with ongoing 'cultural and economic progress' without determining a cause and effect relation between the variables. The subsequent causality results evince that the adjustment speed of expenditure to changes in GDP declines over time. The hypothesis that Wagner's law might have a higher validity during early stages of development turns out to be viable for the United Kingdom, Denmark, Sweden and Finland. In general, the results support the notion that Wagner's law in its pure form may have reached its limit in recent decades.

The paper is organized as follows: Section 2 describes Wagner's law and classifies each country

[2] Wagner postulates the development tendency of the public sector for modern 'constitutional and welfare states' (Wagner (1911): 734). It remains a matter of doubt if developing countries fulfill these characteristics. Studies from Kuznets (1958) and Morris and Adelman (1989) show that there are significant differences between modern states around the 19^{th} century and recent developing countries.

into three individual stages of development. The subsequent Section 3 presents the analytic framework and empirical methodology while the results are displayed in Section 4. Section 5 deals with robustness checks and provides some alternative sample estimations. Section 6 concludes.

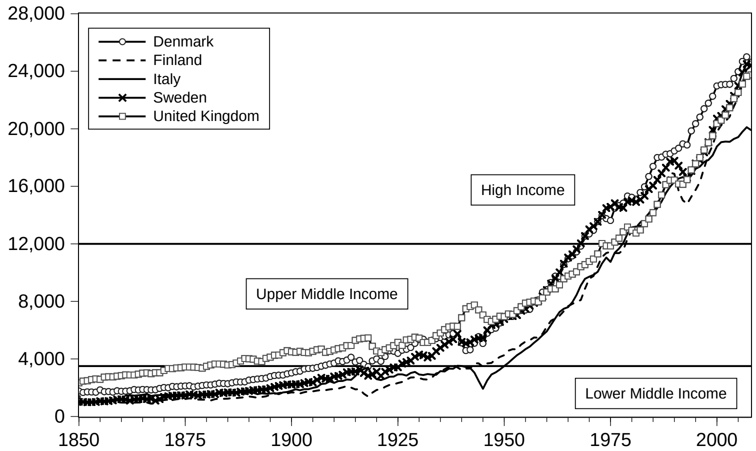
2 Wagner's Law and Economic Development in the 20^{th} Century

In general, Wagner's formulations constitute three reason for the direct linkage between economic growth and government activity: i) changes in the structure of the economy associated with new social activities of the state, ii) increasing administrative and protective functions substituting private for public actions and iii) increasing control of externalities and welfare aspects. As mentioned by Timm (1961), Wagner's hypothesis was conceived as applicable to countries throughout the 19th century, beginning with the industrial revolution. Although Wagner suggests that his law would be operative as long there exists 'cultural and economic progress', Wagner's substantiations assume that the changing role of governments is contingent on the development stage of the economy; that the public expenditures of well-established welfare states should not react to changes in income in the same manner as in emerging states which have just started to respond to the challenges induced by increasing prosperity. This implies, that according to Wagner's hypothesis the direct linkage between increasing state activity and economic growth might have a higher validity during early stages of development than at a later stage.[3]

In order to shed light on the coherence between Wagner's law and development stage, we analyze five advanced Western European countries which can be regarded from an income perspective as equally developed in present days. Figure 1 shows that the GDP per capita in 2008 for the United Kingdom, Denmark, Sweden and Finland range around 23.742 to 24.621 Geary-Khamis dollars. Only Italy's per capita income exhibits a slightly lower but still comparable value of 19.909 Int$. Nevertheless, regarding the development process over the last 150 years, all countries reveal individual patterns especially during the late 19th century. In 1850, the United Kingdom, mother country of industrial revolution, states a per capita

[3] A recent study by Lamartina and Zaghini (2011) embracing 23 OECD countries supports this view. The authors find that the correlation between government activity and economic growth is higher in countries with lower per-capita GDP, suggesting that the catching-up period is characterized by a stronger development of government activity with respect to economies in a more advanced state.

Figure 1: *Development of GDP per capita in 1990 International Geary-Khamis dollars*



Source: Groningen Growth & Development Centre, June 2012.

Note: The graph displays the development of gross domestic product per capita from 1850 to 2008 (measured in 1990 International Geary-Khamis dollars). The horizontal lines divide the data set into three stages of economic development: Lower middle income (less than 3.500 Int$), upper middle income (3.500 - 12.000 Int$) and high income (more than 12.000 Int$).

income of 2.230 Int$, which is more than twice as high as in Finland (911 Int$) and Sweden (1.019 Int$).

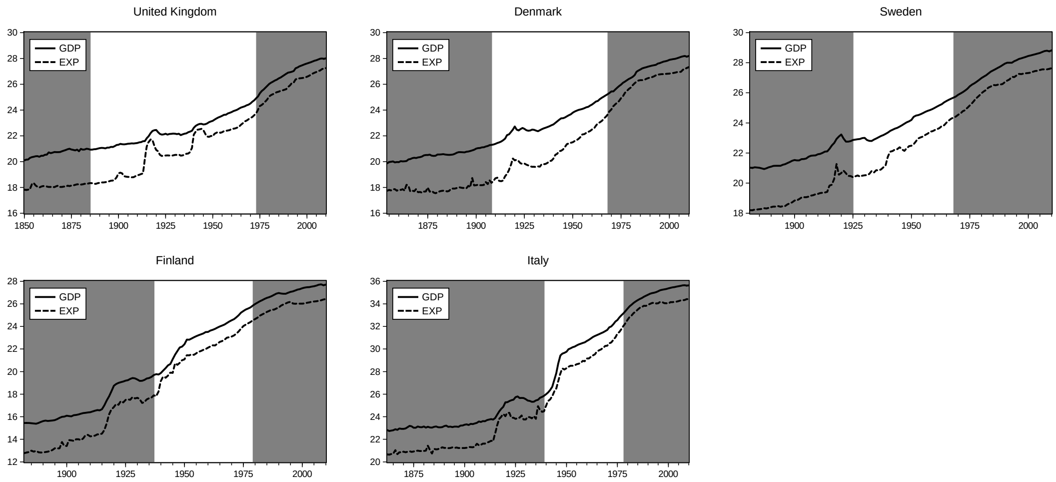
In order to provide comparable development stages throughout the countries, we define three development stages based on the World Bank's income group definitions. The first stage is defined as a 'lower middle income stage' covering GDP per-capita with less than 3.500 Int$. Figure 1 depicts that the United Kingdom is the first country which hits this threshold in 1885 followed by Denmark in 1908, Sweden in 1925, Finland in 1937 and Italy in 1939.[4] The second development stage is classified as an 'upper middle income stage' embracing per capita GDP between 3.500 and 12.000 Int$. Compared to the first stage, it can be seen that during this stage the per capita income of all countries converged. Denmark and Sweden reach the upper mark in 1968, followed by the United Kingdom in 1972, Italy in 1977 and Finland in 1978. The third development stage is defined as a 'high income stage' comprising a GDP per capita income above 12.000 Int$.[5]

[4]It can be argued that Italy's per capita income already reaches the 3.500 Int$ mark in 1918. However, the post-World War I periods caused long-term stagnating income growth. Hence, the 3.500 Int$ boundary was technically first reached in 1939. Nevertheless, this has no effect on the subsequent results.

[5]Our classifications slightly differ from the World Bank income definitions of 2010 in order to provide sufficiently large sample sizes in every development stage.

Figure 2 gives a broad historical overview about the development of gross domestic product

Figure 2: *Development of GDP and central government expenditure*



Source: 1850 to 1995 from Mitchell (2007); 1996 to 2010 from Eurostat, May 2012.

Note: The graph displays the logs of gross domestic product (GDP) and central government expenditure (EXP) for the United Kingdom, Denmark, Sweden, Finland and Italy. The shaded areas highlight the development stages: lower middle income (less than 3.500 Int$ per capita income), upper middle income (between 3.500 and 12.000 Int$ per capita income) and high income (above 12.000 Int$ per capita income).

and central government spending throughout these different income stages. Not surprisingly, all variables have increased considerably over the whole sample period, however, the amount of increase and the stability of the growth pattern differs clearly between the stages and countries. Additionally, it should be noted that the relationship between government expenditure and economic development has changed between the various subsamples. While during the first income stage, government spending and GDP rose almost equally, the second stage pictures a catching-up process of expenditure towards GDP especially evident in Denmark and Sweden. In the last stage of development, however, it appears as if GDP and expenditure drift slightly apart. Furthermore the spread between nominal GDP and nominal expenditure has narrowed over time. In this regard, periods of major social disturbances (e.g. World War I and II) seem to raise expenditures in relation to GDP to a higher level, which is in line with the displacement effect (see Peacock and Wiseman (1961)).

The dynamics of government spending and GDP are indeed remarkable over the last century. Figure 2 indicates the existing but also changing relationship between government expenditure and economic development throughout the history. Nevertheless, empirical studies focusing on Wagner's law in a historical context are scarce. In general, the few studies available confirm the validity of Wagner's law in early stages of development (Thornton (1999), Oxley (1994)). For the United Kingdom and Sweden, Durevall and Henrekson (2011) detect a cointegration relationship between GDP and public spending some 40 to 50 years preceding World War I and a period of 30 to 35 years after World War II. In more recent times, this relationship only holds if they control for the age structure.

3 Analytic Framework, Data and Empirical Methodology

Analytic framework and data

In order to quantify the validity of Wager's law, we concentrate on three - in the literature widespread - functional forms of Wagner's hypothesis which are summarized in table 1.

Table 1: *Functional forms of testing Wagner's hypothesis*

Version	**Functional form**	**Source**
1	$ln(exp) = \alpha + \beta * ln(gdp) + z_t$	Peacock and Wiseman (1961)
2	$ln(exp) = \alpha + \beta * ln(gdppc) + z_t$	Goffman (1968)
3	$ln(exppc) = \alpha + \beta * ln(gdppc) + z_t$	Gupta (1967)

Note: *exp* denotes central government expenditure, *gdp* corresponds to gross domestic product, *gdppc* signifies gross domestic product per capita and *exppc* defines central government expenditure per capita.

In an early, classic version, Peacock and Wiseman (1961) model the log of government expenditure in terms of the log of output. Goffman (1968) adopts this version and includes per capita variables in order to control for the development process of the state. Accordingly, Goffman (1968) quantifies government expenditure as a function of per capita output. A related version correcting for the population development can be found by Gupta (1967), who describes the log of per capita government expenditure as a function of the log of per capita output. In general, the literature deals with some additional naive functional forms of Wagner's law (see for example the seminal studies by Mann (1980) as well as Abizadeh and Yousefi (1988)). However, in order to provide a clearly arranged analysis, we confine ourselves to the three well-established versions mentioned above.

In order to investigate the relationship and causality between these pairs of variables throughout different periods of economic development, we use historical data from Mitchell (2007) who provides data on nominal GNP/GDP and nominal central government expenditure from 1850 to 1995 for the five western European countries Denmark, Finland, Italy, Sweden and the United Kingdom.[6] To capture recent behaviour of government expenditure and economic development, we interpolated the time series by using data from Eurostat for the periods 1996 to 2010. Data on the total population are taken from the Groningen Growth & Development Centre.[7]

Testing for a long-run relationship

To analyze the existence of a long-run equilibrium relationship among government expenditure and GDP, we initially apply the VAR-based cointegration procedure developed by Johansen (1988) and Johansen and Juselius (1990). The approach of testing for a cointegration vector relies on a first-difference VAR of order p:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + C x_t + \epsilon_t \tag{1}$$

where y_t represents a vector of non-stationary I(1) variables containing GDP and expenditure in version 1, expenditure and GDP per capita in version 2 and expenditure per capita and GDP per capita in version 3. The vector X_t contains deterministic variables and ϵ_t normally distributed random error terms.

The cointegration results are very sensitive to the deterministic trend assumption and the choice of the order p in equation (1). According to the data of expenditure and GDP available, it can be seen that the time series follow a linear trend in the log level data. Therefore, as suggested by Franses (2001), our test specification allows for a linear trend in the level data and a constant in the cointegration space ($H_1(r) = \Pi y_{t-1} + B x_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$). To additionally include a case where an individual series might be trend-stationary,

[6] Wagner's original definition of government includes local government units as well as public enterprises. However, as mentioned by Timm (1961), Wagner's law was meant to be valid for every public sub-sector. Despite the decentralization process of government activities, the central government is still the most important sub-sector in terms of expenditure for services of defense, law and order, welfare and general structural changes. Therefore, from an historical perspective the expansion of the central government probably reflects best the traditional government services, which is in line with Wager's hypothesis.

[7] Historical data is always exposed to criticism concerning data quality. Nevertheless, historical data provided by Mitchell has been used in a number of earlier studies (e.g., Easterly (2007), Eloranta (2007), Gollin, Parente and Rogerson (2004), Thornton (1999), Rousseau and Wachtel (1998)).

we also apply the Johansen test specification allowing for a constant and a trend in the cointegration space ($H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$).[8] The optimal lag length in the test specifications were chosen by the Schwarz information criterion. To obviate spurious cointegration, the lag length of the VAR was successively enhanced to remove all serial correlation from the data considering a maximum of 5 lags in each sample.

To test for the number of cointegration vectors Johansen (1988) and Johansen and Juselius (1990) propose two maximum likelihood test statistics (L_{Eigen} and L_{Trace}): the bivariate case of L_{Eigen}, where the null hypothesis of r cointegrating vectors is tested against the alternative of $r + 1$ cointegrating vectors and the bivariate case of L_{Trace}, where the null hypothesis is tested in a way that there are at most r cointegration vectors in the system against its general alternative. The test statistics measuring the reduced rank of the π matrix are computed by

$$L_{Eigen} = -T \cdot ln(1 - \hat{\lambda}_{r+1}) \qquad \text{and} \qquad L_{Trace} = -T \sum_{i=r+1}^{p-2} ln(1 - \hat{\lambda}_i)$$

where T is the sample size and $\hat{\lambda}_{r+1}$,..., $\hat{\lambda}_n$ are the smallest characteristic roots.[9]

Testing for a long-run relationship considering structural breaks

The characteristics of historical time series covering data of major social disturbances (World War I and II, Great Depression etc.) make the conventional cointegration procedure particularly vulnerable to a non-rejection of the no cointegration hypothesis, although the true data generation process of the variables share a common stochastic trend. In order to account for possible structural breaks and regime shifts in the cointegration analysis, we enhance the basic Johansen testing procedure allowing for multiple structural breaks at unknown time.

According to Johansen et al. (2000) the first-difference VAR can be rewritten as q equations assuming that the data contains $q - 1$ breaks. By introducing dummy variables equation (1)

[8] As outlined by Franses (2001), this specification seems to be the most important case for practical purposes.

[9] Lütkepohl, Saikkonen and Trenkler (2001) found that the local power of corresponding maximum eigenvalue and trace tests is very similar. In small samples, however, the trace test tends to have superior power. Yet, the authors recommend applying both tests simultaneously in empirical works.

can be rearranged as follows:

$$\Delta y_t = \alpha \begin{pmatrix} \beta \\ \gamma \end{pmatrix}' \begin{pmatrix} y_{t-1} \\ t \cdot E_t \end{pmatrix} + \mu \cdot E_t + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \sum_{i=0}^{k-1} \sum_{j=2}^{q} \Theta_{j,i} D_{j,t-i} + \epsilon_t \tag{2}$$

with $j = 1, ..., q$ and the defined matrices $E_t = (E_{1,t}, ...E_{q,t})'$, $\mu = (\mu_1, ...\mu_q)$ and $\gamma = (\gamma_1', ..., \gamma_q')'$ of dimension (q $\times$ 1), (p $\times$ q), (q $\times$ r), respectively. The $q - 1$ intervention dummies are defined as $D_{j,t} = 1$ given the notation $t = T_{j-1}$ for all $j = 2, ..., q$. $D_{j,t-i}$ is an indicator function for the i-th observation in the j-th period. Furthermore, the effective sample of the j-th period is defined as $E_{j,t} = \sum_{i=k+1}^{T_j - T_{j-1}} D_{j,t} = 1$ for $T_{j-1} + k + 1 \leq t \leq T_j$ with k determining the order of the vector autoregressive model.[10]

The likelihood ratio test statistics remain unchanged while the computation of the critical values depend on the number of non-stationary relations and the location of the break points (see Johansen et al. (2000)). As with the basic cointegration procedure, we again assume that some or all of the time series follow a trending pattern in levels. Under this condition, we consider two different models of structural breaks: 1) breaks in level only, which are restricted to the error correction term and 2) breaks in level and trend jointly (regime shift) while the trend shifts are restricted to the error correction term and the level shifts are unrestricted in the model.

In order to locate possible structural breaks, we apply the multiple structural breakpoint test developed by Bai and Perron (1998). The intuition behind this testing procedure is an algorithm that searches all possible sets of breaks and calculates a goodness-of-fit measure for each number. By implementing a sequential SupF testing procedure, the null of l breaks is tested against the alternative of $l + 1$ breaks. The number of break dates selected is the number associated with the overall minimum error sum of squares.[11] The model specification to test for parameter instability in the various variables of expenditure and GDP follows an AR(p) process including a constant. In order to guarantee sufficiently large subsamples, the trimming parameter was set to 0.3 allowing for a maximum of two possible breaks in each analyzed sample.

[10] A detailed theoretical as well as practical application of the Johansen et al. (2000) procedure is provided by Joyeux (2007).

[11] For a detailed and formal presentation of the Bai-Perron framework see Bai and Perron (1998) and Bai and Perron (2003).

A VECM approach to test for long-run causality

The model used to test for long-run causality in each subsample is expressed as a restricted VAR in terms of an error correction model:

$$\Delta ln(g)_t = c_{1t} + \sum_{i=1}^{p} \varphi_{1i} \Delta ln(g)_{t-i} + \sum_{i=1}^{p} \vartheta_{1i} \Delta ln(y)_{t-i} + \gamma_1 [ln(g)_{t-1} - \beta_1 \cdot ln(y)_{t-1} + \alpha_1] + \epsilon_{1t} \quad (3)$$

$$\Delta ln(y)_t = c_{2t} + \sum_{i=1}^{p} \varphi_{2i} \Delta ln(g)_{t-i} + \sum_{i=1}^{p} \vartheta_{2i} \Delta ln(y)_{t-i} + \gamma_2 [ln(y)_{t-1} - \beta_2 \cdot ln(g)_{t-1} + \alpha_2] + \epsilon_{2t} \quad (4)$$

where g and y are defined according to the analytic framework as before. Because of the cointegration relationship, at least one of the variables has to significantly adjust to deviations from the long-run equilibrium which is captured by γ_i. The parameter describes the speed of adjustment back to the equilibrium and measures the proportion of last period's equilibrium error that is corrected for. Thus, in equation (3) and (4), the VECM allows for the ascertainment that g granger-causes y or vice-versa as long as the corresponding error correction term γ_i carries a statistically significant coefficient, even if all other coefficients are not jointly significant (see Granger (1988)). The verification of the law is given if significant causality is running from economic growth to government activity. The magnitude of the adjustment parameter γ_i contains information about the capacity of countries to absorb exogenous shocks in different development stages and holds information about the reaction of expenditure to changes in GDP.[12]

As the causality tests are known to be very sensitive to the lag length, in a first step, the amount of the regressors included in the VECM are determined by using Schwartz information criteria. Then subsequently, to remove autocorrelation, we expand the order of the VECM until the Ljung-Box test statistics are insignificant at all lags. Because the time series cover different historical epochs and are split into different samples, the data exhibits individual clustered episodes of relatively high variance. In order to account for cross-equation heteroskedasticity, we employ weighted least squares to sustain consistent and asymptotically

[12] As mentioned by Granger (1969), VAR-based models are only valid to test for causality if instantaneous causality can be excluded theoretically. Wagner's law infers that government expenditure reacts to a change of income in the long-run driven by a changing demand for public goods as a result of increasing prosperity. Thus, it can be assumed that a response of government spending to changes in national income does not appear in the same period, but is delayed by some periods.

efficient estimates.[13]

4 Estimation Results

Long-run equilibrium

Because the Johansen cointegration procedure requires the use of difference stationary variables, we start our empirical analysis by testing the unit-root properties applying the Philipps-Perron test (PP) for which the null hypothesis is non-stationarity and the Kwiatkowski-Phililips-Schmidt-Shin Test (KPSS) for which the null is stationarity in levels and first differences of the logarithmized variables. The lag length for the PP and for the KPSS test is selected based on Newey-West bandwidth using Bartlett Kernel. In general, the test-statistics indicate that all data series in the full sample as well as in the first and second development stage can be treated as integrated of order one. Only expenditure per capita (exppc) in Denmark during the first development stage seems to be stationary in levels. Furthermore, as a consequence of the log transformation, the unit-root tests in the third stage of development depict only level stationary data. Therefore, in order to test for the cointegration relationship in the latest subsample, we use non transformed level data of all variables. In this case, the data is also integrated of order one. Details about the test specifications and results can be found in table A-1 in Appendix A.
Once the unit-root properties of all variables have been ascertained, the question arises of whether there exists a long-run equilibrium relationship between the variables in different stages of development. Table 2 displays a general overview of all pairs of variables in different subsamples where at least one test statistic rejected the null of no cointegration at least at a 10 percent level.[14] The results are based on the Johansen cointegration as well as Johansen cointegration test with structural breaks. The subsequent detailed test statistics as well as determined break points are presented in table B-1, table B-2, table B-3, table B-4, table

[13]The equation weights are the inverses of the estimated equation variances, and are derived from unweighted estimation of the parameters of the system (see Cragg (1983)).

[14]A significant test statistic is based on the assumption that the null hypothesis is true. The Johansen testing procedure tests in the null hypothesis for a no cointegration relationship. Therefore, rejecting no cointegration provides stronger statistical evidence than not rejecting the no cointegration null hypothesis. A significant test statistic yields a stronger statement compared to an insignificant statistic.

B-5, table B-6, table B-7 as well as table B-8 in Appendix B. Since the estimated breakpoint dates of expenditure and GDP are in some cases very close to each other, the depicted test statistics only include the public expenditure breakpoints. Nevertheless, the results are robust considering the GDP breakpoints. In all other cases, the expenditure as well as GDP breakpoints are included.

Due to the integrity of the data in periods of major social disturbances (e.g. World War I and II, Great Depression, Oil crises) and the impact of country specific economic crisis (e.g. Finish and Swedish banking crisis), it is not surprising that during some stages, cointegration is only detected by allowing for structural breaks. As listed in table B-9, the majority of the detected structural breaks by the Bai-Perron procedure coincide with these major economic crises as predicted by Peacock and Wiseman's displacement hypothesis (Henry and Olekalns (2010)).

Table 2: *Cointegration relationships for different development stages*

Country	Variable	Full Sample	Stage I	Stage II	Stage III
United Kingdom	exp and gdp	C	C	C	C
	exp and gdppc	C	C	C	C
	exppc and gdppc	C	C	C	C
Denmark	exp and gdp	C	-	C	C
	exp and gdppc	C	-	C	C
	exppc and gdppc	C	-	C	C
Sweden	exp and gdp	C	C	C	C
	exp and gdppc	C	C	C	C
	exppc and gdppc	C	C	C	C
Finland	exp and gdp	C	C	C	C
	exp and gdppc	C	C	C	C
	exppc and gdppc	C	C	C	C
Italy	exp and gdp	C	C	C	C
	exp and gdppc	C	C	C	C
	exppc and gdppc	C	C	C	C

Note: C denotes that a cointegration vector exists between the set of variables. The cointegration results without structural breaks are based upon the trace and maximum eigenvalue tests derived by Johansen (1988) and Johansen and Juselius (1990). The cointegration results with structural breaks are based upon the trace test derived by Johansen et al. (2000).

The cointegration results reveal that public spending in the United Kingdom, Sweden, Finland and Italy is cointegrated with economic growth independent of development stage or functional form. These findings are in line with Wagner's hypothesis and confirm the statement that the public sector and economic growth display a co-movement phenomenon as long there is cultural and economic progress. This relationship is maintained throughout every stage of development and is still valid today. This constant relationship does not hold for Denmark. In this case, a cointegration relationship for all three versions of Wagner's law was only found in the second and third development stage but not in the first. This is a contradictory finding to the assumption that the relationship between the public sector and economic growth is particularly distinctive during the early stages of development.[15]

Long-run causality and adjustment speed

In order to test for long-run causality between the different variables and different country sets, we estimate for every detected cointegration pair a VECM and apply a one-sided t-test on the error correction term. A negative statistically significant adjustment parameter in the VECM with expenditure and expenditure per capita on the left-hand side implies validity of Wagner's hypothesis bespeaking GDP and GDP per capita respectively to be the driving force of government expenditure.[16] Table 3 presents the estimated error correction terms and the results of the one-sided t-test. According to the estimated VECMs and the corresponding error correction terms, at least one of the coefficients is - in every model - statistically significantly smaller than zero, which is a requirement for the various versions of Wagner's law to be cointegrated. Only Denmark does not exhibit a cointegration relationship in the first stage of development, so that a feasible error correction model could not be estimated.

Starting with the full sample results, it can be seen that only the United Kingdom and Denmark have statistically significant error correction terms in the first and third version which are in line with Wagner's law. However, in both countries, the convergence speed of government spending is relatively slow denoting around 11 periods in Denmark and 19 periods in the United Kingdom until half of the disequilibrium is removed. Thus, Wagner's hypothesis that economic growth is a driving force for government expenditure can be rejected at least

[15]These results are in accordance with other empirical studies which investigate early stages of industrialization (see Thornton (1999) and Oxley (1994)). Durevall and Henrekson (2011) detect, for Sweden and the United Kingdom, a cointegration relationship between the public sector and economic growth, especially between 1860 and the mid-1970s. Comparable country specific studies on advanced industrialized countries in the post-Bretton Woods era are scarce and provide rather mixed results. While Kolluri, Panik and Wahab (2000) yield support of Wagner's law for Italy and the UK, Durevall and Henrekson (2011) and Chow, Cotsomitis and Kwan (2002) detect only long-run relationships controlling for age structure and money supply, respectively.

[16]In general most empirical studies only interpret unidirectional causality running from economic growth to public spending as a pure statistically confirmation of Wagner's law (see e.g. Magazzino (2012)). Yet, if there is a bi-directional causal relationship, then an increase in expenditure may influence GDP, where as an increase in GDP may induce public spending. Despite this feedback effect between the variables, Wagner's law is still valid as long as the expenditure adjustment coefficient is sufficiently large.

Table 3: *Long-run causality and short-run adjustment*

		Full Sample		Stage I		Stage II		Stage III	
Country	G and Y	$Y \to G$	$G \to Y$	$Y \to G$	$G \to Y$	$Y \to G$	$G \to Y$	$Y \to G$	$G \to Y$
UK	exp and gdp	-0.042*	-0.016*	-0.437***	0.022	-0.089**	-0.0152	0.055	-0.101***
		(-1.769)	(-1.629)	(-3.574)	(1.876)	(-2.350)	(-1.131)	(2.767)	(-4.789)
	exp and gdppc	-0.015	-0.017**	-0.339***	0.002	-0.057**	-0.021**	0.064	-0.115***
		(-0.823)	(-2.267)	(-2.875)	(2.336)	(-1.679)	(-1.926)	(2.774)	(-4.883)
	exppc and gdppc	-0.035*	-0.018*	-0.535***	-0.053**	-0.071**	-0.019**	0.051	-0.098***
		(-1.472)	(-1.948)	(-4.428)	(-2.176)	(-1.965)	(-1.678)	(2.839)	(-4.842)
Denmark	exp and gdp	-0.078***	-0.002	-	-	-0.358***	-0.059	-0.021***	-0.001
		(-2.560)	(-0.157)			(-2.977)	(-0.680)	(-3.655)	(-0.251)
	exp and gdppc	-0.048	-0.066***	-	-	-0.487***	-0.197**	-0.008***	-0.003
		(-1.174)	(-3.021)			(-3.547)	(-1.691)	(-3.666)	(-0.337)
	exppc and gdppc	-0.078**	-0.015	-	-	-0.381***	-0.115*	-0.017***	-0.001
		(-2.286)	(-0.865)			(-3.253)	(-1.307)	(-3.671)	(-0.179)
Sweden	exp and gdp	-0.034	-0.083***	-1.554***	0.338	-0.111*	-0.085***	-0.052	-0.188***
		(0.054)	(-3.681)	(-4.886)	(2.156)	(-1.508)	(-2.741)	(-0.694)	(-4.045)
	exp and gdppc	-0.006	-0.073***	-1.595***	0.164	-0.107*	-0.092***	-0.058	-0.209***
		(-0.121)	(-3.820)	(-3.054)	(0.608)	(-1.468)	(-2.687)	(-0.707)	(-4.219)
	exppc and gdppc	-0.027	-0.081***	-1.592***	0.364	-0.114*	-0.081***	-0.054	-0.191***
		(-0.524)	(-3.774)	(-3.388)	(1.667)	(-1.566)	(-2.577)	(-0.688)	(-4.079)
Finland	exp and gdp	-0.068	-0.090***	-0.349***	-0.153**	-0.194*	-0.228***	-0.089***	0.012
		(-1.101)	(-3.098)	(-2.639)	(-2.062)	(-1.365)	(-3.957)	(-3.110)	(3.316)
	exp and gdppc	-0.024	-0.089***	-0.153*	-0.161***	-0.195*	-0.237***	-0.141***	0.044
		(-0.452)	(-3.254)	(-1.456)	(-2.613)	(-1.367)	(-3.887)	(-3.258)	(3.640)
	exppc and gdppc	-0.066	-0.089***	-0.313***	-0.156**	-0.195*	-0.233***	-0.138***	0.039
		(-1.075)	(-3.058)	(-2.414)	(-2.130)	(-1.359)	(-4.049)	(-3.496)	(4.075)
Italy	exp and gdp	-0.042	-0.096***	-0.095	-0.220***	0.289	-0.442***	-0.057***	-0.019***
		(-0.801)	(-3.553)	(-0.796)	(-4.739)	(3.058)	(-6.079)	(2.398)	(-3.788)
	exp and gdppc	-0.002	-0.094***	-0.011	-0.232***	0.282	-0.412***	-0.073***	-0.009***
		(-0.051)	(-3.839)	(-0.086)	(-4.892)	(3.432)	(-6.106)	(-2.834)	(-3.346)
	exppc and gdppc	-0.039	-0.097***	-0.077	-0.232***	0.292	-0.442***	-0.066***	-0.010***
		(-0.728)	(-3.607)	(-0.635)	(-4.872)	(3.103)	(-6.075)	(-2.621)	(-3.585)

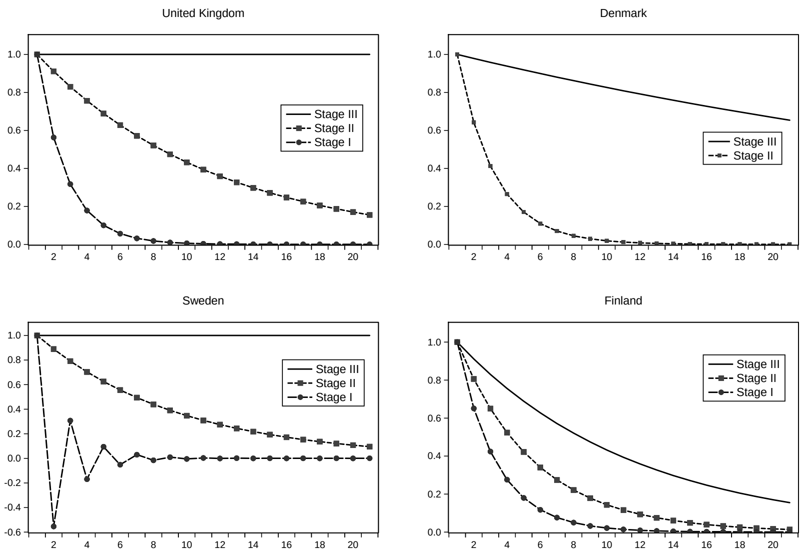
Note: The table displays estimated error correction terms (ect) of corresponding VECMs. The t-statistics are presented in parenthesis. The symbols *, ** and *** indicate significance at the 10%, 5% and 1% level.

in a time period over the last 150 years. Interestingly, at the same time all countries exhibit significant long-run causality running from public spending to economic growth at least in one functional form. These findings support models of economic growth which suggest a possible long-run relationship between the share of government spending in GDP and the growth rate of per capita real GDP (see e.g. Barro (1990), Devarajan, Swaroop and Zou (1996)). Nevertheless, here too the adjustment coefficients are rather low, questioning the economic significance.

These results provide a nuanced picture when dissecting the full sample of the three stages of income development. Particularly striking is that in the UK, Denmark, Sweden and Finland, the error correction terms running from public spending to economic growth decrease in statistical significance as well as in adjustment speed with an increasing state of development.

These findings approve the hypothesis that with an advanced degree of development, public spending does not react to changes in income as sensitive as in earlier development stages. The decreasing adjustment speed of government expenditure towards long-run equilibrium induced by shocks in GDP is visualized in figure 4. In early stages of development, the

Figure 3: *Adjustment speed of government expenditure towards long-run equilibrium induced by shocks in GDP*



Note: The graph displays the expenditure convergence to shocks in GDP for the United Kingdom, Denmark, Sweden and Finland during different stages of economic development. For Denmark no long-run equilibrium between government expenditure and GDP was detected during the first development stage. The expenditure convergences are calculated by $\sum_{n=0}^{20}(1 - ect_{ij})^n$ where $n + 1$ denotes the number of periods, i the country, j the development stage and ect the corresponding error correction term from table 3.

adjustment speed of public expenditure is faster than in latter stages where no adjustment is found in the UK and Sweden and very slow adjustment can be exhibited in Denmark and Finland. The economic relevance of Wagner's law seems to be lapsed in the 'high income stage'.

However, the results for Italy provide a different picture an do not follow this pattern. In this case, statistical causality is only detected in the last development stage, which carries a low adjustment coefficient expressing no economic significance. The missing validity of Wagner's law in Italy might be explained by the deviating pathway of the Italian economy compared to the other countries. On the one hand the Italian economy developed rather slowly reaching the 'upper middle income level' in 1940 despite a comparable high per capita income of 1.350

Int.$ in 1850. On the other hand, the intrinsic Italian welfare system was established in the period following World War II whereby a universalistic welfare model was not introduced until 1978, which might explain the significant results in the last stage of development.[17]

We conclude our main analysis by examining some additional VECM diagnostics to provide some insights into the model specification and residual diagnostics. In general, table 4 displays that the goodness-of-fit measured by the adjusted R^2 is sufficiently large for every VECM. Nevertheless, in the case of Finland (Stage II) and Italy (Stage I), the R^2 is negative. The reason for this lies in the fact that the sample beginning in Finland and ending in Italy, respectively, coincides with extreme values caused by World War II. In both countries the R^2 gets sufficiently large and positive if the sample is shortened or extended and in both cases the estimation results do not change substantially. Additionally, it can be seen that all estimated models evince no sign of serial correlation. In those cases were heteroskedasticity could not be rejected, we employ weighted least squares to sustain consistent and asymptotically efficient estimates. However, the statistical significance and point estimators do not change compared to the standard OLS estimations.

[17]For further information on the development of the Italian welfare state, see Ferrera (1997).

Table 4: *VECM diagnostics*

		Full Sample					Stage I					Stage II					Stage III				
Country	Version	Obs.	Lag	Adj. R^2	Ljung-Box test	White test	Obs.	Lag	Adj. R^2	Ljung-Box test	White test	Obs.	Lag	Adj. R^2	Ljung-Box test	White test	Obs.	Lag	Adj. R^2	Ljung-Box test	White test
UK	1	161	2	0.341	1.876	62.221	36	1	0.250	3.648	41.848	87	1	0.358	4.026	30.650	38	1	0.277	1.976	27.396
	2		2	0.309	2.034	51.613		1	0.193	4.259	37.628		1	0.342	4.474	26.034		1	0.279	1.949	27.910
	3		2	0.309	1.922	55.764		1	0.348	6.077	46.248		1	0.339	4.408	28.788		1	0.295	1.983	27.733
5 % CV					12.59	79.08				12.59	40.11				12.59	40.11				12.59	40.11
1 % CV					16.81	83.30				16.81	46.96				16.81	46.96				16.81	46.96
DK	1	157	2	0.154	7.765	201.889	-	-	-	-	-	59	4	0.327	10.294	173.755^{A}	43	1	0.618	7.590	28.751
	2		2	0.127	7.342	208.193		-	-	-	-		2	0.320	6.423	136.163		1	0.616	7.555	27.179
	3		2	0.151	7.879	205.491		-	-	-	-		2	0.298	8.558	134.846		1	0.610	7.476	30.217
5 % CV					12.59	79.08									12.59	40.11				12.59	40.11
1 % CV					16.81	83.30									16.81	46.96				16.81	46.96
SE	1	130	4	0.169	5.499	276.604	45	4	0.490	6.921	69.767	42	1	0.069	2.475	22.440	43	2	0.354	4.519	67.583
	2		4	0.166	5.147	268.950		4	0.456	7.555	70.189		1	0.069	2.484	22.642		2	0.343	4.466	65.211
	3		4	0.168	5.381	273.988		4	0.484	7.125	69.925		1	0.074	2.514	22.539		2	0.360	4.670	67.083
5 % CV					12.59	234.00				12.59	67.50				12.59	40.11				12.59	79.08
1 % CV					16.81	249.40				16.81	76.15				16.81	46.96				16.81	88.38
FI	1	129	3	0.182	5.967	216.312	56	1	0.450	8.017	50.926	41	1	-0.029	3.413	67.335	31	1	0.514	7.173	28.256
	2		3	0.176	7.175	215.489		1	0.401	9.187	52.173		1	-0.029	3.643	65.388		2	0.523	7.544	80.801
	3		3	0.181	7.105	213.981		1	0.438	7.579	50.868		1	-0.030	3.349	67.465		2	0.507	7.495	81.056
5 % CV					12.59	124.34				12.59	40.11				12.59	40.11				12.59	79.08
1 % CV					16.81	135.81				16.81	46.96				16.81	46.96				16.81	88.38
IT	1	149	1	0.166	4.752	96.639	78	1	-0.009	2.774	33.131	38	2	0.554	9.833	95.609	33	1	0.724	7.094	33.485
	2		1	0.161	4.389	99.472		2	-0.043	2.033	85.594^{B}		2	0.573	10.093	94.049		1	0.734	6.356	35.294
	3		1	0.167	4.538	97.439		1	-0.012	2.556	32.551		2	0.557	9.878	95.502		1	0.739	6.173	35.212
5 % CV					12.59	40.11				12.59	40.11				12.59	79.08				12.59	40.11
1 % CV					16.81	46.96				16.81	46.96				16.81	88.38				16.81	46.96

Note: The declared adjusted R^2 belong to the VECM with the set of expenditure variables on the left-hand side. The Ljung-Box Q-statistics are computed for every lag $p+1$ with the corresponding VECM of order p. The White LM-statistics are calculated including a cross-term.

^{A} 5 % critical value [234.0]; 1 % critical value [249.4]

^{B} 5 % critical value [79.08]; 1 % critical value [88.38]

5 Robustness Analysis

The baseline estimations in the previous section provide evidence of a decreasing response of government expenditure to changes in GDP with an advanced stage of development for the countries United Kingdom, Denmark, Sweden and Finland. In this section, we run several robustness estimations to underpin this changing relation between public spending and economic growth throughout economic development.

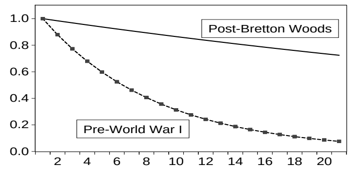
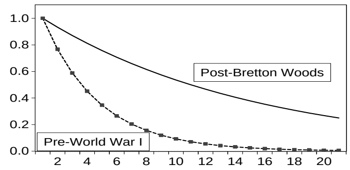
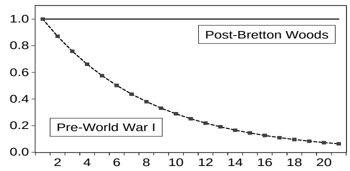
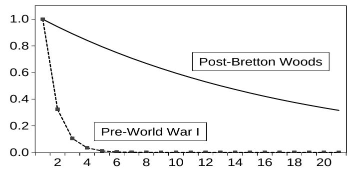
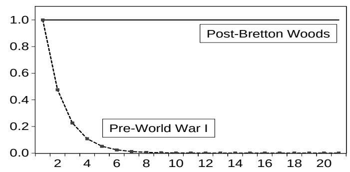
Time series of historical data are exposed to abnormalities during periods of major social disturbances. With respect to the analysis of Wagner's law, this results in several problems. On the one hand, outliers might have a significant effect on the estimation results and on the other hand, structural breaks induced by the displacement effect may permanently bias the adjustment coefficients. A particular crisis-ridden period encompasses the time span from the beginning of World War I until the end of Bretton Woods in 1973. During this period, the economies were heavily affected by World War I and II, the Great Depression and the oil crisis. However, the exact time limitation of a unique crisis is proving very difficult to determine because the aftermath of the initial crisis may last up to several years (see Reinhart and Rogoff (2009)). Therefore, in order to exclude periods of major social disturbances from the analysis, we split our data set for each country into a pre-World War I and a post-Bretton-Woods sample. This approach allows us to compare the relationship between public spending and economic growth in a very low and high development stage without the influence of several major global economic crises.

Table 5 presents the error correction terms for the pre-World War I and post-Bretton Woods sample. It can be seen that the adjustment coefficients with economic growth as the dependent variable are significantly higher during the early pre-World War I sample. In general, this finding applies for all countries. Only Sweden does not provide robust results throughout the different versions of Wagner's law which might be an issue of small sample size.[18]

For Sweden, Finland and Italy the pre-World War I period covers an earlier development stage than the 'lower middle income stage' used in the baseline estimations in the previous section. This might explain the significant increase of adjustment speed for Finland and Italy. Additionally, it is striking that Finland and Italy - both countries with the lowest economic

[18] For Denmark and Italy, cointegration could only be detected in the pre-World War I period using the Engle-Granger approach. In the case of Denmark not all variables (exppc) seem to fulfill the stationarity requirements. Therefore, the displayed error correction terms have to be interpreted with caution.

Table 5: *Long-run causality and short-run adjustment without crises period*

Country	G and Y	pre-World War I $Y \to G$	pre-World War I $G \to Y$	post-Bretton Woods $Y \to G$	post-Bretton Woods $G \to Y$	Adjustment speed of exp towards long-run equilibrium
UK	exp and gdp	-0.121***	-0.064**	-0.016***	-0.031***	
		(-2.218)	(-1.767)	(-4.413)	(-4.362)	
	exp and gdppc	-0.046	-0.128***	0.028	-0.072***	
		(-1.157)	(-2.478)	(3.307)	(-4.566)	
	exppc and gdppc	-0.122***	-0.068**	-0.023***	-0.027***	
		(-2.213)	(-1.829)	(-3.583)	(-4.423)	
Denmark	exp and gdp	-0.233**	-0.023**	-0.067***	0.004	
		(-1.946)	(-2.115)	(-3.300)	(0.792)	
	exp and gdppc	-0.211**	-0.039***	-0.047***	-0.001	
		(-1.778)	(-2.141)	(-3.179)	(-0.983)	
	exppc and gdppc	-0.274**	-0.004*	-0.059***	0.002	
		(-2.307)	(-1.445)	(-3.303)	(0.821)	
Sweden	exp and gdp	-0.129*	-0.214**	0.040	-0.129***	
		(-1.340)	(-1.913)	(1.734)	(-6.743)	
	exp and gdppc	-0.080	-0.264***	0.053	-0.157***	
		(-0.963)	(-2.399)	(1.497)	(-6.324)	
	exppc and gdppc	-0.113	-0.228**	0.050	-0.145***	
		(-1.188)	(-2.058)	(1.528)	(-6.136)	
Finland	exp and gdp	-0.676***	-0.139**	-0.056**	0.005	
		(-3.580)	(-1.830)	(-2.423)	(3.221)	
	exp and gdppc	-0.693***	-0.266***	-0.055**	0.005	
		(-3.842)	(-2.713)	(-2.431)	(3.226)	
	exppc and gdppc	-0.711***	-0.172**	-0.053**	0.001	
		(-3.809)	(-1.927)	(-2.363)	(3.272)	
Italy	exp and gdp	-0.524***	-0.047	0.007	-0.071***	
		(-3.400)	(-0.503)	(0.642)	(-4.381)	
	exp and gdppc	-0.224**	-0.094	0.009	-0.069***	
		(-2.092)	(-0.985)	(0.758)	(-4.020)	
	exppc and gdppc	-0.486***	-0.056	0.007	-0.072***	
		(-3.189)	(-0.624)	(0.474)	(-4.049)	

Note: The table displays estimated error correction terms (ect) of corresponding VECMs. The t-statistics are presented in parenthesis. The symbols *, ** and *** indicate significance at the 10%, 5% and 1% level. The expenditure convergences are calculated for the first functional form of Wagner's law.

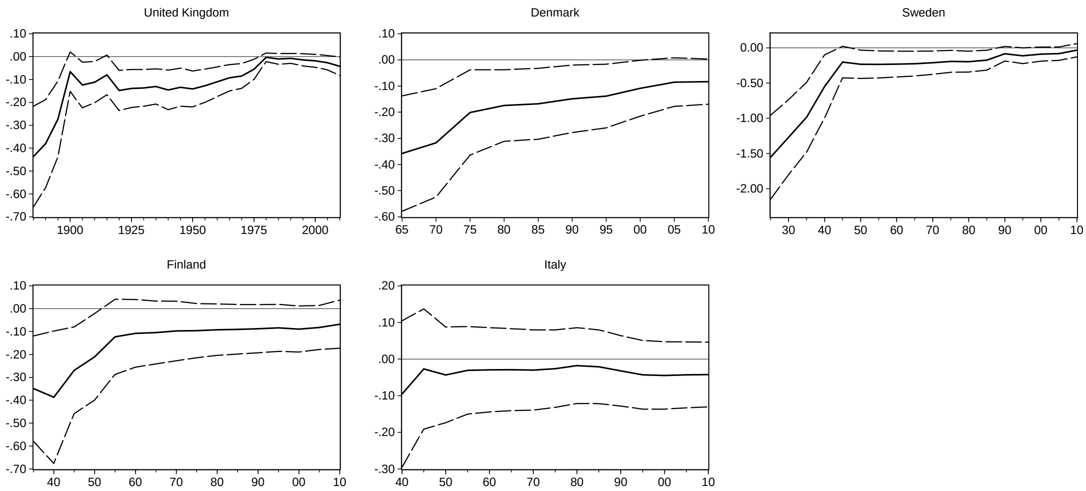
development in 1913 (measured in terms of GDP per capita) - exhibit the highest adjustment speed of expenditure towards the long-run equilibrium. The declining adjustment speed of government expenditure towards long-run equilibrium induced by shocks in GDP is visualized in the right column of table 5. The response of expenditure to changes in GDP happens much faster during the pre-World War I stage than in the post-Bretton Woods sample, supporting the notion that Wagner's law loses its validity with an advanced stage of development.

With regard to the development of the relationship between public expenditure and economic growth throughout the last 150 years, figure 4 displays the development of the expenditure adjustment by recursive VECM estimation. Starting from the 'lower middle income stage', we added 5 years in each step and visualized every corresponding error correction term including

90 percent confidence band.[19]

It can be seen that, with an advanced economic evolution, the adjustment coefficient of expenditure to changes in GDP declines, again suggesting a declining causality between economic growth and government activity. This declining path of the error correction mechanism is valid for the United Kingdom, Denmark, Sweden and Finland. In contrast, Italy displays no sign of significant expenditure adjustment throughout the whole sample period. The recursive estimations confirm the result of the previous section that with an advanced degree of development the adjustment speed of expenditure steadily declines. The insignificant error correction terms around the year 1915 in the UK as well around 1945 in Sweden might be the effect of World War I and II.[20]

Figure 4: *Recursive estimation of expenditure adjustment*



Note: The graph displays the development of expenditure adjustment by a recursive VECM estimation for the first functional form of Wagner's law. The solid line visualizes the point estimation of the error correction term while the dashed lines present the 90 % confidence band.

[19] For Denmark, we started the recursive VECM estimation at the end of the 'upper middle income stage' because of the missing cointegration relationship in the first development stage.

[20] In general, the step-by-step reduction of adjustment speed supports the finding by Durevall and Henrekson (2011), who detect a direct linkage between public spending and GDP in a period of 30 to 35 years after World War II for the UK and Sweden. Lamartina and Zaghini (2011) via recursive pooled estimations, also detect a significant decline in long-run elasticity between GDP and public spending for 23 OECD countries from 1990 to 2006.

6 Conclusion

In order to test the validity of Wagner's law at different stages of economic development, we apply advanced cointegration and causality approaches on five European advanced welfare states: the United Kingdom, Denmark, Finland, Sweden and Italy. By using historical data on government expenditure and GDP from the mid-19th century, we classify every country into three individual stages of development in terms of per-capita income. This approach allows us to issue statements about the dynamic relationship between public spending and economic growth from a within-country perspective and additionally enables us to identify commonalities across countries despite differences in size and development pattern.

The empirical analysis starts by investigating the cointegration relationships for different functional forms of Wagner's law using the Johansen and Juselius (1990) and Johansen et al. (2000) approach allowing for structural breaks. In order to exogenously determine possible structural breaks, the Bai and Perron (1998) algorithm procedure is used, allowing for a maximum of two breaks in each sample. The findings reveal that public spending in the United Kingdom, Sweden, Finland and Italy is cointegrated with economic growth independent of development stage or functional form. However, in the case of Denmark, a cointegration relationship was only detected in the second and third development stage. The co-movement phenomenon between the variables is consistent with Wagners view that there was not necessarily a cause and effect relationship between economic development and government activity (see Peacock and Scott (2000)).

To gain further insights into the coherence between Wagner's law and development stage, we estimate subsequent VECMs and analyze the adjustment speed of public spending to changes in economic growth. The hypothesis that Wagner's law might have a higher validity during early stages of development turned out to be viable for the United Kingdom, Denmark, Sweden and Finland. The estimations exhibit that with an increasing state of development, the error correction terms running from public spending to economic growth decline in statistical significance as well as in adjustment speed. Recursive vector error correction estimations confirm the weakened dynamic relationship between public expenditure and economic growth throughout economic evolution. The United Kingdom, Denmark, Sweden and Finland display a clear declining trend of the error correction mechanism running from GDP to government spending. In general, the results substantiate that the relationship between public spending and economic growth has weakened over the last century. According to data in recent decades, all countries under review support the notion that Wagner's law in its pure form, may have reached its limit.

As mentioned by Lindert (1996), the relationship between income growth and government spending remains a steady black box to explain the increase of government size throughout time. The detailed reasons why Wagner's law holds in some periods and countries may be eclectic and is beyond the scope of this study. In the spirit of Wagner's hypothesis, the weakened relationship between government expenditure and economic growth can be explained by the expanding role of governments associated with strong changes in the structure of the economy. Well established welfare states like the United Kingdom, Denmark, Finland, Sweden and Italy have past those major structural changes in recent days. With regard to the sustainability of growing public debts these signs of expenditure decoupling could have implications for the budgetary process of advanced industrialized countries.

Appendix A: Unit-root results

Table A-1: *Results of unit-root tests for different sample sizes*

		Philips-Perron Test								Kwiatkowski-Phillips-Schmidt-Shin Test							
		Full Sample		Stage I		Stage II		Stage III		Full Sample		Stage I		Stage II		Stage III	
Country	Variable	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
United Kingdom	exp	0.654	-6.398***	-1.924	-6.761***	-0.661	-4.889***	4.850	-3.837***	1.500***	0.192	0.657**	0.500**	1.127***	0.035	0.719***	0.630**
	exppc	0.682	-6.569***	-2.573	-6.665***	-0.690	-4.933***	3.998	-4.087***	1.479***	0.220	0.151	0.500*	1.119***	0.037	0.723***	0.576**
	gdp	2.472	-8.703***	-2.515	-8.318***	1.452	-5.315***	2.223	-4.678***	1.448***	0.745***	0.681**	0.248	1.146***	0.308	0.724***	0.581**
	gdppc	2.511	-8.615***	-2.790*	-8.194***	1.519	-5.275***	1.639	-4.748***	1.410***	0.764***	0.630**	0.279	1.138***	0.339	0.727***	0.452*
Denmark	exp	1.543	-13.351***	-2.522	-15.739***	0.371	-5.350***	1.709	-3.527**	1.429***	0.591**	0.586**	0.500**	0.899***	0.142	0.829***	0.295
	exppc	1.616	-13.318***	-3.858***	-16.007***	0.382	-5.367***	1.314	-3.491**	1.391***	0.664**	0.237	0.500**	0.885***	0.150	0.827***	0.235
	gdp	1.573	-8.873***	-0.001	-7.068***	0.475	-5.482***	1.757	-5.299***	1.510***	0.483**	0.956***	0.102	0.925***	0.183	0.813***	0.468*
	gdppc	1.858	-8.791***	-0.327	-7.026***	0.553	-4.889***	1.385	-5.522***	1.474***	0.599**	0.893***	0.093	0.912***	0.198	0.815***	0.359*
Sweden	exp	0.372	-11.726***	-0.458	-7.687***	0.257	-5.132***	1.522	-6.027***	1.386***	0.168	0.773***	0.093	0.796***	0.093	0.812***	0.373*
	exppc	0.395	-11.717***	-0.563	-7.696***	0.162	-5.119***	0.944	-6.409***	1.382***	0.174	0.758***	0.090	0.794***	0.084	0.813***	0.261
	gdp	1.849	-6.290***	0.067	-3.709***	1.912	-3.249**	3.789	-4.551***	1.423***	0.579**	0.788***	0.145	0.794***	0.437*	0.807***	0.850***
	gdppc	1.932	-6.248***	-0.061	-3.724***	1.801	-3.349**	2.691	-4.359***	1.410***	0.648**	0.773***	0.137	0.793***	0.458*	0.809***	0.678**
Finland	exp	-0.496	-9.669***	0.001	-5.932***	-2.544	-6.502***	-0.441	-3.373**	1.379***	0.148	0.845***	0.142	0.793***	0.315	0.720***	0.089
	exppc	-0.394	-9.585***	-0.029	-5.881***	-2.441	-6.487***	-0.719	-3.475**	1.377***	0.140	0.831***	0.149	0.793***	0.303	0.712**	0.099
	gdp	0.544	-5.234***	0.229	-2.674*	-1.449	-4.296***	0.099	-4.813***	1.447***	0.284	0.832***	0.186	0.768***	0.235	0.739***	0.112
	gdppc	0.607	-5.233***	0.176	-2.661*	-1.397	-4.343***	-0.355	-4.389***	1.437***	0.305	0.812***	0.196	0.767***	0.223	0.738***	0.095
Italy	exp	0.541	-11.106***	-0.062	-9.305***	-2.392	-3.888***	-1.752	-5.054***	1.403***	0.281	1.043***	0.154	0.726***	0.310	0.726***	0.298
	exppc	0.548	-11.069***	-0.199	-9.248***	-2.419	-3.885***	-2.096	-4.953***	1.395***	0.288	0.999***	0.150	0.724***	0.309	0.717***	0.339
	gdp	0.700	-4.893***	0.451	-6.286***	-2.216	-2.235	-0.672	-3.522**	1.500***	0.192	1.037***	0.251	0.699**	0.277	0.658**	0.191
	gdppc	0.703	-4.850***	0.251	-6.168***	-2.229	-2.230	-1.369	-1.845	1.388***	0.339	0.978***	0.241	0.694**	0.276	0.657**	0.434*

Note: The Phillips-Perron (PP) as well as the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for the levels and first differences of the variables were calculated including a constant in the test equation. The bandwidth for the PP and KPSS test was selected based on Newey-West using Bartlett Kernel. All variables in the full sample, Stage I as well as Stage II are log transformed while Stage III displays the results of non transformed level data. The symbols *, ** and *** indicate significance at the 10%, 5% and 1% level using critical values from MacKinnon (1996) and Kwiatkowski, Phillips, Schmidt et al. (1992).

Appendix B: Cointegration results

Sample: Full Sample

Table B-1: *Results of Johansen cointegration test*

		Johansen (1)				Johansen (2)			
Country	Variable		Trace		Max-Eigen.		Trace		Max-Eigen.
UK (1850-2010)	exp and gdp	r=0	11.216	r=0	8.479	r=0	22.275*	r=0	16.747
		r≤1	2.736	r=1	2.736	r≤1	5.528	r=1	5.528
	exp and gdppc	r=0	9.634	r=0	8.004	r=0	24.417*	r=0	17.968*
		r≤1	1.629	r=1	1.629	r≤1	6.449	r=1	6.449
	exppc and gdppc	r=0	11.257	r=0	9.008	r=0	22.968*	r=0	16.760
		r≤1	2.249	r=1	2.249	r≤1	6.207	r=1	6.207
Denmark (1854-2010)	exp and gdp	r=0	8.317	r=0	7.913	r=0	23.445*	r=0	15.992
		r≤1	0.404	r=1	0.404	r≤1	7.453	r=1	7.453
	exp and gdppc	r=0	11.765	r=0	11.475	r=0	22.365	r=0	14.781
		r≤1	0.289	r=1	0.289	r≤1	7.584	r=1	7.584
	exppc and gdppc	r=0	9.031	r=0	8.355	r=0	23.326*	r=0	15.877
		r≤1	0.676	r=1	0.676	r≤1	6.875	r=1	6.875
Sweden (1881-2010)	exp and gdp	r=0	16.738**	r=0	16.719**	r=0	24.817*	r=0	18.371*
		r≤1	0.019	r=1	0.019	r≤1	6.447	r=1	6.447
	exp and gdppc	r=0	16.179**	r=0	15.915**	r=0	25.567**	r=0	19.105**
		r≤1	0.264	r=1	0.264	r≤1	6.462	r=1	6.462
	exppc and gdppc	r=0	17.072**	r=0	17.037**	r=0	25.579**	r=0	19.138**
		r≤1	0.034	r=1	0.034	r≤1	6.440	r=1	6.440
Finland (1882-2010)	exp and gdp	r=0	14.804*	r=0	13.876*	r=0	22.833*	r=0	13.933
		r≤1	0.928	r=1	0.928	r≤1	8.901	r=1	8.901
	exp and gdppc	r=0	13.763*	r=0	12.437*	r=0	21.579	r=0	12.442
		r≤1	1.326	r=1	1.326	r≤1	9.138	r=1	9.138
	exppc and gdppc	r=0	14.500*	r=0	13.621*	r=0	23.385*	r=0	13.799
		r≤1	0.879	r=1	0.879	r≤1	9.587	r=1	9.587
Italy (1862-2010)	exp and gdp	r=0	18.678**	r=0	18.651***	r=0	25.804**	r=0	19.269**
		r≤1	0.027	r=1	0.027	r≤1	6.535	r=1	6.535
	exp and gdppc	r=0	18.295**	r=0	18.179**	r=0	27.221**	r=0	20.657**
		r≤1	0.115	r=1	0.115	r≤1	6.564	r=1	6.564
	exppc and gdppc	r=0	18.692**	r=0	18.652***	r=0	25.995**	r=0	19.382**
		r≤1	0.040	r=1	0.040	r≤1	6.613	r=1	6.613

Note: Johansen (1) allows for a constant in the cointegration space and for a linear trend in the level data: $H_1(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_{\perp}\gamma_0$; Johansen (2) allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_{\perp}\gamma_0$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Osterwald-Lenum (1992).

Table B-2: *Johansen cointegration test with structural breaks*

		Bai-Perron Breaks		Johansen (1)		Johansen (2)	
Country	g and y	g	y		Trace		Trace
UK (1850-2010)	exp and gdp	1916	1936	r=0	34.11*	r=0	25.81
				r≤1	12.50	r=1	9.04
	exp and gdppc	1916	1936	r=0	34.76*	r=0	26.12
				r≤1	13.33	r=1	8.41
	exppc and gdppc	1916	1936	r=0	41.77**	r=0	36.15
				r≤1	12.07	r=1	9.37
Denmark (1854-2010)	exp and gdp	1900	1920	r=0	26.94	r=0	43.54*
				r≤1	11.28	r=1	12.66
	exp and gdppc	1900	1920	r=0	27.09	r=0	45.35**
				r≤1	11.84	r=1	13.14
	exppc and gdppc	1900	1920	r=0	26.88	r=0	44.57**
				r≤1	11.38	r=1	12.93
Sweden (1881-2010)	exp and gdp	-	1920	r=0	40.69**	r=0	58.67***
			1966	r≤1	10.90	r=1	18.38
	exp and gdppc	-	1920	r=0	41.67**	r=0	58.00***
			1966	r≤1	11.12	r=1	18.76
	exppc and gdppc	-	1920	r=0	41.40**	r=0	57.69***
			1966	r≤1	11.34	r=1	18.31
Finland (1862-2010)	exp and gdp	-	1920	r=0	36.00***	r=0	36.28**
				r≤1	11.06	r=1	11.12
	exp and gdppc	-	1920	r=0	34.84***	r=0	35.27*
				r≤1	11.89	r=1	11.29
	exppc and gdppc	-	1920	r=0	36.47***	r=0	36.27**
				r≤1	11.58	r=1	11.29
Italy (1862-2010)	exp and gdp	1935	1942	r=0	53.32***	r=0	73.50***
				r≤1	8.31	r=1	13.77
	exp and gdppc	1935	1942	r=0	48.70***	r=0	72.83***
				r≤1	8.38	r=1	14.13
	exppc and gdppc	1935	1942	r=0	52.29***	r=0	73.59***
				r≤1	8.23	r=1	14.14

Note: The cointegration approach allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_{\perp}\gamma_0$. Break specification: Johansen (1) allows only for breaks in levels which are restricted to the error correction term. Johansen (2) allows for breaks in trend and constant jointly with trend shifts restricted to the error correction term and level shifts unrestricted in model. Break points were estimated by Bai and Perron (1998) procedure considering the following linear regression for each variable: $y_t = \mu + \psi_i \sum_{i=1}^{p} y_{t-i}$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Johansen et al. (2000).

Stage I: Lower Middle Income

Table B-3: *Results of Johansen cointegration test*

		Johansen (1)				Johansen (2)			
Country	Variable		Trace		Max-Eigen.		Trace		Max-Eigen.
UK (1850-1885)	exp and gdp	r=0	15.968**	r=0	12.779*	r=0	30.936***	r=0	27.242***
		r≤1	3.189	r=1	3.189	r≤1	3.694	r=1	3.694
	exp and gdppc	r=0	15.671**	r=0	13.184**	r=0	30.652***	r=0	26.977***
		r≤1	2.487	r=1	2.487	r≤1	3.675	r=1	3.675
	exppc and gdppc	r=0	26.613***	r=0	23.252***	r=0	30.555***	r=0	26.932***
		r≤1	3.361	r=1	3.361	r≤1	3.622	r=1	3.622
Denmark (1854-1908)	exp and gdp	r=0	6.788	r=0	6.055	r=0	12.941	r=0	6.967
		r≤1	0.733	r=1	0.733	r≤1	5.975	r=1	5.975
	exp and gdppc	r=0	6.012	r=0	5.763	r=0	13.326	r=0	7.777
		r≤1	0.249	r=1	0.249	r≤1	5.549	r=1	5.549
	exppc and gdppc	r=0	5.734	r=0	5.655	r=0	13.436	r=0	7.819
		r≤1	0.079	r=1	0.079	r≤1	5.618	r=1	5.618
Sweden (1881-1925)	exp and gdp	r=0	16.146**	r=0	13.153*	r=0	29.237**	r=0	16.998*
		r≤1	2.992	r=1	2.992	r≤1	12.239	r=1	12.239
	exp and gdppc	r=0	17.398**	r=0	14.833**	r=0	27.639**	r=0	16.432
		r≤1	2.564	r=1	2.564	r≤1	11.207	r=1	11.207
	exppc and gdppc	r=0	15.938**	r=0	13.198*	r=0	28.296**	r=0	16.695
		r≤1	2.739	r=1	2.739	r≤1	11.600	r=1	11.600
Finland (1882-1937)	exp and gdp	r=0	5.585	r=0	5.545	r=0	16.057	r=0	11.936
		r≤1	0.039	r=1	0.039	r≤1	4.120	r=1	4.120
	exp and gdppc	r=0	4.449	r=0	4.107	r=0	15.428	r=0	11.423
		r≤1	0.342	r=1	0.342	r≤1	4.005	r=1	4.005
	exppc and gdppc	r=0	5.232	r=0	5.149	r=0	16.056	r=0	12.008
		r≤1	0.083	r=1	0.083	r≤1	4.048	r=1	4.048
Italy (1862-1939)	exp and gdp	r=0	25.375***	r=0	25.345***	r=0	30.151**	r=0	25.345***
		r≤1	0.029	r=1	0.029	r≤1	1.632	r=1	1.632
	exp and gdppc	r=0	21.908***	r=0	21.724***	r=0	30.540***	r=0	25.606***
		r≤1	0.183	r=1	0.183	r≤1	4.935	r=1	4.935
	exppc and gdppc	r=0	25.269***	r=0	25.113***	r=0	30.210***	r=0	25.296***
		r≤1	0.156	r=1	0.156	r≤1	4.914	r=1	4.914

Note: Johansen (1) allows for a constant in the cointegration space and for a linear trend in the level data: $H_1(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$; Johansen (2) allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Osterwald-Lenum (1992).

Table B-4: *Johansen cointegration test with structural breaks*

		Bai-Perron Breaks		Johansen (1)		Johansen (2)	
Country	g and y	g	y		Trace		Trace
UK (1850-1885)	exp and gdp	-	1875	r=0	35.66***	r=0	35.16**
				r≤1	9.19	r=1	8.98
	exp and gdppc	-	1875	r=0	35.78***	r=0	35.39*
				r≤1	9.48	r=1	9.40
	exppc and gdppc	-	1875	r=0	35.62***	r=0	35.31*
				r≤1	9.32	r=1	9.32
Denmark (1854-1908)	exp and gdp	1892	-	r=0	21.63	r=0	31.68
				r≤1	8.97	r=1	7.93
	exp and gdppc	1892	-	r=0	21.99	r=0	32.00
				r≤1	8.91	r=1	8.38
	exppc and gdppc	-	-	r=0	-	r=0	-
				r≤1	-	r=1	-
Sweden (1881-1925)	exp and gdp	-	-	r=0	-	r=0	-
				r≤1	-	r=1	-
	exp and gdppc	-	-	r=0	-	r=0	-
				r≤1	-	r=1	-
	exppc and gdppc	-	-	r=0	-	r=0	-
				r≤1	-	r=1	-
Finland (1882-1937)	exp and gdp	1916	1915	r=0	41.58***	r=0	46.06***
				r≤1	7.47	r=1	11.24
	exp and gdppc	1916	1915	r=0	42.24***	r=0	47.91***
				r≤1	7.25	r=1	14.63
	exppc and gdppc	1916	1915	r=0	42.39***	r=0	46.29***
				r≤1	7.44	r=1	11.35
Italy (1862-1939)	exp and gdp	1914	1915	r=0	30.61**	r=0	38.11**
				r≤1	8.82	r=1	10.36
	exp and gdppc	1914	1915	r=0	30.08**	r=0	37.84**
				r≤1	9.13	r=1	10.23
	exppc and gdppc	1914	1915	r=0	31.34**	r=0	38.85**
				r≤1	8.97	r=1	10.04

Note: The cointegration approach allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. Break specification: Johansen (1) allows only for breaks in levels which are restricted to the error correction term. Johansen (2) allows for breaks in trend and constant jointly with trend shifts restricted to the error correction term and level shifts unrestricted in model. Break points were estimated by Bai and Perron (1998) procedure considering the following linear regression for each variable: $y_t = \mu + \psi_i \sum_{i=1}^{p} y_{t-i}$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Johansen et al. (2000).

Stage II: Upper Middle Income

Table B-5: *Results of Johansen cointegration test*

Country	Variable	Johansen (1)				Johansen (2)			
			Trace		Max-Eigen.		Trace		Max-Eigen.
UK	exp and gdp	r=0	15.798**	r=0	12.058	r=0	26.865**	r=0	16.531
(1886-1972)		r≤1	3.740	r=1	3.740	r≤1	10.335	r=1	10.335
	exp and gdppc	r=0	15.477**	r=0	13.241*	r=0	28.583**	r=0	18.706*
		r≤1	2.236	r=1	2.236	r≤1	9.877	r=1	9.877
	exppc and gdppc	r=0	15.858**	r=0	13.002*	r=0	28.154**	r=0	18.156*
		r≤1	2.855	r=1	2.855	r≤1	9.999	r=1	9.999
Denmark	exp and gdp	r=0	7.619	r=0	7.619	r=0	17.072	r=0	10.459
(1909-1967)		r≤1	0.000	r=1	0.000	r≤1	6.613	r=1	6.613
	exp and gdppc	r=0	9.389	r=0	9.381	r=0	16.114	r=0	10.013
		r≤1	0.009	r=1	0.009	r≤1	6.101	r=1	6.101
	exppc and gdppc	r=0	7.795	r=0	7.792	r=0	16.268	r=0	10.136
		r≤1	0.003	r=1	0.003	r≤1	6.133	r=1	6.133
Sweden	exp and gdp	r=0	11.360	r=0	10.778	r=0	21.502	r=0	12.577
(1926-1967)		r≤1	0.582	r=1	0.582	r≤1	8.924	r=1	8.924
	exp and gdppc	r=0	10.729	r=0	10.195	r=0	20.874	r=0	12.137
		r≤1	0.534	r=1	0.534	r≤1	8.736	r=1	8.736
	exppc and gdppc	r=0	10.769	r=0	10.187	r=0	20.906	r=0	12.169
		r≤1	0.582	r=1	0.582	r≤1	8.737	r=1	8.737
Finland	exp and gdp	r=0	25.108***	r=0	20.323***	r=0	30.385**	r=0	21.684**
(1938-1978)		r≤1	4.785**	r=1	4.785**	r≤1	8.701	r=1	8.701
	exp and gdppc	r=0	26.879***	r=0	24.545***	r=0	29.969**	r=0	21.473**
		r≤1	4.709**	r=1	4.709**	r≤1	8.496	r=1	8.496
	exppc and gdppc	r=0	25.613***	r=0	21.052***	r=0	30.902***	r=0	22.119**
		r≤1	4.561**	r=1	4.561**	r≤1	8.783	r=1	8.783
Italy	exp and gdp	r=0	25.522***	r=0	25.475***	r=0	44.654***	r=0	36.055***
(1940-1977)		r≤1	0.047	r=1	0.047	r≤1	8.599	r=1	8.599
	exp and gdppc	r=0	27.176***	r=0	27.170***	r=0	44.611***	r=0	36.009***
		r≤1	0.006	r=1	0.006	r≤1	8.602	r=1	8.602
	exppc and gdppc	r=0	25.682***	r=0	25.626***	r=0	44.596***	r=0	36.015***
		r≤1	0.056	r=1	0.056	r≤1	8.582	r=1	8.582

Note: Johansen (1) allows for a constant in the cointegration space and for a linear trend in the level data: $H_1(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$; Johansen (2) allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Osterwald-Lenum (1992).

Table B-6: *Johansen cointegration test with structural breaks*

Country	g and y	Bai-Perron Breaks		Johansen (1)		Johansen (2)	
		g	y		Trace		Trace
UK	exp and gdp	1915	-	r=0	28.19*	r=0	30.25
(1886-1972)				r≤1	7.44	r=1	9.47
	exp and gdppc	1915	1918	r=0	28.74**	r=0	31.27
				r≤1	7.64	r=1	10.04
	exppc and gdppc	1915	1918	r=0	28.48*	r=0	31.23
				r≤1	7.72	r=1	10.01
Denmark	exp and gdp	1919	1920	r=0	42.28**	r=0	54.22***
(1909-1967)		1933	1932	r≤1	13.88	r=1	16.76
	exp and gdppc	1919	1920	r=0	43.69***	r=0	53.75***
		1933	1933	r≤1	13.18	r=1	17.70
	exppc and gdppc	1919	1920	r=0	43.01**	r=0	54.15***
		1933	1933	r≤1	13.37	r=1	17.36
Sweden	exp and gdp	1939	-	r=0	36.96**	r=0	44.37
(1926-1967)		1949		r≤1	14.24	r=1	13.73
	exp and gdppc	1939	-	r=0	36.57*	r=0	44.35
		1949		r≤1	14.40	r=1	13.88
	exppc and gdppc	1939	-	r=0	35.98*	r=0	45.43*
		1949		r≤1	14.30	r=1	14.08
Finland	exp and gdp	-	1951	r=0	31.21**	r=0	31.62
(1938-1978)				r≤1	10.53	r=1	14.89
	exp and gdppc	-	1951	r=0	31.48**	r=0	31.13
				r≤1	10.67	r=1	15.15
	exppc and gdppc	-	1951	r=0	31.93**	r=0	30.74
				r≤1	11.00	r=1	14.83
Italy	exp and gdp	1950	-	r=0	64.07***	r=0	66.89***
(1940-1977)				r≤1	22.82***	r=1	21.72**
	exp and gdppc	1950	-	r=0	64.33***	r=0	67.10***
				r≤1	22.97***	r=1	21.80**
	exppc and gdppc	1950	-	r=0	64.00***	r=0	66.64***
				r≤1	22.91***	r=1	21.83**

Note: The cointegration approach allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. Break specification: Johansen (1) allows only for breaks in levels which are restricted to the error correction term. Johansen (2) allows for breaks in trend and constant jointly with trend shifts restricted to the error correction term and level shifts unrestricted in model. Break points were estimated by Bai and Perron (1998) procedure considering the following linear regression for each variable: $y_t = \mu + \psi_i \sum_{i=1}^{p} y_{t-i}$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Johansen et al. (2000).

Stage III: High Income

Table B-7: *Results of Johansen cointegration test*

		Johansen (1)				Johansen (2)			
Country	Variable		Trace		Max-Eigen.		Trace		Max-Eigen.
UK	exp and gdp	r=0	26.527***	r=0	26.489***	r=0	34.334***	r=0	29.073***
(1973-2010)		r≤1	0.037	r=1	0.037	r≤1	5.261	r=1	5.261
	exp and gdppc	r=0	29.444***	r=0	28.355***	r=0	34.432***	r=0	29.386***
		r≤1	1.089	r=1	1.089	r≤1	5.046	r=1	5.046
	exppc and gdppc	r=0	26.885***	r=0	26.788***	r=0	34.026***	r=0	28.818***
		r≤1	0.097	r=1	0.097	r≤1	5.208	r=1	5.208
Denmark	exp and gdp	r=0	18.658**	r=0	15.327**	r=0	24.437*	r=0	17.221*
(1968-2010)		r≤1	3.331	r=1	3.331	r≤1	7.216	r=1	7.216
	exp and gdppc	r=0	20.448***	r=0	17.545**	r=0	27.137**	r=0	20.088**
		r≤1	2.903	r=1	2.903	r≤1	7.049	r=1	7.049
	exppc and gdppc	r=0	17.516**	r=0	15.188**	r=0	25.247*	r=0	18.069*
		r≤1	2.328	r=1	2.328	r≤1	7.178	r=1	7.178
Sweden	exp and gdp	r=0	21.034***	r=0	20.828***	r=0	35.532***	r=0	29.034***
(1968-2010)		r≤1	0.206	r=1	0.206	r≤1	6.498	r=1	6.498
	exp and gdppc	r=0	16.709**	r=0	15.844**	r=0	32.987***	r=0	26.658***
		r≤1	0.864	r=1	0.864	r≤1	6.329	r=1	6.329
	exppc and gdppc	r=0	18.720***	r=0	18.716***	r=0	33.111***	r=0	26.487***
		r≤1	0.005	r=1	0.005	r≤1	6.625	r=1	6.625
Finland	exp and gdp	r=0	12.549	r=0	10.586	r=0	21.973	r=0	11.640
(1979-2010)		r≤1	1.963	r=1	1.963	r≤1	10.332	r=1	10.332
	exp and gdppc	r=0	12.263	r=0	11.483	r=0	24.484*	r=0	14.875
		r≤1	0.779	r=1	0.779	r≤1	9.609	r=1	9.609
	exppc and gdppc	r=0	11.361	r=0	10.726	r=0	24.023*	r=0	15.509
		r≤1	0.635	r=1	0.635	r≤1	8.514	r=1	8.514
Italy	exp and gdp	r=0	6.539	r=0	6.448	r=0	24.859*	r=0	19.215**
(1978-2010)		r≤1	0.091	r=1	0.091	r≤1	5.644	r=1	5.644
	exp and gdppc	r=0	6.441	r=0	5.280	r=0	20.303	r=0	15.084
		r≤1	1.161	r=1	1.161	r≤1	5.219	r=1	5.219
	exppc and gdppc	r=0	7.602	r=0	5.557	r=0	20.234	r=0	14.681
		r≤1	2.045	r=1	2.045	r≤1	5.552	r=1	5.552

Note: Johansen (1) allows for a constant in the cointegration space and for a linear trend in the level data: $H_1(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0) + \alpha_\perp \gamma_0$; Johansen (2) allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Osterwald-Lenum (1992).

Table B-8: *Johansen cointegration test with structural breaks*

		Bai-Perron Breaks		Johansen (1)		Johansen (2)	
Country	g and y	g	y		Trace		Trace
UK	exp and gdp	-	1993	r=0	63.46***	r=0	56.65***
(1973-2010)				r≤1	18.28***	r=1	13.56
	exp and gdppc	-	1993	r=0	58.90***	r=0	56.57***
				r≤1	16.05**	r=1	15.08
	exppc and gdppc	-	1993	r=0	58.90***	r=0	56.57***
				r≤1	16.05**	r=1	15.08
Denmark	exp and gdp	1994	-	r=0	32.28	r=0	59.26***
(1968-2010)				r≤1	8.05	r=1	12.54
	exp and gdppc	1994	-	r=0	25.75	r=0	59.79***
				r≤1	7.86	r=1	12.64
	exppc and gdppc	1994	-	r=0	25.44	r=0	59.05***
				r≤1	9.31	r=1	12.53
Sweden	exp and gdp	-	-	r=0	-	r=0	-
(1968-2010)				r≤1		r=1	-
	exp and gdppc	-	-	r=0	-	r=0	
				r≤1		r=1	
	exppc and gdppc	-	-	r=0	-	r=0	-
		-		r≤1		r=1	
Finland	exp and gdp	1990	-	r=0	28.65	r=0	48.35*
(1979-2010)		2001	-	r≤1	7.46	r=1	20.80
	exp and gdppc	1990	-	r=0	30.59	r=0	49.06**
		2001		r≤1	7.38	r=1	20.39
	exppc and gdppc	1990	-	r=0	30.59	r=0	49.06**
		2001		r≤1	7.38	r=1	20.39
Italy	exp and gdp	-	2001	r=0	42.10***	r=0	63.49***
(1978-2010)				r≤1	11.87	r=1	22.50**
	exp and gdppc	-	2001	r=0	39.85***	r=0	62.04***
				r≤1	8.21	r=1	22.00**
	exppc and gdppc	-	2001	r=0	40.55***	r=0	62.12***
				r≤1	8.36	r=1	21.88**

Note: The cointegration approach allows for a constant and a trend in the cointegration space and for a linear trend in the level data: $H^*(r) = \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0$. Break specification: Johansen (1) allows only for breaks in levels which are restricted to the error correction term. Johansen (2) allows for breaks in trend and constant jointly with trend shifts restricted to the error correction term and level shifts unrestricted in model. Break points were estimated by Bai and Perron (1998) procedure considering the following linear regression for each variable: $y_t = \mu + \psi_i \sum_{i=1}^{p} y_{t-i}$. The symbols *, ** and *** indicate significance at 10%, 5% and 1% level by employing critical values from Johansen et al. (2000).

Table B-9: *Bai-Perron break points and economic crisis*

Country	Estimated Breaks	Crisis
United Kingdom	1875	Long Depression of 1873
	1915, 1916, 1918	World War I
	1936	World War II
	1993	Exchange Rate Mechanism crisis
Denmark	1892	-
	1900	-
	1919, 1920	World War I/ Danish banking crisis
	1933	Great Depression
	1994	Scandinavian banking crisis
Sweden	1920	World War I
	1939, 1949	World War II
	1966	-
Finland	1915, 1916, 1920	Word War I
	1949, 1951	World War II
	1990	Finish banking crisis
	2001	Early 2000s recession
Italy	1914, 1915	World War I
	1935	Great Depression
	1942, 1950	World War II
	2001	Early 2000s recession

References

Abizadeh, S. and Yousefi, M. (1988). "An empirical re-examination of Wagner's law". *Economics Letters*, *26*(2), 169 – 173.

Akitoby, B., Clements, B., Gupta, S. et al. (2006). "Public spending, voracity, and Wagner's law in developing countries". *European Journal of Political Economy*, *22*(4), 908–924.

Alesina, A., Baqir, R. and Easterly, W. (1999). "Public Goods And Ethnic Divisions". *The Quarterly Journal of Economics*, *114*(4), 1243–1284.

Alesina, A. and Wacziarg, R. (1998). "Openness, country size and government". *Journal of Public Economics*, *69*(3), 305–321.

Andres, J., Domenech, R. and Fatas, A. (2008). "The stabilizing role of government size". *Journal of Economic Dynamics and Control*, *32*(2), 571–593.

Annett, A. (2001). "Social Fractionalization, Political Instability, and the Size of Government". *IMF Staff Papers*, *48*(3), pp. 561–592.

Babatunde, M. A. (2011). "A bound testing analysis of Wagner's law in Nigeria: 1970-2006". *Applied Economics*, *43*(21), 2843–2850.

Bai, J. and Perron, P. (1998). "Estimating and Testing Linear Models with Multiple Structural Changes". *Econometrica*, *66*(1), 47–78.

Bai, J. and Perron, P. (2003). "Computation and analysis of multiple structural change models". *Journal of Applied Econometrics*, *18*(1), 1–22.

Barro, R. J. (1990). "Government Spending in a Simple Model of Endogenous Growth". *Journal of Political Economy*, *98*(5), S103–26.

Baumol, W. J. (1967). "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis". *The American Economic Review*, *57*(3), pp. 415–426.

Chang, T. (2002). "An econometric test of Wagner's law for six countries based on cointegration and error-correction modelling techniques". *Applied Economics*, *34*(9), 1157–1169.

Chow, Y.-F., Cotsomitis, J. A. and Kwan, A. C. C. (2002). "Multivariate cointegration and causality tests of Wagner's hypothesis: evidence from the UK". *Applied Economics*, *34*(13), 1671–1677.

Cragg, J. G. (1983). "More Efficient Estimation in the Presence of Heteroscedasticity of Unknown Form". *Econometrica*, *51*(3), 751–63.

Dao, M. Q. (1995). "Determinants of Government Expenditures: New Evidence from Disaggregative Data". *Oxford Bulletin of Economics and Statistics*, *57*(1), 67–76.

Devarajan, S., Swaroop, V. and Zou, H. (1996). "The composition of public expenditure and economic growth". *Journal of Monetary Economics*, *37*(2), 313 – 344.

Durevall, D. and Henrekson, M. (2011). "The futile quest for a grand explanation of long-run government expenditure". *Journal of Public Economics*, *95*(7-8), 708–722.

Easterly, W. (2007). "Inequality does cause underdevelopment: Insights from a new instrument". *Journal of Development Economics*, *84*(2), 755 – 776.

Eloranta, J. (2007). "From the great illusion to the Great War: Military spending behaviour of the Great Powers, 1870 1913". *European Review of Economic History*, *11*(02), 255–283.

Ferrera, M. (1997). "The uncertain future of the Italian welfare state". *West European Politics*, *20*(1), 231–249.

Franses, P. H. (2001). "How to deal with intercept and trend in practical cointegration analysis?" *Applied Economics*, *33*(5), 577–579.

Goffman, I. (1968). "On the empirical testing of Wagner's law: A technical note". *Public Finance/Finances Publiques,*, *23*, 359–366.

Gollin, D., Parente, S. L. and Rogerson, R. (2004). "Farm Work, Home Work, and International Productivity Differences". *Review of Economic Dynamics*, *7*(4), 827–850.

Granger, C. W. J. (1969). "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods". *Econometrica*, *37*(3), 424–38.

Granger, C. W. J. (1988). "Some recent development in a concept of causality". *Journal of Econometrics*, *39*(1-2), 199–211.

Gupta, S. (1967). "Public expenditure and economic growth: a time series analysis". *Public Finance/Finances Publiques*, *22*, 423–461.

Henry, O. and Olekalns, N. (2010). "Peacock and Wiseman's displacement hypothesis: some new long-run evidence for the UK". *Applied Economics*, *42*(11), 1455–1460.

Iniguez-Montiel, A. (2010). "Government expenditure and national income in Mexico: Keynes versus Wagner". *Applied Economics Letters*, *17*(9), 887–893.

Johansen, S. (1988). "Statistical analysis of cointegration vectors". *Journal of Economic Dynamics and Control*, *12*(2-3), 231–254.

Johansen, S. and Juselius, K. (1990). "Maximum Likelihood Estimation and Inference on

Cointegration–With Applications to the Demand for Money". *Oxford Bulletin of Economics and Statistics*, *52*(2), 169–210.

Johansen, S., Mosconi, R. and Nielsen, B. (2000). "Cointegration analysis in the presence of structural breaks in the deterministic trend". *Econometrics Journal*, *3*(2), 216–249.

Joyeux, R. (2007). "How to deal with structural breaks in practical cointegration analysis?" In B.B. Rao (editor), "Cointegration for the Applied Economist", 195 – 221. Palgrave Macmillan.

Kolluri, B., Panik, M. and Wahab, M. (2000). "Government expenditure and economic growth: evidence from G7 countries". *Applied Economics*, *32*(8), 1059–1068.

Kuznets, S. (1958). "Underdeveloped countries and the pre-industrial phase in the advanced countries". In A.N. Agarwala and S.P. Singh (editors), "The Economics of Underdevelopment", 135 – 153. Oxford University Press.

Kwiatkowski, D., Phillips, P. C., Schmidt, P. et al. (1992). "Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?" *Journal of Econometrics*, *54*(13), 159 – 178.

Lamartina, S. and Zaghini, A. (2011). "Increasing Public Expenditure: Wagner's Law in OECD Countries". *German Economic Review*, *12*, 149–164.

Lindert, P. H. (1996). "What Limits Social Spending?" *Explorations in Economic History*, *33*(1), 1 – 34.

Lütkepohl, H., Saikkonen, P. and Trenkler, C. (2001). "Maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process". *Econometrics Journal*, *4*(2), 8.

MacKinnon, J. G. (1996). "Numerical Distribution Functions for Unit Root and Cointegration Tests". *Journal of Applied Econometrics*, *11*(6), 601–18.

Magazzino, C. (2012). "Wagners Law and Augmented Wagners Law in EU-27. A Time-Series Analysis on Stationarity, Cointegration and Causality". *International Research Journal of Finance and Economics*, *59*, 205–220.

Mann, A. (1980). "Wagner's law: An econometric test for Mexico, 1925-1970". *National Tax Journal*, *33*, 189–201.

Mattos, E. and Rocha, F. (2008). "Inequality and size of government: evidence from Brazilian states". *Journal of Economic Studies*, *35*(4), 333–351.

Milesi-Ferretti, G. M., Perotti, R. and Rostagno, M. (2002). "Electoral Systems And

Public Spending". *The Quarterly Journal of Economics*, *117*(2), 609–657.

Mitchell, B. (2007). *International Historical Statistics (Europe 1750 - 2005)*. Palgrave.

Morris, C. T. and Adelman, I. (1989). "Nineteenth-century development experience and lessons for today". *World Development*, *17*(9), 1417 – 1432.

Osterwald-Lenum, M. (1992). "A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics". *Oxford Bulletin of Economics and Statistics*, *54*(3), 461–72.

Oxley, L. (1994). "Cointegration, Causality and Wagner's Law: A Test for Britain 1870-1913". *Scottish Journal of Political Economy*, *41*(3), 286–98.

Peacock, A. and Scott, A. (2000). "The Curious Attraction of Wagner's Law". *Public Choice*, *102*(1-2), 1–17.

Peacock, A. T. and Wiseman, J. (1961). *The Growth of Public Expenditure in the United Kingdom*. NBER Books, National Bureau of Economic Research, Inc.

Reinhart, C. M. and Rogoff, K. S. (2009). "The Aftermath of Financial Crises". *American Economic Review*, *99*(2), 466–72.

Rodrik, D. (1998). "Why Do More Open Economies Have Bigger Governments?" *Journal of Political Economy*, *106*(5), 997–1032.

Rousseau, P. L. and Wachtel, P. (1998). "Financial Intermediation and Economic Performance: Historical Evidence from Five Industrialized Countries". *Journal of Money, Credit and Banking*, *30*(4), pp. 657–678.

Thornton, J. (1999). "Cointegration, causality and Wagner's Law in 19th century Europe". *Applied Economics Letters*, *6*(7), 413–416.

Timm, H. (1961). "Das Gesetz der wachsenden Staatsausgaben". *FinanzArchiv / Public Finance Analysis*, *21*(2), pp. 201–247.

Wagner, A. (1893). *Grundlegung der Politischen Ökonomie. Teil I: Grundlagen der Volkswirtschaft*. C.F. Wintersche Verlagshandlung.

Wagner, A. (1911). "Staat (in nationalökonomischer Hinsicht)". In "Handwörterbuch der Staatswissenschaften", 727–739. Gustav Fisher Verlag.